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Green infrastructure needs green governance: Lessons from Australia's largest integrated stormwater management project, the River Torrens Linear Park

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ABSTRACT

The River Torrens Catchment in Adelaide has suffered from poor water quality and flooding for decades. To address these challenges, a green infrastructure project, specifically a Linear Park, was created within the catchment. Although the project has functioned reasonably well since its implementation, its complex nature poses several management challenges. Despite the scale of this project, there is little scholarly literature available. Hence, to analyse these management challenges, this paper reviews the original project documentation, as well as regulations and policy documents together with findings from interviews with key project informants. The aim is to investigate the key drivers for implementation; the major stakeholders involved; and the challenges emerging from the multidimensional attributes of the project. The challenges relate to the inconsistent and informal management structure, the involvement of multiple stakeholders, and pressure from surrounding development. The challenges are further grouped under four main themes, including communication and collaboration, project design goals, institutional and political frameworks, and planning and development regulations. This paper argues that green governance is the key to the successful implementation and management of sustainable green infrastructure projects. The findings from this case study can inform policymakers, planners and researchers to propose appropriate scenarios to manage urban stormwater and to reclaim neglected waterways.

1. Introduction

In the 21st century, linear parks have emerged as an increasingly valuable green space typology (Koc et al., 2017) in the context of urban densification. While the High Line (Washburn, 2013) in New York (2009–2014) revitalised a disused railway to maximise recreational space in the metropolis, Turenscape's 'Red Ribbon' Tanghe River Park (2006) (Saunders, 2013) transformed a degraded river corridor in Qinhuangdao, China. Linear parks like these represent important examples of green infrastructure which comprise waterfront developments, transport corridors, trails or greenways to provide high quality, multi-functional urban spaces. This paper focuses on a linear park as a specific example of green infrastructure (GI) which is broadly defined as an interconnected system of green spaces, comprising natural areas like waterways, woodlands or parks that are planned and managed to provide social, economic and environmental benefits.

Urban linear parks are distinguished by their scale and linear morphology. While the High Line repurposed 1.5 miles of a disused elevated railway, projects like the Vauxhall Missing Link (2015) greenway cut through several London districts to connect this borough to the Thames. Washington DC's Marvin Gaye Park (Rosenberg, 2015), formerly the Needle Park due to the prolific intravenous drug use in the area, transformed the city's north eastern neighbourhoods with a 2-mile greenway.

Acknowledging the many functions and benefits of these transformative projects, linear parks along waterways have historically been designed to mitigate flooding or to improve stormwater quality (Austin, 2014) as in the case of Frederick Law Olmsted's initiative to control the marshes of Back Bay and the Fens with Boston's influential Emerald Necklace, which begun in 1878 (Marks et al., 2015; McCool, 2012). The value of this function escalates given the impact of urban densification and the concomitant impact of impermeable surfaces on precious water resources (Carter et al., 2018; Samant and Brears, 2017, Yok Tan and Jim 2017). This paper focuses on the lessons that can be learned from a study

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of the River Torrens Linear Park (RTLP) in Adelaide, Australia, which was begun in the early 1980s. This is the largest integrated stormwater project in Australia (Jones, 2010; Shanahan et al., 2010). Although the total length of the River is around 75 km, the RTLP covers a distance of 50 km with an overall area of 30 km^2 (Mugavin, 2004).

The RTLP represented a viable alternative to conventional approaches to stormwater management. Waterways have long been reduced to suitable sites to discharge waste (Austin, 2014) or channelized exclusively for drainage purposes (Liao, Deng, and Tan, 2017). Discharge of untreated sewage and stormwater runoff can severely damage waterways and rivers. It compromises aquatic ecosystems and interrupts the natural flow thereby decreasing water quality (Samant and Brears, 2017; Schuch et al., 2017; Vojinović and Huang, 2014). Given these impacts, green infrastructure, specifically linear parks, represents a sustainable model to manage urban water. Firstly, linear parks mitigate riverine floods (Renaud et al., 2016; van Wesenbeeck et al., 2017); this risk is projected to be increasing (WIREs Water, 2015). Secondly, they help to transform neglected waterways into cleaner landscapes (Chini et al., 2017). Thirdly, they help to protect and preserve the aquatic species within river systems (Liao, Deng, and Tan, 2017; Samant and Brears, 2017).

Despite these benefits, the morphology of a linear park can present many issues relating to governance as the park cuts through different districts or neighbourhoods. Consequently, the management of waterways or river basins usually involves multiple administrators (Mohamad et al., 2018; Lebel et al., 2013; Zhao et al., 2017). This is further complicated if the basin authorities compete with each other (Lebel et al., 2013). Ernstson et al. (2010) and Meerow and Newell (2017) emphasise the need to address this potential competition and to establish a suitable governance model to ensure the long-term sustainability of a project. Acknowledging these challenges, Liao, Deng, and Tan (2017) and others (for example Francesch-Huidobro et al., 2017; Takeuchi et al., 2016) call for new case studies focusing on water-related green infrastructure to better understand their governance models with a view to promote their future application.

Motivated by these prior studies, this paper examines the challenges that have arisen, relating to governance, during the implementation and evolution of the River Torrens Linear Park (RTLP). To do so, the paper identifies the drivers for the project in the 1970s, the multiple functions of the park and the key stakeholders and their divergent priorities. Drawing on archival material and existing documentation of the RTLP as well as primary data derived from interviews with key project informants, this paper argues that the successful governance of the project has been compromised due to the multidimensional attributes. These are identified in a systematic discussion of the data. The success of a sustainable linear park hinges on a suitable model of green governance as a strategy to reclaim overlooked waterways as potential sites for green infrastructure.

2. Challenges to implementation

2.1. Cleaner water and competing functions

The majority of greenway projects serve multiple functions in addition to improving water quality (Ahern, 2010; Austin, 2014; De Sousa, 2014). The Millennium Ecosystem Assessment (2005) categorised these functions under four components, including supporting, provisioning, regulating and cultural services. Green infrastructure supports soil formation and nutrient cycling. The provisioning functions include contributions to food and freshwater supply. Climate regulation, flood control and improved water quality are considered to be regulating functions. Cultural services include the facilitation of recreation and ecotourism and opportunities to foster spiritual and educational values.

Ahern (2013) and others scholars (such as Benedict and McMahon, 2012; De Sousa, 2014; Green Nylen and Kiparsky, 2015) argue that multi-functionality is a key principle of well-planned green infrastructure. Firstly, Ahern (2011) identified space limitations as a major driver for diversifying green infrastructure; land must be put to the most efficient and cost-effective use. Emerton and Bos (2004) argued that using green infrastructure to maintain the quality and quantity of water availability can lead to positive economic benefits. Moreover, the prevention of water-related damage to people and property is an indirect economic benefit.

Secondly, the provision of multiple functions through green infrastructure can offset the potential trade-offs that might emerge from the application of conventional stormwater infrastructure (Meerow and Newell, 2017). In the case of the Emerald Necklace, for example, the project provided solutions to stormwater challenges whilst offering recreational opportunities, therefore increasing community acceptance (Eisenman, 2013; McCool, 2012).

Thirdly, the widespread advocacy for sustainability and resilience from policymakers (Millennium Ecosystem Assessment, 2005; World Bank Group, 2017; WWAP United Nations World Water Assessment Programme, 2017) and scholars (Marchese et al., 2018; Redman, 2014; Schuetze and Chelleri, 2011) further highlights the importance of diverse functions. For instance, the United Nations Sustainable Development Goal 15 "focuses on preserving and sustainably using the Earth's terrestrial species and ecosystems" (United Nations, 2017, 10), which hinges on the multifunctional benefits of healthy ecosystems.

Further drivers for green infrastructure related to waterways, which complicate governance, include issues such as flooding and urban heat (Emilsson and Ode Sang, 2017; Pauleit et al., 2017); urbanisation issues, including population growth (Montalto et al., 2013; Poustie et al., 2015); economic needs like the cost of potable water and land (Wild et al., 2017); socio-cultural values including the connection of people to water (Feng and Tan, 2017); and ecological issues such as the protection of natural ecosystems (Andersson et al., 2017; Pickett, Cadenasso, and McGrath, 2013a). Accordingly, green infrastructure encompasses diverse land uses to serve the needs of varying interest groups (Hansen et al., 2017; Pickett, Cadenasso, and McGrath, 2013b; Yok Tan and Jim, 2017).

2.2. Diverse stakeholders

Further challenges to the governance of multi-functional green infrastructure – to meet the social, economic and environmental drivers – is the need for multi-stakeholder collaboration (De Sousa, 2014; Feng and Tan, 2017). As highlighted by Takeuchi et al. (2016) and Mander et al. (2007) stakeholders such as communities, government institutions, the private sector and non-governmental organizations are simultaneously needed to realise the multiple benefits. These stakeholders have varying degrees of expertise, needs (Benedict and McMahon, 2012) and attitudes across space and time (Mander et al., 2007). For instance, whereas upstream stakeholders might be interested in the recreational use of green infrastructure, downstream communities might be concerned with dangers related to flooding. Moreover, stakeholders' priorities are likely to change in response to the paradigm of a particular period (Mander et al., 2007).

This diversity of stakeholders requires a collective process to set goals (Margerum and Robinson, 2015). Cohen-Shacham et al. (2016) identified the need for robust governance and a clear understanding of the goals of the infrastructure based on clarification

of the varying stakeholders' values and interests. Additionally, high level leadership and regulation are deemed to be critical to reach a consensus (Azadi et al., 2011). Similarly, Azadi et al. (2011) highlights the state's role as decisive to drive a better outcome. This scenario is logical given that most water projects must comply with federal, state, and city standards (Dhakal and Chevalier, 2016).

However, without effective stakeholder involvement, the governance of green infrastructure can lead to institutional uncertainties in terms of the roles, priorities and responsibilities (Margerum and Robinson, 2015; Stockdale and Barker, 2009). Secondly, there is the potential for the stakeholders – particularly the public users – to develop divergent perceptions about the purpose of such initiatives (Gashu et al., 2019). Thirdly, there is the danger of compromising the social and environmental benefits of such solutions (Hillman et al., 2003). Due to these challenges, it can take a long time to realise the full potential of such infrastructure project (De Sousa, 2014).

2.3. Governance

These potentially competing functions, together with diverse stakeholders, present challenges to the long-term sustainability of green infrastructure. These challenges are further complicated by questions of governance. Chelleri, Schuetze, and Salvati (2015) see political barriers as the main challenge to sustainable water management. For Cohen-Shacham et al. (2016), effective governance is compromised by the lack of a shared vision and priorities; poor coordination among stakeholders; and the need to balance the intensive use of the project with its maintenance. Furthermore, Ashley et al. (2015) identified conflicts of ownership, management of maintenance responsibilities and weak regulation as the most pressing challenges.

An extensive review of recent studies (Francesch-Huidobro et al., 2017; Lebel et al., 2013; Schiappacasse and Müller 2015; Waylen et al., 2017) showed that the challenges to governance can be grouped as follows: 1) project design goals (multiple); 2) institutional and political system; 3) communication and collaboration; and 4) legal frameworks.

As illustrated by Floyd et al. (2014) in the case of Australia, government reforms in the water sector can increase the number of institutions with water management responsibilities. This situation usually complicates the clarity of responsibilities and engagement among these institutions (Floyd et al., 2014). Another institutional challenge is the development of appropriate policies to guide sustainable green infrastructure (Sharma et al., 2012).

As shown in Fig. 1, each of the above issues could be further categorised as internal or external factors. This categorisation helps to understand the actual origin of the existing problem (Azadi et al., 2011; Butler et al., 2017; CIRIA, 2013). Butler et al. (2017) see internal factors as those issues which originate with the infrastructure itself or the management. External factors are the issues originating from indirect or outside stakeholders. Their study (Butler et al., 2017) on sustainable and resilient water management identified poor management, insufficient maintenance, funding constraints and depletion of resources as part of the internal issues. The external issues included population growth, climate change and political pressure.

The above categorisation is similar to the findings of Azadi et al. (2011) on green space management. Their study identified a clear delineation of roles – design, implementation, maintenance and funding – among the state, private agencies and community groups as internal factors. The external issues related to leadership, a sound financial position, well-functioning regulations and the political context (Azadi et al., 2011).

Getzner et al. (2014) argued that a suitable governance model to address these challenges depends on the context of the challenges. For instance, the main challenge of the Hohe Tauern National Park in Austria related to conflicts between landownership and the large number of tourists. To address this challenge, decision-making committees, diverse boards and cross-regional initiatives were instituted to ensure a complex system of dialogue, engagement and decision making (Getzner et al. 2009, 2014). In contrast, the Jostedalsbreen National Park in Norway, which attracted fewer tourists, instituted a less-complex governance system because the public owned a larger portion of the land (Storm et al., 2009). Also, the management objectives focused on conserving biodiversity.

The above review is not exhaustive. However, it highlights the nature of the challenges, which can compromise the effective governance of green infrastructure. Consequently, the discussion in this paper will proceed by drawing a link between the driving forces for the implementation of the RTLP, the involvement of multiple stakeholders and challenges related to governance. These challenges will be categorised to determine whether they require an internal or external response. The next section outlines the methods for this paper.

3. Materials and methods

This paper adopts a case study approach to understand how the RTLP project has been managed to address flooding and stormwater quality. This case study is relevant as it aims to highlight some of the drivers and the governance framework to manage stormwater through the implementation of the linear park. Therefore, the results from this case study could provide lessons for other cities seeking to reclaim the full potential of their waterways and to maintain them in sustainable ways.

3.1. Policies and regulations

The first stage of data collection comprised a critical review of the regulations, policy and project documents to understand the issues affecting the RTLP. The pre-implementation documents included the "River Torrens Study: a co-ordinated development scheme" (Hassell and Partners, 1979) and "the River Torrens Flood Mitigation Study" (The Engineering Water Supply Dept, 1981). Both studies resulted in the publication of two reports in 1979 and 1980 respectively.

The River Torrens Study resulted in a detailed description of the influence of ecological and cultural factors on the River (Hassell and Partners, 1979). It provided a thorough description of the approach to ecological landscape planning. The River Torrens Flood Mitigation Study also provided an in-depth assessment of the history of flooding in the catchment, future flood probabilities, suitable flood management options and the estimated cost of each option (Dexter, 1997).

3.2. Interviews and field studies

Multiple site visits enabled the researchers to appreciate, understand and capture images of various components of the RTLP. Following the site visits, the research team conducted semi-structured interviews through purposive and non-proportional quota sampling (Etikan and Bala, 2017) of key informants. Accordingly, the selection of interviewees was restricted to those who could provide expert information about the project. The selection was not restricted to a specific number of interviewees; it was dictated by the availability of suitable participants. As shown in Table 1, informants from State Government agencies, Local Councils, elected community leaders and other voluntary community groups were contacted.

Fig. 1. Factors influencing the performance of Green Infrastructure

Table 1
Details of informants.

Informants	No. contacted	No. accepted to participate
State Agencies	10	5
Local Councils	11	4
Elected Community leaders	8	3
Community groups and private agencies	4	2
Total	**33**	**14**

Of the 33 informants contacted, 14 agreed to participate in the study. Ten respondents had direct involvement in the RTLP as administrators or volunteers. Informants from the state agencies were those engaged in state-wide issues such as planning, open space, water and natural resources management. The local councils were those located within the Torrens River Catchment, with a particular emphasis on those directly adjoining the RTLP. The elected community leaders were contacted because they represented their communities at the Local Councils. In addition, we sought to include community groups to capture a diverse range of respondents and enhance the validity of the outcomes.

The research team analysed the interview data using NVivo, a software program for analysing qualitative data. This enabled the researchers to provide an accurate and fair representation of data (Welsh, 2002). All interviews were audio-recorded with consent. The recordings were subsequently transcribed and coded into nodes within the software. The coding was categorised under the research objectives – drivers, challenges and management strategies.

3.3. Participation in governance workshop

There was an opportunity to participate in governance workshops in 2019. The workshop was conducted to determine management objectives, responsibilities and suitable governance strategies to manage the current challenges affecting the River Torrens. In addition to the interviews, the workshops enabled us to observe and understand the varying views of stakeholders regarding the role and governance challenges of the RTLP.

3.4. Adelaide, River Torrens and the linear park

As shown in Fig. 2, the River Torrens (also known as Karrawirra Parri) is located in Adelaide, the State Capital of South Australia. It extends from the Mount Lofty Ranges (east of Adelaide) to the Gulf St. Vincent (west). The River divides Adelaide into the Northern and Southern suburbs. It is the largest urban waterway in Adelaide. The RTLP is located along both sides of the River.

Although Adelaide is generally prone to water scarcity, the city experienced a significant number of flood events (of varying degrees) before the implementation of the RTLP. The River Torrens cannot be compared to other notable Australian rivers, such as the Brisbane River, the Yarra River in Melbourne or the River Murray. Instead, it is a small stream, which was named as 'River Torrens' by Colonel Light, who chose the original site for Adelaide (Taylor, 2010). However, it demonstrated 'season to season' variability in precipitation, runoff and streamflow between the eastern and western ends of the River (Taylor, 2010). It was observed from the field that there is significant variability between the streamflow in the rural catchment and the urban catchment, including the Breakout Creek.

In addition, Adelaide has a Mediterranean climate composed of hot, dry summers and cold, wet winters. As shown in Fig. 3, the average annual rainfall is 560 mm. About 71% (413 mm) of the

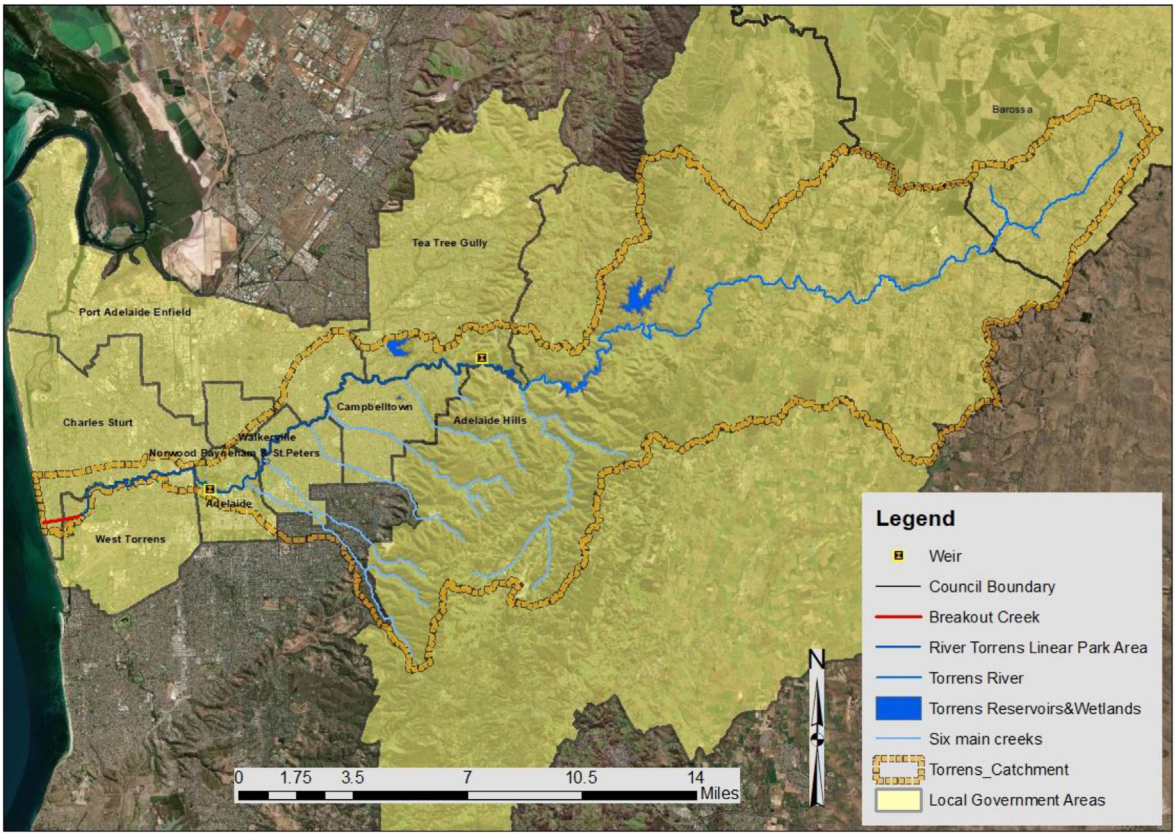

Fig. 2. Location of the Torrens Linear Park in Adelaide.
Source: Produced by authors using Publicly available GIS data from South Australia Government.

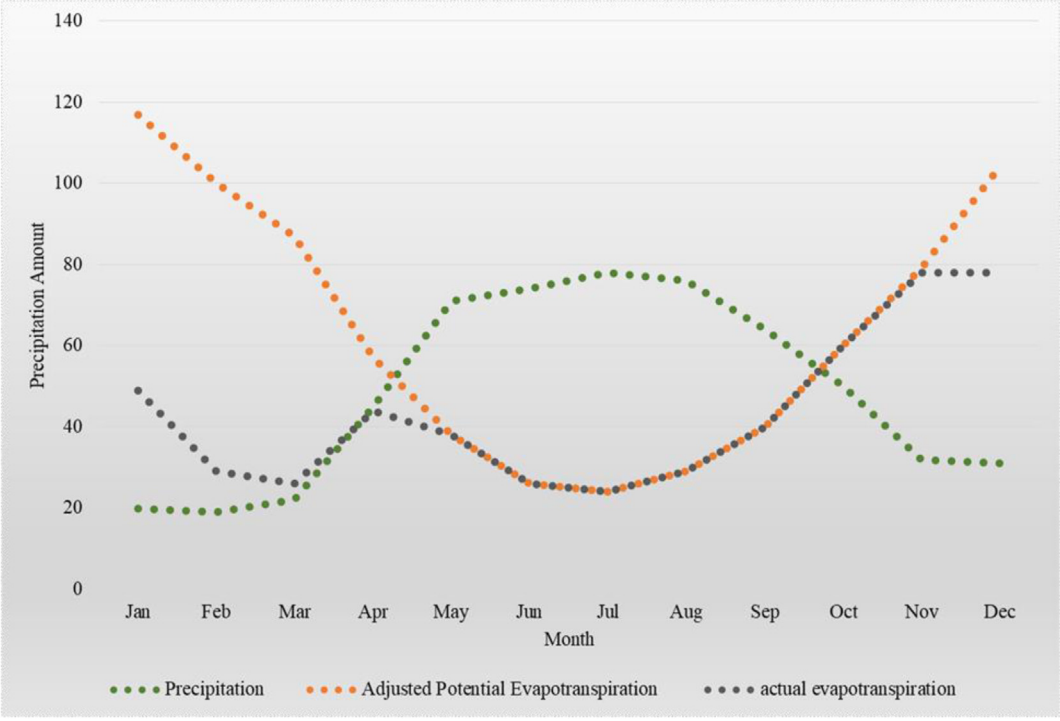

Fig. 3. Annual water balance components for Adelaide.
Source: Based on WebWIMP
(http://climate.geog.udel.edu/~wimp/).

rainfall occurs in winter and spring (May–October). 29% (169 mm) of the annual rainfall occurs in summer (November–April). During this period, the maximum daily temperature can exceed 40° Celsius, which usually occurs in February.

Thus, the city and most importantly, the Torrens Catchment exhibits two distinct characteristics. The first characteristic is the likelihood of floods occurring in the winter. Almost all the notable floods experienced in Adelaide in the Torrens Catchment were the result of continuous and excessive rainfalls (Smith and Twidale, 1987). According to Bourman (2010), flood risks are highest in the floodplain areas where improper development has occurred. It usually affected areas downstream of the River.

The second characteristic is the likelihood of the River Torrens to dry-up in the summer. The earliest settlers were disappointed with this feature of the River (Stacy and Venus, 2001). As shown in Fig. 3, the actual and potential evapotranspiration levels in summer (November–March) are higher than the amount of rainfall. As such, there is usually unmet atmospheric demand for moisture during the summer. The expectation for devastating rainfall and flooding was usually low in the summer.

However, flood events in Adelaide do not only occur in the winter. The unusual characteristics of the South Australian climate make the rainfall pattern unpredictable. According to Daniels et al. (2010), there have been flood events in the summer. Other factors (see section 4.1.2), such as channel sedimentation, urbanisation and the predominantly clay soils resulted in unpredictable events (Taylor, 2010). For instance, the dryness of the clay soil in the summer means that a minor rainfall event can cause significant flooding due to the soil's lack of porosity. In addition, the lower reaches of the River Torrens (See the Breakout Creek area in Fig. 2) – like many other streams in Adelaide – was perched above the surrounding floodplain (Bourman, 2010). As a result, whenever precipitation events breach the perched levee, unexpected floods occurred in downstream areas.

According to Curran et al. (2010) these attributes make the management of water resources challenging, especially in the drought periods. For instance, the rainfall at the hills – upstream – far exceeds that of the downstream. Curran, Wright, and Ray (2010) show that the amount of rainfall in the hills exceeds 1100 mm per year, double the average amount of rainfall in the entire Adelaide region.

4. Results

4.1. Drivers for RTLP's implementation

Historically, many factors influenced the implementation of the RTLP. The drivers comprise both biophysical and socio-political issues, which are consistent with some of the drivers highlighted in Section 2. These drivers directly define the multifunctional attributes of the RTLP. The primary function is stormwater management. The secondary functions comprise mobility (transportation), recreation, and environmental biodiversity. The subsidiary functions together with the flood mitigation role, make the RTLP a multifunctional asset.

4.1.1. Flooding, stormwater quality and water conservation

Evidence from archival documents and a limited number of scholarly studies show that the city of Adelaide experienced riverine flooding during the early colonial settlement along the River Torrens. The first floods may have occurred before 1841 (Smith and Twidale, 1987). Despite notable floods events such as those of 1841 and 1889, it was not until the 20th century that flooding became a public concern. Flooding occurred in almost every year of the first two decades. The most notable events occurred in 1904, 1908, 1913 and 1917. In 1931, also, flood events destroyed and inundated many roads (Smith and Twidale, 1987).

Most of these incidents were attributed to the overflow of the Torrens during the unexpected rainfall events in the winter. Meanwhile, flooding was in sharp contrast to the dryness of the river in the summer as discussed in Section 3.4. The interview results corroborate the findings from the literature. Interviewees were mostly asked to explain the drivers for implementing the RTLP. As shown in Fig. 4(a and b), flooding was the most widely recognised driver. Although not all the interviewees were aware of flooding as a significant driver, some highlighted the issues of flooding historically. As said by one interviewee, "in the 30s and 40s there were floods". Another interviewee also mentioned there were "great risk of flooding" and "there is no doubt that flooding was the main driver" for the implementation of the RTLP.

Apart from the flooding, residential development, agricultural production and industrial practices posed water quality challenges within the River. The construction of dwellings in the low-lying areas (western parts) of the River Torrens increased significantly. The number of dwellings (19,941) in 1921 had more than doubled in 1986 (74,886) (Smith and Twidale, 1987, Smith and Twidale, 1987). Most of these dwellings were constructed in the floodable zones of the River. Moreover, they automatically increased stormwater runoff due to the conversion of natural land surfaces into impermeable surfaces.

In line with these drivers (flooding, poor water quality and drought), various government reports identified stormwater management as the primary function of the park. It provides a 1 in 200-year flood protection (Dexter, 1997) to ensure optimum safety for people and property. It also helps to improve the quality of stormwater entering the River Torrens. As shown in Table 2, stormwater management strategies within the RTLP and the Torrens catchment, include the construction of the Kangaroo Creek Dam (see Fig. 2); weirs; bank layback; provision of wetlands (see Figs. 2 and 5); Break Out creek; and installation of pollutant traps and rehabilitation projects. The Kangaroo Creek Dam stores floodwater to avoid downstream inundation. The wetlands (see Fig. 5) assist in filtering the stormwater before it enters the River.

Initially, the River did not discharge directly into the sea but created a series of muddy pools and reed beds at the coast. To address flood challenges, Breakout Creek was established (see Fig. 2 above). It incorporated the construction of wetlands, the widening of the watercourse, the creation of viewing platforms and plantings to enable the River to flow directly into the sea.

4.1.2. Environmental challenges and depletion of biodiversity

The Torrens Catchment faced many environmental issues, some of which contributed to the flood incidents and the poor water quality in the River. Various human activities intensified sand and clay extraction, timber and firewood harvesting. Erosion, gullying and sedimentation within the Torrens Catchment were rampant. Also, one interviewee recounted that people used to indiscriminately dump refuse in many sections adjacent to the River, which washed into the riverbed following a storm. Consequently, human footprints dominated the natural attributes of the River.

As the natural environment reached a deplorable condition, it became noticeable that the River needed a positive intervention. One respondent commenting on the environmental problems mentioned the River looked "very sad" during the 1970s. According to the interviewee, the River usually dried up in the summer and sometimes formed a series of muddy pools. Another respondent mentioned that the European settlement was very destructive to the pre-European vegetation along the River.

Hence, the environmental issues, which were primarily the outcome of human practices, contributed to the implementation of

a

b

The 10 most repeating words	Length	Count	Weighted Percentage (%)	Similar Words
Floods	6	70	4.98	flood, flooded, flooded', flooding,
River	5	33	2.35	river
Water	5	31	2.20	water
Government	10	14	1.00	government, governments
Space	5	12	0.85	space, spaces
Development	11	11	0.78	developed, development,
Adelaide	8	11	0.78	Adelaide
Create	6	11	0.78	create, created
Torrens	7	11	0.78	Torrens
Stormwater	10	10	0.71	stormwater

Fig. 4. (a, b). Most frequently used words to describe the driving forces for the RTLP implementation.
Source: Results from authors' interview, 2019.

Table 2
Structural strategies for managing stormwater in Torrens Catchment.

Stormwater management attribute of the RTLP	Description
Kangaroo Creek Dam and weirs	• The dam is located on the River in the rural catchment • Has 18.7 GL storage capacity with 8 GL flood storage capacity • The weirs help to improve water quality by filtering sediments
Bank Layback	• Watercourse widening to increase hydraulic capacity
Weed Control and revegetation	• Introduction of indigenous plants • Removal of exotic, harmful and woody weeds • Provision of open space for recreation
Wetlands and breakout creek	• Connection of the River to the sea to enable flow directly into the sea • Creation of viewing platforms • Provision of wetlands to store water and improve infiltration (see Fig. 5)
Rehabilitation and pollutant removal	• Renewal of streams in the catchment • Fencing of creeks to block waste materials from entering the watercourses • Conversion of some Creeks into SuDS • Dredging of watercourses • Installation of gross pollutant and silt traps at the drain outlets to block solid waste materials

the park. In view of these drivers, the biodiversity function of the RTLP is characterised by revegetation and introduction of native vegetation in the Park. This practice added value and diversity of fauna and flora within the Park.

4.1.3. Increasing knowledge of people and public pressure

As the floods and environmental problems worsened, people gradually recognised the negative impact of human activities. Awareness of the value of environmental conservation, green open space and recreational practices increased among citizens and professionals. The citizens were keen to improve the quality of the River Torrens as a greenway. These drivers defined the subsidiary functions of the Park (See Fig. 6).

According to one interviewee, the inclusion of recreational facilities, transportation and biodiversity improvement responded to this driver. The opportunities for transport, and the development of the O-Bahn busway link responded to a protest to the proposal for a freeway in the corridor in the 1960s and 1970s. This feature has transformed the commute of many residents in the northeast of the city and fuelled residential development. At the same time, the cycling and walking trails, ovals, tennis courts, playgrounds and open spaces provide avenues for both passive and active recreation. The recreational function appears to be the most visible function of the RTLP. The interviewee added that the integration of these functions with the flood mitigation significantly induced acceptance by all stakeholders, particularly the communities.

4.2. Stakeholder involvement and factors influencing their interest

The diverse functions and attributes of the RTLP attracted multiple stakeholders from both State and Local Governments. The River passes through several Local Councils. As shown in Fig. 2 (above), nine Local Council areas directly adjoin the RTLP. Although not statutory, these Councils are major stakeholders in various aspects of the Park. They actively contribute to maintenance activities and oversee the Park's assets. These Councils, together with other councils within the Torrens Catchment, played immense roles in the implementation of the Linear Park.

As the largest waterway in Adelaide, representing the "heart" of Adelaide, one of the interviewees stated that, "the River is the backdrop to the form of the city and the development that goes along it". This attribute attracts a wide range of stakeholders. The stakeholders include the communities, Local Councils and State agencies. The interviews show that some personalities in the rural catchment – outside the urban catchment where the RTLP is located – also show interest in the park's management. Thus, stakeholder interest in the RTLP is not limited to urban dwellers who frequently visit and use the park.

The land forming the linear park is owned by more than one entity. The State and the Local Councils own most of the land. The State owns the lands known as the Crown Land along the river. The Crown Land falls under the responsibility of the Minister of Environment and Water. Also, the South Australian Water Corporation

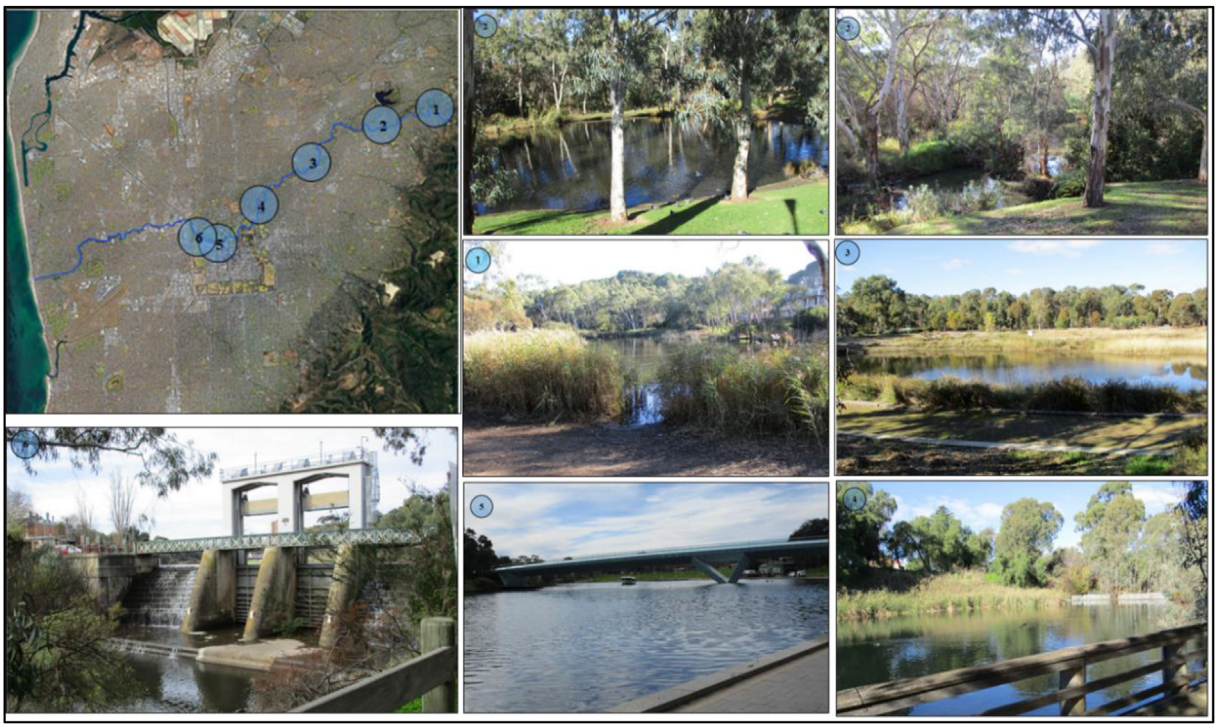

Fig. 5. Wetlands, dams and a weir within the RTLP
Photos: Authors, June 2019.

Fig. 6. Busway, cycling and walking trails within the RTLP
Photos: Authors, June 2019.

(SA Water) exercised ownership over the riverbed. Moreover, about eight Local Councils directly adjoining the RTLP own some portions of the land within their Council areas.

Before the implementation, however, most parts of the Linear Park were privately owned. Private ownership changed following the formation of the River Torrens Acquisition Act 1970–1972. The Act gave control of the land to the Councils. Nevertheless, some interviewees believe private individuals still own parts of the land because there are private properties within the Park. According to one respondent, for instance, parts of the Linear Park located in the Adelaide Hills Council is privately owned. Hence, land ownership is complicated, automatically attracting more than one stakeholder. As one of the interviewees highlighted:

"It is a bit of mixed bag, there are some that are Crown Land, there are some bits that are not. Probably, if you look at it from the sea up until the foothills, is probably more Crown Land than private land. Once you get up to the hills, it is probably more private lands."

Finally, the multifunctional attributes, which resulted from the drivers, and subsequently, the functions integrated into the RTLP attract multiple stakeholders from various disciplines. Table 3

Table 3
Drivers of multiple agencies and stakeholders in the RTLP.

Function/symbol	Driver	Key Agency/stakeholder
1. Flood mitigation	• Recurrence of floods • Property damage	• Local councils • Department for Planning, Transport and Infrastructure (DPTI)
2. Integrated stormwater management	• Water scarcity • Water pollution	• Department of Environment and Water • South Australian Water Corporation (SA Water) • Stormwater Management Authority
3. Recreation	• Improving quality of life • Demand for recreational facilities	• Local Councils • Office for Recreation, Sport and Racing (ORSR) • Riverbank Authority (dissolved in July 2018)
4. Transportation	• Accessibility	• Department for Planning, Transport and Infrastructure (DPTI)
5. Biodiversity and ecosystem conservation	• Depletion of resources • Erosions • Loss of native vegetation	• Department of Water and Environment • Adelaide Mount Lofty Ranges (AMLR) Region Natural Resources Management Board (NRMB) • Communities groups
6. Environmental improvement	• Pollution	• Environmental Protection Authority • Department of Environment and Water
7. Cultural identity, health, wellbeing and tourism	• Requirement for equity • Preserving the heritage of the Torrens River • Preserving the interest of the Aboriginal people	• Local Councils • Communities groups • Department of Environment and Water (DEW) • Department of Health and Wellbeing (DHW) • Department for Trade, Tourism and Investment DTTI) • Private businesses

shows that stakeholders comprise State Government Agencies, Statutory Authorities, Local Councils, community groups and private businesses. Although few of these bodies play active roles, each of these bodies has some form of de facto interest in the progress of the Park. For instance, the flood mitigation and the stormwater management component attracts institutions like the Stormwater Management Authority, the South Australia Water Corporation and the Local Councils.

As shown in Table 3, DPTI, DEW, ORSR, DHW and DTTI are all State-level agencies. However, DPTI, DEW and ORSR play active roles in the management of the park. The Minister for each of these agencies has the responsibility for overseeing its area of interest, which is not restricted to the RTLP. For instance, DEW has a Minister in charge of water and environmental issues in South Australia. The Minister for DPTI is also responsible for transport, land use development and open space within the RTLP. SA Water, the Stormwater Authority, EPA, Adelaide and Mount Lofty Ranges Natural Resources Management (NRM) Board and Riverbank Authority are statutory State bodies. The latter was dissolved in 2018, and a new State Government appointed committee will replace it.

Each of these bodies – mainly SA Water and NRM – have had active responsibilities in the management of the Park. Both SA Water and NRM were the most referenced State Government agencies during the interviews. SA Water's primary interest relates to water. NRM, in partnership with the DEW, is the custodian of public parks, gardens and heritage places. Their role reflects their responsibility for promoting natural resource sustainability. An ongoing institutional reform by DEW will replace the urban component of the NRM Board with a new body known as Green Adelaide. According to one interviewee, the RTLP will be part of Green Adelaide.

Each Local Council manages and maintains its portion of the Park. One elected community leader indicated that they (Councils) share the costs of maintenance with SA Water. However, the Councils mostly focus on assets such as cycling trails, lighting and signage. The local communities are mainly the beneficiaries of interventions occurring in the Park. There are a few community groups such as the Friends of the Billabong and the Western Adelaide Coastal Residents Association that volunteer to maintain plants in their respective areas of the Park. Consequently, the range of stakeholders with interest in the RTLP signifies the multifunctional character of the Park.

4.3. Emerging challenges

The interviews also inquired about the challenges emerging from the management of the stormwater within the Torrens Catchment. With the help of NVivo, the challenges have been categorised into context-specific issues, which are explained as follows:

4.3.1. A summary of the RTLP's management challenges

The RTLP has not had consistent and well-organised leadership since its implementation. Firstly, its emergence and character was the result of collaborative leadership. Leaders from Local Government saw the need to convert the riverbank into a Linear Park. Reviews show twelve Local Councils within the Torrens Catchment collaborated to raise their concerns about the deteriorating nature of the River. Their concerns led to a series of reforms before the RTLP's implementation.

Secondly, the State Government, represented by SA Water, facilitated the implementation of the Park. According to one of the interviewees, both the Liberal and Labour Parties at that time backed the funding of the Park. As stated by the interviewee, the State and the Local Councils reached a consensus for the former to bear the cost of implementation. The latter would subsequently commit to maintenance.

Thirdly, the State Government established the Torrens Catchment Water Management Board (the Board) in 1995 – just before the implementation was fully completed – to provide catchment-based leadership to manage water resources. According to the former General Manager of the Board, the Board received yearly funding specifically towards the Torrens Water Catchment, including the Linear Park.

The Board resolved to enhance coordination and consistency. For instance, it identified the communities as the key to success by initiating educational programs from the outset. The programs aimed to induce a change in communities' attitudes and practices within the Catchment. One such change was the introduction of trash racks within the communities. This initiative was meant to reduce the amount of debris entering the River. The Board also played a crucial role in setting up the Torrens Taskforce to undertake a series of actions related to the River. In doing so, the Board upheld the stormwater management function by providing technical and financial assistance for flood mitigation works. It also

ensured consistency.

However, the Board only existed from 1995 to 2005. Ever since the Board's mandate ended, there has not been consistent and coordinated leadership specific to the RTLP and the Catchment. The NRM Board replaced the Torrens Catchment Water Management Board in 2005. However, the NRM Board's remit went well beyond the RTLP, the Torrens Catchment and more specifically, water resources management. This time, the resources meant for the River and the Catchment were distributed over the entire Adelaide Region.

Attempts to institutionalise coordinated leadership since 2005 have failed. In 2012, a Memorandum of Understanding between the State Government and the eight Local Councils (excluding Adelaide Hills Councils) established the River Torrens Linear Park Coordinating Committee. The interviewee who set up the Committee said the purpose was to provide consistency in the Park's management. However, the Committee failed to function as consistently as it was intended. The same person who set up the Committee said the inconsistency resulted from the lack of leadership. According to another interviewee, the only time there was a reasonable and consistent leadership for the RTLP was during the tenure of the Torrens Catchment Water Management Board. This issue reiterates the difficulties in managing the Linear Park.

4.3.2. Response from interviewees

The interviewees identified about 20 challenges, some of which are related. For each issue, the number of respondents are identified as well as the number of times the respondents referred to that same challenge. As shown in Fig. 7, eight (8) interviewees mentioned pressure from surrounding development and population growth 23 times; the highest number of references. Some of the respondents mentioned factories, businesses and continuous residential development near the park as a significant challenge.

The competition among the functions had 14 references from eight respondents. This challenge relates to the on-going demand for recreational facilities within the linear park. As a result, respondents have different perceptions regarding the functions of the RTLP. For instance, one interviewee indicated that getting people to understand the park's role in managing stormwater was very difficult.

Seven respondents mentioned challenges such as poor stormwater management; lack of ownership and neglect; inadequate community involvement; and limited funding. However, they vary in terms of the total number of references. For instance, the lack of ownership had 18 references. Respondents raised this issue because they perceived no one seems to care about the Park. As highlighted in section 4.2, this challenge is related to the involvement of too many stakeholders. 'Limited availability of funding' had 13 references, which is an external issue, as shown in section 2. Some respondents attributed the current state of neglect to this factor.

Other pressing challenges – mentioned by six respondents include the 'lack of clarity of responsibilities'; 'lack of shared vision and priorities among stakeholders'; and 'lack of formal coordination'. The 'lack of formal coordination', with 15 references, has been the subject of the on-going governance workshop (see section 3.3). Most of the respondents attribute all the other issues – such as fragmentation of responsibilities – to the absence of formal coordination.

The challenge regarding the varying priorities and motivation mostly relates to the Local Councils and other State Agencies involved. As presented already, about eight Local Councils have voluntarily taken up maintenance responsibilities. However, their activities focus on recreational assets rather than water management or biodiversity. Meanwhile, there has not been a uniform approach among the Local Councils. This issue resulted from 'the different levels of financial capacity in each Council'. Also, each Council along the Park owns and is responsible for some sections of the Park only (and not the entire park).

Less than five respondents mentioned challenges including 'poor maintenance'; 'lack of leadership', 'inconsistent institutional setup', 'delay in response to problems' and 'blue-green algae bloom'. As reviewed in Section 2, most of these issues are related and result from the governance structure. The next section puts these challenges into context.

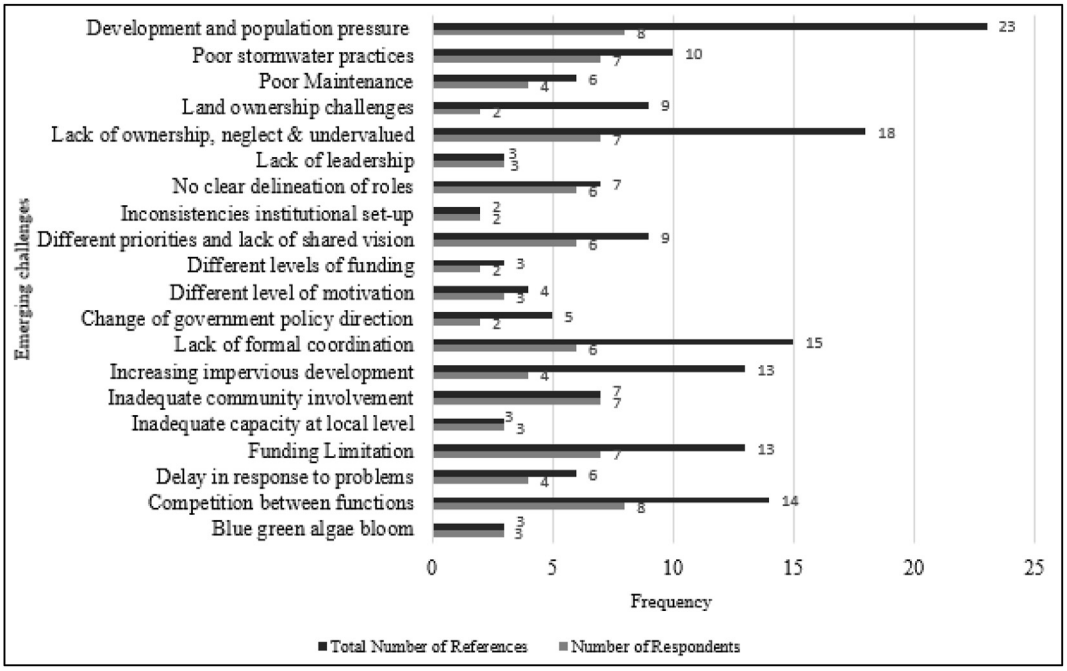

Fig. 7. Challenges emerging from management of RTLP project.

5. Discussion

Based on the challenges identified in Section 2, RTLP governance challenges have been categorised in Fig. 8. Some of the issues require an internal response, whereas others require an external response at State level. For instance, the competition among functions emanates from the project design goals, which make the RTLP a multifunctional asset. Managing this challenge requires an internal response from the key stakeholders. Thus, there is a need to set priorities regarding the functions of the RTLP.

Challenges such as inconsistent institutional set-up; funding limitations; lack of formal coordination; and change of government's policy have a critical influence on the RTLP. These issues require an external response because they derive from the institutional system and political decisions by the State Government. A clear example is the Government's decision to replace the Torrens Water Catchment Board with the NRM. Further, the recent decision to introduce Green Adelaide will substantially affect the management of the River. These decisions attest to the critical role of the State in managing and sustaining stormwater management projects.

Communication and collaboration is an internal issue, which relates to the multi-stakeholder involvement. Inadequate communication and collaboration can be linked to the poor maintenance; lack of shared vision; delay in response to issues and lack of ownership. Establishing a structure for effective communication and collaboration could enable stakeholders to share a common vision for maintenance, funding and jointly claim ownership for the RTLP. Also, all stakeholders will be aware of the stormwater management function and provide timely responses to threats when they occur.

Moreover, physical issues such as the blue-green algae bloom, poor stormwater practices; land ownership issues and pressure from surrounding development are mostly issues of planning, enforcement of regulation and regular maintenance. These issues require both internal and external responses from the stakeholders and planning institutions to promote sustainable stormwater practices within and around the catchment.

Finally, Fig. 9 shows that all the issues are related and could influence each other. For instance, a consistent institutional setup (influenced by political decision) could facilitate regulation enforcement and effective development control. An effective development control could determine a revision of the project design goals. Also, a well-stipulated design goal will determine the range of stakeholders involved and how they communicate and collaborate to address the challenges. Moreover, strong communication and collaboration among stakeholders will most likely attract political support. Understanding the above framework – in terms of the context of the challenges and the link between them – could be vital to provide a suitable and timely response; the green governance.

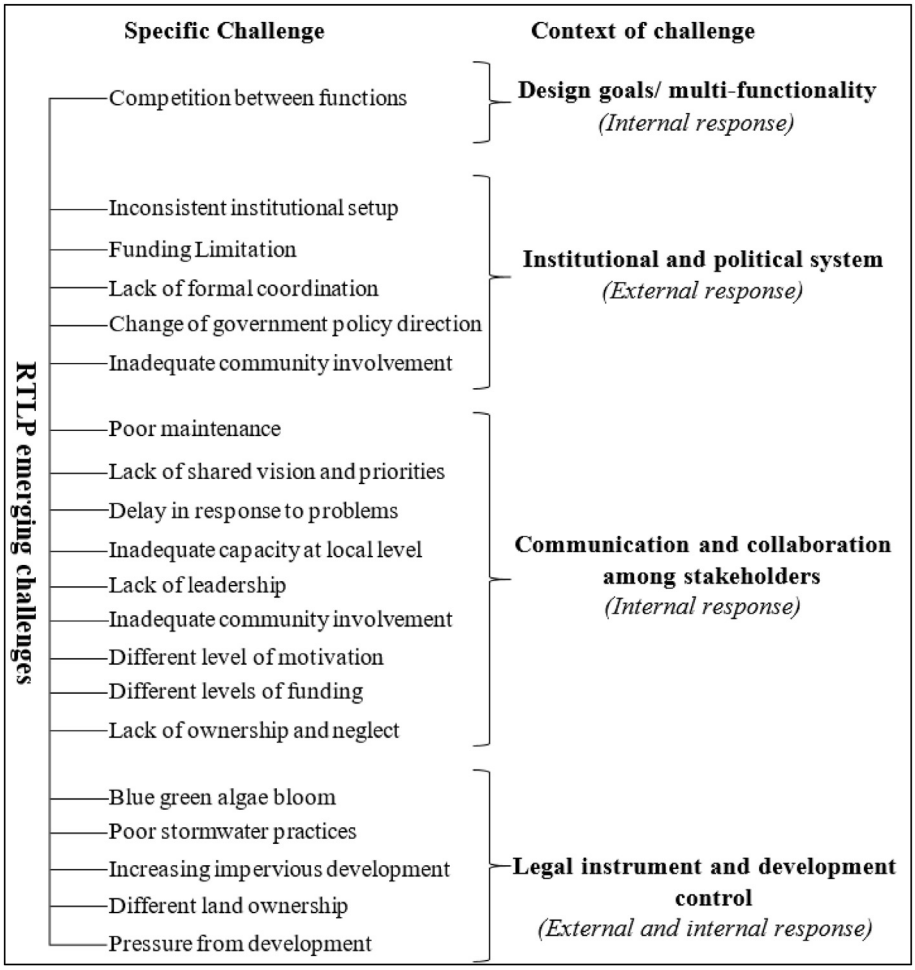

Fig. 8. Thematic context of RTLP's challenges.

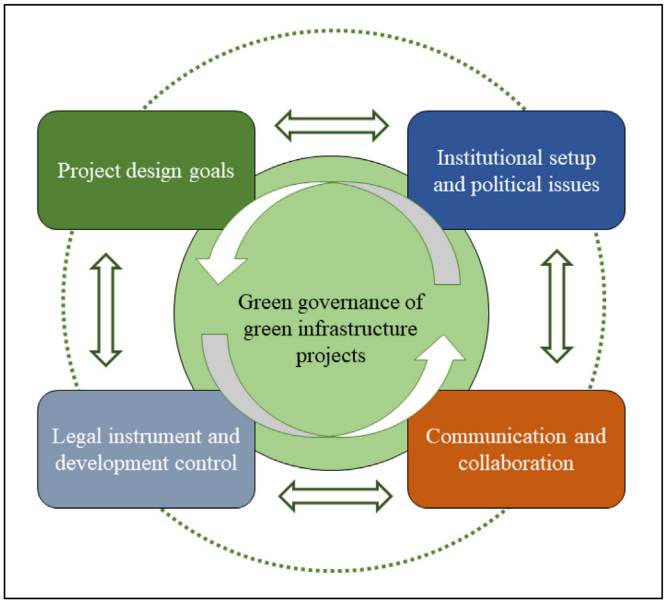

Fig. 9. Cyclical link among the themes.

6. Conclusion

This paper suggests that the multidimensional attributes, comprising project design goals and multiple stakeholder involvement pose challenges to sustainable stormwater management and governance. For instance, although the flood incidents primarily influenced the decision to implement the RTLP project, it performs other subsidiary functions, which serve multiple stakeholders from both state and local governments. Furthermore, these stakeholders view the RTLP differently, regarding its purpose, ownership, stewardship and responsibilities.

This paper argues that governance that is well-coordinated and focused in its remit is essential to drive all management activities whilst prioritising the environmental quality of waterways. For example, while the Torrens Catchment Water Management Board – which operated between 1995 and 2005 – prioritised the River, it did not operate independently. Instead, its governance model seemed to hybridise the models for the Austrian and Norwegian examples mentioned. For instance, the Board focused on stormwater quality and ecosystem improvement while engaging all stakeholders, including the communities. Moreover, the Board was instrumental in managing conflicts between stakeholders.

Green governance, then, must mediate between internal and external issues without losing sight of the sustainable management of water quality, flood mitigation and the ecology of a waterway like the RTLP. In this case study, the State Government's decision to replace the Torrens Catchment Water Management Board with the NRM Board, shows the critical role of the state in the management of sustainable green infrastructure. This result corroborates the findings of other studies reviewed in Section 2. It suggests that external issues related to higher-level leadership might be the foundation upon which other internal challenges relating to communication, collaboration and project design goals can be resolved.

Based on these findings, we recommend that policymakers and planners have to conduct in-depth studies to understand context-specific opportunities for reclaiming neglected waterways. However, cities should be aware and prepare adequately for the challenges that lie ahead by implementing cross-boundary green governance to manage green infrastructure. Finally, there is a need for further studies regarding appropriate scenarios to attain political support and pathways to mobilise consistent, coordinated and focused green governance. Accordingly, cities will be better placed to promote the sustainable development of urban linear parks and a healthy riverine system in future.

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.

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