Land Use Policy 42 (2015) 307–317

Contents lists available at ScienceDirect

Land Use Policy

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

Urban morphology dynamics and environmental change in Kano, Nigeria

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ARTICLE INFO

Article history:
Received 3 April 2014
Received in revised form 26 July 2014
Accepted 5 August 2014

Keywords:
Urban sustainability
Vulnerability
Resilience
Coupled human and natural system
African city

ABSTRACT

In recent years, a critical understanding of human–nature interactions has become central to studies exploring the dynamics of urban morphology and the sustainability of growing cities in the developing world. Accordingly, numerous scholars have employed the coupled human and natural systems (CHANS) framework as a tool for understanding how cities are evolving in times of profound global change. Focusing on the case of Kano, northern Nigeria's largest city, this paper explores the potential of the CHANS framework in the analysis and interpretation of the human–nature interface in cities of the global south. Drawing on the qualitative analysis of graphic information and classical and contemporary literature, the centuries-old spatial morphology of Kano is traced and analysed. In the process, the paper highlights how change in the roles of traditional institutions of urban land administration have triggered the degeneration of the city's resilient indigenous urban morphology.

Field investigations and the analysis of a variety of 19th, 20th and, 21st century images reveal significant change in the city's traditional building materials, roofing styles, street forms, distribution of ponds, and green and open spaces. Population pressure on urban land has also been a major driving force behind the unfolding changes. One catastrophic outcome of these changes has been the exacerbation of recurrent floods. In drawing attention to wider lessons for urban planners in other developing country contexts, the paper stresses the need to analyse any notable spatial and non-spatial events in cities in relation to the changing dynamics of urban morphology.

Introduction

Urban morphology – the study of the form of human settlements and the process of their formation and transformation – entails the spatial analysis of urban structures, land use, street patterns, buildings, and open spaces (Conzen, 1988; Gauthier and Gilliland, 2006). By its very nature, it is an interdisciplinary field of study (Moudon, 1997) that researchers have relied upon for urban landscape modelling and measuring a wide range of urban characteristics, including air quality, traffic noise, and accessibility (Cionco and Ellefsen, 1988; Yoshida and Omae, 2005; Webster, 2010; Edussuriya et al., 2011; Wang and Kang, 2011). A number of critical scholars, however, have suggested that an analysis of urban morphology can also provide important new opportunities for researchers to explore complex, multifaceted urban sustainability issues that have proved difficult to analyse in the past (Van Diepen and Voogd, 2001; Wu, 2008).

There is now widespread consensus amongst scholars that multiple environmental challenges confront most cities and towns in developing countries. One very significant challenge is the increased prevalence of urban flooding, which the UN Habitat (2011) has identified as an overwhelming threat to urban sustainability. The urban poor are often exposed to high degrees of vulnerability that can be exacerbated by flooding, which can spread disease, displace populations and devastate livelihoods and infrastructure. Flooding is thus a multifaceted problem that demands a combination of policy, scientific, and technical responses.

While spatial planning is both a science and policy response, and has been used as a valuable tool for flood risk management (Tunstall et al., 2009; Burch et al., 2010), its success largely depends on the nature of a given urban area's social and economic standing. For example, the Hyogo Framework of Action mandates countries

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http://dx.doi.org/10.1016/j.landusepol.2014.08.007
0264-8377/

to apply disaster reduction modalities relevant to their land use systems (Schanze, 2009). But unfortunately, due to low adaptation and coping strategies, some developing countries do not possess the capacity to actualise this mandate (Satterthwaite, 2008). Many African cities are a case in point, where urban planning systems have not been satisfactory and have been constrained by a wide range of factors, including rapid population growth, weak institutions, dependence on foreign expertise, and political instability (Parnell et al., 2009; Parnell and Simon, 2010). In order to address urban morphology related challenges in developing countries, a better understanding of the nature of urban socio-ecological systems is first needed.

In such contexts, it becomes critical to understand the morphology of cities within the broader context of their socio-ecological systems. Accordingly, researchers focusing on issues concerning urban sustainability have stressed the need to integrate human and earth system histories to facilitate the analysis and interpretation of human and natural systems (Costanza et al., 2012). However, there are few examples of analyses which have employed indigenous urban morphology and land use systems in the context of sub-Saharan Africa (Kajoba, 2002; Awuah et al., 2010). As such, Baker (2000) has urged planners to incorporate a better appreciation of African indigenous concepts in their urban planning strategies. Indeed, the landscapes of many African cities provide excellent vehicles for understanding environmental change and its connection to institutions, resilience, and sustainability dynamics.

Urban areas are complex arenas that emerge through the interaction of both natural and human agents. Hence, any satisfactory diagnosis of urban sustainability challenges must be able to employ an interdisciplinary lens. One of the emerging interdisciplinary frameworks that sustainability scientists are increasingly using is the coupled human and natural systems (CHANS) framework. Researchers have employed the CHANS approach to develop frameworks that examine the relationships and linkages between the human and natural dimensions of environmental change in a wide range of different landscape settings (Liu et al., 2007a; Marina et al., 2011; Fu et al., 2013). Turner et al. (2003) further note its significance for landscape research, particularly in its ability to identify gaps in socio-ecological processes and facilitate a more systematic understanding of vulnerability in a landscape system. This model is instructive for examining urban morphology dynamics because its flexibility allows researchers to pursue a more holistic and interdisciplinary approach by integrating a diverse range of theories and techniques to explain the dynamics of human–nature interactions (An, 2012; Wandersee et al., 2012).

Some urban researchers consider the CHANS framework to be a variant of socio-ecological systems approaches (Alberti et al., 2011; Wang et al., 2011), which recognise the key role of institutions in regulating the interface of biophysical and social environments (Kluvankova-Oravska and Chobotova, 2007). At the same time, however, the CHANS approach seeks to promote enquiry into integrated solutions (Kangas et al., 2005; Cordell and Kerschner, 2007). While urban areas are in the rank of the most important hubs of human–natural systems interactions, in many cases they also represent examples of the dichotomisation of human and natural systems. As such, Marcus and Colding (2011) have advocated for the 'spatial morphology of social–ecological systems' as a strategy to fuse the roles of urban planning, design and governance.

As will be explored in this article, the CHANS model is a useful tool for the analysis of complex urban environmental problems that elude technological and policy responses. It provides a valuable point of departure for the analysis of flooding events, a prime example of a biophysical and social problem that intertwines human and natural systems of the urban environment. This paper, therefore, aims to contribute to the literature on urban environmental change by exploring the role and responses of indigenous urban morphology to flood risks. Drawing on the case of Kano, northern Nigeria's largest city, the paper explores the relevance of a socio-ecological systems approach in determining vulnerability and resilience of urban morphology. In doing so, the analysis underscores the importance of integrating the social, spatial, ecological and temporal dimensions of urban systems in the developing world. The paper concludes that studies of this nature are imperative for understanding and designing more sustainable solutions for environmental problems in the world's most rapidly urbanising areas.

Table 1
Population trends of Kano city.

Year	Observer	Estimated population (ancient city)
1820s	Hugh Clapperton	30,000–40,000
1851	Henry Barth	60,000
1903	Freidrich Lugard	30,000 (Kano market alone)
1932	Colonial government	83,000
1952	Colonial government	131,000
1963	Nigerian government census	250,000
1991	National population commission	Around 1.5 million
2006	National population commission	Around 2 million

Source: Barth (1857); Maiwada (2000); Barau (2010)

Materials and methods

The study area

The ancient walled-city of Kano dates from the late 10th century and at that time was one of the most important hubs on the Trans-Saharan Trade route. The city's walled perimeter covers an area of 29 km^2, sitting between latitude 12°02′ N and longitude 08°30′ E. Its topography of undulating plains is underlain by basement complex rocks of Precambrian age (Olofin, 1987). The natural vegetation of this area is classified as Sudan savannah, but has been transformed into a derived savannah region due to human impact (Ahmed, 2010). Its tropical wet and dry climate is marked by seasonal rainfall (April–October) with a mean annual temperature of 30 °C (Buba, 2000).

By the mid 16th century, its 7500 houses made Kano the third largest city in Africa after Cairo in Egypt and Fez in Morocco (Last, 1979). At that time, the area of the walled city was roughly 5400 acres, out of which only 2000 acres were actually inhabited by people (Frishman, 1977). Over time, metropolitan Kano and its urban population have continued to expand, having a significant influence on land-use and ownership, economic activities and labour markets (Maconachie, 2007). According to Paden (1973) Kano's population density was the highest in sub-Saharan Africa during the 1960s, and today, Kano (the ancient city and metropolis) is the second largest city in Nigeria with an estimated population of 3.19 million in 2007 (UN-Habitat, 2008). A summary of trends in Kano's population change is presented in Table 1 (Fig. 1).

Though many interacting factors have shaped the morphology of Kano over time, these factors cannot be disconnected from changing geography and rainfall patterns. While rainfall variability in Kano has been described as being 'normal' between 1931 and 1960 (Ati et al., 2008), since the 1960s the rainfall received in the Kano region has exhibited notable fluctuations (NIMET, 2008; Ati et al., 2008; Ahmed, 2010). Not only has the quantity of rainfall fallen to below the 1000 mm annual range, but Kano also faces skewed rainfall distribution. Buba (2000) points out that in the late 1980s, each year 80% of rains in Kano fell within just 3 months (July–September), putting increasing stress on natural drainage systems. Alongside these changes in rainfall patterns, however,