Applied Geography 90 (2018) 82–95

Contents lists available at ScienceDirect

Applied Geography

journal homepage: www.elsevier.com/locate/apgeog

Dwindling rivers and floodplains in Kumasi, Ghana: A socio-spatial analysis of the extent and trend

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ARTICLE INFO

Keywords:
Encroachment
Floodplains
Land filling
Land use
Rivers

ABSTRACT

Rivers and floodplains in urban areas are under threat from anthropogenic pressures, and are among the most degraded ecosystems in cities in many developing countries. Spatial analysis and social qualitative data are used to ascertain the extent and trend of loss of rivers and floodplains in Kumasi, a fast urbanising city in Ghana. Results of the study show a drastic decrease in the number and area of the rivers and floodplains in less than 3 decades. The spatial extent of the rivers and floodplains reduced by 83% from 38 km^2 in 1985 to 6 km^2 in 2013, creating a sparsely distributed and fragmented inland water network in the city. To maintain such systems, it is critical for the city managers to strictly enforce a "no development" zone along rivers and in floodplains through integrated land use planning and people-managed relocation of settled illegal property owners in rivers and floodplains. The enforcement could rely on participatory processes and institutional collaborations to achieve positive outcomes such as high level of spatial and environmental quality.

1. Introduction

Inland water systems loss is among the obvious urban environmental changes in recent times, particularly in developing countries where rapid and spontaneous urbanisation is a commonplace (Armenteras et al., 2012; Carpenter, Stanley, & Vander, 2011; Cobbinah, Erdiaw-Kwasie, & Amoateng, 2015). Urbanisation level in these countries is expected to exceed 50% by 2020 with the urban areas anticipated to be home to over 90% of global population growth over the next four decades (UNDESA/PD, 2015). Consequently, inland aquatic systems are subjected to severe pressures associated with unprecedented urbanisation levels irrespective of technological progress or infrastructure development (Redman & Jones, 2005; Lee et al., 2006; Ramsar Convention Secretariat [RCS], 2007). This entails series of chemical, biological and physical disturbances that eventually lead to disappearance of the aquatic systems. The most degraded of these inland water systems are rivers and floodplains, reflected in alteration of spatial extent and configuration – quantity, morphology and distribution – partly because of these aquatic systems' common existence in urban areas (Everard & Moggridge, 2012; Lerner & Holt, 2012). The degradation and loss of these inland water systems continues despite the increasing recognition of their importance in providing multiple functions and values that are beneficial to the sustenance of both natural systems and human environments, in addition to being defining and founding features of human settlements (Carpenter et al., 2011; Finlayson et al., 2005; RCS, 2007).

Rivers are described as surface waters that flow downstream from one place to another serving as vital linkages between the land and other water bodies, while floodplains represent transitional lands between terrestrial and aquatic systems that contain shallow water and vegetation (Dodds, 2002; Finlayson et al., 2005; RCS, 2007). Rivers and floodplains are always in a state of flux and as such have variable spatial expression with their form, size and shape largely dependent on local physiographic condition (Du, Ottens, & Sliuzas, 2010; Finlayson et al., 2005). Urban geographers and spatial scientists have commonly described rivers and floodplains as having temporal and dynamic dimensions spatially (that is, wet or dry and deep or shallow at different periods of the year), qualities that render these water areas amenable to invasion by other land uses and land covers (Dewan & Yamaguchi, 2009; Du et al., 2010; Ranganathan, 2015). Thus, in geographical and spatial sense, the very physicality of rivers and floodplains make them colonisable by growing urban land uses just like other natural land covers.

Recent studies based on analysis of remotely sensed and Geographic Information Systems (GIS) data indicate that this 'inevitable' loss of urban rivers and floodplains has become pervasive and palpable in rapidly urbanising cities of developing countries. For example, using satellite images, Du et al. (2010), report that 4039 ha of surface water

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https://doi.org/10.1016/j.apgeog.2017.11.007
Received 1 January 2017; Received in revised form 22 November 2017; Accepted 23 November 2017

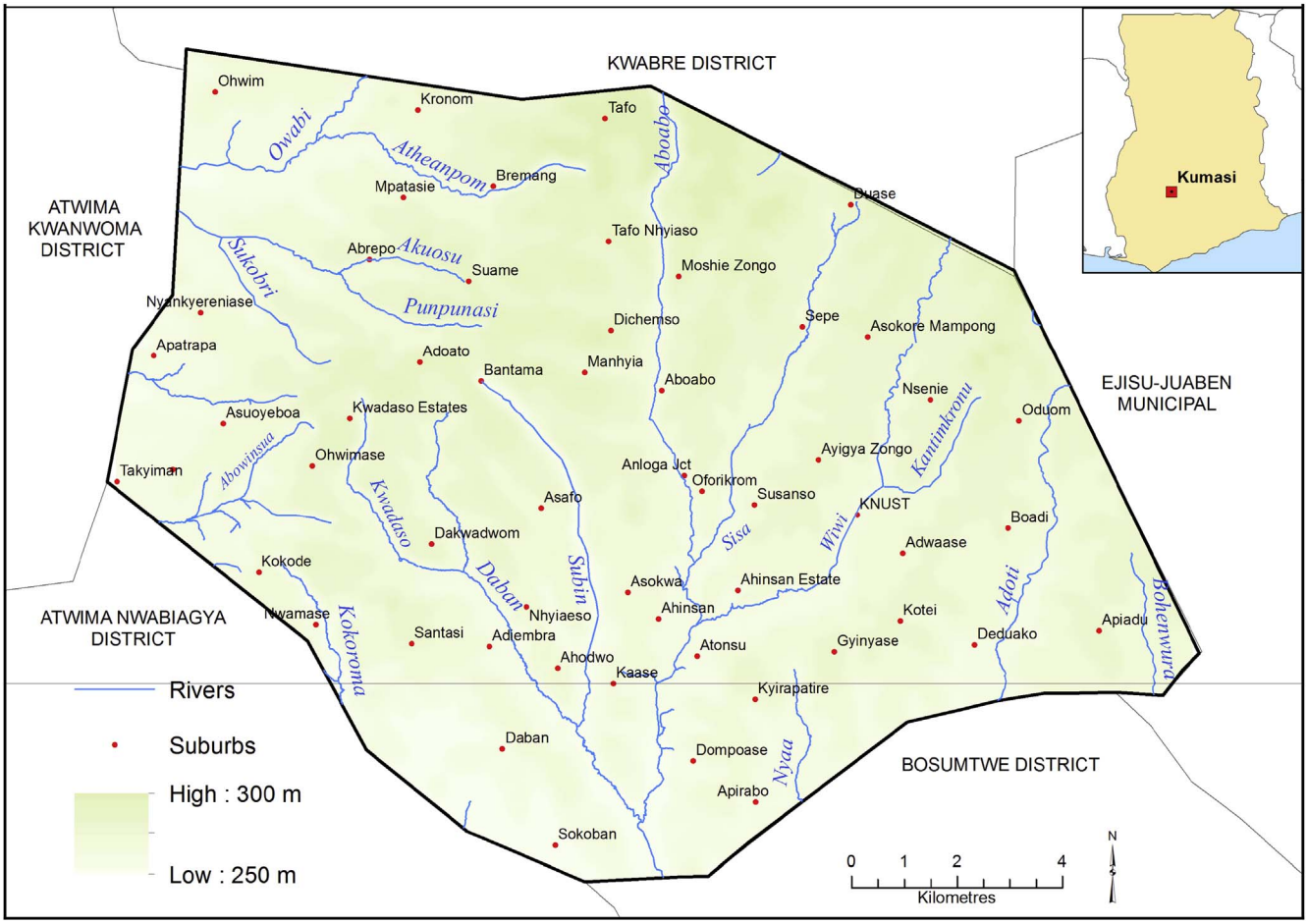

Fig. 1. The study location.

bodies (lakes and shallow waters) in Wuhan, China were converted to urban land uses between 1991 and 2004. Similarly, Dewan and Yamaguchi (2009), using topographic maps and satellite images, examined land use/cover changes in Dhaka, Bangladesh, and reported that the spatial coverage of the rivers and wetlands in the city reduced from 16,131.2 ha in 1975 to 11,174.9 ha in 2003, a decrease of about 31%. Moreover, Suresh (2001, pp. 97–106) in his systematic counting and assessment of lakes in Bangalore, found that while 51 lakes existed in the city in 1985, only 17 lakes were left in 2000. While these studies together with similar spatial studies (e.g., Disperati & Virdis, 2015; Prasad et al., 2009) underscore the extensive conversion of water areas into other land uses in urban areas in response to increasing population and economic activities, they provide limited insight on the trends, processes, nature, causes and implications of loss of the inland water systems. However, lack of such holistic understanding which mainly results from the methodology used presents significant roadblock to a more reality-based strategy for protecting the rivers and floodplains to ensure optimal ecosystem functioning in urban areas.

A typical reflection of this situation is in Ghana, where recent significant demographic translocation has undermined the coexistence of humans and inland water systems in the major cities. The country's urban population has more than tripled in less than three decades from 3.9 million (32%) in 1984 to 12.5 million (50.9%) in 2010 to exceed the rural population for the first time in history (Ghana Statistical Services [GSS], (2013)). This rapid urbanisation has promoted degradation of urban inland water resources through urban land expansion and pollution, especially in cities such as Accra, Kumasi, Sekondi-Takoradi and Tamale, which are the main concentration points of the growing urban population (Ministry of Works and Housing [MWH], 2006; GSS, 2013). In particular, rivers and floodplains are exposed to high levels of urban encroachment, increased sediment loads and siltation, and pollution of inland waters systems (Hens & Boon, 1999). The cumulative effect has been disappearance and extreme degradation of these water areas in the urbanscape (Hens & Boon, 1999; MWH, 2006). Nonetheless, no comprehensive studies has been undertaken to fully ascertain and understand the loss of rivers and floodplains in cities in the country, and hence poorly understood and addressed by academics and practitioners alike.

Unfortunately, available empirical studies indicate that spatially degraded inland water systems are characterised by narrowed, straightened or buried channels, lack of riparian zones, and banks and beds that are filled with physical structures, which collectively undermine ecosystem services, such as flood mitigation, water supply and microclimate regulation among others provided by these water areas (Amoateng, Finlayson, Howard, & Wilson, 2017; Gibbs & Salmon, 2015; Islam et al., 2010). Researchers such as Amoateng et al. (2017) and Islam et al. (2010) report that the conversion of inland waters to land (urban lands) leads to spatial fragmentation and breakdown of the connections in the surface water network. This damages the natural drainage network as well as reduces retention capacity of inland water systems, creating permanent and/or intermittent flood damage zones with several adverse implications for various facets of the urban environment (Amoateng et al., 2017; Islam et al., 2010).

The need for comprehensive research into the loss of rivers and floodplains in developing countries is therefore imperative not only for salvaging the physical availability of these aquatic inland systems in urban areas but also for forestalling socio-environmental problems that become eminent with their disappearance from the urbanscape. To