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Research Paper

Urban green infrastructure and ecosystem services in sub-Saharan Africa

Marié J. du Toit[a,*], Sarel S. Cilliers[a], Martin Dallimer[b], Mark Goddard[b], Solène Guenat[b], Susanna F. Cornelius[a]

[a] Unit for Environmental Sciences and Management, North-West University, Potchefstroom, Private Bag X6001, 2520, South Africa
[b] Sustainability Research Institute, School of Earth and Environment, University of Leeds, Woodhouse Lane, Leeds LS2 9JT, UK

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ABSTRACT

Africa is urbanizing at an astonishing rate. To meet many of the Sustainable Development Goals there will be a requirement for cities in sub-Saharan Africa to plan for, and manage, the rapid rise in the urban population. Green infrastructure has the potential to provide multiple ecosystem services to benefit the urban population. The general objective of this review is to consolidate research undertaken on urban green infrastructure and the associated ecosystem services in sub-Saharan African cities. The 68 reviewed papers spanned 20 countries and included 74 urban areas. However, only 38% of sub-Saharan countries had any research carried out in them. The most represented ecosystem services were regulating and provisioning, with supporting services getting the least attention. Overall there was a lack of in-depth studies on all ecosystem services, especially supporting and cultural services. Seven overarching categories of barriers and challenges to the sustainable delivery of ecosystem services emerged from the reviewed papers, namely: (i) socio-cultural values, traditions and perceptions; (ii) lack of capacity; (iii) governance, urban planning and social inequality; (iv) lack of data and/or case studies; (v) ecosystem disservices; (vi) spatial trade-offs and conflicts; (vii) climate change. These barriers we identified will need to be addressed if the future, long-term sustainable provision of ecosystem services in sub-Saharan African cities is to be assured.

1. Introduction

The rise in papers focussing on urban ecosystem services (ES) underscores its importance (e.g. Elmqvist et al., 2013; Ernstson & Sörlin, 2013; Luederitz et al., 2015). Moreover, the concept of ES as essential components of sustainable and resilient cities is firmly entrenched (e.g. Ahern, Cilliers, & Niemelä, 2014; Andersson et al., 2014; Steiner, 2014), despite the ecosystem 'disservices' (ecosystem functions that are harmful to human well-being) which can also be a feature of nature (Gómez-Baggethun & Barton, 2013; Lyytimäki & Sipilä, 2009). Increasing evidence for the impact of climate change and the effects of natural hazards on populated areas emphasize the need for better planned and re-imagined cities. The disastrous and often tragic effects of these hazards force decision-makers to search for viable strategies to mitigate such events. Several studies document the potential of green spaces to mitigate climate change effects and reduce vulnerability (Gill, Handley, Ennos, & Pauleit, 2007; Munang, Thiaw, Alverson, Liu, & Han, 2013; Ojea, 2015; Zölch, Maderspacher, Wamsler, & Pauleit, 2016). In urban areas, green spaces can provide several benefits (urban ES) that improve the quality of life in cities (Gómez-Baggethun & Barton, 2013). Some of the benefits include: temperature mitigation (Susca, Gaffin, & Dell'osso, 2011), pollution reduction (Pugh, Mackenzie, Whyatt, & Hewitt, 2012), biological carbon storage (Davies, Edmondson, Heinemeyer, Leake, & Gaston, 2011), human health and well-being (Keniger, Gaston, Irvine, & Fuller, 2013; Shanahan, Fuller, Bush, Lin, & Gaston, 2015; Tzoulas et al., 2007), good social relations (Kuo & Sullivan, 2001; Sullivan, Kuo, & De Pooter, 2004), and habitat for biodiversity (Dallimer et al., 2012; Goddard, Dougill, & Benton, 2010).

Urban green spaces can be defined as "an umbrella term for all areas of land [that consist predominantly of unsealed, permeable, 'soft' surfaces such as soil, grass, shrubs and trees]…whether or not they are publicly accessible or publicly managed. It includes… all areas of parks, play areas and other green spaces specifically intended for recreational use, as well as other green spaces with other origins" (Swanwick, Dunnett, & Woolley, 2003:97). A term with similar uses that has become popular is urban green infrastructure, which can be defined as "all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales" (Tzoulas et al., 2007:169). In this paper we will use both the term urban green infrastructure (GI) and urban green spaces

* Corresponding author.
E-mail addresses: 13062638@nwu.ac.za (M.J. du Toit), Sarel.Cilliers@nwu.ac.za (S.S. Cilliers), M.Dallimer@leeds.ac.uk (M. Dallimer), M.Goddard@leeds.ac.uk (M. Goddard), eesgu@leeds.ac.uk (S. Guenat), ancia@livinglands.co.za (S.F. Cornelius).

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interchangeably depending on the term used by authors in their papers.

While it is expected that the global urban population will reach 2.5 billion in the next four decades, 90% of this increase will occur in Asia and Africa (United Nations, 2015b). This rapid urbanisation is a severe threat to the provision of ES on a local and global scale (Güneralp et al., 2013; Seto, Guneralp, & Hutyra, 2012). This is, not least, because the costs and benefits of urban GI are rarely considered in expanding cities. Indeed, urban GI is infrequently prioritised in planning and development processes (Mensah, 2014). Existing studies have focused overwhelmingly on the developed world. The areas that are especially neglected are Africa, Latin America, and Russia (Haase, Frantzeskaki, & Elmqvist, 2014). Yet urban ES may be disproportionately important in African cities where low levels of employment and high poverty necessitate an increased reliance on urban GI for the provision of ES, such as water, fuel and food production (Anderson, Okereke, Rudd, & Parnell, 2013). Moreover, the research on urban ES that has been undertaken in African cities is dominated by work in South Africa where an ES approach to urban planning and development is slowly emerging (Cilliers, Cilliers, Lubbe, & Siebert, 2013; Goodness & Anderson, 2013; Schäffler & Swilling, 2013).

To our knowledge only four reviews have been published on African ES collectively or urban GI. The first paper focussed on ES provision and its role in providing sustainable livelihoods throughout Africa (Egoh et al., 2012). Thereafter, Cilliers et al. (2013) focussed on ES of urban GI in Africa, with Mensah (2014) the first to expressly research the challenges that constrain the management and development of GI in African cities. Lastly, Wangai, Burkhard, and Müller (2016) published a recent review on ES in Africa which aimed to assess the current state of research in Africa. However, as yet no review has exclusively focussed on sub-Saharan African (SSA) countries. Moreover, only the reviews of Cilliers et al. (2013) and Mensah (2014) exclusively addressed urban areas. To adequately address research gaps, the current status of research in SSA must first be determined. Therefore, the general objective of this review is to consolidate research undertaken on urban GI and the associated ES in SSA cities. Specifically, we asked: (1) How many SSA countries and cities are represented? (2) How many papers explicitly focussed on ES and of those how many provided results on assessed ES? (3) Which specific ES were assessed? (4) What are the barriers, challenges and limitations affecting urban GI and the sustainable delivery of ES?

2. Africa in context: urbanization and population growth

This section gives a brief overview on urbanization and population growth in Africa to inform the current situation and highlight important issues afflicting African cities. Across Africa, by 2050, there will be 1.26 billion people living in cities which is triple the 400 million urban dwellers in the continent today (UN-Habitat, 2014), representing the fastest rate of urbanisation of any continent. If many of the Sustainable Development Goals (including those on sustainable communities and cities) (United Nations, 2015a) are to be met, cities in SSA must plan for, and manage, the rapid rise in the urban population. This is potentially problematic given that current projections suggest that almost three-quarters of Africa's population growth will occur in small to medium-sized cities of less than one million, which tend to be settlements with high levels of poverty (Anderson et al., 2013) and the weakest social, institutional and political capacity to address the coming challenges.

Urbanisation is generally a precursor for economic growth as cities provide the necessary density of people, goods, infrastructure and services (World Bank, 2009). However, in SSA urbanisation has actually been associated with stagnating, rather than expanding economies (Turok & McGranahan, 2013). Various reasons have been proposed for such differences, including the fact that other indices of development, such as literacy rates, are lower in Africa; the dependence of several African countries on natural resource exploitation for their economic growth, lower institutional capabilities, and poor quality infrastructure (Freire, Lall, & Leipziger, 2014). However, Kessides (2006:xxvi) regards the widely held opinion of Africa as 'urbanization without growth' as a myth, arguing that many of the countries had economic growth based on urban sectors but that, crucially, SSA cities do not reach their full productive potential due to "widespread neglect and bad management".

The root cause of large scale urban poverty is the historically unprecedented exponential increases in rural to urban migration in developing countries (Nuwagaba, 2003). Rapid urbanisation has resulted in populations growing too fast for the urban economy, and for planners and policy makers to provide for their basic needs (Lusugga Kironde, 2006; Turok & McGranahan, 2013), meaning that the majority of new urban dwellers live in informal settlements or slums (Smit, Musango, Kovacic, & Brent, 2017). Slums can be defined as spatial agglomerations of households without access to any of the following: improved water, sanitation, sufficient living area, durable dwellings, or security of tenure (UN-Habitat, 2010). This definition, however, does not include many other basic requirements for enhancing human wellbeing, such as access to food, clean energy or indeed green spaces and nature.

Africa continues to have the highest proportion of its urban population living in informal developments. Urban poverty is, therefore, higher in Africa than in any other continent, with more than 43% of urban Africans living below the poverty line (Anderson et al., 2013). However, Kessides (2006) argues that urban poverty is not mainly due to urban expansion or to be blamed on weak African economies. Rather, she claims that "much of the deprivation in cities and the emerging urban public health problems relates to institutional failures that perpetuate social exclusion and inequalities between the urban poor and the urban nonpoor" (Kessides, 2006:xxvi). Urban poverty is multidimensional, encompassing both material and psychological deprivation (Hove, Ngwerume, & Muchemwa, 2013). Increasing deprivation causes a cascading effect of several other problems such as the development and spread of new diseases, hunger, unemployment, crime and conflict, as well as political related suppression (Bolnick et al., 2006; Hove et al., 2013; Liu et al., 2008). Many of these problems are interrelated and preventable (Bolnick et al., 2006). Diseases which commonly occur in urban areas, for instance, are derived from poor environmental conditions such as infected water and sanitation and air pollution (outdoor and indoor smoke) (Bolnick et al., 2006; Turok & McGranahan, 2013), with many other diseases (such as HIV/AIDS, TB and diabetes) aggravated by hunger and nutrition deficiencies (Bolnick et al., 2006; Liu et al., 2008). The impact of HIV/AIDS on Africa is disastrous (Hove et al., 2013). Kessides (2006:xv) describes it as the "cruellest factor draining Africa's development impetus" in its role as a major contributing factor to the degradation of human capital and administrative capacity.

As cities rapidly expand, a lack of planning can force new arrivals to inhabit unsuitable landscapes that are vulnerable to flooding and landslides such as steep hills or deep valleys (Lusugga Kironde, 2006). Such newly occupied areas can be fragile and sensitive to environmental change, and without proper housing these settlements rapidly degrade (UNEP, 2009). Without basic services, the accumulation of waste and the deterioration of the quality of green spaces can hinder attempts to provide any form of green or grey (man-made, e.g. roads, buildings) infrastructure (Dubbale, Tsutsumi, & Bendewald, 2010; Okpala, 2009), subsequently resulting in further deterioration of the services and facilities that are present (Mutisya & Yarime, 2011; Okpala, 2009). Moreover, urban GI is disappearing at an alarming rate in African cities (Mensah, 2014) and the provision of high quality accessible urban green space in cities is rarely recognised as an essential component of the liveability of cities (Djibril, Coulibaly, Wang, & Ousmane, 2012; Olaleye, Ayoade, & Omisore, 2013).

Current economic growth in SSA has proved unable to provide sufficient employment and housing, requiring most urban dwellers to rely on the informal economy and housing. In fact, on average, 60% of the urban workforce is employed in the informal economy in SSA

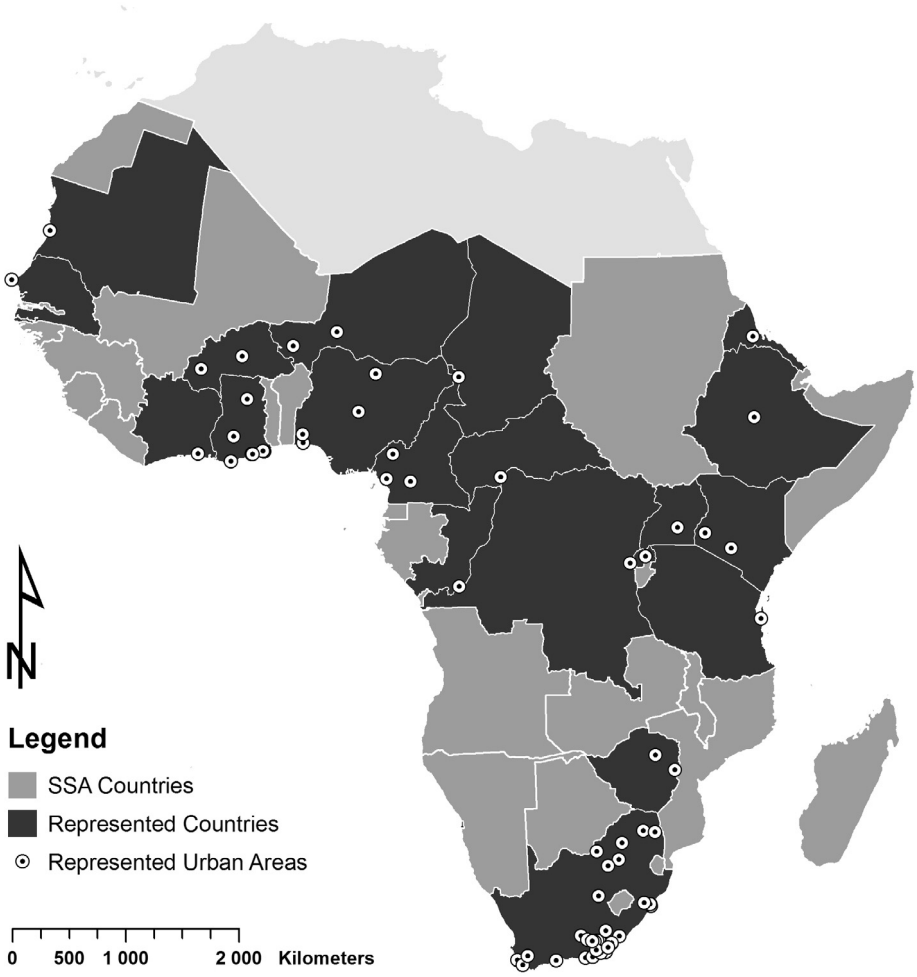

Fig. 1. Map of the location of all the countries and urban areas represented by the selected 68 papers on green infrastructure and ecosystem services in sub-Saharan Africa.

countries (Hove et al., 2013). Furthermore, as cities expand, the associated conversion of land represents a threat to ecosystem quality and function, with implications for the human population and ecosystem service provision. Transformation of the landscape to accommodate housing results in losses of high quality agricultural land (d'Amour et al., 2017) and intensifies the burden of food provision on farmers (Simon, McGregor, & Nsiah-Gyabaah, 2004). Nevertheless, given around two-thirds of the urban area in 2050 has yet to be built (Fragkias, Güneralp, Seto, & Goodness, 2013) there is a tremendous opportunity to ensure that sustainable urban development approaches are hard wired in expanding cities. Planning for future urban development will have to take into account ways to integrate informal populations into the city. There is a need for grey infrastructure developments that provide opportunities to ensure that urban GI is fully considered in any plans. If this process is to be successful, it is essential that the needs of the urban poor and those living in slums are taken into account. Thus far, research suggest that limited institutional capacity, lack of political will, corruption (Okpala, 2009) and lack of financial resources mean that the prospects of incorporating urban GI into city expansion plans are low.

3. Methods

Academic literature on urban ES and GI were reviewed using Google Scholar and the EBSCO Discovery Service (EDS) search platform of the North-West University (NWU) library (http://library.nwu.ac.za/eds-search). The EDS platform accesses 73 international databases to which the library is subscribed. The keywords used were "urban" and "Africa" and "ecosystem services", "environmental goods and services", "environment", "green infrastructure" and "green space". The search included papers published before the end of January 2017. The search results listed approximately 8,000,000 papers sorted according to relevance. The first 300 results listed papers that included two or more search terms. We scanned the paper titles and abstracts for papers relevant to our goals and identified 82 potentially relevant papers. The full texts of these papers were then further scanned to determine their direct relevance. We selected only papers that studied urban areas in SSA that mention ES/environmental goods and services or green space/GI. Of the 82 papers, 53 were selected. From these, we identified further papers from the reference lists of the relevant papers to find additional papers not picked up by the initial search. This resulted in 15 additional papers being identified, finalizing the number of papers included in this review to 68.

The 68 papers were divided between those only mentioning green space/GI (9 studies) and those mentioning ES/environmental goods and services (59 studies). Thereafter, those that mention ES were further divided into papers that only mention the term ES once or twice in the introduction or conclusion (13 papers) and the papers that specifically focus on ES as part of the results and discussion (46 papers). The 46 papers that discussed ES were categorized according to the TEEB framework (TEEB, 2011). The Economics of Ecosystems and Biodiversity (TEEB) report identified 22 different urban ES (TEEB, 2011) grouped into the four ES categories as described by the Millennium Ecosystem Assessment (2005) namely: provisioning, regulating, habitat or

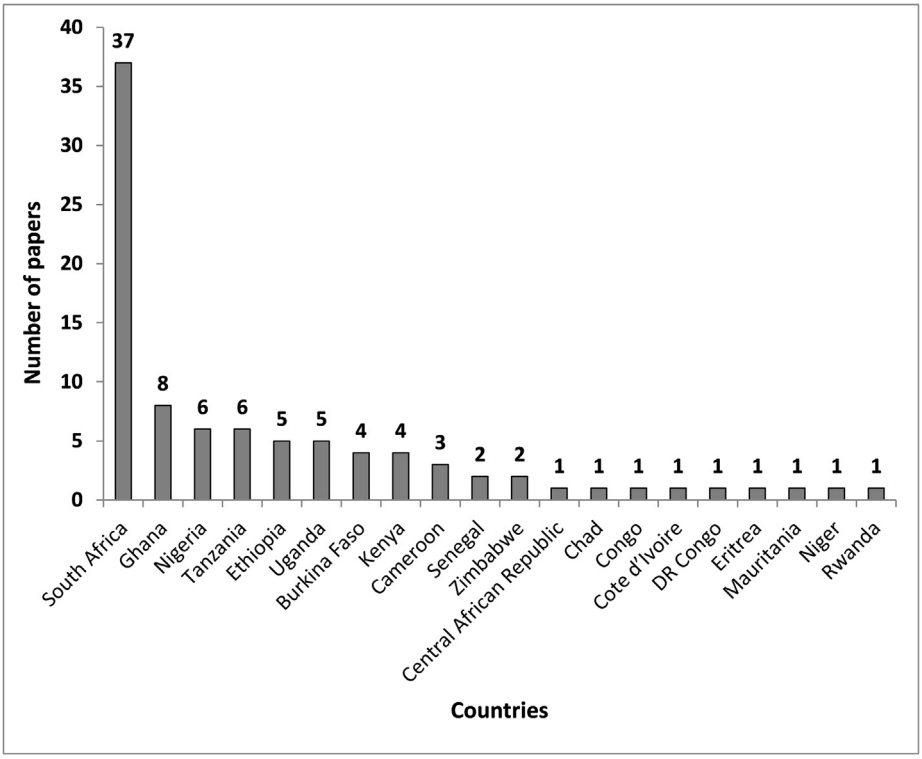

Fig. 2. The number of papers on green infrastructure and ecosystem services per country in sub-Saharan Africa.

supporting, and cultural services. Each paper could belong to multiple categories according to the ES listed within them. The papers were then further refined by dividing them between papers with empirical data through quantification of ES in some way or recorded perceptions of individuals through questionnaires or interviews (hereafter called assessed ES) (34 papers) and those that only discuss ES or list other studies without doing surveys or experimental work themselves (12 papers) (see also Fig. 5). All 68 selected papers were also investigated for any listed barriers, challenges or constraints (hereafter called barriers) to the development and maintenance of urban green spaces and their sustainable supply of ES. These barriers were categorized into groups based on the themes emerging from the papers themselves.

4. Results

The papers reviewed spanned 20 countries and included 74 urban areas (Fig. 1). However, these 20 countries only represent 38% of all the SSA countries (53 countries in total). South Africa was most studied (37 papers) with Ghana second (8) and Nigeria and Tanzania each represented by 6 papers (Fig. 2). Eleven of the 17 most represented urban areas were in South-Africa with Durban the city with the most published papers (8) (Fig. 3). The most studied urban areas outside South Africa were Dar es Salaam, Tanzania (6) and Addis Ababa, Ethiopia (5) (Fig. 3). The importance of ES and GI as themes in the academic literature can be seen by the steady increase of papers in the period since the first papers in 2005 up until January 2017 (Fig. 4).

The selected papers also included existing reviews and overviews. Three mentioned in the introduction and four others on urban agriculture, urban forests and sustainable stormwater management. The earliest relevant review investigated the role of urban agriculture in the resilience and sustainability of cities (De Zeeuw, Van Veenhuizen, & Dubbeling, 2011). Cilliers et al. (2013) followed with a review of ES of urban green spaces in Africa and concluded that there is a strong bias towards South Africa with few studies conducted in other African cities. Their case study of Potchefstroom, South Africa, showed that socio-economic status determines the type of demand for ES (Cilliers et al., 2013). Thereafter, Mensah (2014) discussed the distribution of urban green spaces in Africa and specifically the challenges faced in maintaining them. In their overview, Conigliaro, Borelli, and Salbitano (2014) reported on the usefulness of urban and peri-urban forests and the importance of trees for sustainable urban development. They highlighted that well managed and planned urban forests can meaningfully contribute towards poverty alleviation and reduced malnutrition (Conigliaro et al., 2014). The role of urban and peri-urban agriculture and forestry in mediating climate change was investigated by Lwasa et al. (2015), and Mguni, Herslund, and Jensen (2016) reviewed sustainable stormwater management and use of GI approaches. Lastly, Wangai et al. (2016) reviewed research on ES in Africa, but did not specifically focus on urban areas. They also found that South African studies still dominated, with other main findings that provisioning services were the most commonly studied ES type, with trade-offs and synergies barely addressed (Wangai et al., 2016).

4.1. Urban green infrastructure

Several studies focus only on urban green spaces or urban GI and either mention ES briefly or omit the topic entirely. There are a few studies that only mention ES. In Durban, South Africa research was undertaken developing an urban greening planning tool based on photo-realistic visualizations (Donaldson-Selby, Hill, & Korrubel, 2007). The authors indicated that the best interest of urban residents are often not taken in consideration in the planning and management of urban green areas and suggested that participatory decision support systems are needed to empower urbanites (Donaldson-Selby et al., 2007). McConnachie and Shackleton (2010) investigated the distribution of public green spaces in nine small towns in South Africa. The authors found that there are significant differences between the amount of green space in poor and affluent areas (McConnachie & Shackleton, 2010). Other authors investigated the extent and change of green space in urban areas (Barau, Maconachie, Ludin, & Abdulhamid, 2015; Odindi & Mhangara, 2012). Mpofu (2013) evaluated the performance of the Addis-Ababa Sanitation, Beautification and Park Development Agency

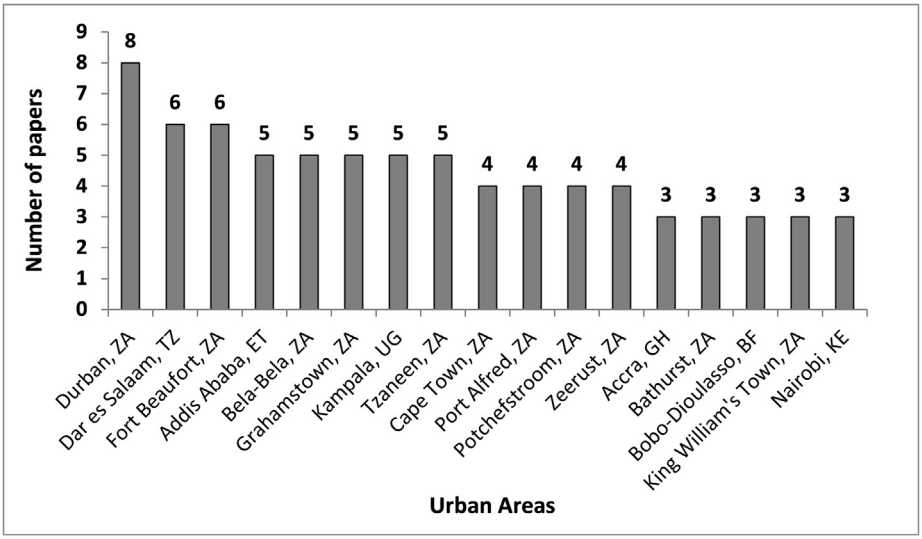

Fig. 3. The most represented urban areas in the papers on green infrastructure and ecosystem services in sub-Saharan Africa.

indicating various challenges facing the city and maintenance of its green spaces. Olaleye et al. (2013) studied factors influencing green space provisioning, whereas Kaoma and Shackleton (2014) evaluated trees in homestead gardens. Other studies focussed on provisioning and management of trees and urban green spaces (Chishaleshale, Shackleton, Gambiza, & Gumbo, 2015; Seburanga, Kaplin, Zhang, & Gatesire, 2014), examples of ES provided by GI (Bobbins & Culwick, 2015), the evaluation of the attitudes of municipal officials responsible for urban greening towards trees (Gwedla & Shackleton, 2015), and an evaluation of urban ground water quality (Kringel et al., 2016).

Studies that do not mention ES in any form at all include a study on the extent and state of urban green spaces (McConnachie, Shackleton, & McGregor, 2008), municipal level climate change implementation (Roberts, 2008), and GI planning (Cilliers, 2009). Cilliers (2009) highlighted the fact that urban areas are generally perceived to be economically more valuable than green areas, the so-called Green-Value-Gap. Drechsel and Dongus (2010) reported on the dynamics and sustainability of urban agriculture, and Fanan, Dlama, and Oluseyi (2011) did a remote sensing analysis of land use and land cover change. The authors recommended reclamation of parks and buffer zones as well as “aggressive re-greening” activities in Abuja, Nigeria (Fanan et al., 2011). Muderere (2011) argued for the integration of urban wildlife into planning in Harare, Zimbabwe and Djibril et al. (2012) reported on the importance of urban green spaces in Abidjan City, Ivory Coast. It was indicated that provision and management of green spaces was regarded as less important than provision of basic services by city authorities (Djibril et al., 2012). Lastly, Anchang, Ananga, and Pu (2016) described a useful approach to map urban vegetation using satellite imagery for areas with technical and budget constraints.

4.2. Ecosystem services

Only 61% of the papers discussing ES types actually assessed it in some way (Fig. 5). Furthermore, these papers represent only 12 of the 20 countries covered by this review. This means that only 23% of SSA countries produced research on ES that assessed it in some way generating empirical data. Regulating and provisioning services were the most studied (represented by 17% of SSA countries respectively) as well as having the most papers with assessed ES (Fig. 5). Cultural and supporting/habitat services were markedly less studied (Fig. 5). Cultural ES were assessed in only four countries (8%) with supporting services assessed in only two countries (Fig. 5). The country with most studies that generated empirical data was South Africa. The specific ES assessed in the selected papers are listed per category in Tables 1–4, indicating the number of studies that assessed a particular ES as well as the represented countries. Each table is followed by a brief summary of the key findings per ecosystem service type.

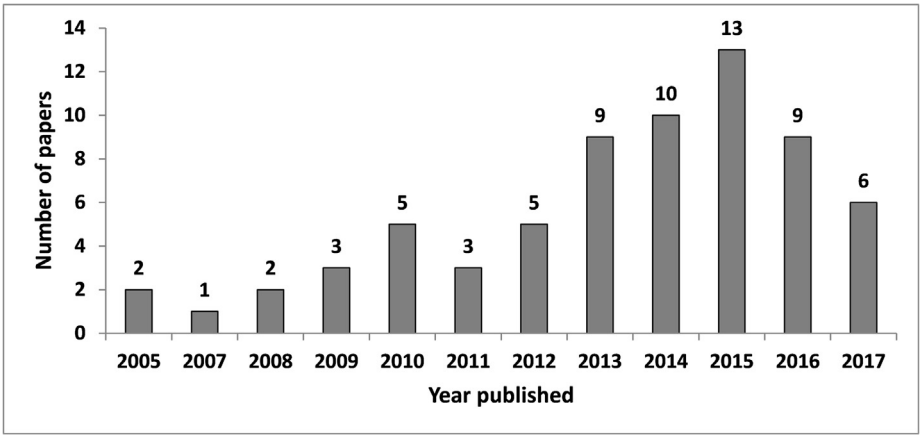

Fig. 4. The total number of papers on green infrastructure and ecosystem services in sub-Saharan Africa published per year included in the review. *Note that only papers published by the end of January 2017 were included.

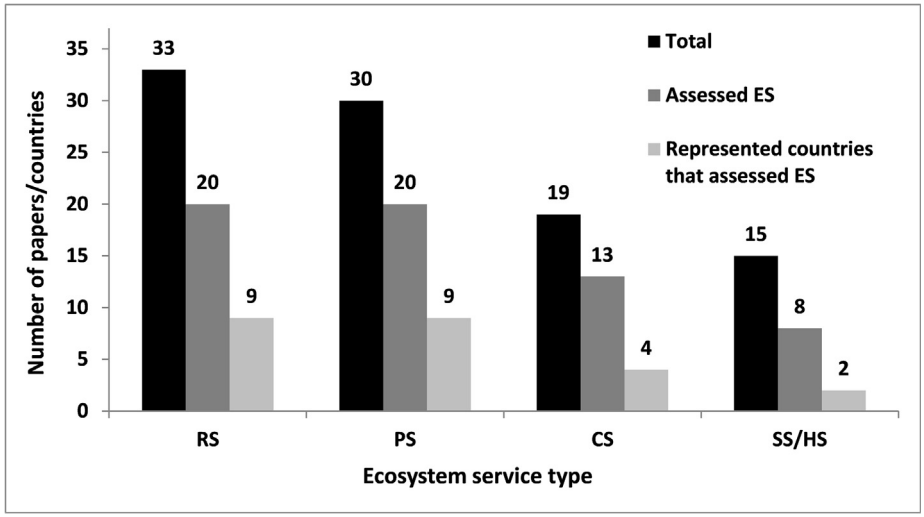

Fig. 5. The number of papers per specific ecosystem service type (RS = regulating services, PS = provisioning services, CS = cultural services, SS/HS = supporting and habitat services). The columns indicate the total number of papers, the number of papers that assessed ecosystem services and the number of represented countries in the papers that assessed ecosystem services.

4.2.1. Regulating services

The most assessed regulating services are temperature regulation, shade and the regulation of water flow and runoff (Table 1). The reality of urbanization pressures on urban forests in Africa was the impetus for two studies to determine public perceptions on the ES rendered by these forests (Adekunle, Agbaje, & Kolade, 2013; Sutherland, Sim, Buthelezi, & Khumalo, 2016) and one which quantified the monetary value of these ES (Dumenu, 2013). Interestingly, in Abeokuta, Nigeria only 13% of the benefits of the forest were perceived to be regulating services (Adekunle et al., 2013), whereas in Kumasi, Ghana the three highest rated services were air quality regulation, shade and temperature reduction (Dumenu, 2013). In Abeokuta, Nigeria most of the respondents were poor, whereas in Kumasi, Ghana the respondents were students and staff of a university. The important role of urban GI in temperature regulation was quantified in Addis Ababa, Ethiopia; Dar es Salaam, Tanzania; and Bobo-Dioulasso, Burkina Faso (Cavan et al., 2014; Di Leo, Escobedo, & Dubbeling, 2016; Feyisa, Dons, & Meilby, 2014). All of the studies indicated that vegetation have a cooling effect, however Feyisa et al. (2014) determined that park shape, the type of tree species and its size had an effect on the efficacy of the green space to influence air temperature. Moreover, residential areas with lower socio-economic status have fewer regulating services due to notably lower tree cover (Cilliers et al., 2013). Local residents' response on the benefits of urban parks, street trees and gardens also indicated the importance of shade, temperature regulation, and windbreaks to green space users (e.g. Rabare, Okech, & Onyango, 2009; Shackleton, Chinyimba, Hebinck, Shackleton, & Kaoma, 2015). Several researchers also highlighted the importance of GI in climate change mitigation and reducing the impacts of natural hazards such as flooding (e.g. Roberts et al., 2012). Moreover, calculating the economic value of ES indicated the investment potential of urban natural assets for financial decision-makers (de Wit et al., 2012). Some studies specifically emphasized the economic impacts of loss of valuable ES (Dumenu, 2013; Schuyt, 2005).

4.2.2. Provisioning services

The provisioning services rendered by ecosystems provide direct benefits to urban residents and many of the poorest households are dependent on them for subsistence. The specific ES assessed also reflect this (Table 2). Gathering of medicinal plants, crop cultivation for food, fuel wood, and utilization for building materials are the most studied provisioning services (Table 2). Fifty-five percent of the papers interviewed poor residents of which many of them are unemployed or receive very little monthly income. Moreover, most of them are still reliant on fire wood for heating and cooking (e.g. Davenport, Shackleton,

Table 1
List of all the regulating services studied in the selected papers from sub-Saharan Africa, ranked according to the number of studies. Also indicated are the citations of all the studies that assessed the respective ES and the represented countries listed alphabetically.

Specific services assessed	Nr of studies	Represented SSA countries with references
Temperature regulation	9	Burkina Faso (Di Leo et al., 2016), Ethiopia (Cavan et al., 2014; Feyisa et al., 2014), Ghana (Dumenu, 2013) South Africa (Cilliers & Cilliers, 2015; Richardson & Shackleton, 2014; Roberts et al., 2012; Shackleton et al., 2014; Sutherland et al., 2016), Tanzania (Cavan et al., 2014)
Shade	7	Ghana (Dumenu, 2013), Kenya (Rabare et al., 2009), South Africa (Cilliers et al., 2013; Richardson & Shackleton, 2014; Shackleton et al., 2014; Shackleton et al., 2015; Sutherland et al., 2016)
Regulation of water flow and runoff	6	Nigeria (Adekunle et al., 2013), South Africa (Cilliers & Cilliers, 2015; Davids et al., 2016; de Wit et al., 2012; Roberts et al., 2012; Sutherland et al., 2016)
Air quality regulation	4	Ghana (Dumenu, 2013), South Africa (Richardson & Shackleton, 2014; Shackleton et al., 2014; Shackleton et al., 2015)
Carbon storage	4	Ghana (Nortey et al., 2016), South Africa (Davids et al., 2016; Schäffler & Swilling, 2013; Shackleton et al., 2015)
Erosion prevention	3	Eritrea (Esmail & Geneletti, 2017), South Africa (Davids et al., 2016; Shackleton et al., 2015)
Water purification and waste treatment	2	South Africa (de Wit et al., 2012), Uganda (Schuyt, 2005)
Pollination	2	Burkina Faso, Ghana (Stenchly, Lippmann, Waongo, Nyarko, & Buerkert, 2017), South Africa (Sutherland et al., 2016)
Noise reduction	2	Ghana (Dumenu, 2013), South Africa (Shackleton et al., 2015).
Windbreaks	2	South Africa (Richardson & Shackleton, 2014; Shackleton et al., 2015)
Sediment trapping	1	South Africa (Davids et al., 2016)
Retention of nutrients	1	South Africa (Davids et al., 2016)
Watershed protection and contribute to rainfall	1	Ghana (Dumenu, 2013)

Table 2
List of all the provisioning services studied in the selected papers from sub-Saharan Africa, ranked according to the number of studies. Also indicated are the citations of all the studies that assessed the respective ES and the represented countries listed alphabetically.

Specific services assessed	Nr of studies	Represented SSA countries with references
Medicinal plants	12	Ghana (Dumenu, 2013), Nigeria (Adekunle et al., 2013), South Africa (Cilliers & Cilliers, 2015; Cilliers et al., 2013; Davenport et al., 2012; Lannas & Turpie, 2009; Lubbe et al., 2010; Munien et al., 2015; Shackleton et al., 2014; Shackleton et al., 2015; Shackleton et al., 2017; Sutherland et al., 2016)
Crop cultivation for food	12	Ethiopia, Nigeria, Senegal (Padgham et al., 2015); South Africa (Cilliers et al., 2013; Hamann et al., 2015; Kaoma & Shackleton, 2015; Lannas & Turpie, 2009; Lubbe et al., 2010; Munien et al., 2015; Shackleton et al., 2014; Shackleton et al., 2015; Sutherland et al., 2016), Tanzania (Magigi, 2013; Padgham et al., 2015), Uganda (Padgham et al., 2015; Schuyt, 2005)
Fuel wood	10	Nigeria (Adekunle et al., 2013), South Africa (Hamann et al., 2015; Kaoma & Shackleton, 2015; Lannas & Turpie, 2009; Richardson & Shackleton, 2014; Shackleton et al., 2014; Shackleton et al., 2015; Shackleton et al., 2017; Sutherland et al., 2016), Zimbabwe (Mashapa et al., 2014)
Building materials and fencing poles	9	Nigeria(Adekunle et al., 2013), South Africa (Davenport et al., 2012; Hamann et al., 2015; Kaoma & Shackleton, 2015; Shackleton et al., 2014; Shackleton et al., 2015; Shackleton et al., 2017; Sutherland et al., 2016), Uganda (Schuyt, 2005)
Wild food	7	Nigeria(Adekunle et al., 2013), South Africa (Davenport et al., 2012; Kaoma & Shackleton, 2015; Lannas & Turpie, 2009; Shackleton et al., 2017; Sutherland et al., 2016), Zimbabwe (Mashapa et al., 2014)
Livestock grazing and fodder	7	Ethiopia, Nigeria, Senegal (Padgham et al., 2015); South Africa (Davenport et al., 2012; Hamann et al., 2015; Lannas & Turpie, 2009; Shackleton et al., 2014; Shackleton et al., 2015; Sutherland et al., 2016); Tanzania, Uganda (Padgham et al., 2015)
Freshwater from a natural source	3	South Africa (Davids et al., 2016; Hamann et al., 2015; Sutherland et al., 2016)
Harvesting e.g. papyrus, fish farming	3	Nigeria (Padgham et al., 2015), South Africa (Sutherland et al., 2016), Uganda (Schuyt, 2005)
Hunting	2	Nigeria(Adekunle et al., 2013), South Africa (Lannas & Turpie, 2009)
Wood tools, brushes	2	South Africa (Davenport et al., 2012; Sutherland et al., 2016)
Fibre	1	Nigeria (Adekunle et al., 2013)
Hedge	1	South Africa (Cilliers et al., 2013)

& Gambiza, 2012; Mashapa, Gandiwa, Mhuriro-Mashapa, & Zisadza-Gandiwa, 2014; Munien, Nkambule, & Buthelezi, 2015). For instance, in Mutare, Zimbabwe, 75% of 260 respondents relied on the natural forest for wood fuel (Mashapa et al., 2014). Thirty percent of the papers interviewed residents along a socio-economic gradient, from extreme poverty to affluence, indicating the changes in reliance on provisioning services as income improves (e.g. Lubbe, Siebert, & Cilliers, 2010; Shackleton et al., 2017). Even though all but two papers (Cilliers & Cilliers, 2015; Hamann, Biggs, & Reyers, 2015) relied on the perceptions of respondents regarding their utilization of provisioning services, five papers specifically calculated the direct use values of these services to residents based on the respondents' own reported values. These direct use values were calculated for trees (Kaoma & Shackleton, 2015), wetlands (Lannas & Turpie, 2009; Schuyt, 2005), and thickets and grasslands (Davenport et al., 2012). In several small towns in South Africa, about 20% of household incomes were obtained through sales of products such as fire wood, wild fruits and building materials sourced from the natural environment (Davenport et al., 2012; Kaoma & Shackleton, 2015). Importantly, some authors caution that the current utilization of areas are not sustainable with many areas already in a degraded state (Lannas & Turpie, 2009). Moreover, degradation is

Table 4
List of all the habitat or supporting services studied in the selected papers from sub-Saharan Africa, ranked according to the number of studies. Also indicated are the citations of all the studies that assessed the respective ES and the represented countries listed alphabetically.

Specific services assessed	Nr of studies	Represented SSA countries with references
Habitat	6	Ghana (Dumenu, 2013) South Africa (Cilliers & Cilliers, 2015; de Wit et al., 2012; Richardson & Shackleton, 2014; Shackleton et al., 2015; Sutherland et al., 2016)
Maintenance of functional diversity	2	South Africa (Suri et al., 2017; van der Walt et al., 2015)

Table 3
List of all the cultural services studied in the selected papers from sub-Saharan Africa, ranked according to the number of studies. Also indicated are the citations of all the studies that assessed the respective ES and the represented countries listed alphabetically.

Specific services assessed	Nr of studies	Represented SSA countries with references
Recreation	11	Ghana (Dumenu, 2013), Kenya (Rabare et al., 2009), Nigeria (Adekunle et al., 2013), South Africa (Cilliers & Cilliers, 2015; de Wit et al., 2012; Munien et al., 2015; Richardson & Shackleton, 2014; Shackleton & Blair, 2013; Shackleton et al., 2014; Shackleton et al., 2015; Shackleton et al., 2017)
Aesthetic value	11	Ghana (Dumenu, 2013), Kenya (Rabare et al., 2009), South Africa (Cilliers & Cilliers, 2015; Cilliers et al., 2013; de Wit et al., 2012; Richardson & Shackleton, 2014; Shackleton & Blair, 2013; Shackleton et al., 2014; Shackleton et al., 2015; Shackleton et al., 2017; Sutherland et al., 2016)
Social cohesion	5	Kenya (Rabare et al., 2009), South Africa (Cilliers & Cilliers, 2015; Munien et al., 2015; Shackleton et al., 2014; Shackleton et al., 2015)
Education	4	Kenya (Rabare et al., 2009), South Africa (Munien et al., 2015; Shackleton et al., 2014; Shackleton et al., 2015)
Supernatural beliefs and spiritual value	3	Nigeria (Adekunle et al., 2013), South Africa (Shackleton et al., 2015; Sutherland et al., 2016)
Place of spiritual reflection, e.g. religious meetings	3	Kenya (Rabare et al., 2009), South Africa (Munien et al., 2015; Shackleton et al., 2017)
Tourism	3	South Africa (de Wit et al., 2012; Shackleton & Blair, 2013; Sutherland et al., 2016)
Sense of place	3	South Africa (Cilliers & Cilliers, 2015; de Wit et al., 2012; Munien et al., 2015)
Heritage, cultural and historical values	2	South Africa (Munien et al., 2015; Shackleton et al., 2014)
Hunting (perceived by residents as cultural services)	1	South Africa (Sutherland et al., 2016)
Relieves stress	1	South Africa (Shackleton et al., 2015)

typically aggravated in most areas as more people continually settle around these areas and contribute to their overutilization (Lannas & Turpie, 2009; Schuyt, 2005). This is of great concern as the papers indicate that many of the urban poor are heavily reliant on the provisioning services of GI. Furthermore, as a part of GI, urban agriculture can provide an important source of food and income, for example, 65% of the surveyed farmers in Dar es Salaam, Tanzania, used their produce for subsistence (Magigi, 2013).

4.2.3. Cultural services

Recreation and aesthetic value were by far the most assessed cultural services in the 13 studies (Table 3). In all of the six studies of urban parks and trees, respondents indicated that the major reasons why public green spaces are important are for recreation or relaxation, with many indicating the importance of aesthetics and facilities such as sports fields to attract them (e.g. Rabare et al., 2009; Shackleton & Blair, 2013). The importance of this is reflected in the fact that in Kisumu, Kenya, 45% of surveyed residents did not visit urban parks due to a lack of facilities and poor management (Rabare et al., 2009). Trees can also have important cultural and heritage value to communities (Shackleton et al., 2014); the same with certain forest animals (Sutherland et al., 2016). In a survey on the use of church gardens, respondents indicated that they experienced peace and tranquillity in a garden and it enhanced the atmosphere of spiritual reflection and prayer (Shackleton et al., 2017). Social cohesion, education and tourism were also important studied services (Table 3). In their study of the economic value of ES in Cape Town, de Wit et al. (2012) indicated that the tourism value of natural assets represented the ES with the highest monetary worth for the municipality.

4.2.4. Habitat/supporting services

Our review indicated that habitat and supporting services are the most neglected ecosystem service type. This ES type is represented by one study in Ghana, with the remaining five studies conducted in South Africa. Most of the results were obtained through questionnaires and interviews of local residents. The most assessed specific ES was habitat for species. When asked about the benefits of urban forests, only 7% of respondents in Kumasi, Ghana, listed habitat for wildlife (Dumenu, 2013). In three towns in South Africa, when asked about the benefits of street trees in urban areas, the majority of respondents in only two agreed that trees provide habitat for birds (Richardson & Shackleton, 2014; Shackleton et al., 2015). In quantifying the economic value of green spaces and ES both Cilliers and Cilliers (2015) and de Wit et al. (2012) included habitat as an important aspect. However, de Wit et al. (2012) highlighted that it is difficult to determine the value of biodiversity in isolation, rather, it should be regarded as an essential umbrella service forming the basis of most of the other ES. Shackleton et al. (2015) suggest that because these type of benefits are less obvious they are less frequently recognized by people. Only two studies directly assessed supporting services through quantifying functional diversity of birds and vegetation respectively. The results indicated that urban rivers provide important habitat for species and functional groups that would otherwise not occur in suburbs (Suri, Anderson, Charles-Dominique, Hellard, & Cumming, 2017), whereas (van der Walt, Cilliers, Du Toit, & Kellner, 2015) indicated that there were clear differences between plant species - and functional diversity in remnant natural areas along an urban-rural gradient. Plant species diversity of native grassland fragments decreased with urbanisation along with functional homogenization of urban fragments (van der Walt et al., 2015).

4.3. Barriers to the sustainable delivery of ecosystem services in sub-Saharan Africa

Seven overarching categories of barriers to the sustainable delivery of ES emerged from the reviewed papers, namely: (i) socio-cultural values, traditions and perceptions; (ii) lack of capacity; (iii) governance, urban planning and social inequality; (iv) lack of data and/or case studies; (v) ecosystem disservices; (vi) spatial trade-offs and conflicts; and (vii) climate change. Issues identified within these 7 categories are presented in Supplementary Table 1 and the key findings are summarised briefly below.

4.3.1. Socio-cultural values, traditions and perceptions

In addition to traditional beliefs held by local residents (e.g. Adekunle et al., 2013; Sutherland et al., 2016), perhaps the most pertinent socio-cultural barrier across SSA cities is a lack of relevant local valuation of ES. In their review of 52 studies on ES across 16 African countries, Wangai et al. (2016) found that 44% of studies conducted economic valuation of ES. This method of valuation is at odds with many African societies that conduct non-monetary trade and Wangai et al. (2016) conclude that more relevant value estimations can be made by capturing the value of non-monetized ES in Africa. Residents have insufficient understanding of the function and value of wetlands and rivers which they perceive as degraded and filthy water bodies and as wastelands (Schuyt, 2005; Suri et al., 2017).

4.3.2. Lack of capacity

A lack of capacity and expertise for identifying and managing urban GI is a pervasive barrier to the provision of ES across African cities. A lack of capacity often stems from financial limitations (e.g. Bobbins & Culwick, 2015; Chishaleshale et al., 2015) and this extends into a lack of technological capacity (e.g. Anchang et al., 2016), institutional capacity (e.g. Udoh, 2016) and a deficiency of infrastructure (e.g. Di Leo et al., 2016; Shackleton et al., 2015). In addition, poor awareness and knowledge of the benefits provided by green space suggests a need for improved education among local communities and decision-makers (e.g. Gwedla & Shackleton, 2015; Kaoma & Shackleton, 2015; Ward & Winter, 2016).

4.3.3. Governance, urban planning and social inequality

The Global South suffers from weak systems of formal government and planning which hinders the governance of urban ES (Wilkinson, Saarne, Peterson, & Colding, 2013). At a strategic level, policy trade-offs are apparent between environmental priorities and urban development (e.g. Chu, Anguelovski, & Roberts, 2017). A common theme that emerges from a number of studies is a lack of coordination and cooperation at multiple scales: among stakeholder groups, management levels, and institutions (Bobbins & Culwick, 2015; Esmail & Geneletti, 2017; Jorgensen, Trotter, & Hill, 2015; Sutherland et al., 2016). The upshot of this is a lack of holistic multi-sectoral urban planning for the implementation of GI projects (e.g. Douglas, 2016). Other key issues include a lack of ownership information (Davids, Rouget, Boon, & Roberts, 2016), insecure land tenure (Shackleton et al., 2015), or the erosion of traditional tenure arrangements that protected land from development (Padgham, Jabbour, & Dietrich, 2015). Disparities in the availability of green space between established wealthy suburbs, poor suburbs, and new housing programme areas in nine small towns in South Africa point to social inequality with respect to access to ES (McConnachie & Shackleton, 2010).

4.3.4. Lack of data/and or case studies

A shortage of data and/or case studies on urban ES result in a lack of evidence to showcase the benefits of implementing urban GI in SSA. This shortage often stems from a lack of capacity (Section 4.3.2), As acknowledged by Bobbins and Culwick (2015), such evidence is required to provide a basis for ES valuation while a lack of case studies hinder the mainstreaming of the GI concept. Moreover, a lack of baseline data on the current provision of ES precludes the establishment of targets and subsequent monitoring of GI projects.

4.3.5. Ecosystem disservices

Urban GI can also promote ecosystem 'disservices' (Dobbs, Kendal, & Nitschke, 2014; Lyytimäki & Sipilä, 2009; von Döhren & Haase, 2015). A common concern amongst residents in SSA cities is the perception that urban GI can negatively impact safety, such as where vegetation cover harbours criminals (e.g. Richardson & Shackleton, 2014; Shackleton et al., 2015), peri-urban green spaces offer a fire risk (Munien et al., 2015) or sustainable urban drainage systems (SUDS) provide a drowning risk (Mguni et al., 2016). SUDS can be defined as stormwater management systems that maintain "natural water flow mechanisms" or using "structures that seek to 'imitate' … the natural hydrologic cycle" (Poleto & Tassi, 2012:56). Other studies highlight biological hazards caused by contaminated food and water or zoonotic diseases (Douglas, 2016; Lwasa et al., 2015; Nortey, Aheto, Blay, Jonah, & Asare, 2016; Padgham et al., 2015). A hedonic price analysis conducted by Cilliers and Cilliers (2015) revealed that perceived ecosystem disservices could explain lower house prices of residential properties located adjacent to green spaces in Potchefstroom, South Africa.

4.3.6. Spatial trade-offs and conflicts

Population growth, urbanization and limited space cause ever increasing pressure on land, manifesting into trade-off decisions about land use conflicts, such as agricultural development at the expense of natural ecosystems (Carreño, Frank, & Viglizzo, 2012). Urbanisation across SSA cities has caused habitat loss, including urban grasslands (Sutherland et al., 2016) and mangrove forests (Udoh, 2016), ultimately impacting the sustainable delivery of ES (Wangai et al., 2016). Trade-offs also occur between different ES in the attempt to provide multifunctional GI, such as conflicts between food production (provisioning ES) and flood reduction (regulating ES) in urban floodplains (Douglas, 2016), and the challenge of aligning ES and biodiversity objectives in Durban, South Africa (Davids et al., 2016).

4.3.7. Climate change

Climate change is perhaps the most pervasive and challenging of all the identified barriers to the sustainable delivery of ES in SSA. The only way to effectively address it is through mitigation and adaptation approaches. In Durban, South Africa, the municipality specifically identified the urban heat island, stormwater runoff, water conservation and sea level rise as some of the challenges facing them due to climate change (Roberts & O'Donoghue, 2013). Moreover, poor communities will be the most vulnerable due to their lower adaptive capacity (Bele, Sonwa, & Tiani, 2014). In Durban it was initially difficult to implement climate adaptation plans as the climate change debate was a global one and there was a lack of data on the local impacts of climate change (Roberts, 2008). Particular impacts such as an increase in rainfall compounds urban problems such as flooding, health risks, water availability and pollution (Lwasa, 2010; Roberts, 2008). However, in adapting to climate change, although Durban is currently regarded as a global leader in climate adaptation planning, initial challenges were found to be institutional (lack of knowledge and commitment between different municipal sectors) and resources (human and financial) as well as a focus on more urgent development needs (Roberts, 2010).

5. Discussion

Only 38% of sub-Saharan countries are represented by this review. Wangai et al. (2016) had similar findings and we reiterate their call to urgently extend studies to cover the missing countries. Moreover, only 23% of the countries assessed ES in some way. More research in other SSA countries is needed to provide case studies and data determining whether the development of urban GI and the delivery of their ES are unique or similar to the results documented in this paper. Some countries reviewed are represented by only one or two studies (Fig. 2), therefore, studies throughout the entire SSA area need to increase. Wangai et al. (2016) and Cilliers et al. (2013) report on the strong bias towards South Africa and in our study we find the same bias as 54% of all papers focused on South Africa. However, the current review did not include reports, dissertations and theses, and other grey literature that might give a clearer picture on the extent of research conducted in SSA countries. Moreover, we also limited our review to papers published in English thereby excluding other potentially relevant papers published in other languages (Wangai et al., 2016).

Our study was the first study to comprehensively identify barriers and challenges hampering the delivery of ES and the development and maintenance of green spaces. The only other study to specifically focus on challenges is that of Mensah (2014:1) who listed "rapid urbanisation, low resource base of institutions on green spaces, lack of priority to green spaces, corruption, uncooperative attitudes of the local people and political instability" as barriers that hindered the development of green spaces. Of the barrier categories identified in our review, the most universal barriers are those of a lack of capacity and governance, poor urban planning and social inequality. To meaningfully address any of the problems and shortfalls in ecosystem service delivery in SSA countries, the significant problems of poverty and economic development should be dealt with first. The papers of Kessides (2006), Lall (2017) and Ravallion (2009) offer sage advice on describing the problems in African cities and ways to solve it. The main findings point to the lack of accountability on all levels of government, poor urban policies, lack of finances and wise allocation of revenues, and specifically poor investment in public infrastructure (Kessides, 2006; Lall, 2017; Ravallion, 2009).

There is a lack of in-depth studies on all ES. Of the studies that assessed ES in some way, many were in the form of questionnaires reporting only on the perceptions of respondents with no direct quantification or values measured. This confirms Wangai et al. (2016) who also found that few studies really quantified ES. The most represented ES were, by far, regulating and provisioning, with supporting services getting the least attention. This lack of data translates into a lack of baseline data on the current provision of ES which precludes the establishment of targets and subsequent monitoring of GI projects. Moreover, none of the reviewed papers indicated cities with adequate GI and ES delivery to all citizens. The lack of ecological baseline data is critical as accurate and up-to-date information will be required to enable future development on sustainable pathways.

In considering the lack of studies on supporting services, Pearson (2016) states that arguments for conserving biodiversity have differed widely based on conflicts in opinions on the value of biodiversity. Perceptions on nature conservation has changed from early opinions of 'nature for itself' to the current view of 'people and nature' (Mace, 2014). Initially it was felt that nature should be conserved in its pristine state excluding humans, whereas now it is acknowledged that people are part of ecosystems and benefit through ES but that these interactions should be sustainable and resilient (Mace, 2014). In their discussion on managing for 'biodiversity-friendly cities' McDonnell and Hahs (2014) shows through the careful interplay of two ideologies of nature for the benefit of people and conservation of local biodiversity, that cities need win-win scenarios for both people and nature. Linked to the lack of research on supporting services might be the lack of appreciation of biodiversity by people caused by the 'extinction of experience' of nature (Soga & Gaston, 2016). Because most people now live in cities, their experience of nature is limited to what they observe and interact with in cities. Therefore, inadequate supply and poor quality green spaces can desensitize people to 'what there ought to be' and with successive generations born and growing up in cities these perceptions can worsen.

An evaluation of the reviewed papers reporting on the perceptions of respondents revealed that the socio-economic status of the respondents influenced their perceptions regarding the benefits of green spaces. The more affluent the respondents are, the less emphasis they put on the importance of provisioning services of green spaces. In a study in Kumasi, Ghana on the benefits of urban forests, all the

respondents were affiliated with the university either as employees or as students (Dumenu, 2013). When asked about the benefits of urban forests none of them mentioned food or fuel wood as a benefit. Whereas, in Abeokuta, Nigeria where most of the respondents were poor they listed provision of food and fuel wood as the most important benefit of urban forests (Adekunle et al., 2013). Therefore, though it is clear that many cities lack adequate urban GI (Mensah, 2014) the success of effectively providing green spaces will depend on the type of benefit residents require from green spaces. However, these requirements can change over time. For instance, in cities where urban GI is currently needed to sustain livelihoods when the economic situation of residents improve and they no longer depend on green spaces for survival, their requirements may change together with their perceptions on the benefits of green spaces and their utilization of it. Therefore, for any given city the specific requirements of green spaces may differ spatially along a socio-economic gradient and temporally as economic situations of residents improve or decline. Planners and decision makers will need to understand this dynamic and incorporate it into strategic city planning.

Related to this dynamic is the trade-off decisions needed to be made regarding the delivery of ES. Ensuring multi-functionality of ecosystems require careful management and monitoring. For example, an over reliance on the provisioning services of wetlands to the point of degradation also erodes the regulating capacity of the system. In many cities the current rate of dependence on provisioning services of natural ecosystems is not sustainable. In planning urban GI decision-makers will need to balance adequate provisioning services with conservation of enough urban GI to sufficiently provide regulating services such as temperature amelioration and flood protection. However, the reviewed papers indicate that many urban residents rely on urban GI for subsistence, therefore, we need to look for alternatives for food provisioning such as gardens on vacant lots, vertical- and roof gardens and other innovative solutions. A study by Grewal and Grewal (2012) in Cleveland, America indicated that through careful planning and private and institutional cooperation it can be possible for a city to meaningfully increase local self-reliance in food.

In stating the case for the importance of accurate local valuation of ES, Ernstson (2013) use the example of a pine forest in Cape Town, simultaneously highly valued for recreational purposes by some and despised by others for endangering local endemic vegetation which when restored will enhance fresh water flows and long-term conservation of biodiversity. He uses this as evidence to “support the argument that ecosystem services are not something ‘out there’ that scientists simply can measure, but rather they are contested and highly entangled with social and political processes, not least that of value articulation” (Ernstson, 2013:10). Chan et al. (2012) proposed a framework to ensure the deliberate inclusion of cultural and social values of all ES in decision-making. They caution that interventions without incorporating cultural values not only alienate locals but can even have negative unintended consequences undermining intended outcomes. Therefore, ES need to be locally assessed and context specific, documenting the actual culturally perceived value of ES by targeted individuals.

Urban GI is not equally distributed in cities, therefore not all residents equally benefit from services such as the cooling effects of plants and parks for recreation. This unequal distribution needs to be addressed as the low cost housing areas and slums where it is least abundant is usually those areas where it is most needed. Poor quality or absent urban GI and public services poses health risks. Moreover, well managed liveable cities attract international investors and an educated work force with major advantages to local and regional economies (Kessides, 2006).

In conclusion, research in SSA should increase. There is a lack of in-depth studies specifically those assessing ES. The seven identified barrier categories need to be addressed. ES should be locally assessed and context specific. Moreover, in the management and future planning of cities decision-makers should remember that urban GI and its associated ES requirements can differ spatially and temporally. Furthermore, trade-offs in prioritization of specific ES above others such as provisioning instead of regulating should be carefully considered. The current state of research in SSA on urban GI and ES is inadequate to effectively and confidently ensure that sub-Saharan Africans receive ‘the future they want’ in prosperous ‘liveable’ cities. How the gaps and barriers can be addressed, and if it can be addressed, are important questions facing scientists and decision-makers today.

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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.2018.06.001.

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