

Peri-urban land use pattern and its relation to land use planning in Ghana, West Africa



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HIGHLIGHTS

- Patterns of peri-urban development differ between northern and southern Ghana.
- Population growth is an important driver of urban development in both study areas.
- Land inheritance contributes to urban sprawl in Bolgatanga.
- The oil boom increases competition for land use in Takoradi.
- Land tenure and lacking law enforcement challenge land use planning in both areas.

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ABSTRACT

Population growth, economic development, and rural migration to urban areas have caused rapid expansion of urban centres in Ghana. One reason is that spatial planning and in particular urban planning face different social, economic and political challenges which hinder a structured and planned urban development, therefore causing urban sprawl. We hypothesise that different peri-urban patterns are driven by geographical, historical, cultural and economic discrepancies between southern and northern Ghana, and reflect the effectiveness of land use planning instruments. We tested our hypothesis by comparing patterns of urban development in two case study regions: Takoradi in southern Ghana and Bolgatanga in northern Ghana, representing an economically vibrant and a non-vibrant region, respectively. This paper provides new insights for the study sites based on a mixed-method approach. We applied an interdisciplinary approach combining expert interviews, a literature review, and a bi-temporal change analysis based on remote sensing/geo-information systems. We assigned confidence levels of the findings from the respective methods based on their plausibility and sensitivity. Expert opinion indicated that land use planning fails due to the lack of implementation of legal regulations, to the customary land tenure and lack of participation of local citizens in the planning process. The remote sensing analysis revealed that urban development was stronger in Takoradi (7.1% increase between 2007 and 2013) than in Bolgatanga (1.1% increase between 2007 and 2013). Urban development patterns differ with a dominance of small-scale scattered settlement units (SUs) in Bolgatanga and a mixture of small- and large-scale SUs

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in Takoradi. Besides population growth, markets and industry are identified as major drivers of urban development in the Takoradi area (large SUs) and customary land tenure in the Bolgatanga area (small SUs).

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1. Introduction

Worldwide, urban sprawl is one of the key drivers of unsustainable development (Camagni, Gibelli, & Rigamonti, 2002; Jabareen, 2006; Næss, 2001). Its negative impacts are particularly visible and crucial in developing countries such as the West African countries, where unplanned land use change obstructs sustainable management efforts (Anderson, Okereke, Rudd, & Parnell, 2013; Buhaug & Urdal, 2013). Some of the current migration from Africa to Europe and across the world could be better managed by a comprehensive development of urban areas, particularly in the poor countries in West Africa (Bakewell, 2008; ESPON, 2015; Hummel & Liehr, 2015).

Urban population in West Africa is particularly fast growing in the coastal areas (Hitimana, Allen, Heinrigs, & Tremolières, 2011). During colonial times, commercial activities concentrated strategically along the sea coast (Kuper, 1965). In the 1960s and 70s, after the colonial rule, new bureaucracies, infrastructure, and companies provided employment in coastal urban centres. This led to rapid immigration to urban areas in Anglophone Africa (Okpala, 2009), which became attractive because of the opportunities to reduce dependency on agriculture and diversify household income. Other factors were improved social care and/or escape from armed conflicts (AfDB, 2005). Today, changing lifestyles and globalisation effects (e.g. land grabbing) push urban development forward (Cohen, 2006). Additional reasons for informal processes of urban development in Anglophone West Africa are governments' low levels of financial capacity, ineffective administrative systems, poor governance, mismanagement of resources, and corruption (Okpala, 2009).

Ghana can be seen as an example for trends in urban development in Anglophone West Africa (Otoo, Whyatt, & Ite, 2006). Population densities along the coastline, but also in traditional inland trading centres such as Tamale and Kumasi, grew considerably during colonial times and through European investments. Between 1960 and 1984, Ghana's population doubled (12.3 million in 1984; GSS, 1989) with an annual growth rate of 2.7%. For urban areas, migration from rural areas remained the main source of growth (Frazier, 1961; Liebenow, 1986), resulting in an annual growth rate of 4.7%. This led to a strong increase in the urban population, which reached 50.9% of the total population in 2012 (GSS, 2012). This population growth was higher than the growth of the total West African population, which increased by about 40% between 1960 and 1980. The share of urban population is also higher in Ghana than in West Africa, where in 2010 about 42% of the West African population lived in urban areas (OECD, 2015). This higher population pressure in Ghana has led to extreme pressure on natural resources. For example, between 1975 and 2000, urban expansion in Ghana triggered deforestation processes resulting in a more than 22% loss in forest area (USGS, 2013). Land use planning is key to meeting increasing demands for human needs and at the same time maintaining the natural environment.

Regional development in Ghana is spatially heterogeneous with a clear distinction between the northern and the southern part of the country. The coastal region in southern Ghana has long been the focus of national investments for economy and trading (Bukari, Aabeyir, & Basommi, 2014; Plange, 1979). In addition to the ports, the area is rich in natural resources such as minerals, oil and tim-

ber, which are the main drivers of Ghana's economic development (Alfsen, Bye, Glomsrod, & Wiig, 1997). Northern Ghana used to be seen mainly as a source of labour for the export-oriented sectors of mining and cocoa in the south (Plange, 1979). At the end of the 1950s, the north lagged behind the south in terms of economy, sanitation, level of education, and general infrastructure. However, Ghana is struggling to develop the north, where about half of the population lives in extreme poverty (MDG Ghana, 2012). The three northern regions are the regions with the highest share of people living in poverty (GSS, 2014a). In the Upper East Region, 44.4% (2013) of the people live in poverty, and 20.9% in the Western Region (absolute poverty line: US\$1.83 per day, GSS 2014).

1.1. Historical background of land use planning in Ghana

Like in most of the Anglophone West African countries, urban land use planning in Ghana is oriented on British town planning legislation. The British Town and Country Planning Act of 1947 specified procedures for controlling urban sprawl, for example, by seeking permission from the local council, and by slum clearance (Okpala, 2009; UK Parliament, 2016). All areas of the country were requested to have a development plan. During independence, informal urban sprawl increased considerably, and public hygiene as well as environmental quality declined. Before 1993, urban citizens were not informed about compulsory land acquisition for water, electricity, roads and other land use priorities by the centralised Town and Country Planning Department. This led to the displacement of affected citizens and to increasing poverty (Kasanga & Kotey, 2001). Between 1992 and 1994, Ghana restructured its urban and land use planning system into a decentralised form where more political, planning and administrative power was transferred to the district level in order to facilitate an increase in exchange between governmental and public concerns. The district assemblies have legislative, executive and deliberative powers. For example, they have the right to change local taxes and laws, and to implement projects on improving rural incomes and general welfare (Botchie, 2000). Expectations with respect to local participation, acceptance, and effective use and management of local resources have been high, even though participation is still limited to public consultation (Okpala, 2009).

The declared goal to become a middle-income country by 2020 has accelerated ambitious land use plans and development in Ghana (NDPC, 1995). Ghana has improved public infrastructure such as schools, hospitals and roads in the country (Kasanga & Kotey, 2001). The Land Administration Project from 2003 to 2010 pushed land use planning in Ghana forward (TCPD, 2014). The project aimed to provide spatial solutions for reaching defined social, economic and environmental policies while considering the spatial impact from any form of development. Information pertaining to land, such as location, size, improvements, ownership and value, was documented. The project identified people who were interested in land as real estate, and collected information concerning the type and duration of land use and owner rights (Karikari, 2006). A change in land use planning could be triggered by the Land Use and Spatial Planning Bill, which was ratified in July 2016 and aims at harmonising existing land use laws, construction laws and regulations, while lending more power to the Town and Country

Planning Department in order to ensure conformity and compliance with spatial plans and planning standards at the national, regional and district levels (Parliament of Ghana, 2016).

The northern and southern parts of Ghana differ in their customary land tenure system. In the Upper West and Upper East Region, the allodial titleholder is the Tendamba. The Tendamba is like an earth priest, and is a descendant of the early settlers of the villages (Kotey, 1993). He has a moral role, for example, in land dispute resolution, annual sacrifices for peace and prosperity, sanctions for violations, and allocation of vacant land to “strangers” (Kasanga & Kotey, 2001). In addition, local chiefs control the traditional land and give the plots to titleholders in order to administer an area (Tonah, 2005). Growing population pressure and commercialisation of land in the north led to conflicts between the Tendamba and local chiefs claiming allodial land titles (Kotey, 1993). Historically, southern Ghana has always been more densely populated than northern Ghana. Local institutions are therefore more experienced with respect to land agreements, particularly land rents for people outside the community.

About 78% of the land in Ghana is under customary land ownership (Kasanga & Kotey, 2001). However, in urban areas, statutory tenure predominates and, particularly in the centres of big cities such as Accra and Kumasi, settlement development is better controlled (Kasanga & Kotey, 2001; Konadu-Agyemang, 1991). However, in peri-urban areas, where land tenure is in transition to customary land tenure, user rights are not clearly defined and cause conflicts. Problems arise from undocumented informal agreements under the customary land tenure system. The majority of owned land is not formally registered, leading to existence insecurity (Twerefou, Osei-Assibey, & Agyire-Tettey, 2011). Formal registration processes are part of the national framework of land use planning. However, statutory land entitlement demands the registration of only one person, which is in most cases the group leader, e.g. family head, and decisions are taken without consulting the other group members (Kasanga & Kotey, 2001). Kasanga & Kotey (2001) pronounced the statutory and customary land tenure system “on collision course” even though customary land tenure is legally acknowledged by statutory land tenure (in reference to Article 36(8) of the 1992 Constitution). Statutory land tenure is characterised by written and registered records of land entitlement and, therefore, should promote investments in land property. Furthermore, it should contribute to the public good or national interest (Kasanga & Kotey, 2001). However, the statutory system is often perceived by the local population as part of the colonial heritage (Deininger, 2003) imposed from top-down. For example, in 1897, the government tried to enforce a regulation through the Lands Bill that all unoccupied land in the Crown belonged to the government. This led to strong resistance from the land chiefs. Land ownership and land use are still a sensitive issue in Ghana (Konadu-Agyemang, 1991), and for this reason the government refuses to nationalise land. A detailed description of land use planning in Ghana is provided in Annex A.

1.2. Monitoring and modelling urban development – a plea for an interdisciplinary perspective

Patterns and processes of urban development can be best observed in the peri-urban fringe where urban land uses are in transition to rural land uses and where dynamics between urban and other land uses are most visible (Tacoli, 1998). We refer to “urban development” as a spatial expansion of urban area in the periphery. We use the term “urban sprawl” to describe a special type of urban development where the development occurs scattered and uneven on new (non-urban) lots, leading to inefficient resource utilisation, i.e. land fragmentation (Camagni, Gibelli, & Rigamonti, 2002). Often, urban sprawl indicates poorly planned and poorly managed urban

growth (Siedentop & Fina, 2012). Development is patchy, scattered, and with a tendency towards discontinuity (EEA, 2006). Especially in developing countries, urban sprawl occurs as a result of illegal house construction not conforming to land use planning.

Extreme uncertainties exist with respect to the assessment of complex real life problems related to urban development, such as land use conflicts, which requires the collaboration of multiple disciplines (Brewer, 1995; Miller, 1985; Rolen, 1996). Single disciplines comprise deep but fragmented knowledge (Stern, 1986). Spatial patterns and dynamics of urban sprawl over time can be analysed, for example, based on multi-temporal remote sensing data (Bhatta, 2010; Brinkmann, Schumacher, Dittrich, Kadaore, & Buerkert, 2012; Griffiths, Hostert, Gruebner, & Van Der, 2010; Oloukoi, Oyinloye, & Yadjemi, 2014; Tewolde & Cabral, 2011), but the underlying determinants of these patterns would require an understanding of the political, administrative and social driving forces (Lambin & Geist, 2006). From our perspective, such analysis is best done in an interdisciplinary framework.

The objective of the presented study is twofold. We provide new insights for a specific study site and test the applicability of a transparent framework to compare and contrast information from different scientific disciplines in a mixed-method approach. We hypothesise that regional and cultural differences together with different land tenure systems and economic settings in southern and northern Ghana have led to different patterns of urban development. We expect that urban development takes place faster but in a more regulated way in southern Ghana than in northern. We hypothesise that urban development in northern Ghana is more fragmented and on a small scale due to less supervision by land use planners and to the tenure system practised there. Furthermore, we provide insights into how the national land use planning framework is approached in practice under different spatial contexts. And finally, we prove that our mixed-method approach is applicable for land use planning research in West Africa despite some challenges.

We selected Takoradi as a representative urban area for the south of Ghana and Bolgatanga representing an urban area in the north of Ghana. Both study areas are experiencing urban growth, but this differs in drivers and patterns. This study is important because it shows the inherent challenges in the blueprint implementation of the existing land use planning laws in Ghana. The study also demonstrates the relative importance of considering regional differences in the implementation of these laws. The drivers, character and consequences of urban expansion in Ghana are still poorly understood (Doan & Oduro, 2012), and according to our knowledge, there is no study that compares urban development between the northern and southern part of Ghana with a comprehensive approach comparing a literature review with remote sensing data and expert interviews. For example, Poku-Boansi & Amoako (2015) compared spatial inequalities of cities within Ghana, including Takoradi and Bolgatanga, using statistics (secondary data) without consulting experts or comparing urban development with the aid of remote sensing data.

The specific research questions are:

- What are the patterns of peri-urban development and differences between northern and southern Ghana, using Bolgatanga as an example for the north and Takoradi as an example for the south?
- What are the determinants of urban development for both study areas?
- Which conclusions can be drawn for land use planning? What are the current opportunities and challenges of land use planning and how can they be linked to urban sprawl?
- What are the (dis-)advantages of a mixed method approach to analyse peri-urban land use patterns?

The analysis of the dynamics of urban and peri-urban areas from a social science perspective introduces reasoning of human behaviour and provides a background of historical, cultural and social development (e.g. Beauchemin & Bocquier, 2004; Gough & Yankson, 2000; Oteng-Ababio & Agyemang, 2012). In-depth interviews provide qualitative data where, for example, the value and management of different land use types can be identified. But studies focusing solely on interviews often lack an understanding of interdependencies between human behaviour and spatial configuration, such as the effect of the distance to roads, irrigation systems, markets or the suitability of a location for house construction. Consequently, a link between remote sensing observations and human behaviour is needed to understand the complexity of human-environment interactions (Campbell, Lusch, Smucker, & Wangui, 2005; Liverman & Cuesta, 2009; Rindfuss & Stern, 1998). Today, census and household data are often combined with remote sensing to analyse patterns of land use change (Cardille & Foley, 2003; Doan & Oduro, 2012; Martinuzzi, Gould, & Gonzalez, 2007). The combination of in-depth interviews and remote sensing is uncommon, because the integration of qualitative and quantitative data is still challenging (Gobin, Campling, Deckers, & Feyen, 2001; Haregeweyn, Fikadu, Tsunekawa, Tsubo, & Meshesha, 2012; Rindfuss et al., 2003a, 2003b). We advocate a mixed analysis using remote sensing, expert interviews and a literature review, and contrast the information in a confidence table.

2. Study areas and methods

2.1. Study areas: Takoradi (in the south) and Bolgatanga (in the north)

We selected Takoradi and Bolgatanga as representatives of urban areas in the south and north, respectively, because they are characterised as having similar urban populations with similar population pressure, but they differ in their past economic and political relevance. Takoradi is part of the twin city Sekondi-Takoradi (merged in 1946) with roughly 170,000 inhabitants. The city is located in the coastal zone of the Atlantic Ocean (see Fig. 1) within the formal rainforest zone in the south of Ghana. Recognised by the state as a highly prioritised area for fast development and growth, it was the first region in Ghana selected for the regional spatial development framework in 2012 to officially coordinate multiple spatial demands and to regulate the trade-offs of urban development (TCPD, 2012). The beneficial strategic location close to the Atlantic Ocean as a connection to the international market and the discovery of off-shore oil have drawn attention to Sekondi-Takoradi at the national level. The city has been declared as a free trade zone and an industrial core region in order to attract foreign investment, thus aiming to accelerate the rate of economic growth and pushing Ghana's decentralisation (Ghana Free Zones Board, 1997). Rural communities surrounding the urban area are characterised by agriculture and fisheries along the coast.

Bolgatanga, with 66,000 inhabitants, is the capital of the Upper East Region, and is located close to the border to Burkina Faso and Togo (GSS, 2012). It lies in the Guinea Savannah Zone in transition to the Sudanian Savannah Zone, which is characterised by mosaics of trees, open grassland and crops on a relatively flat terrain (Fig. 3). The main source of income in this region is small-scale subsistence farming of maize, sorghum, and millet intercropped with groundnuts or beans on compound and bush farms (Birner, Schiffer, Asante, Gyasi, & McCarthy, 2005) as well as small-scale gold mining. The income of the urban population is based on petty trading, house rents or indirectly on agriculture where labour is paid for livestock rearing and commercial farming outside the city. The contribution of the region to the country's gross domestic product is

much lower compared to Sekondi-Takoradi (GSS, 2012). The region is experiencing high population pressure with a population density of 118 people/km², which is higher than the national average of 103 people/km² (GSS, 2013). One reason for the high population density is the high fertility rate of 4.7 children per woman. In addition, there is immigration from other districts and Burkina Faso coming to Bolgatanga for trading and to escape from conflict regions, e.g. Bawku (Ampofo, Kumi, & Ampadu, 2015). The share of urban population in the region increased from 3.9% in 1960 to 21% in 2010 (GSS, 2014a) due to infrastructural development since 1990 (e.g. schools, hospitals and electricity), especially in Bolgatanga (Bolgatanga District Assembly, 2002). The high population pressure has resulted in land fragmentation and land degradation. An overview of the two regions is provided in Table 1.

The spatial extent of the remote sensing analysis needed to focus on subsets of the region due to the processing effort for delineating small-scale buildings as a proxy-indicator for informal urban sprawl. We therefore focused the remote sensing analysis on areas with particularly fast urban development in 2007 – 2012. For the focus area in the north, we chose an area towards Bongo, which is the closest settlement to Bolgatanga – settlement structures expand towards Bongo along the road. Bolgatanga itself is situated in a region with nearly no geographical constraints such as mountains or large waterbodies. Therefore, urban development in Bolgatanga can potentially spread in all directions. Sekondi-Takoradi shows a different environmental configuration. Due to its location along the Atlantic coast, the urbanised zone is located in the south and east of the city (Fig. 1). Thus, settlement development occurs mainly to the north and west. In this study, the area to the west of Takoradi in closest proximity to Agona was chosen as the focus region for the remote sensing analysis.

2.2. Methods

Our analyses considered patterns of urban development, and driving forces of urban development as well as opportunities and challenges of urban and peri-urban land use planning. Patterns of urban development are the spatial and temporal traces of urban development (Lasuén, 1973), for example land fragmentation and settlement configuration. We combined three different methodological approaches: expert interviews, remote sensing/GIS and literature review. We started our analysis with expert interviews to assess perceived patterns and drivers of urban development in the study areas. In addition, experts were interviewed about strengths and weaknesses of land use planning, since informal rules in addition to formal regulations were expected to shape the land use pattern (Fig. 2). This was followed by a remote sensing analysis to validate how reliable these perceived patterns and drivers were, using the number, size, and density of scattered buildings. This analysis was used as a proxy indicator for informal urban development. A literature review was performed before the field work to get an idea of the topic, but in a reduced way in order to remain unbiased for the interviews. An extensive literature review on district and local levels was carried out complementarily to the remote sensing analysis in order to validate the findings. Based on the consistency of the results of the three methods, we assigned confidence levels (Table 6a and 6b).

Urban sprawl is difficult to detect without comparing spatial land use plans with existing urban housing. We can identify urban sprawl through the use of different methods with the following characteristics: a land use and land cover change with low but scattered building density, uneven building sizes, mixed land uses, and their negative effect on the environment and people (Chin, 2002). "Bolgatanga area" refers to the city of Bolgatanga and its surrounding area including Bongo, while "Takoradi area" refers to the city of

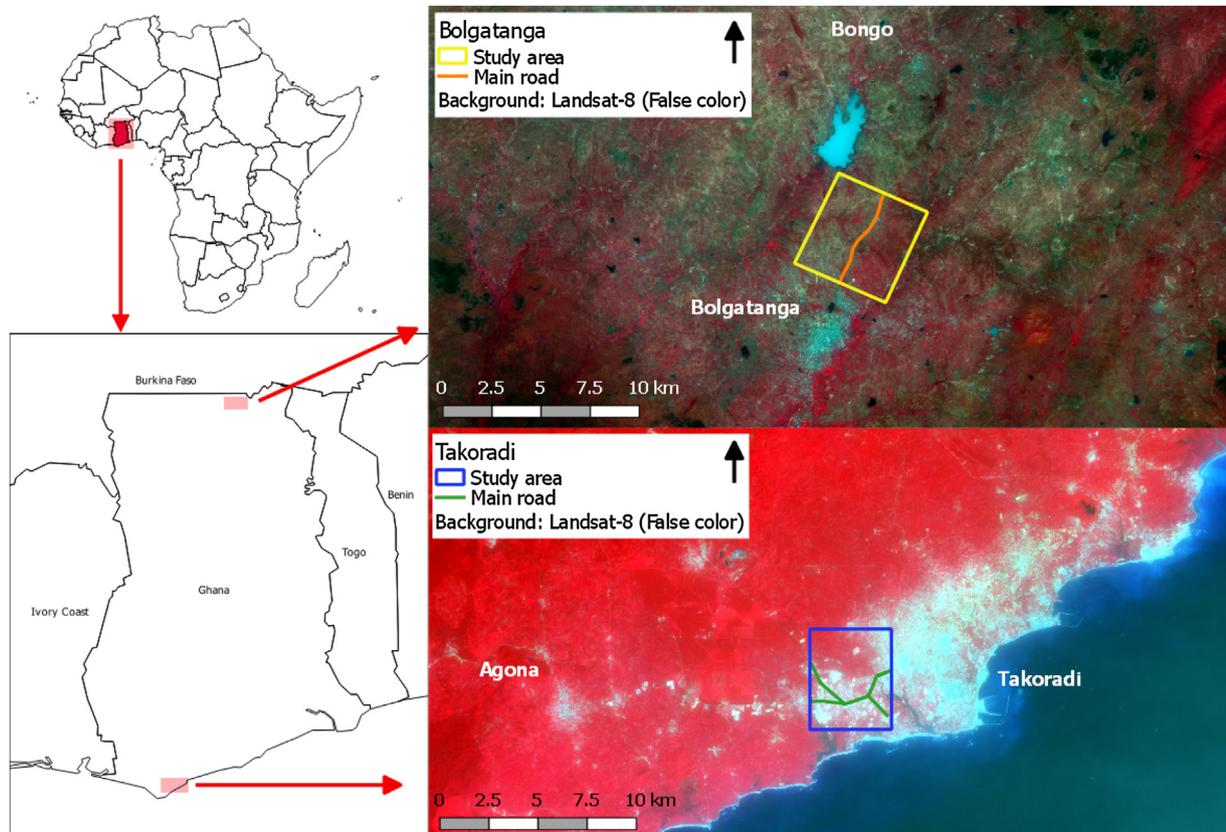


Fig. 1. Location of the study areas in Ghana, West Africa. National and administrative boundaries from OpenStreetMap (<http://www.openstreetmap.org>). Right maps: location of the northern study area: Bolgatanga towards Bongo; location of the southern study area: Takoradi towards Agona. The 5 km × 5 km focus areas were selected for the remote sensing analysis (see Section 2.2.2).

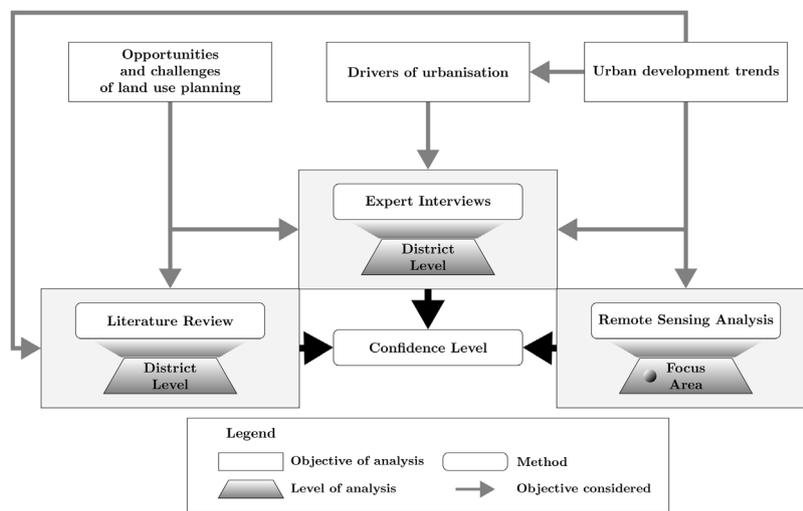


Fig. 2. Methodological framework and analysis scales.

Takoradi (often known as Sekondi-Takoradi) and the surrounding area including Agona located in the Ahanta West District.

2.2.1. Expert interviews

In both regions, we started by forming regional focus groups consisting of a few, but highly relevant experts. We define “experts” as people with extensive knowledge and experience regarding land use planning in the study regions or residents who have lived there for more than 20 years, who were included as key knowledge holders. In total, we conducted in-depth interviews with 14 experts, 9

in the Takoradi area, 4 in the Bolgatanga area, and one expert at the national level who knew both study areas. The experts were also chosen according to availability and willingness to contribute to our study.

Our focus group consisted of two groups: (1) land use planning experts at the district level to obtain a clear understanding of urban development in the context of the process of formal and informal land use planning, and (2) representatives of organisations with legal and cultural mandates in land use planning at different levels of statutory planning. Examples are public authorities on



Fig. 3. Examples from the focus areas in Bolgatanga (right) and Takoradi (left). The small-scale structures and the small building cluster in the Bolgatanga subset can be clearly identified. The Takoradi subset shows a mix of large and medium-sized building clusters.

Table 1

Characteristics of the study areas Takoradi (as part of Sekondi-Takoradi), Bolgatanga and Ghana; data from 2010 where no year is indicated.

Study areas	Takoradi	Bolgatanga	Ghana
Administrative Region	Western Region	Upper East Region	In total, 10 Regions
Regional population	2,376,021	1,046,545	Total population: 24,658,823
Urban population ^a	Sekondi: 70,361 Takoradi: 97,352	Bolgatanga: 65,549	Total urban population: 12,545,229
Share of urban population in the region	42.4%	21%	Share of urban population: 50.9%
Average household size (persons)	3.6	4.9	4.4
Mean annual per capita income in US\$	363 (2008)	115 (2008)	400 (2008)
Share of population in poverty in the region ^b	20.9% (2013)	44.4% (2013)	Total poverty: 24.2% (2013)
Regional population growth rate	In extreme poverty: 5.5%	In extreme poverty: 21.3%	In extreme poverty: 8.4%
Trading opportunities	2.0%	1.2%	National population growth rate: 2.5%
Main economic sectors of the region	Harbour located on the Atlantic (international) Oil, gas, rubber; mining of: gold, bauxite, iron and diamonds	Border with Burkina Faso and Togo Agriculture; small-scale gold mining	Border trade with Burkina Faso, Togo and Ivory Coast; harbours Services: 51.4% (mainly transport and public administration) Industry: 18.6% (mainly construction and manufacturing) Agriculture: 29.9% (mainly crops)
Climate zones of the region	Deciduous Forest and Coast Savannah; 1500 mm mean annual rainfall	Guinea and Sudanian Savannah; 1000 mm mean annual rainfall	Guinea Savannah, Sudanian Savannah, Transition Zone, Deciduous Forest, Rain Forest and Coast Savannah; 1200 mm mean annual rainfall

Source: GSS (2008); GSS (2012); GSS (2014a); Rainfall data: FAO (2005).

^a Counted as people living in the urban area.

^b Absolute poverty line: US\$1.83 per day; extreme poverty line: US\$1.10; equivalent adult per year in the January 2013 prices of Greater Accra Region; extreme poverty line = even if a household spends its entire budget on food, it still would not meet the minimum calorie requirement (2,900 cal per adult equivalent of food per day) GSS (2014a).

different levels, non-governmental organisations, traditional heads and long-term residents (Table 2). The largest number of experts belonged to the Town and Country Planning Department, which is the leading institution for the planning and management of urban and rural development at national, regional, and district levels. Hen Mpoano is a regional non-governmental organisation providing support in mapping and collaborating with rural coastal communities. Spatial Solution is a small company specialised in urban design and spatial planning. Both organisations were not working in northern Ghana.

After a general introduction to our research, the interviewees were requested to present their understanding of land use planning and urban development in the focus areas, the different stages of the planning process, the roles of different institutions, how land

use priorities were considered in the planning process, the spatially explicit key determinants of spatial growth in the districts, and the internal and external obstacles to sustainable development. Other questions addressed participatory land use planning and suggestions for future land use planning. Each interview took 30–75 min. The questionnaire is provided in Annex B.

We focused on individual interviews rather than on group discussions (Potter, 2011), as it turned out to be impossible to gather all experts at the same time. Internet-based consultation and other SoftGIS methodologies (Kyttä & Kahila, 2011) were also not applicable because the internet access of the participants was rather limited. We employed in-depth interviews to obtain comprehensive knowledge about the variation in land use planning processes and to allow respondents to express their knowledge of and expe-

Table 2
Interviewed governmental and non-governmental experts at the different levels for the two study areas; TCPD = Town and Country Planning Department, EPA = Environmental Protection Agency; NGO = Non-Governmental Organisation.

Level	Experts on governmental level	Experts on non-governmental level
		Representatives for the north (Bolgatanga area)
National	TCPD Technical Director of Ghana	–
Regional	EPA staff Upper East Region	–
District	TCPD planner Bongo District	Chief of Bongo District
Local (city)	–	Resident living in Bolgatanga for more than 30 years
		Representatives for the south (Takoradi area)
National	TCPD Technical Director of Ghana	–
Regional	Regional director of TCPD and staff of EPA Western Region	Staff of Hɛn Mpoano and Spatial Solution
District	TCPD Planner of Ahanta West District	Community development officer of Ahanta West District
Local (city)	TCPD planner of Sekondi-Takoradi Metropolitan Area	Residents living in Takoradi for more than 30 years and for more than 20 years in Agona

rience with the issue under discussion. We applied open-ended questions to gain a profound insight into the regional spatial differences and perceived development processes (Bradburn, Sudman, & Wansink, 2004).

Interviews were transcribed and analysed in a content analysis. After a first text analysis, we conducted a coding to conceptually validate and/or extend our hypothesis (Hsieh & Shannon, 2005; Mayring, 2000). The codes were further refined after the first reading and resulted in 14 codes, for example, determinants of urban development, land use priorities, and challenges of land use planning. The interviews were analysed in the qualitative analysis software ATLAS.ti, which simplifies the content analysis of interviews and improves transparency by providing support in managing, shaping and analysing qualitative data (ATLAS.ti, 2015). The hermeneutic unit holds all data sources, quotations, codes, conceptual linkages (families, networks), memos, etc., and therefore helps to organise the complexity of the content.

2.2.2. Remote sensing/GIS analysis

In our study, remote sensing data were exclusively used to identify patterns of urban development, but not for interpreting further drivers, such as distance to roads or markets. Single buildings in the study areas can only be identified on very high-resolution satellite images. Access to such data is very limited and expensive, and available data sets lack the benefit of multi-spectral images.

Consequently, and due to difficulties in discriminating buildings from bare soil in remote sensing data using classic classification algorithms, we decided to perform a manual digitalisation of each building. However, it was the most time-consuming method. For this reason, we decided to monitor urban development between 2007 and 2013 within two 5 km x 5 km focus areas in the peri-urban zones of the two cities. When selecting the focus areas, we kept a 2.5-km distance to the main road from Takoradi to Agona and from Bolgatanga to Bongo (Fig. 3). Clusters of buildings with a distance of less than 25 m to the next building were defined as building cluster and digitised as one unit. In the following, the term “settlement unit” (SU) is used for compounds of the digitised buildings and building clusters. The subsequent analyses of urban sprawl were based on parameters like number and size of SU, total size of the built-up area, built-up density, and the average size of SU. High resolution data were taken from DigitalGlobe via GoogleEarth without cloud cover; reference dates of the data for Bolgatanga are 01/10/2007 and 06/01/2013, while data for Takoradi refers to 02/15/2007 and 06/01/2013.

2.2.3. Literature review

For the literature review, we used databases such as Science Direct and Google Scholar, and added grey literature from free web searches to collate information on customary norms and experience. Land use planning in Ghana is mainly conducted by national and international non-governmental organisations and thus not published in peer-review journals (Cohen, 2006). The literature review was conducted over three weeks between December 2015 and January 2016. Our search terms are provided in Table 6a and 6b. In total, 72 publications were identified as relevant for our research objectives.

2.2.4. Confidence level

To express the reliability of our results, we followed the approach of confidence levels provided by Jacobs, Burkhard, Van Daele, Staes, & Schneiders (2015), which is based on Mastrandrea, Mach, Plattner, Edenhofe, & Stocker (2011) for the IPCC Fifth Assessment Report and the Millennium Ecosystem Assessment (MA, 2005). They used a combination of agreement and evidence levels to evaluate confidence in the validity of a finding. The reason for developing a confidence table for the IPCC Report was the inconsistent interpretation of the degree of certainty between the working groups (Mastrandrea, Mach, Plattner, Edenhofe, & Stocker (2011)). Part of the evidence level is its type, amount, quality, and consistency, but further specifications on measuring those parameters are not described in the report. The agreement level is based on the consensus across the scientific community. The author teams agreed on the final confidence level, as it is the case in our study, too. We transformed the matrix model from Mastrandrea, Mach, Plattner, Edenhofe, & Stocker (2011) and Jacobs, Burkhard, Van Daele, Staes, & Schneiders (2015) by specifying the level of agreement and level of evidence by defined thresholds for the respective methods.

In our case, the level of evidence is defined by the number of methods which can provide information. Thus, we have robust evidence if three methods, medium evidence if two methods, and limited evidence if only one method can provide evidential information (Table 3).

The level of agreement is defined differently for the respective methods (Table 3). We have high agreement if all or more than 60% of the interviewees or more than two sources of literature confirm the argument. For remote sensing, a high agreement between different data is not applicable, since we used one study site per location. Medium agreement is defined if 25–60% of the interviewees, one or two references, or remote sensing analyses confirm the argument. Low agreement is provided if less than 25% of the interviewees and if the number of confirmations and rejections is the same in literature. For expert interviews and literature, the number

Table 3

Combinations between agreement and evidence levels for a finding. Each level is defined for the respective method (RS = remote sensing; expert interviews: literature review). For the agreement levels for literature and expert interviews, the number of confirmations is reduced by the fraction of rejections.

Symbol	Level of agreement	Explanation
XX	High agreement	Statement was confirmed within one method - for interviews: > 60% of interviewees confirmed - for literature: more than two sources confirmed - for RS: not applicable (only one location)
X	Medium agreement	Statement was confirmed but limited data within one method - for interviews: 25–60% of interviewees confirmed - for literature: one or two sources confirmed - for RS: confirmed
?	Low agreement	Confirmation and rejection within one method - for interviews: <25% of interviewees confirmed - for literature: confirmation and rejection balanced - for RS: rejection
-		No data or no evidence
Level of Evidence		Explanation
High evidence		All three methods can provide information
Medium evidence		Two methods can provide information
Low evidence		One method can provide information

of confirmations is reduced by the fraction of rejections. For remote sensing, we have low agreement if the argument is not supported by the remote sensing analysis.

The confidence levels used (Table 4) were very high, high, medium, low and very low. Very high confidence is given if we have enough data and results from all three methods, e.g. enough literature as reference (robust evidence) with a high level of accordance between remote sensing and expert interviews (all methods support the hypothesis). High confidence is provided if we have medium evidence (data from two methods) and still high accordance between their results. We also have high confidence if all three methods provide enough data but statements are slightly diverging (medium agreement) or data are limited but results are in high accordance. Conversely, we have low confidence if we have contradictory results from only two methods, e.g. literature and expert interviews. Furthermore, low confidence in findings occurs if only one method on the topic is accessible with limited information to serve as evidence for the argument.

3. Results: integrative analysis of interviews, remote sensing/GIS and literature

In the following, we present a comparative and integrative analysis of our three different data sets. Table 6a and 6b, to which we refer throughout the text, provides information on the level of confidence in the findings to assess how reliable the observed or assumed trends and patterns of urban development are.

3.1. Patterns of urban development

Considerable urban development rates and land fragmentation trends were observed in both areas. This trend was confirmed by all three methods (very high confidence, Table 6a). Analysis of the remote sensing data (Fig. 4) shows that in the Bolgatanga area, the built-up area increased in the period between 2007 and 2013 from 3.6% to 4.7%, equivalent to an increase from 91 ha to 118 ha (+30.4%). In the same period, the number of settlement units (SUs) increased from 873 to 1156 (+32.4%). The number of SUs smaller than 500 m²

increased by two thirds from 371 to 548 SUs within the analysed period. These change rates together with the decreasing average SU size (Table 5) indicate that urban expansion was mainly based on smaller SUs, thus indicating informal urban sprawl.

The histogram of the SU sizes in the two study areas (Fig. 5) shows that the frequency of SUs of nearly all size ranges increased from 2007 to 2013. Nevertheless, the highest increase can be observed for the smaller SU sizes, which already dominated in both study sites. SUs bigger than 1 ha were only present in the Takoradi area. Similar to very small buildings (<100 m²), the frequency of such large SUs did not increase considerably between 2007 and 2012.

In the Takoradi area, the remote sensing/GIS analysis identified an increase in the built-up area from 12.5% (312 ha) in 2007–19.6% (490 ha) in 2013. The number of SUs grew from 201 to 381. Though the number of SUs smaller than 500 m² was much lower than in the Bolgatanga area, it increased from 70 to 155. This SU size distribution is well in line with the perceptions of the experts, who reported fast growing informal urban sprawl areas located side by side with huge industrial compounds. While the largest five SUs of the entire built-up area in Bolgatanga covered only 13% in 2007 and 11% in 2013, the largest five SU in Takoradi covered 52% and 49%, respectively. Half of the growth of the built-up area in Takoradi between 2007 and 2013 was due to two SUs in the west. The literature supports the observed trend that large buildings are a typical pattern of urban development in the Takoradi area (e.g. Awuah & Hammond, 2014; Somiah, Osei-Poku, & Aidoo, 2015; STMA, 2013). However, the trend of large buildings was only reported by one expert for the Bolgatanga area (very low confidence).

Urban development in the Takoradi area was proceeding much faster than the small-scale scattered development in the Bolgatanga area. However, negative consequences for individuals were much more immediate in the Bolgatanga area due to the higher dependence on land for food provision through subsistence farming. Currently, based on expert statements, land parcels for agriculture are too small to feed the increasing household size of the families, and individual food crises are triggered. Local markets are poorly developed, and financial resources of farmers are very limited. Coping capacities were therefore assumed to be lower for the Bolgatanga area, which could lead to local food crises provoked by urban sprawl where land becomes useless for agriculture.

3.2. Driving forces of urban development

Our three data sets show at a high confidence level that population growth is a driving force of urban development in both study areas (Table 6a). More than 60% of the experts and more than two sources of literature confirmed this fact and provided many statements with high agreement. Expert interviews and literature analysis indicate that natural population growth and migration from rural areas due to poverty and land conflicts are the main reasons for increasing population in the Bolgatanga area, while in the Takoradi area, population growth is mainly based on migration due to employment opportunities in the industry and the servicing sectors.

In general, industry development was identified as a strong driver of urban development in the Takoradi area, particularly the oil and gas industry along the coast of Cape Three Point. This has resulted in increasing demand for settlement areas for industrial employees and workers (confirmed by >60% of the experts and more than two literature sources). Competition between industry and residential/agricultural land use was identified for the Takoradi area by both experts and literature. Zoning regulation was reported to be less strict, leading to mixed land uses, which were considered less desirable than separated land uses. Within the region, spill-overs from already congested areas were assumed to drive

Table 4
The table of confidence of findings from interviews, remote sensing and literature (Table 6a and 6b).

Level of confidence	Limited evidence	Medium evidence	Robust evidence
High Agreement	Medium	High	Very High
Medium Agreement	Low	Medium	High
Low Agreement	Very Low	Low	Medium

Adapted from Jacobs, Burkhard, Van Daele, Staes, & Schneiders (2015) based on Mastrandrea, Mach, Plattner, Edenhofe, & Stocker (2011) and MA (2005).

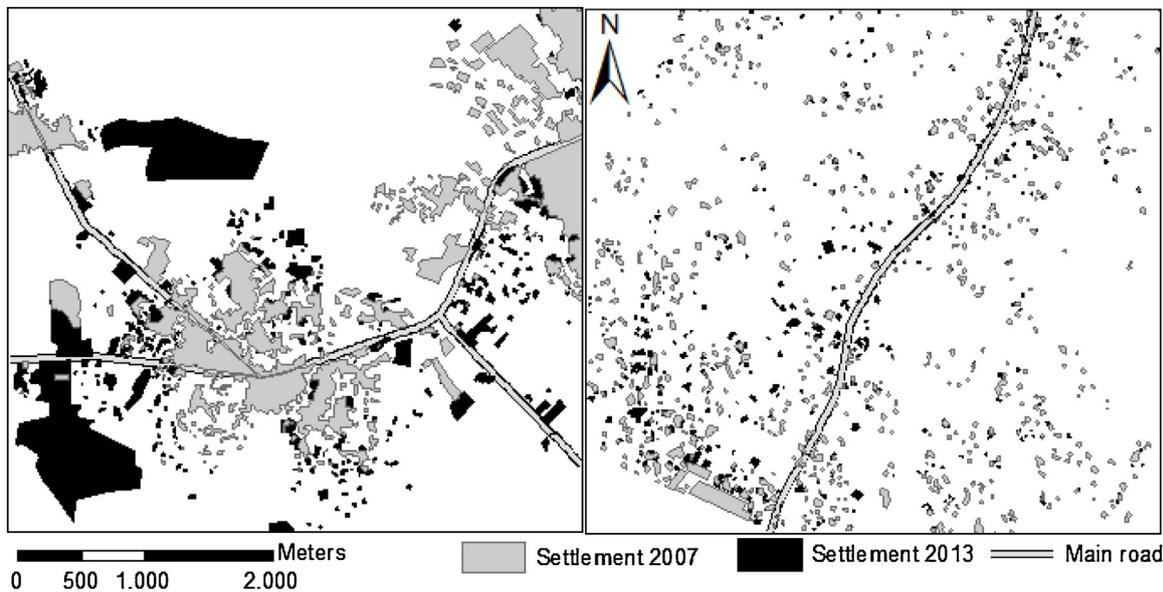


Fig. 4. Settlement expansion in a Bolgatanga subset (right) and Takoradi (left). Grey and black areas show expansion in 2007 and 2013, respectively.

Table 5
Comparison of the development of settlement pattern of Bolgatanga and Takoradi study area between 2007 and 2013.

Built-up area on the 5 km × 5 km focus areas	Bolgatanga		Takoradi	
Year	2007	2013	2007	2013
Area [ha]	91	118	312	490
Area [%]	3.6	4.7	12.5	19.6
Settlement units [No.]	873	1156	201	381
Average settlement unit size in m ²	1036	1021	15,554	12,868
SU <500m ²	371	548	70	155
SU <100 m ²	42	83	19	34

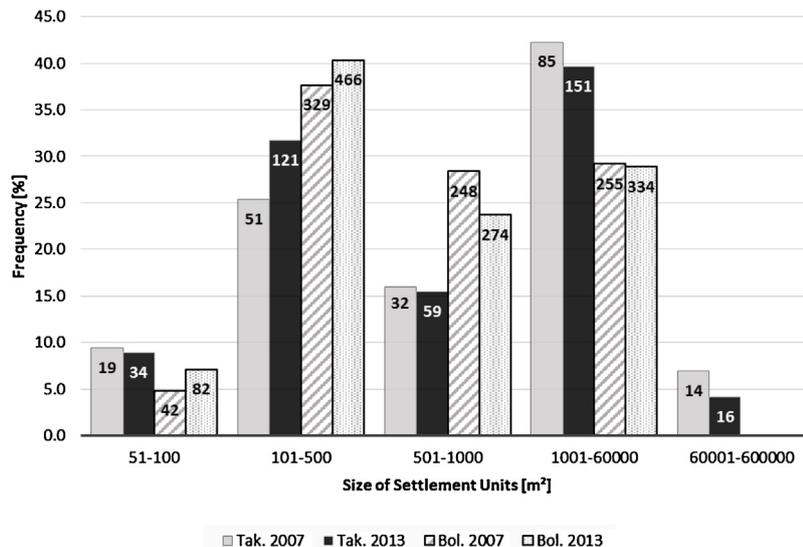


Fig. 5. Histogram of the Settlement Unit (SU) sizes in study areas for years 2007 and 2013. Overall number of SUs in the Bolgatanga area (Bol.) is much higher than in the Takoradi area (Tak.). On the other hand, large SUs can only be found in the Takoradi area.

Table 6a

Confidence of findings of patterns and drivers of urban development for the Bolgatanga area (B) and Takoradi area (T). References from literature review in Annex C; references of expert interviews in Annex D and E. For methodology see Chapter 2.2. RS = Remote sensing; B = Bolgatanga and the surrounding area including Bongo; T = Takoradi and the surrounding area including Agona; XX = high agreement; X = medium agreement; ? = low agreement; – = no data or no evidence.

Analysed topic	Keywords	Interviews		RS analysis		Literature		Confidence	
		B	T	B	T	B	T	B	T
Patterns of urban development	Urban sprawl (unstructured urban expansion)	XX	XX	X	X	X	XX	Very High	Very High
	Land fragmentation	XX	XX	X	X	X	X	Very High	Very High
	Scattered small settlement units (for RS: < 500 m ²)	X	XX	X	X	X	XX	Very High	Very High
	Scattered large settlement units (for RS: > 10.000 m ²)	?	XX	-	X	-	XX	Very Low	Very High
Drivers of urban development	Population growth (housing)	XX	XX	-	-	XX	XX	High	High
	Roads	?	X	-	-	X	X	Low	Medium
	Markets (trade and economy)	X	XX	-	-	XX	XX	Medium	High
	Mining of gold, stones or sand	-	-	-	-	X	X	Low	Low
	Agriculture	XX	?	-	-	X	?	Medium	Very Low
	Governmental buildings and staff accommodations (decentralisation processes)	?	?	-	-	?	X	Very Low	Low
	Customary land tenure	XX	X	-	-	XX	-	High	Low
	Educational facilities	XX	?	-	-	?	XX	Medium	Medium
	Heavy industry and worker's accommodations	-	XX	-	-	-	XX	No	High
	Real estate and hotels	?	X	-	-	-	XX	Very Low	Medium
	Infrastructural development in general (electricity, piped water, hospitals)	?	?	-	-	?	?	Very Low	Very Low
	Changing lifestyle	-	?	-	-	-	X	No	Low

Table 6b

Confidence of findings of challenges and opportunities of urban and peri-urban land use planning for the Bolgatanga area (B) and Takoradi area (T). References from literature review in Annex C; references of expert interviews in Annex D and E. Methodology in Chapter 2.2.; NGO = Non-governmental organisation; B = Bolgatanga and the surrounding area including Bongo; T = Takoradi and the surrounding area including Agona; XX = high agreement; X = medium agreement; ? = low agreement; – = no data or no evidence.

Analysed topics	Keywords	Interviews		RS analysis		Literature		Confidence	
		B	T	B	T	B	T	B	T
Challenges for urban and peri-urban land use planning (LUP)	Customary land tenure	XX	XX	-	-	XX	XX	High	High
	Lack of participation by people	?	?	-	-	?	X	Very Low	Low
	Lack of communication between industry & government	-	?	-	-	-	XX	No	Medium
	Distrust in government	X	X	-	-	X	X	Medium	Medium
	Governmental decentralisation	?	?	-	-	?	?	Very Low	Very Low
	Joint planning across district borders	?	?	-	-	X	X	Low	Low
	Lack of law enforcement	X	XX	-	-	X	X	Medium	Medium
	Lack of financial capacity	X	X	-	-	X	?	Medium	Low
Opportunities of urban and peri-urban LUP	Funding for urban LUP from NGOs and/or industry (biased)	-	X	-	-	-	X	No	Medium
	Land Administration Project	X	?	-	-	?	?	Low	Very Low
	Land Use Bill	-	?	-	-	-	X	No	Low
	National and Regional Spatial Development Framework	X	X	-	-	-	X	Low	Medium
	Public-Private-Partnerships (private = industry)	-	X	-	-	-	?	No	Low
	Awareness raising and local participation	XX	XX	-	-	X	?	Medium	Medium
Tendency towards multi-storey structures	-	X	-	-	-	X	No	Medium	

migration and informal urban sprawl. Real estate property and hotels were booming (medium confidence for the Takoradi area). Experts also reported the tendency to live outside the main cities due to increasing rents, pollution and traffic loads. A new town concept is evolving in Takoradi, where workers and residents are encouraged to settle outside completely built-up areas by constructing affordable, public housing in the peri-urban areas (Owusu & Oteng-Ababio, 2015).

Roads as drivers of urban development were rated with low confidence level for the Bolgatanga area and with medium confidence for the Takoradi area. For the Takoradi area, an expert reported that individuals buy parcels of land in remote areas, but have not settled there yet because most of them are waiting until access roads are constructed. For example, vacant lands towards the north of Takoradi, although unused, have been considered for industrial development once basic infrastructure such as roads and electricity are made available. In Takoradi, agricultural land area competes with industrial and residential land uses (very low confidence of agriculture as driver of urban development). Conversely, displacement was reported as an issue in the Bolgatanga area, where small-scale farmers preferred to settle close to their farmland. This activity increases land fragmentation and urban development. However, we have medium confidence that agriculture is a driver of urban development because some comments from experts and interviews were only related to land fragmentation, which does not directly lead to urban development.

An expert in the Bolgatanga area mentioned the increase in governmental buildings in the course of the decentralisation process as a factor contributing to urban development. He highlighted that the administrative role of Bolgatanga as the regional capital had increased and that new districts, such as the Bongo district, had been established. As a consequence, new accommodations for administrative staff were needed. The Ghana Statistical Service showed that splitting-up of land is also taking place on the administration level. Between 2004 and 2008, 60 new districts were created in Ghana (GSS, 2013). However, a direct link between governmental decentralisation and urban development was not confirmed by the literature (Codjoe, Badasu, & Kwankye, 2014; Lund, 2006; Owusu & Oteng-Ababio, 2015). Consequently, governmental decentralisation as a driver for urban development connotes a very low confidence level in the Bolgatanga area and a low confidence level in the Takoradi area.

Apart from roads, other infrastructural development such as electricity, schools, hospitals and water provision appears uncorrelated with urban development. Poku-Boansi & Amoako (2015) showed that in the past, the government had focused infrastructural development on fast growing urban areas, which in turn caused immigration from rural areas where public services are non-existent. They identified that in 2000, 35.4% of the population in Sekondi-Takoradi had access to hospitals within their localities, while this was reported for only 0.6% of the population of Bolgatanga. Furthermore, Poku-Boansi & Amoako (2015) argued that the scattered urban development in northern Ghana poses a challenge to infrastructure planning, since the provision of social services in localities with few residents makes the service economically inefficient. However, infrastructure for sanitation and waste management is also a general problem in cities of Ghana, including Takoradi (Owusu & Afutu-Kotey, 2010). Experts provided conflicting statements as evidence. Therefore, infrastructural development (excluding roads) has a very low confidence level as a driver for urban development in both study areas.

Even though it was not mentioned by the experts, sand, stone and gold mining form an additional driving force of urban development. Mining was mentioned several times in the literature as a driver of urban development for both study areas (for the Bolgatanga area: Agyemang, 2010; Owusu, 2009; for the Takoradi area:

AWDA, 2014; Rocha, 2012), but it appeared irrelevant from the point of view of the experts interviewed. Due to a lack of more complete information, mining as a driver had a low confidence level.

Based on the expert interviews (> 60% confirmed), the customary land tenure system was identified as an indirect driver of urban development with high confidence for the Bolgatanga area. The customary land tenure system, particularly for those lands which are based on inheritance rights, provides the entry point for urban development. Splitting-up of land into smaller parcels leads to land fragmentation, as the small parcels are not suitable for agriculture and local planning (parcel by parcel planning), but suitable for settlements (Tonah, 2005). Statutory land tenure could terminate the process of land fragmentation. In addition, chiefs and families are gradually interpreting common land as private ownership, which facilitates the selling of land for house construction (Dietz, Geest, & Obeng, 2013). However, fragmented small-scale land ownership is hard to manage by large-scale investors, since these have to convince many different owners of small parcels.

In contrast to the customary land tenure in the Bolgatanga area, individuals in southern Ghana own vast parcels of land. As it is easy for private investors to purchase large tracts of land, they are motivated to convince the few affluent people in the community. Instead of contacting the municipal authority, investors directly approach the land owners. As a result, existing land use plans contradict investors' development plans. Nevertheless, about 50% of the experts mentioned customary land tenure as a driver of urban development in the Takoradi area, a finding that could not be confirmed through literature (low confidence level).

3.3. Opportunities and challenges for urban and peri-urban land use planning

The experts named several challenges for land use planning in the study areas. Literature and experts identified customary land tenure system, distrust in the government, and lack of law enforcement as main reasons. Especially for the customary land tenure system, we have high confidence that it is not only a driver of urban development but also a challenge to land use planning as such (Table 6b). People insist on their customary land use rights, which complicates statutory planning. Poor communication and misunderstandings between government and population have led to an increase in informal settlements. Involvement of the local population in land use planning decisions is often limited to chiefs or selected representatives. However, statements from experts and literature were diverse, so that a lack of participation by people led to a very low confidence level for the Bolgatanga area and low confidence for the Takoradi area.

Challenges in the Takoradi area are the influence of non-governmental organisations or industry on urban land use planning, and the lack of communication between industry and government (medium confidence). For example, four experts of the Takoradi area pointed out that the KOICA (Korea International Cooperation Agency) and the business community (e.g. Tullow Oil) have a strong influence on the decisions of planners and town council in relation to land use priority and rezoning channelled through funding. Governmental decentralisation was contested as a challenge of land use planning by the experts and literature for both study areas. A higher financial burden as well as more governmental power and proximity to the people was transferred to district assemblies.

To counteract the challenges, the experts and literature suggested an improvement in communication channels such as radio announcements and information boards with development plans. Only when land owners are sensitised and educated regarding land use planning, and adequately compensated in the case of com-

pulsory land acquisition, will they understand the necessity for national land use planning (medium confidence). Especially for the Takoradi area, land use plans need to be developed before industries emerge, and cooperation with private companies should be enforced. Public-Private-Partnerships (PPP) were named by three experts as an opportunity for attracting investors for prospective development and covering the costs of basic infrastructure. However, literature gives contradictory statements if PPPs are conducted in the Takoradi area (Aye & Crook, 2003; Owusu & Afutu-Kotey, 2010). The World Bank Group (2015) stated that PPPs in Ghana are generally weak due to limited fiscal and technical capacity, a missing legal framework and, consequently, a lack of interest of the private sector. Therefore, we have low confidence for this area. For the Bolgatanga area, PPPs were not mentioned by the experts and were proposed by literature only for agricultural areas.

Another opportunity for the Takoradi area is the building of multi-storey structures for residences in order to efficiently utilise the limited space in the city centre (reflecting medium confidence). This would imply a change from individual ownership to statutory land ownership in order to prevent one-storey buildings of former farming communities in the city centre or to prevent uncompleted constructions due to individual financial problems. Historically, individuals (families, clans) own the land in the city centre, but they do not have the capacity to develop the land profitably.

Land use planning regulations and guidelines, for example the Land Administration Project, the National and Regional Spatial Development Framework, and the upcoming Land Use Bill were considered as opportunities for land use planning but with low confidence (apart from the National and Regional Spatial Development Framework for Takoradi with medium confidence) due to the abovementioned lack of law enforcement, inequalities and financial gaps. Similarly, decentralisation is contested as a challenge. On the one hand, it is seen as a challenge because of lacking financial capacities of local assemblies, lacking synchronisation of activities between local and regional units, and delays in the implementation of frameworks, because every district is supposed to prepare a district development framework. On the other hand, decentralisation is an opportunity because of the increased power of local assemblies.

4. Discussion

4.1. Discussion of findings

The results show that regional differences in urban development and spatial planning exist which can be traced back to colonial times and are continued by ineffective post-colonial institutions and poor governance. This finding is confirmed by Poku-Boansi & Amoako (2015) and the UN-Habitat (2008). But also customary land tenure and ignorance of people played a role. Ineffective land use planning can contribute to an increase in land fragmentation resulting in loss of land for food provision. Land use planning is the key to maintaining resources. For example, Asare-Kyei, Kloos, & Renaud (2015) studied indicators for climate change risk in northern Ghana where land use planning was seen as a national indicator for climate change risk by experts. These experts also believed that areas with effective land use plans could contribute to meeting the needs of the people whilst protecting natural resources.

Road network was less obvious as a driver of urban development, even though the general trend for West Africa is the increase in cities in the hinterlands due to the expanding road network (UN-Habitat, 2014). In the case of Ghana, that statement might be true for Kumasi as expanding city in the hinterlands, but not for Bolgatanga. Furthermore, the general infrastructural develop-

ment of electricity and hospitals, for example, as drivers of urban development could not be confirmed. Even though infrastructural improvements in the 1990s were named as the centre of attraction for Bolgatanga (Bolgatanga District Assembly, 2002), this driver can be questioned based on our findings. For example, Poku-Boansi & Amoako (2015) and also the Ghana Statistical Service (GSS, 2014b) mentioned the poor infrastructure in Bolgatanga.

4.2. Discussion of the mixed-method approach

Our approach combined three different methods to characterise processes and key drivers of urban development in two representative areas. An advantage was that we were able to compare the information provided with the three methods and thus assign confidence levels. Expert interviews and literature analysis described patterns of urban development and helped to connect those patterns with legal, socio-cultural and environmental drivers. The benefit of utilising remote sensing data consists of an objective characterisation of the physical consequences of formal and informal agreements. Furthermore, the remote sensing analysis can show either the compliance or the ignorance of legal land use planning mentioned by expert interviews and literature analysis by using small-scale buildings as a proxy-indicator for informal urban sprawl. In both areas, perceived patterns of urban development matched well with the results from interpreted remote sensing data. The extended literature review provided important sources of information for the purpose of estimating the level of confidence. Though not considered by expert knowledge, the literature reviewed that sand, stone and gold mining were drivers of urban development in both study areas. Furthermore, it questioned some of the experts' statements and supported a critical reflection of the findings. The reason for not mentioning mining as a driver could be that it is more likely taking place in rural areas, which were not in the focus of the experts.

However, the information provided by expert opinion and literature has some weaknesses. The most important weakness is the limited number of experts available for the interviews and their composition in the focus groups. Though we strived to identify the most important and relevant persons, their opinion and perceptions do not cover all potential aspects. The lower number of experts for Bolgatanga was due to non-availability of land use planners and local organisations working on land use planning. A response by the regional planner of the Upper East Region would have given us the opportunity to contextualise the regional level planning variations. The literature research was based on the keywords that we identified when analysing the interviews (Table 6a and 6b). This might have thematically limited the selection of literature. Furthermore, peer-reviewed literature was rare for the study areas. Therefore, grey literature was also used where quality could not be assessed. A single method approach might be the better choice when a lot of data and certainty exists. But even though there are weaknesses, a mixed-method approach allows us to obtain a clearer picture of an uncertain issue.

Considering the remote sensing/GIS analysis, our data set allowed a very detailed manual classification of buildings. However, the lack of the near-infrared band reduced the accuracy of classification processors, specifically in arid areas such as the Bolgatanga area where open soil features hinder a discrimination of settlement areas. The availability of a very high resolution satellite dataset including infrared or a time series with high temporal resolution could provide further details and better support a comparative overview of urban development trends for the areas under study. Furthermore, it would allow the assessment of single buildings within building clusters. Additional statistical analysis, for example of spatially explicit population census data, could have strengthened our analysis. In addition, we would have appreciated

access to local land use plans to compare zoning variations with the urban development seen in the remote sensing/GIS data. Furthermore, by developing datasets with the requisite data structures, we could use additional landscape indices to reveal further information about the spatial arrangement and heterogeneity of urban development, and to further discriminate levels of landscape fragmentation and/or aggregation over time.

We adapted the confidence level approach of Jacobs, Burkhard, Van Daele, Staes, & Schneiders (2015) to a general assessment of findings from a mixed-method approach. Our intention was to increase transparency through defined thresholds for the agreement levels as well as evidence levels. Mastrandrea, Mach, Plattner, Edenhofe, & Stocker (2011) and Jacobs, Burkhard, Van Daele, Staes, & Schneiders (2015) used the evidence levels for assessing the output from models while we focused on the amount of methods which provided information. In our case, it was necessary to adapt evidence levels to data availability and applicability. For example, we had only one set of data per location for remote sensing, for experts we had a limited number, and for literature we had a potentially limited data set due to the possible combinations and terms used for the search. It can be concluded that even the change of one statement within a method could have changed the agreement level. Considering this fact, there is still high uncertainty in our findings. As a next step in combining information from diverse methods, we suggest consideration of type and quality of methods for confidence levels.

5. Conclusions and outlook

Urban expansion, particularly informal urban expansion with small settlement units, is one of the key processes that we observed in both study areas, while particularities in land tenure, customary norms, historical development, strategic-geographical location and related economic priorities led to a different speed and pattern of urban development. For the Takoradi area, the expansion was faster than in the Bolgatanga area, which is with high confidence due to its economic vibrancy and markets. The expansion of scattered large settlement units in the Takoradi area was due to the rise of the oil and gas industry. In the Bolgatanga area, especially customary land tenure was a driver of urban development. Population growth remains an important driver of urban development with high confidence in both areas. We recommend that national land use planning needs to be adapted to respective local conditions.

The development-related separation between northern and southern Ghana has been prominent in the past and might continue in the future even though urban development in the hinterland is gaining momentum through newly developed trade and road connections (UN-Habitat, 2014). Projections of urban population in Ghana show a share of urban population of 72.3% in 2050, which would be above the average of 65.7% for all West African countries (UNDESA, 2011). Owusu & Oteng-Ababio (2015) assume that urban growth will concentrate on large cities such as Accra. In the Western Region, oil production, mineral extraction and cash cropping will further attract work migrants. By implication, agricultural activity will decline in favour of the servicing sector (Owusu & Oteng-Ababio, 2015). The government needs to provide job opportunities and affordable housing facilities while intensifying planning laws and regulations, otherwise informal urban sprawl will continue (Yeboah & Obeng-Odoom, 2010) and poverty might increase again.

Also considering the challenges of land use planning revealed by our study, customary land tenure should be one of the focal points in spatial planning. Great efforts to improve local participation and law enforcement are necessary. A key step towards this achievement is the adoption of participatory land use planning with critical adaptation to and emphasis on sectoral planning. Such a

bottom-up approach for planning with adequate compensation of compulsory acquired land could facilitate the incorporation of the development of local plans at the district and municipal levels into the respective regional spatial development frameworks. Furthermore, we see a need for an improved dialogue between district and municipal assemblies, private organisations, and civil society organisations for collaboration with regard to technical know-how and funding. The Land Use Planning Bill could help to unify laws and regulations and to support the decentralisation process, but it is just starting and must prove itself.

The flexibility in the use of confidence level analysis presents a promising approach to improve interdisciplinary research as exemplified in this study. In evaluating different data sources for a specific theme, researchers from different disciplines are confronted with having to communicate and deal with unfamiliar methods and approaches. The confidence level provides a qualitative synthesis of a team's judgement on the validity of a finding. A low confidence level depicts either data gaps or contradictory statements from the research findings, and thus helps to detect needs for refined research and data analyses before giving political recommendations for taking action.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.landurbplan.2017.02.004>.

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