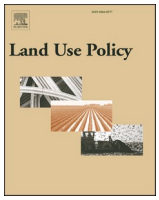
Land Use Policy 133 (2023) 106865

Contents lists available at ScienceDirect

Land Use Policy

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



Nature-Based Solutions (NBS) in spatial planning for urban flood mitigation: The perspective of flood management experts in Accra

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ARTICLE INFO

Keywords:
Naure-Based Solutions
Urban expansion
Urban floods
Urban flood management
Spatial planning
NBS integration

ABSTRACT

The rapid rate of urban expansion with its associated physical development in recent years conflicts with the urban ecosystem and the services it provides. In most Sub-Saharan African cities, rapid urban expansion often does not conform to existing spatial plans. Physical developments are sometimes carried out in unauthorized areas, contributing to urban floods. The Sub-Saharan African regions' flood management strategies mainly focus on engineering solutions but have not been fully functional in mitigating urban floods. There is a scarcity of knowledge on how urban flood-related NBS measures can be part of the spatial development in Sub-Saharan African cities for effective flood management. In order to address this gap, this study employed content and text analysis of policy documents and interviews to understand how current spatial and flood mitigation schemes in Accra, Ghana reflect possible NBS applicability and identify possible approaches to integrating NBS into existing planning schemes to prevent urban floods. The study found that Accra's spatial plans and flood mitigation schemes reflect a possibility of NBS integration. Additionally, the study unveiled techniques for integrating NBS measures and possible implementation barriers and facilitation in the Ghanaian context, which can be linked to combating the challenges that the Ghanaian spatial planning and flood management authorities face. The research, therefore, contributes to knowledge of how NBS can be integrated into spatial planning systems and flood mitigation schemes in Sub-Saharan African regions.

1. Introduction

The rapid rate of urban expansion with its associated physical development in recent years conflicts with the urban ecosystem and its services (Qian and Wu, 2019). The conflict between physical development and the ecosystem is due to the natural landscape in most metropolitan regions of the world being transformed into the prevalence of 'hard surfaces' (Kabisch et al., 2016). It is becoming increasingly noticeable that for the last two decades, the prominent feature of modern cities' growth is hard surface development (Medrano, 2019). Lee et al. (2018) highlighted that the loss of natural areas coupled with climate change factors has contributed to numerous environmental problems, including urban floods.

According to Jha et al. (2011), urban flooding has been one of the most challenging issues in cities across the globe. It is partly attributed to urbanization rates and how cities are developing (Jha et al., 2011). Urban floods are recorded every year in most urban centres, and the losses that come with them are always devastating (Stevens, 2012). Therefore, in high-income areas, attention has been drawn to adopting innovative ways to address the urban flood menace and recognize most natural areas' re-nurturing (Gustafsson and von Platen, 2018).

Lately, Nature-Based Solutions (NBS) have become one of the innovative measures to restore the ecosystem and reduce the environmental challenges in urban centres (Medrano, 2019). The European Commission (2020) defines NBS as actions inspired, supported by, or copied from nature used to address a variety of social, economic, and environmental challenges sustainably. The need for NBS is attributed to the current climate change and urban expansion being a significant challenge for most cities in high, medium, and low-income countries (Kabisch et al., 2016; Fritz, 2017).

Since the inception of NBS as a concept and its practicality, several NBS studies have been done globally. However, it seems to be most appreciated by high-income areas and has been studied and applied in multiple ways (Walters et al., 2016). For example, studies investigated the usage of NBS in climate change adaptation and mitigation, highlighted in Kabisch et al. (2016) and Fritz (2017). Also, based on

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https://doi.org/10.1016/j.landusepol.2023.106865
Received 16 January 2023; Received in revised form 20 July 2023; Accepted 11 August 2023
Available online 25 August 2023

hydrological model analysis, Gustafsson and von Platen (2018) found the application of NBS measures like small-scale wetlands and retention ponds can potentially reduce flood risk. Ferreira et al. (2021) also revealed that providing vegetated surfaces offers opportunities for evapotranspiration, water interception, and infiltration, contributing to reduced surface runoff and water pollution in cities. In contrast, medium to low-income regions, including Sub-Saharan Africa, present limited studies on NBS measures (Babí Almenar et al., 2021), especially, for urban flood mitigation. Urban flood mitigation studies in these areas are rather focused on applying engineering solutions (Soz et al., 2016).

Studies revealed that parts of the Sub-Saharan African region have had the worst urban flood impacts (Amoako, 2012). The prevailing urban flood occurrences have generated several strategies in the region to curb the situation. These strategies are influenced by studies mostly focused on engineering solutions, including dams, levees, storm drains, flood control pumping stations, walls, and others (Soz et al., 2016). However, the engineering strategies have not been fully functional in mitigating urban floods (Tauhid and Zawani, 2018).

Tauhid and Zawani (2018) attributed the non-functional engineering urban flood management strategies to the prevailing spatial planning and green loss-related challenges. The rate of urbanization in Sub-Saharan Africa in recent times has been higher than in other regions (Acheampong and Ibrahim, 2016). Urbanization is characterized by uncontrolled rapid urban expansion due to ineffective spatial planning systems and approaches (Acheampong and Ibrahim, 2016), contributing to urban floods in most African cities (Amoako and Boamah, 2014). Mustafa et al. (2018), argue that uncoordinated spatial planning tends to change the local hydrological conditions and increase flood risk in urban centres. They also highlighted that a spatial planning system that is oriented towards strict specifications and development control leads to a substantial urban flood mitigation.

Despite the relationship between uncontrolled rapid urban expansion and urban flood occurrences in the Sub-Saharan African region, there are limited green-related measures like NBS in their general urban flood management and spatial planning strategies (Tauhid and Zawani, 2018). Spatial planning systems or land use regulations that are oriented to promote green developments like NBS and increase the perviousness of urban surfaces can minimize flood risks (Mustafa et al., 2018). Studies including Perez-Molina (2019) unravel the importance of land use regulations on urban flood mitigation in some parts of Sub-Saharan Africa. However, no studies capture how urban flood-related NBS measures can be made part of the spatial development and flood management practices in the Sub-Saharan African region to prevent urban floods. In this context, how can Sub-Saharan African cities incorporate NBS measures into their physical development aimed at mitigating urban floods? Unravelling this knowledge will contribute to implementing and operationalizing NBS usage for flood prevention, especially in Sub-Saharan Africa and other medium to low-income regions.

Considering the limited knowledge on NBS usage in Sub-Saharan Africa and other medium to low-income areas, as well as the absence of green measures or natural means of mitigating urban floods in these areas, this study specifically presents approaches to integrating urban flood-related NBS measures into the spatial development and flood management practices to reduce and prevent urban flood occurrences in the Sub-Saharan African context, explicitly focusing on Accra, the capital of Ghana and one of the rapidly urbanizing areas in West Africa (Fält, 2020), battling with urban flood issues (Amoako, 2012). In this regard, this study employed content analysis to explore existing local spatial and flood management plans to reveal how they reflect the possibility of NBS integration and draw on the ideology of flood management and spatial planning professionals through semi-structured interviews to establish guidelines or approaches to facilitate NBS integration into spatial and flood management schemes in Accra to ensure effective flood mitigation. In connection with the study focus, the research hypothesised that (1) approaches employed for integrating NBS in the spatial development of high-income areas are similarly effective for NBS integration in medium to low-income areas and (2) the existence of spatial planning and flood management problems in cities is significantly associated with the challenges that impede the integration of NBS in the spatial development of cities aimed at mitigating urban floods.

This paper is structured into five sections. The second section highlights the general background of NBS, spatial planning and NBS integration principles, and urban flood management in Ghana. Section three describes the study area and elaborates on the research design, data used, and analysis. Findings are presented in the fourth section, while the fifth and sixth section discusses and concludes the study, respectively.

2. Background: NBS, spatial planning, and urban flood management

2.1. Urban flood-related NBS

Several urban flood-related NBS measures are being used worldwide, especially in high-income countries (Kumar et al., 2020). The European Commission (2015) and a state-of-the-art review by Ruangpan et al. (2020) proved that most urban flood-related NBS measures have been instrumental in minimizing floods in major cities. Accordingly, the European Commission (2015) and Ruangpan et al. (2020) reveal six NBS measures frequently used by several high-income areas to tackle urban flood situations. They include green roofs, vegetated swales, rain gardens, rainwater harvesting, detention basins, and porous pavements, and they will be the focus of this study.

2.2. Spatial planning and NBS integration

2.2.1. The concept of integration in spatial planning

The concept of integrated spatial planning was instigated by the realisation of the increasingly interdependent nature of the world (Kidd, 2007). Environmental, social, and economic components determining the functionality of cities are mostly interrelated and influenced by each other (Santos and Serpa, 2020). Integrated spatial planning, therefore, aims at the spatial development of an area that considers complexities of environmental, social, and economic challenges (Kidd, 2007). There are different frameworks developed on integrated spatial planning, some of which include Kidd (2007) and Healey (2006). Healey (2006), described a framework and distinguished four ways or actions of integrating different policies into spatial planning. These include co-ordination, framing, linking policy and action, and linking multiple actors (Table 1). van Straalen (2012) explained that in the process of introducing a new dimension to scale up the spatial planning system, Healey's framework is useful in realising the success of the integration process. Therefore, integrating NBS in the spatial development and flood management strategies in cities can conceptually benefit from such a framework.

2.2.2. NBS integration in spatial planning

The concept of NBS and spatial planning is explained by Grădinaru and Hersperger (2019) as planning an area by consolidating and promoting the development of green areas. Having the two concepts in a city's blueprint ensures coordination with other policies like climate change adaptation, water management, and flood mitigation (Grădinaru and Hersperger, 2019). Zwierzchowska et al. (2019) also highlighted that green and sustainable planning ensures physical development is always in line with green areas' growth. The characteristics of NBS and spatial planning in cities help reduce environmental-related challenges, including urban floods (Grădinaru and Hersperger, 2019). In the process of connecting spatial planning and NBS, UK Green Building Council (2021), Sarabi et al. (2020), and Kopsieker et al. (2021) made suggestions on six main principles and strategies for including NBS in spatial planning to ensure sustainable development of cities. The first strategy covers defining the ambition of applying NBS in cities, thus, identifying

Table 1
Healey's framework for integration.

		Type of Integration	Meaning
A		*Co-ordination*	
	A1	Aligning	Fitting into other policies and strategies
	A2	Co-aligning	Manual adjustments among diverse strategies
	A3	Multilevel co-aligning	Manual adjustments both vertically and horizontally
B		*Framing*	
	B1	Widening a policy frame	Extending an existing frame to encompass a new dimension
	B2	Creating a new frame or vision	Developing a new policy focus and discourse
	B3	Creating a place-focused policy frame	Focus specifically on place qualities and spatial organisation
C		*Linking policy and action*	
	C1	Policy and delivery	Connecting policy assertions to a specific delivery mechanism
	C2	Regulation and investment	Linking principles governing land use regulation to those governing development investment
D		*Linking multiple actors*	
	D1	Involving	Drawing the community and key stakeholders into the plan-making process
	D2	Sharing knowledge and ideas	Drawing on and developing knowledge with stakeholders
	D3	Sharing ownership	Developing a shared commitment to the content and legitimacy of a plan/strategy

Source: Healey (2006)

the purpose of using NBS. The second strategy highlights assessing the possible impacts of the NBS, thus, examining the NBS to determine its functionality and quality. The third strategy also covers the maximization of multifunctionality, thus, creating an interconnection of the NBS and other practices. Cost-benefit and funding of the NBS make up the fourth strategy. The fifth strategy hammers on creating a long-term management plan for the NBS, while the final strategy highlights collaboration, education, and innovation. Kopsieker et al. (2021) and Sarabi et al. (2019) further highlighted that issues such as financial delays, lack of institutional collaboration, and poor knowledge base could hinder the smooth implementation of NBS in the European region, while, stakeholder partnership, provision of economic incentives, and local people involvement is crucial in stimulating NBS usage in the European region (Sarabi et al., 2019).

In addition to the aforementioned studies conducted in the UK and the European region, Olander et al. (2022) have also emphasized the importance of accelerating the adoption of NBS in US cities. Their recommendations include prioritizing research to determine the optimal implementation of NBS in different urban contexts, providing education and capacity building for federal agencies, integrating NBS in the design and management of federal facilities, updating policies to include legal processes for NBS usage, and securing domestic and international funding for NBS initiatives.

In the Oceania region, Bush et al. (2023) have outlined approaches for mainstreaming NBS in Australian cities. They include designing NBS solutions tailored to address local climatic conditions, integrating NBS with conventional measures to offer multifaceted solutions, critically analysing past, present, and future ecological injustices, considering local factors like urban form and socio-cultural practices through collaboration among different stakeholders, and incorporating indigenous knowledge to decolonize the design and management of NBS.

Lechner et al. (2020) and Morita and Matsumoto (2021) have also shed light on the nature of NBS integration in Asian cities. They highlight the significance of incorporating NBS in urban planning through legislation and effective enforcement, investing in infrastructure, providing extensive education and communication about the benefits of NBS, coordinating various institutions, and leveraging indigenous knowledge to inform decision-making processes and maximize the effectiveness of NBS. They further elaborated that, challenges such as population density, land acquisition issues, political interference, and existing implementation challenges can potentially hinder the successful adoption of NBS in Asian cities.

2.2.3. Spatial planning in Ghana

In Ghana, the Land Use and Spatial Planning Act, 2016 (Act 925) provides a mandate to the Land Use and Spatial Planning Authority (LUSPA) to see to the overall orderly spatial planning in the country. The spatial planning is done at three major levels and thus, has a three-tier planning system. The first is national and the regional. On the national, Act 925 gives a mandate to LUSPA to prepare a National Spatial Development Framework (NSDF). The NSDF becomes part of a comprehensive National Development Plan that seeks to ensure the overall development of Ghana. The Regional LUSPA offices also develop a Regional Spatial Development Framework (RSDF) seeking to control the development of land use areas in the region. The NSDF inspires this plan. The second tier is the structure plan prepared in accordance with the RSDF by LUSPA metropolitan, municipal, and district offices. The structure plan highlights the district or municipality's broad land use structure. The third tier is the local plans prepared on a neighbourhood or community basis. With this, the specific form of regulations and land development are narrowed to individual plot levels. The local plan is the plan that usually provides the basis for the decision-making about building permits which developers submit to the district authorities to ask permission before any physical development happens (Government of Ghana, 1993).

2.3. Urban flood management in Ghana

The overall urban flood management framework is highlighted in the Ghana National Disaster Management Plan. It is designed and formulated at the national level by the National Disaster Management Organisation (NADMO). The National Disaster Management Act 1996, Act 517, establishes NADMO and gives them the mandate to prepare the National Disaster Management Plan for all disasters in Ghana, including urban floods. Implementation of the management plan and other related activities are executed at the local or metropolitan/municipal/district level by the NADMO district offices, metropolitan/municipal/district assemblies, the Land Use and Spatial Planning Authority (LUSPA), Hydrological Service Department (HSD) district offices, among others. At the regional level, involved institutions harmonize and coordinate plans and activities at the metropolitan/municipal/district level. There are four main stages in managing disasters in Ghana: preparedness, response, recovery, and mitigation/prevention (Flanagan et al., 2020).

Harnessing the mitigation/prevention stage, which is the focus of this study, there is a wide range of plans, interventions, and projects to deal with Ghana's urban flood menace. Plans like metropolitan/municipal/district land use and structure plans prepared and implemented by the districts/municipal LUSPA prevent developers from building in waterways and environmentally sensitive areas (TCPD.. n.d.). Also, there are construction and maintenance of storm drain projects carried out by the HSD and the municipal assembly. There are also clearing, dredging, and desilting of rivers and drains activities, which are also done annually (Nansam-Aggrey, 2015). Furthermore, there are resettlement projects to relocate slum dwellers living on rivers' banks (TCPD.. n.d.). The above-mentioned plans, projects, and activities are primarily engineering-inclined, and they are all geared towards mitigating urban floods in Ghana.

3. Methods

3.1. Case study justification and description

Uncontrolled rapid urban expansion is also evident in major metropolitan areas in Ghana, including Accra and Kumasi (The World Bank, 2015; Cobbinah, 2017). The Greater Accra Metropolitan Area (GAMA),

for example, accommodates about 25% of Ghana's urban population (Ghana Statistical Service, 2014a, 2014b), and it is attributed to the socio-economic prospects that the city presents, which resulted in high in-migration in the metropolitan area. The high in-migration caused about a 35% increase in the area's physical expansion between 1985 and 2015 (Ministry of Environment et al., 2017). Interestingly, about 20% of GAMA's urban expansion has been observed in the Ga East Municipality (Amfo Otu et al., 2012). The municipality's expansion comes with hard surface development, including roads, pavements, buildings, and other structures.

As developments are spreading in the municipality, developers put up structures that are not adequately checked, resulting in undesirable erected structures (Acheampong and Ibrahim, 2016). The enforcement of spatial plans in Ga East has been a great challenge, retarding the quality of physical development (Acheampong and Ibrahim, 2016). This increasing anomaly has contributed to the free flow of water through rivers, infiltration capacity, and water runoff on urban surfaces contributing to urban floods (UNCT Humanitarian Support Unit, 2015). In recent years, areas that were free from floods some time ago are now recording flood events (Ackom et al., 2020). The municipality is, therefore, one of the significant areas in GAMA that can benefit from using urban flood-related NBS measures to minimize its increasing flood events taking into consideration the physical expansion rate in the area, and therefore selected for this study.

Ga East Municipality is one of the sixteen municipalities making up GAMA. It is one of the fast-developing areas in GAMA, with an estimated 2020 population of about 200,000 and a total land area of 83.5 km^2 (Ghana Statistical Service, 2014a, 2014b). It is situated in the northern part of GAMA, bordered by Ga West Municipality to the west, Akwapim South District to the north, Adentan Municipality to the East, and Accra Central (AMA) to the South (see Fig. 1).

According to Ghana Statistical Service (2014a) (2014b), the municipality forms part of the Savannah ecological zone with an annual rainfall pattern of around 730 mm. The municipality's average temperature ranges between 25.1 °C in August, the coolest, and 28.4 °C in March, the hottest, with an average of 26.8 °C (Ghana Statistical Service, 2014a, 2014b). The municipality experiences two rainy seasons, the same as the entire country. The area's relief is generally gentle, with undulating features in some parts having heights ranging from 42 to 374 m. The major rivers that run through the municipality include Sesemi, Dakubi, and the Odaw River.

3.2. Study Approach

The study adopted a case study approach and mainly qualitative methodologies to answer the research questions and achieve the research objectives. In this regard, this study was inspired by theories in spatial planning integration, for instance, Healey's integration framework to weigh the possibilities of integrating NBS in spatial development and flood mitigation actions in the Ga East. Content and text analysis were used to analyze spatial and flood management plan documents and transcribed interviews conducted with flood management and spatial planning professionals. The subsequent sections explain research steps, data sources, collection, and analysis methods.

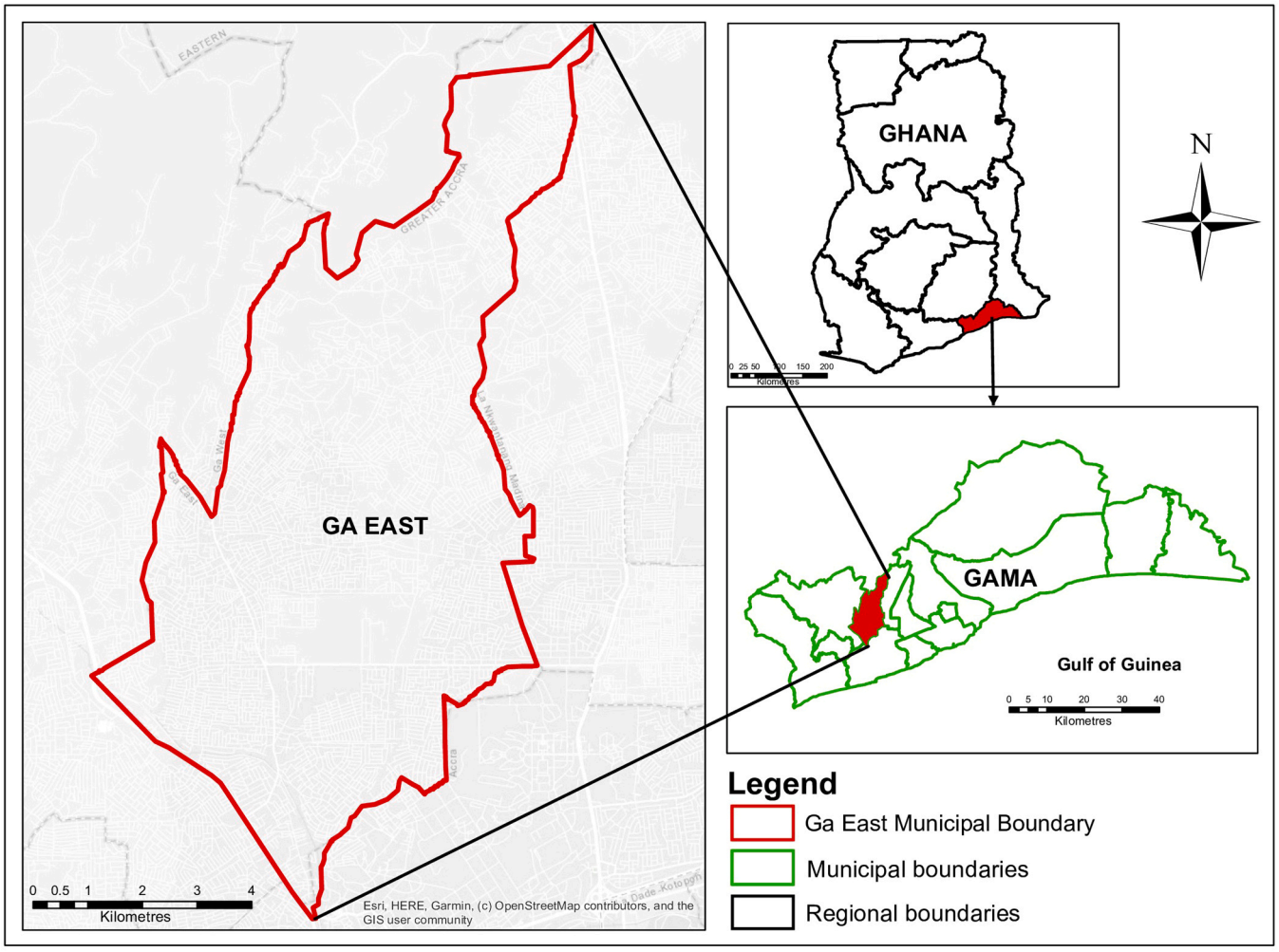

Fig. 1. Context map of Ga East Municipality. Sources: CERGIS-University of Ghana, ESRI, OSM.

3.2.1. Research steps

At the initiation of this study, an analysis of spatial and flood management plans was conducted to explore the extent to which the existing plans in Ga East could facilitate the integration of NBS. The detailed process of the plan analysis is outlined in Section 3.2.4. Additionally, semi-structured interviews were conducted with professionals in flood management and spatial planning to gather their insights on potential approaches for NBS integration. The methodology employed for conducting the interviews is described in Section 3.2.3. Subsequently, the interviews were transcribed and analysed, as detailed in Section 3.2.4. The findings from the spatial and flood management plan analysis, as well as the interview analysis, were then compared with existing spatial planning integration theories and principles to assess their alignment with theoretical perspectives. The subsequent stages of the research involved comparing the study results through an examination of relevant literature on NBS integration in other regions to highlight the study's validity, followed by a comprehensive discussion and conclusion of the study. An overview of the research steps is presented in Fig. 2.

By adopting these methods, a deeper comprehension of the spatial planning system in Ga East can be achieved by identifying specific components of spatial plans that can stimulate NBS integration as well as enabling the utilization of indigenous knowledge to identify viable approaches for integrating NBS and mitigating floods. Furthermore, comparing the study findings to the global context will serve to affirm the study's significance, supported by evidence from around the world.

3.2.2. Data sources and collection

To achieve the research objectives, both primary and secondary data were used. Primary data concerned opinions of urban flood management and spatial planning professionals (key informants) regarding NBS integration. This was obtained through semi-structured interviews done both online and face-to-face. The secondary data included spatial plans and flood management documents (Table 2) obtained from government institutions.

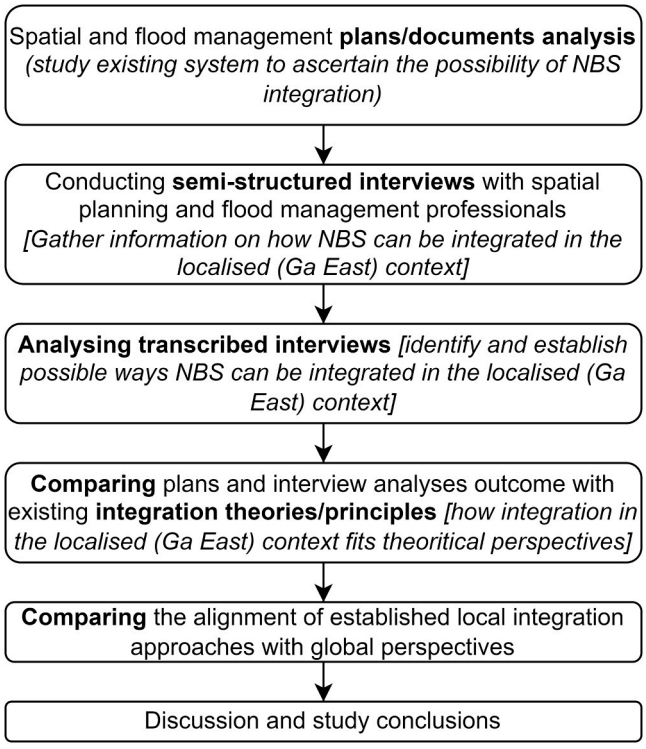

Fig. 2. Overview of research steps.

Table 2
Spatial and flood management documents used.

Name of document	Year	Institution
Greater Accra Spatial Development Framework (GARSDF) volume 2	2017	Land Use and Spatial Planning Authority (LUSPA)
National Zoning Guidelines and Planning Standards	2011	Land Use and Spatial Planning Authority (LUSPA)
Ghana National Disaster Management Plan	2010	National Disaster Management Organisation (NADMO)

3.2.3. Semi-structured interviews and sampling technique of key informants

Semi-structured interviews were conducted with key informants on how urban flood-related NBS measures adopted for this study can be integrated into spatial plans and flood mitigation schemes. The study employed Semi-structured interviews because they help in extracting targeted and relevant responses and views from respondents on a subject and geographical area (Rahman, 2019), in our case, concrete suggestions on how NBS measures can be part of Accra's spatial planning and flood mitigation schemes, specifically in the Ga East Municipality. Interviews covered the key informant's institution and role, their general knowledge of urban floods, and NBS, including integration strategies. Purposive sampling was used to select the key informants who are professionals involved in the management of urban floods and spatial planning in the Ga East municipality, specifically, planners, engineers, or technical officers working in flood management institutions.

Online interviews were conducted with 4 key informants from the respective institutions. Additionally, 6 key informants' interviews were held face-to-face with the help of a field assistant due to internet connection limitations. The duration of the interviews was approximately 45–60 min, and the interviews were transcribed afterwards. just.

3.2.4. Content and text analysis

This study employed qualitative content analysis, supported by Atlas.ti software to explore how existing spatial and flood management plans for the Ga East and Accra reflect a possibility of NBS integration and interpret the views of key informants on the integration of NBS measures in the Ga East. Utilizing White and Marsh (2006), this approach goes beyond just counting, for example, the keywords or extracting the objective in a document to examine its meaning or pattern. It helps to better explain how the specified NBS measures can be

Table 3
Institutions of key informants.

Key informant ID	Institution	Number of interviewees	Portfolio
Municipal level			
1	Ga East Town and Country Planning Department (TCPD) – Municipal LUSPA	1	Spatial planner
2	Ga East Municipal Works Department	1	Engineer
3	Ga East Parks and Gardens Unit	1	Technical officer
4	Ga East NADMO Office	1	Technical officer
5	Ga East Department of Urban Roads (DUR)	1	Engineer
6	Ga East Environmental Protection Agency (EPA)	1	Environmentalist
National level			
7	TCPD Head Office – Now Land Use and Spatial Planning Authority (LUSPA)	1	Spatial planner
8	NADMO Head Office	1	Technical officer
9	Department of Urban Roads (DUR) Head Office	1	Technical officer
10	Hydrological Service Department (HSD) Head Office	1	Engineer

integrated into spatial planning and flood mitigation in diverse ways for the context of Accra, Ghana.

First, the Spatial Development Framework document for the GAMA and the Zoning Guidelines and Planning Standards document, covering the Ga East Municipality, were analysed. The documents were analysed to understand how the existing spatial planning and flood management system works (is supposed to work) concerning NBS. Getting the existing planning system understanding helps also to identify a potential connection with integration components in theory like the co-ordination (aligning, etc.) ideology of Healey's. Hence, areas within the planning system could be spotted to fit in and adjust to suit and promote NBS usage.

An operational definition for NBS, inspired by Cohen-Shacham et al. (2019) was used to identify NBS-related content in the spatial and flood management documents. For this analysis, the study defined NBS as a stated principle in the plan that ensures and encourages activities to increase, promote and preserve natural areas in cities. Therefore, this definition was applied in categorizing the principles, and key statements in the spatial and flood management plans into three groups; Group A, B, and C. Group A covers elements and principles that seek to preserve and protect green areas, including environmentally sensitive areas. Group B also covers related statements and principles that tend to create green-related areas, including gardens, parks, etc. Group C refers to specifications that are unrelated to the protection of natural areas and the promotion of green areas but may have a possibility of indirectly supporting nature protection and green development practices.

The second step involved analyzing the transcribed interviews. This was to extract professionals' perceptions of what needs to be done to make urban flood-related NBS part of Ga East spatial development to contribute to urban flood reduction. The ideas perceived by the key informants help to propagate a connection of extending or developing a new policy focus, connecting some policy assertions and their implementation and how they connect to integration components in theory like the co-ordination, framing, linking policy and action and linking multiple actors' element of Healey's framework.

The transcribed documents were uploaded into Atlas.ti, and were grouped according to the key informant institutions and key informant ID. The transcribed interviews were coded (open) to extract information about the key informants' ideology and views pertaining to NBS integration in the Ga East municipality. Hence, an inductive approach was used to analyze the transcribed interviews and coded them on different themes. They included techniques adapted to integrate the NBS measures in spatial and flood mitigation schemes, factors that could facilitate and hinder the NBS measure's implementation, and how key informants see the easiness of implementing the specified NBS measures. Fig. 3 shows an illustration of the study analysis. All interviewees' profiles were anonymously treated throughout the study to ensure their privacy rights were duly observed and interview data were archived in the author's university's file repository and google drive and personal hard disks which are only accessible to the paper authors.

4. Results

4.1. Analysis of NBS in spatial and flood management plans

According to GARSDF, the Ga East Municipality is broadly zoned as residential. Even though the municipality is broadly residential, other land uses exist like open spaces, industrial, commercial, educational, civic, and cultural, including other infrastructure and transportation facilities. The GARSDF indicated that all physical developments should align with the specifications highlighted in the national zoning guidelines and planning standards.

The national zoning guidelines and planning standards provide detailed instructions and specifications on Ghana's approved components of any physical development that is carried out. All physical developments carried out in the Ga East Municipality are also bounded by the principles stated in the national zoning guidelines and planning standards. Table 4 gives an overview of the analysis of the principles highlighted in the zoning guidelines and planning standards in relation to Group A, B, and C of NBS themes explained in Section 3.2.4.

On flood management, The National Disaster Management Plan guides NADMO in ensuring that all disasters, including urban floods, are properly managed. The plan's main objective is based on the effective coordination of flood management actions among respective institutions. Table 5 presents an overview of the plan analysis.

Based on Table 4, five out of the nine principles in the spatial plan's specifications on group A and B NBS elements exhibit a strong reflection of possible NBS integration in the spatial development or redevelopment of Ga East and Accra. However, the flood management plan highlighted in Table 5 presents only two out of the six principles of group A and B NBS elements. Focusing on the Group C elements, especially in the flood management plan, they present imprints of the "co-ordination"

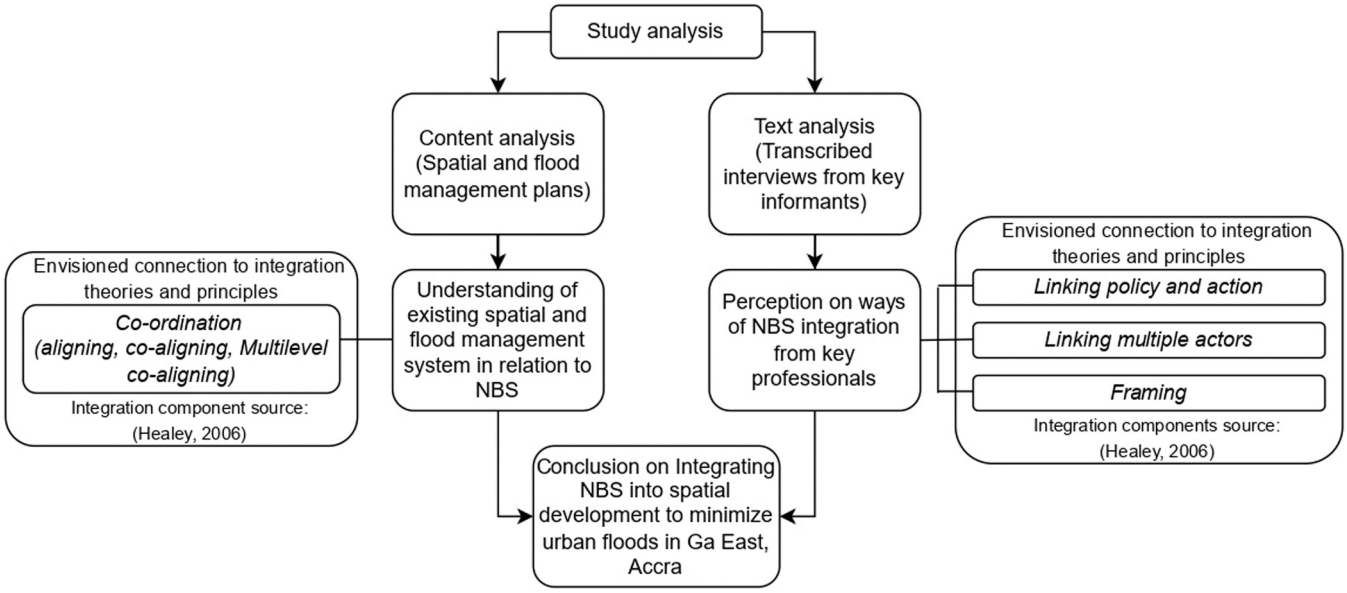

Fig. 3. Structure of study analysis.

Table 4
Overview of the national zoning guidelines and planning standards concerning Group A, B, and C NBS themes.

Domain	Principle /section	Description	NBS Theme	Remarks/specification
Site development	Site planning	Involves preparing plots for a building or structure to be put up	Group A and B	The document highlights that developers should include landscaping not less than 2 m wide on a plot for a building or any structure
Land uses	Development of open spaces and buffers	Includes parks, gardens, sports centres, and other recreational areas	Group A and B	The document highlights no development for sports, etc., should be erected very close to rivers and environmentally sensitive areas. Thus, development can only be done from 30 to 60 m and 10–20 m away from rivers and forest areas, respectively
	Residential development	Involves the putting up of buildings as homes	Group B	The document highlights that developers should make space for the open area(s) in the design of a residential area or building. These areas can be used as a playground and public gatherings
	Development of civic and cultural areas	Comprises health facilities, churches, offices, among others	Group B	The document specifies hospital facilities should have landscaping around to enhance natural thermal comfort and aesthetics
	Development of commercial areas	Comprises markets, shopping malls, and other shop complexes	Group C	No greenery specification
	Development of industrial areas	Consists of manufacturing, oil and gas, warehouse	Group C	No greenery specification
	Development of educational areas	Comprises constructing schools and other training facilities	Group C	No greenery specification
Infrastructure/ Transport	Development of transportation facilities	Transportation facilities in this context consist of roads, pavements, and parking lots	Only group B NBS	The document specifies that highways and urban roads must have medians of about 5–10 m and have buffers for future road expansion
	Water and electricity	The building of pipe-borne and borehole facilities as well as putting up high-tension lines and transformer stations	Group C	No greenery specification

component of Healey's framework. Principles like plan review, awareness creation, research and institutional co-ordination will be advantageous to fitting NBS into flood management policies and strategies and making manual adjustments as well.

4.2. Integration of the specified NBS measures

The key informants' views helped get insights into the issues that will make the specified urban flood-related NBS measures (green roofs, vegetated swales, rain gardens, rainwater harvesting, detention basins, and porous pavements) integration a reality in the context of the Ga East Municipality. Based on the ten key informants' interviews, specific core NBS integration techniques and situations that could hinder or facilitate implementing the measures were revealed as follows.

4.2.1. Integration techniques for the specified NBS measures

The analysis revealed four main NBS integration techniques in the context of the Ga East Municipality. The techniques include piloting the specified NBS measures, public education and sensitization, a combination of NBS with existing practices and flood projects, and legal obligation and re-strategizing enforcement of plans.

4.2.1.1. Piloting the NBS measures. In making the specified NBS measures part of the municipality's spatial development and flood mitigation, key informants suggested, piloting the measures before their implementation. The specified NBS measures must be implemented in a few selected locations in the municipality to determine how effective they will be in reducing the rate of flood occurrences. The piloting is to ascertain the functionality of the measures. The outcome of the piloting will then be the basis for implementing the measures throughout the municipality. Further explanation revealed that piloting would be necessary since NBS measures like green roofs, vegetated swales, rain gardens, detention basins, and porous pavements are not common in the Ghanaian horoscope. This piloting technique also describes the co-ordination approach in Healy's framework. Thus, testing the alignment of NBS and its suitability in the Ga East Municipality as a basis to make adjustments to existing policies and strategies.

4.2.1.2. Public education and sensitization. According to key informants, it is essential to make the specified NBS measures well-known and educate the public and developers on how they work. This is also in connection to the unpopularity of green roofs, vegetated swales, rain gardens, detention basins, and porous pavements. A measure like rainwater harvesting, however, seems to be familiar to several households in the Ghanaian context termed as "rain gutters" but its design and usage hardly contribute to flood reduction. Hence, flood management institutions, developers, and the public must be educated on the need to have some of the specified NBS measures and how they are appropriately designed and constructed to prevent floods. Adapting this sensitization approach explains linking multiple actors' components of Healey's framework. Thus, sharing of knowledge and ideas on the specified NBS to all stakeholders and the local people to draw all actors and create a commitment mindset in using NBS.

4.2.1.3. Combination with existing practices and flood projects. Another integration technique revealed by key informants is combining the NBS measures with traditional flood mitigation and other physical development practices. Measures like vegetated swales present the advantage of natural infiltration that normal drains do not have. Hence, vegetated swales will be a meaningful measure alongside drain construction to effectively manage water flows and reduce the rate of urban floods in the municipality.

Additionally, the key informants explained, traditional ways of "rain gutters" and backyard gardens can be upgraded and used as modern rainwater harvesting and rain gardens. The purpose of the already existing "rain gutters" in various homes in the Ga East Municipality is not necessarily linked to reducing runoff volume. Instead, they use it to obtain water for domestic use. Mostly in poor water supply areas, various homes use barrels to collect water from roofs anytime there is rain. With this, more water volumes still end up on the ground. Only a few houses in the municipality have a well-constructed system that connects roofs to underground storage. In this sense, how individuals harvest rain can be improved to effectively meet international design for rainwater harvesting standards to reduce runoff depth. Also, developers, especially in the municipality, mostly convert portions of their compounds into mini gardens where they sometimes grow fruits, vegetables, and herbs for domestic consumption (UN-HABITAT, 2011). The backyard gardens can be upgraded to meet the rain garden specifications to help reduce runoff depths and prevent floods.

The combination approach also reflects the co-ordination element in

Table 5
Overview of the Ghana National Disaster Management Plan 2010.

Domain	Principle /section	Description	NBS Theme	Remarks/ specification
Administrative	Institutional coordination	Creating a well-coordinated programme for agencies and departments involved in disaster (flood) management	Group C	The document specifies harmonizing the activities and functions of different institutions
Land use	Hazard mapping	To identify ecological and built environment sites prone to hazards (flood) to guide other policies and legislation nationwide	Group A	The document specifies the mapping of all areas prone to different hazards to ensure effective land use (spatial) planning and develops safe havens for disaster (flood) emergencies
	Rehabilitation, resettlement, and reconstruction	Remaking of disaster (flood) affected communities	Group A and B	The document specifies the relocation of communities or people living in flood-prone areas for redevelopment
Innovation	Awareness creation/ training	Providing education for all flood management stakeholders and creating awareness	Group C	The document specifies education and awareness creation are geared toward emergency response functions
	Plan review	The periodic review of the disaster (flood) management plan	Group C	The plan review is geared towards mainstreaming and promoting a comprehensive disaster (floods) risk reduction culture
	Research	Conducting studies on disasters (flood)	Group C	The plan specifies research to be conducted to assess the socio-economic effect of the various disasters (floods) to aid training purposes

Healey's framework in a way of joining and harmonizing the NBS measures with "rain gutters," backyard gardens and drain construction activities. This will also aid in the realization of NBS in spatial and flood management actions.

4.2.1.4. Legal obligation and re-strategizing enforcement of plans. The key informants also indicated the use and application of the specified NBS measures must be part of the legal codes for any physical development and re-strategize how plan enforcements are managed. Before granting a development permit in Ghana, developers submit their development design to the LUSPA office within their municipality or district for processing and checks by the Statutory Planning Committee of a district or municipal assembly. In the processing, the committee checks whether the development design conforms with prepared local plans and other details like the consideration of building lines, sub-division of the plot, and orientation of the development. Hence, the key aspects checked in the development design, can also include the presence of specified NBS measures.

Key informants further explained making NBS usage a legal obligation should not be an end point. Rather, re-strategizing existing plan enforcement mechanisms should be the next stage. Enforcement of laws guiding the spatial development of the Ga East municipality and Ghana has been challenging. It is currently one of the major problems retarding the orderly physical development of major neighbourhoods in the municipality with irregularities such as building in waterways, river buffers, and wetlands, encroachment on road spaces, farmlands, and other forest areas, as well as the non-adherence of including landscaping in physical developmental projects. Political pressures mostly inspire the mentioned irregularities and make up the non-functioning of plan enforcement schemes. In this regard, re-strategization of the existing enforcement mechanism could be achieved, for instance, by making it free from political pressures. Thus, making spatial planning institutions autonomous without facing any intimidation from political forces.

The technique of Legal obligation and enforcement re-strategizing explains the linking policy and action component of Healey's integration framework. Thereby, the principles of land use and other related regulations will include NBS specifications and the various mechanisms of implementing the NBS will also be modified in the Ga East.

4.2.2. The integration barriers and facilitation of the specified NBS measures

There are important factors that can either hinder or facilitate the successful integration of the specified NBS measures in the spatial development and flood management actions in the municipality. Analysis revealed four major aspects/domains that could unearth the integration barriers and facilitation. These aspects revolve around economics or finance, land acquisition, institutional coordination, and knowledge base and local people's interest. Tables 6 and 7, therefore, give an overview of the barriers and facilitation measures in the integration process for Ga East.

Considering Tables 6 and 7, the provision of government subsidies will help solve economic-related problems that could hinder NBS integration. Additionally, attractive compensation packages could also deal with land-associated barriers. Effective institutional collaboration could also eliminate the uncertainties among the various flood management institution, which will be advantageous in integrating the NBS measures. Furthermore, involving the locals through sensitization and other training ventures will build the interest of people in the usage of the NBS measures, which will solve the problem of low interest in the use of the NBS.

4.2.3. Easiness in integrating the specified NBS measures

Based on the economic, land acquisition, and lack of expert knowledge-related issues that could hinder the smooth integration of the NBS measures, key informants underlined difficulties in implementing detention basins and green roofs (see Fig. 4). On the other hand, based on some existing practices that are similar to some of the specified NBS measures, key informants generally highlighted that it would be easy and possible to implement porous pavements, rainwater harvesting, rain gardens, and vegetated swales (see Fig. 4).

4.3. The relation between spatial and flood management schemes and key informants' assertion on NBS integration in the Ga East

Spatial plans that guide Ga East and Accra's physical development

Table 6
Overview of the specified NBS integration barriers.

Domain	NBS integration barrier code	Description	Support statement from key informant	Related specified NBS measures
Economic/ finance	Existing flood mitigation project finance issues	There exist inadequacy and delay in the release of funds to flood management-related institutions to carry out their mandate.	*"The main challenge we face is financial. Sometimes, we must wait for the government to approve and release funds before we carry out specific task. At times, there might be a need to maintain and fix sections of roads in the municipality but due to the delay and unavailability of funds we are not able to carry out the maintenance works. These maintenance works also come with fixing the drains that will help prevent floods." – key informant 5.*	Links to all the specified NBS measures.
	Cost requirement of the specific NBS measure	Some of the specified measures are very expensive to establish. People might not be interested in spending additional costs on the construction of some of the specified NBS measures.	*"Green roofs, implementation might be very difficult because most housing developments are done on individual basis and some people mostly in the city are just looking for places, they want to put their head. So, they might not be interested in doing a project that will put some additional cost on their expenses." – key informant 10.*	Links to green roofs, rainwater harvesting, rain gardens, and detention basins.
Land	Land unavailability	The Ga East Municipality is almost covered with built-up urban structures according to land cover studies. Implementing the specified NBS measures will also require land. This land unavailability could be a barrier to implementing some of the specified NBS measures.	*"Currently, the entire municipality is almost built-up, and the way buildings have been put very close to roads leaves no space for to implement the swales." – key informant 10.*	Links to Vegetated swales, rain gardens and detention basins.
	Political interference in land acquisition	Unexpected influences from political leaders and property owners sometimes interrupt institutions from acquiring land for urban flood mitigation-related projects. Even though there exist regulations like The State lands Act, 1962 (Act 125), giving mandate to the government to compulsorily acquire lands in the nation's interest to carry out developmental projects.	*"Sometimes we have to change the designs of roads because we could not reach an agreement with property owners. This disagreement normally happens when the property owners have political aids. As an institution, we have the power by law to acquire lands that are of national interest, but because of the political influences, things do not happen as planned". – key informant 9*	Links to detention basins and vegetated swales.
Institutional coordination	Poor communication and coordination of activities	There exist poor communication and coordination of activities among flood management institutions. This sometimes affects the smooth implementation of flood-related projects.	*"Some institutions carry out projects including drainage management without consulting us. Sometimes this results in an uncoordinated development of stormwater management systems which invariably sometimes do not contribute to benefiting from stormwater systems as its intended". – key informant 10*	Links to all specified NBS measures.
	Different interests from the various institutions	There exist different interests in terms of organisational schedule, structure, and activities among institutions. This has also affected the smooth implementation of the flood-related project and could also be a hindrance to the integration of the specified NBS measures.	*"In the collaboration process, everyone has their vested interest. So, everybody tries to tune the engagement to suit their interest. When this happens, it becomes difficult to bring other organizations on board and expect them to work towards a common goal when they have different directives." – key informant 9.*	Links to all specified NBS measures.
knowledge base and local people's interest.	Little or no expert knowledge and less interest from local people	Lack of experts and little knowledge about the specified NBS measures is likely to diminish the development of interest local people have in the usage of the NBS measures.	*"For now, it might be very difficult to apply some NBS measures like green roofs in our system because we do not have experts in the country who have high knowledge in applying them." – Key informant 8.*	Links to all specified NBS measures.

portray a high potential of NBS integration in relation to group A and B NBS definition adapted for this study. However, the lenses of group A and B definitions seem to be relatively weaker for the flood management plan. Nevertheless, according to key informants and inferences from Poku-Boansi et al. (2020), flood management activities like the prevention of encroachment and developments close to rivers and demolishing of buildings, properties, and other structures built in waterways and other environmentally sensitive areas by the Town and Country Planning Department (TCPD) and Environmental Protection Agency (EPA) have imprints of group A and B NBS. Thus, they ensure natural areas' protection and conservation and make space for green development.

In relation to the key informants' assertions, certain levels of initiative could be adapted taking into consideration the spatial and flood management plans. First, with the research specification highlighted in the flood management plan, the technique of piloting can be part of disaster-related research conducted. Hence, the research outcome will be a basis for the uncommonly specified NBS measures to be implemented on a full scale.

Secondly, the technique of public education and sensitization, as mentioned by key informants can be captured in the principle of training and awareness creation in the flood management plan to enlighten the public on the importance of using and designing the specified NBS measures for flood prevention in various neighbourhoods. This could be beneficial to NBS measures like green roofs, vegetated swales, rain gardens, detention basins/ponds, and porous pavements which are seldomly known in the municipality and the Ghanaian context.

Additionally, the technique of legal obligation and re-strategizing plan enforcement stated by key informants throws more light on the strength and capabilities of the existing spatial planning and flood management schemes in ensuring NBS usage and integration in Ga East. Thus, spatial plans in conjunction with other legal instruments including National Building Regulations 1996 (LI 1630) and Local Government Act, 1993 (Act 462) provides a system to ensure that there is orderly development in the municipality, which is free from irregularities like building and encroachment in environmentally sensitive and flood-prone areas. Also, the plans highlight greenery and landscaping inclusion in the physical development of various neighbourhoods. Therefore,

Table 7
Overview of the specified NBS integration facilitation measures.

Domain	NBS integration facilitation code	Description	Support statement from key informant	Related specified NBS measures
Economic/ finance	Provision of government subsidies	There should be subsidies to support the construction and implementation of the NBS measures. If the Government can roll out subsidy policies, it will encourage developers to make the NBS measures part of their development design and construction.	*"If the government provides subsidies to developers who wish to make green roofs for their homes, it may encourage other developers and increase their interest in using the green roof.". - key informant 2*	Links to green roofs, porous pavements, rain gardens and rainwater harvesting.
Land acquisition	Providing attractive compensation packages	Providing compensation packages will ensure quick and easy land acquisition for the NBS measures. In this regard, families and individual land and property owners will be keen to offer their lands, if need be, to carry out some of these NBS measures.	*"Since most lands are privately owned, landowners should also be willing to avail their lands for a possible purchase, and the government should also present good offers in the realm of compensation to carry out these NBS projects." – key informant 10.*	Links to Vegetated swales, rain gardens and detention basins.
Institutional coordination	Effective institutional collaboration	Effective collaboration on the part of the flood management institutions through structural meetings would facilitate the implementation of the NBS measures. Flood management institutions can schedule engagements that favour all parties to discuss how to apply some of the specified NBS measures in a coordinated way.	*"I think all stakeholders coming together and accepting these measures will also be a step in ensuring an easy implementation of these NBS measures" – key informant 8.*	Links to all specified NBS measures.
Knowledge base and local people's interest.	Local people involvement	Urban floods are rampant in the municipality, and inhabitants are ready to embrace any government outlines to prevent flood events. There should be sensitization exercises to educate the local people on the design and how to use the NBS measures and how important they are in preventing urban floods. Involving the local people also builds on peoples' interest in using the NBS measures.	*"The people in the municipality are yearning for solutions to the flood happenings in the municipality. Therefore, I do not think they will reject projects like this. However, the local people should be well-informed and involved through a form of public education about the measures" – key informant 5.*	Links to all specified NBS measures.

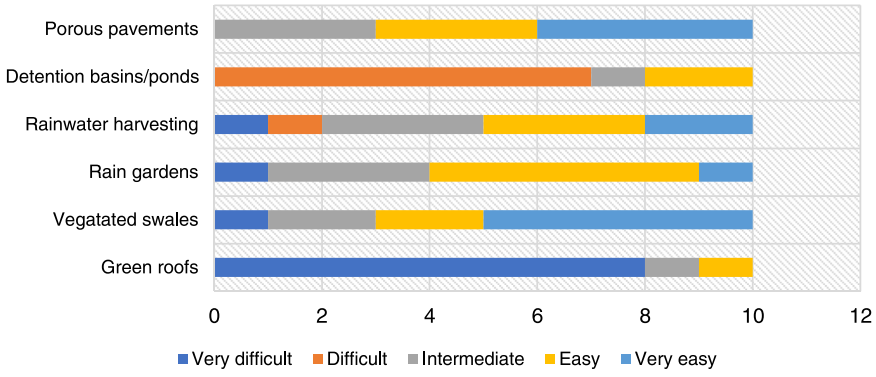

Fig. 4. Easiness in implementing the specified NBS measures.

the implementation of these spatial plan specifications can be extended to include the specified NBS measures, not forgetting applying the legal obligation and re-strategizing plan enforcement to make the use of some of the NBS measures mandatory in flood management programmes, projects, and activities. For example, making use of vegetated swales as part of storm drain construction in suitable locations within the municipality.

Regarding the NBS integration barriers and facilitators, key informants' assertion highlights the integration barriers are mostly existing problems that contradict specifications made in the spatial and flood management plans. For instance, on the issue of land unavailability, analysis from the spatial planning document revealed that the physical development of the municipality should be done to reserve spaces for landscape development, which could possibly be used to implement some of the specified NBS measures. Also, the barrier of poor communication and coordination of activities and different interests amongst flood management institutions contradicts the specification of institutional coordination in the Ghana Disaster (flood) Management Plan.

In principle, NBS integration has a high possibility considering spatial plans and the flood management scheme that governs the Ga East Municipality but existing practices, according to key informants, will make some of the NBS measures, specifically detention basins and green roofs difficult to be applied in the Ga East. Hence, the facilitation measures will aid the suppression of the integration barriers and accelerate the functionality of spatial and flood management schemes in using specified NBS measures to minimize flood occurrences in the municipality.

4.4. Comparing the integration of NBS in Ga East to other regions worldwide

When examining the global perspective on NBS integration, as presented in Section 2.2.2, it becomes evident that various commonalities exist among NBS integration approaches. These shared traits encompass ensuring the suitability of NBS within the local environmental context, making NBS usage a legislation, facilitating effective communication and providing education on NBS implementation, incorporating NBS into the design and redevelopment of local facilities, and promoting institutional coordination. Notably, the analysis demonstrates that the NBS integration techniques applicable to Ga East and the broader Ghanaian context can be traced back to these global approaches.

Moreover, the barriers encountered in integrating NBS in Ga East,

such as a poor knowledge base, inadequate institutional collaboration, and financial delays, align with the challenges highlighted in Europe and Asia. This convergence of obstacles further strengthens the validity of our findings. However, it is worth noting that barriers specific to the Ga East context, including political interference and land acquisition, were solely mentioned in the Asian studies, indicating unique challenges faced in that region.

5. Discussion

The study results revealed that the spatial and flood management schemes that guide the physical development and flood mitigation in the Ga East Municipality present a high potential of instilling the use of the specified NBS measures. The integration potential from the mentioned plans' perspective has a positive relationship with key informants' ideology on the techniques to use to make the NBS integration possible. Considering theories about integration in spatial planning, specifically Healey's integration framework, defining actions to integrate new approaches into spatial planning practices, the dissection of the spatial and flood management schemes along with key informants' ideology contains nearly all the key elements described by Healey. Thus, there are elements of co-ordination, framing, linking policy and action, and linking multiple actors to shape NBS integration in Ga East. This signifies a high level of easiness with regard to the 'plugging in' of NBS measures to accelerate the effectiveness of urban flood prevention actions. As described by Vigar (2009), the elements in Healey's integration are also suitable for new planning issues including sustainability ambitions which could be linked to the use of NBS.

In contrast, the barriers connected to the NBS integration were mostly associated with the shortfalls in effective spatial plan implementation and practices and flood management activities. This finding substantiates the hypothesis presented in the introduction of this paper, which suggests that "the existence of spatial planning and flood management problems in cities is significantly associated with the challenges that impede the integration of NBS in the spatial development of cities aimed at mitigating urban floods." The presence of ineffective spatial plan implementation and flood management challenges raises concerns about the clarity and comprehensiveness of the existing spatial planning documents for Ga East. It is notable that these plans lack explicit implementation pathways, which may lead to debates regarding their effectiveness. However, the establishment of legislative instruments, such as the Local Government Act (Act 462), outlines the required procedures to ensure strict adherence to the specifications outlined in spatial plans (Government of Ghana, 1993). Unfortunately, as explain by Acheampong and Ibrahim (2016), there are still irregularities with the spatial development of Ghanaian urban centres including Ga East. This emphasizes the urgent need for spatial planning and flood management institutions, as well as relevant stakeholders, to address these spatial planning challenges proactively to facilitate successful NBS integration in Ga East and similar contexts.

Also, weighing the NBS barriers against Healey's principles on integration calls for extra attention to the application dynamics pertaining to the integration techniques raised by key informants. For instance, the economic-related barriers encompassing the cost requirement of some NBS measures and existing flood mitigation project finance issues contradict the regulation and investment sub-principle of linking the policy and action component of Healey's. These economic-related barriers could directly or indirectly affect the application of some integration techniques raised by key informants. Also, the barrier of land unavailability and acquisition issues contradicts with policy and delivery sub-principle of linking the policy and action ideology of Healey's. The barrier could hugely affect the legal obligation and plan enforcement re-strategization. Additionally, the barrier of little or no interest from local people and key actors is also a disadvantage to the component of linking multiple actors of Healey's framework. The no-interest barrier if dealt with will positively influence the success of most of the integration techniques raised by key informants. Thus, people and other stakeholders may easily abide by regulations and programmes outlined by authorities if there is a strong sense of acceptance of using the specified NBS measures. Therefore, in the context of Ga East, integrating NBS in the spatial and flood mitigation schemes, looking through the lens of Healey's ideology, for instance, will require extra attention to linking policy and action and linking multiple actors components.

One key integration area that the key informants seldomly mentioned was the multi-level co-aligning sub-principle by Healey, also related to the territorial integration (Kidd, 2007). From the Ghanaian spatial planning perspective, all municipal and district spatial development framework should be embedded in the national spatial frameworks (Acheampong, 2019). However, in the context of integrating NBS in the spatial development of Ga East, key informants rarely mentioned how their stated integration aligns with the regional and national spatial development principles. Moreover, the various neighbourhoods within Ga East also present different physical development characteristics which may also demand specific and unique approaches. Hence, applying certain NBS integration techniques may either be difficult or irrelevant to the different jurisdictional boundaries in Ga East. Therefore, the territorial integration or the multi-level co-aligning component as explained by Healey and Kidd is crucial for the NBS integration in the Ga East.

Notably, the integration of NBS in spatial planning and flood mitigation strategies for Ga East, as explained by key informants, shares remarkable similarities with the approaches employed globally, as discussed in Section 4.4. Specifically, when comparing NBS integration approaches in high-income regions such as the United States, Australia, UK, and Europe, where NBS is widely embraced (Walters et al., 2016), the primary distinction lies in the re-strategizing of plan enforcement, a factor which is also identified in the Asian region (Lechner et al., 2020). This variation is attributed to disparities in plan enforcement mechanisms between high-income countries and medium to low-income areas like most parts in Asia (Morita and Matsumoto, 2021) and Ghana, as revealed by the United Nations (2008). These findings suggest that the systems established to scale up NBS utilization and its efficacy for flood mitigation in high-income regions can be similarly applied in Ghana and other Sub-Saharan African countries, as well as other medium to low-income areas, with a strengthened focus on enforcement mechanisms. This further supports the hypothesis positing that "approaches employed for integrating NBS in the spatial development of high-income areas are similarly effective for NBS integration in medium to low-income areas.".

Additionally, another major difference in NBS integration in high-income countries and medium to low-income areas lies in the barrier of the high cost of applying some of the NBS measures, specifically for green roofs, and rainwater harvesting. This is attributed to the average socio-economic status of locals in Ga East, which is described to be middle class according to GEMA (2018), which may incur an economic burden to the municipal inhabitants. Other NBS integration barriers described by key informants were at par with what Kopsieker et al. (2021) and Sarabi et al. (2019) discovered on financial delays, lack of institutional collaboration, and poor knowledge base as hindrances to implementing NBS in the European region in addition to the political interference and land acquisition problems revealed by Lechner et al. (2020) in Asia. The commonality between Ga East and Asian cities regarding land acquisition issues in NBS integration can be attributed to the rapid urbanization observed in these regions, leading to extensive land consumption (Wang and Kintrea, 2021).

Harnessing on the facilitation measures described by key informants, there was no difference to what is being applied in high-income countries and globally. These facilitation measures connect well with Healey's integration principles which gives a positive indication to achieving a successful NBS integration in the spatial development and flood management actions in Ga East, Accra and other Sub Sahara

African countries and can be functional in high-income countries as well.

6. Conclusion

This study aimed to discover how urban flood-related NBS measures can be integrated into the spatial development and flood management actions in Accra to prevent urban floods. The study analysis revealed that there is a possibility of NBS integration taking into consideration the presently used spatial and flood management plans. Also, the study unveiled techniques for integrating NBS measures and possible implementation barriers and facilitation in the Ghanaian context which can be linked to combating the challenges facing the Ghanaian spatial planning and flood management system. The NBS integration approaches covering techniques; piloting, education and sensitization, combination of NBS and traditional measures, legal obligation and re-strategizing enforcement of plans mechanism along with envisaged barriers and facilitators were not a deviation from what is being applied in high-income areas, except for plan enforcement concerns. Also, the NBS integration approaches raised by key informants align well with Healey's integration framework, signifying a possible success of NBS integration in the Ga East.

Although the study outcome relates well with notable theories and frameworks on integrated spatial planning, the scarce consideration for territorial or multi-level co-aligning components from theories was seen as a limitation in NBS integration in Ga East. The consideration of the territorial component would have further expanded the NBS integration dimension to tackle the spatial disparities among different neighbourhoods in Ga East while connecting to the principles at the regional and national levels. Additionally, the Covid 19 and its restrictions were also part of the limitations of the study. Researchers were not able to visit the study area themselves. Hence, vital photographs that could have supported the presentation of results could not be obtained.

Nevertheless, this research has discovered knowledge on how NBS can be integrated into spatial planning systems and flood mitigation schemes in the Ghanaian setting and possibly applicable in other Sub-Saharan African and medium to low-income cities. Therefore, the outcomes of this study hold significant potential for adoption by key stakeholders such as the Land Use and Spatial Planning Authority (LUSPA), National Disaster Management Organisation (NADMO), Ga East Municipal Assembly (GEMA), other municipalities, and collaborating institutions. These findings can inform future endeavours in designing and revising spatial plans, as well as implementing flood mitigation actions and strategies. The primary focus should be on addressing the challenges within the spatial planning and flood management system, particularly in areas of enforcement and institutional coordination. This will help create a spatial planning environment that makes it easier to not only integrate NBS but also other multiple innovative programmes and projects. In reference to this study, future research can also look at NBS integration from the perspective of the local people and inhabitants to measure for example their acceptability and willingness.

CRediT authorship contribution statement

Asare Prince: Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Atun Funda:** Conceptualization, Formal analysis, Methodology, Supervision, Writing – review & editing. **Pfeffer Karin:** Conceptualization, Formal analysis, Methodology, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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