THE DYNAMICS OF IMPLEMENTING CLIMATE CHANGE ADAPTATION AT THE LOCAL MUNICIPAL LEVEL

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Abstract
The purpose of the paper is to evaluate the dynamics of implementing climate change objectives within the South African local government. Climate change has been intensifying over the years and cities are recognised to be vulnerable. The promulgation of various acts and plans, such as the Constitution of the Republic of South Africa (1996), Spatial Planning and Land Use and Management Act (SPLUMA), National Urban Development Framework and Integrated Development Plan (IDP), is to ensure environmental protection inclusive of climate change mitigation and adaptation. However, the multiplicity of challenges, such as budgetary constraints, lack of political will, capacitated personnel, coupled with service delivery backlogs, deter the commitment by the municipality to implement measures to adapt and mitigate climate change. The persistence of climate change effects around the city has reduced the resilience of South African cities. The resilient theory asserts that cities must have the ability to operate post any perturbation. The adaptation to climate change around the city is important to ensure the system's ability to be resilient. The study found that the multiplicity of factors, interplaying within the City of Polokwane, demonstrates difficulties to adapt and mitigating climate change. The study concludes that the employment of solar systems, maintenance of drainage systems and proper planning are key determinants of affective planning in an attempt to mitigate and adapt to climate change.

Keywords: climate change adaptation, resilient theory, multilevel governance, planning.

DOI: 10.21303/2504-5571.2022.002442

1. Introduction
Globally, climate change has been intensifying over the years with effects, such as floods, heatwaves, seawater levels raising, desertification and high temperature [1, 2]. This intensification has deepened the vulnerability of many cities to climate change. This is because many cities are located along the coast and threatened by seawater level raising, while others are overpopulated. In South Africa, there has been a construction of structures along some coasts to circumvent the encroachment of seawater into the city. However, cities, such as Johannesburg, Pretoria, Cape Town, Durban and Polokwane, are plagued by traffic congestion and high production of waste, which potentially increase the Greenhouse Gas emissions [3]. This is coupled with the high consumption of electricity that is generated from the burning of fossil fuels. Buildings were found to contribute over 40% of emissions into the atmosphere [4]. The South African government has promulgated various policies and plans, such as SPLUMA, NUDF and IDP, to ensure the implementation of strategies to mitigate and adapt to climate change [5]. However, most South African municipalities are plagued with multiple challenges, such as the lack of commitment to addressing climate change mitigation, while ensuring that the city is adaptable. South African local municipalities are facing a mammoth challenge of delivering basic services to their constituencies, while ensuring the implementation of climate change policies within a constrained budget [6]. Therefore, most local municipalities resort to their constitutional mandate to provide services at the expense of environmental protection. Thus, cities continue to emit a lot of GHGs, which contributes to climate change. The purpose of this paper is to evaluate the dynamics of implementing climate change objectives, such as mitigation and adaptation in the city of Polokwane.

Resilient theory
Etymologically, resilient theory stretches back to the 1620s and “stems from the Latin term resilio” [7], which means to bounce back or spring back [8]. Simmie & Martin [9] postulate that resilience comes from the Latin term resiliere, which means to leap back or rebound. Regardless of the different connotations of the term “resilience”, its meaning is centralised on the ability of the system to bounce back post perturbation. The etymological origin of the resilient theory is found in...
the field of ecology [10], which found an inroad to climate change, planning and urbanisation. Due to the etymology of the resilient theory, its application in social sciences should be carefully scrutinised. The central conceptualisation of the theory remains contested due to the applicability of resilience in different fields. The resilient theory has been conceptualised as the ability of a system, community or city to bounce back to its original state post-disturbance or change [8]. According to Liao [11], the more stabilised the system is post-perturbation, the more resilient the engineering system is. According to Cosens [12], resilience can be described as the “capacity of the system to absorb disturbance, adapt and reorganise, while changing to retain essentially the same function, structure, identity and feedbacks”. The view of resilient theory as the ability of a system to return to its normalcy can be somewhat misleading in understanding the dynamism of the city and climate change. In clearing the confusion, resilience in a city context connotes multiple equilibria [12], in which a system settles in another different but stable state. However, in understanding urban resilience, the ecological system offers a fertile avenue for planning discourses.

**Climate change adaptation aspiration in South Africa**

Globally, many countries have promulgated strategies and legislations to ensure that they mitigate and are adaptable to the adverse effects of climate change. In South Africa, these plans and strategies (Spatial Planning and Land Use Management Act, Spatial Development Frameworks and Integrated Development Plan (IDP)) remain only a policy framework at the national government without any pragmatic evidence on the ground within the context of climate change mitigation and adaptation [13]. The adoption of these plans and acts in South Africa has not enabled the reduction of Greenhouse Gas emissions, traffic, congestion, waste production and clearing of greenery [3], which are the biggest influencers of climate change. Some scholars argue that the absence of a legislative framework or a drive to implement climate change mitigation and adaptation measures is due to the lack of the national government’s commitment to enforcing compliance [6]. The local government is confronted with a mammoth challenge to provide basic services to their constituencies, while implementing climate change policies within a constrained budget [6]. According to Dannevig, Rauken and Hovelsrud [14], adaptation and mitigation to climate change have been put on the agenda in all municipalities albeit with wide differences in terms of implementation levels and efforts. However, one of the most important hindrances to the implementation of climate change policies has been identified as the lack of capacity, political will and funding problems within the local government.

Some municipalities in the world have commissioned very expensive disaster management and assessment plans and developed different methodologies to assess climate risks [14]. The danger of applying such type of costly assessment might lead to a municipality being discouraged if it does not meet its desired outcomes. Furthermore, poor municipalities will not be able to afford such costly climate risk assessments, while still grappling with the provision of basic services to ordinary citizens in South Africa. Thus, some scholars are proponents of integrating climate change aspirations with the constitutional obligations by the municipalities, which are at the level of provision of basic services [15]. However, Bulkeley and Betsill [16] argue that the global, national and local environmental politics within climate change discourses take place in isolation. Consequently, this lacks adequate questioning of the geographical imaginations, which underpins the notion of nested and discrete scales of those who are mandated as political authorities over the environment. Therefore, an alternative approach to climate change was through an understanding of the important roles that planning plays in the pursuit of climate protection [17]. According to Mokoele and Sebola [18], an important role of planning in order to mitigate climate change blurs the boundaries by meshing the global and local spheres. It can be argued, that climate change cannot be addressed in isolation but requires concerted efforts from the global, national, local and other stakeholders if any success has to be made within these discourses [19]. Moser and Ekstrom [15] further postulate that the barrier to implementing climate change mitigation and adaptation is those malleable ones that can be overcome with efficient and effective political will, social support, resources and concerted efforts. In South Africa, resources, such as budgets, human resources and infrastructure, remain the major barriers to the implementation of climate change mitigation and adaptation, coupled with other developmental responsibilities at the local level.

To effectively address climate change, Dannevig *et al.* [14] developed four steps that can be used to implement climate change adaptation. These steps are considered indicators for measuring
the implementation of climate change adaptation and provide a thorough assessment of climate change adaptation measures from problem formulation until the implementation stage [14]. Despite the development of these various indicators for the implementation of policy, the idea of the multi-level approach toward climate change should not be neglected. Firstly, the assessment of the need to implement policy in some sectors: the achievement of this indicator requires a municipality to formally decide on the desire and the commitment to assess the risk and vulnerability to climate change and plan to adapt [14]. Therefore, the formal decision and commitment to assess these risks and vulnerabilities help to provide a goal-directed plan and condition the concerted efforts to mitigate climate change. The municipality can make these decisions during their council meetings; the declaration from the mayor or the statement in the municipal plan [14]. The dearth of climate change policy implementation can be attributed to the absence of national policy and legislative framework that mandates the municipality to implement such policies [19].

Secondly, qualitative risk and vulnerability assessments and/or adaptation measures are identified in municipal plans [14]. The achievement of this indicator can be done either through carrying out a thorough qualitative assessment of climate change and/or by identifying adaptation and mitigation measures in the municipal plan. This shows the importance for the municipalities to have unambiguous plans that indicate the risks and vulnerabilities of climate change [18]. Furthermore, since adaptation is context-related, there is a need for the municipality to provide a detailed plan on how to adapt to climate change. Dannevig et al. [14] have defined a qualitative vulnerability assessment as an “evaluation of information and data (such as climate scenarios, hydrological or geological data) by specialists in the municipality or external experts”. Within the climate change discourse, the implementation of adaptation and mitigation should go beyond just unpacking and understanding data but must embrace plans on how to implement adaptation policies. However, some municipalities, especially the poor ones, lack the capacity in terms of specialists to assess and interpret climate change risk and vulnerability assessment. Dannevig et al. [14] postulate that the general risk and vulnerability assessment that does not explicitly aim to address climate change does not qualify in this stage.

Thirdly, quantitative vulnerability assessment, adaptation measures, identified in plans, and adaptation measures, implemented in regulations, should be considered. According to Dannevig et al. [14], a quantitative vulnerability assessment can be referred to as an assessment that includes modelling climate change impacts, such as drought, floods, sea-level rise, surface water accumulation or avalanches. The municipality should be able to quantify the risks of climate change. To achieve this stage, it requires that adaptation measures be identified in municipal plans and that various municipalities account for adaptation and mitigation in the regulations. The national and provincial governments must take responsibility to ensure that the municipality goes past this stage through the enforcement of the policy to adapt and mitigate climate change. Therefore, multilevel governance enables [19] the implementation of qualitative and quantitative vulnerability assessment to reduce some of the challenges that municipalities are confronted with on a day to day basis. Lastly, structural measures and/or adaptation should be mainstreamed in the regular planning process. Municipalities must at all times embrace that commitment to adapt and mitigate climate change in planning at all levels. Therefore, the achievement of the climate change adaptation will be realised when the municipality has completed all these stages and then mainstreams climate change into the day to day planning processes [20]. To address climate change at all levels, this subject must be a continuous discourse to enhance knowledge and understanding of the risks and vulnerabilities that humanity is facing, thereby providing proactive measures to address it.

The categorisation of all these adaptation achievements becomes unambiguous and enables a better understanding of explaining various degrees of implementation. The application of these indicators is divorced from the challenges that municipalities are continuously confronted with, especially in developing countries, such as South Africa. Therefore, multilevel governance can be used as a model to help bridge the gap between the implementation of climate change policies [19] and the challenges municipalities face by bringing the national, provincial, local government, private sectors, civil societies and the communities around the same table on climate change discourses [21]. Due to the multifaceted challenges that the municipality is facing, it is important to explore the barriers to the implementation of climate change objectives.
Barriers to Implementing Climate Change Adaptation

Dannevig et al. [14] provide indicators for the implementation of climate change adaptation and the requirements to achieve climate change objectives. However, the implementation of climate change mitigation and adaptation policies within municipalities is not a simple, unambiguous and straightforward process. Urban areas are key players in addressing this unprecedented environmental change and the provision of a clearer understanding of climate change objectives. The notion of the barrier refers to the obstacles that can be overcome through numerous means, and this includes the shift in thinking and management culture, prioritisation, creative management, concerted efforts, political will or social support, resources, land uses and institutions [22]. The social barriers that are malleable with increased political will and accessibility of recourses (Moner & Ekstrom, 2007) are related to the social and cultural processes that govern how communities respond to climate change stimuli [22]. These barriers include normative and institutional determinants amongst others, such as denial, helplessness, values and caste [22].

Literature continues to indicate that barriers can be divided into various categories, which are institutional, social, international and financial constraints [19]. All the South African local municipalities must put in place plans to address all the barriers within their ability and capacity. Those barriers beyond the local government’s ability and capacity to deal with require concerted efforts between national, provincial, and local levels and all stakeholders [19] to circumvent all the malleable problems. The inculcation of all affected stakeholders into planning through multilevel governance holds the potential to address climate change adaptation barriers [19]. However, Moser and Ekstrom [15] argue that the ability of local municipalities to address all the climate change barriers does not necessitate the successful implementation of the policy. A hypothetical smooth and barrier-free municipality is not a sufficient condition to guarantee the successful implementation of climate change adaptation [15]. The local level of government continues to face a lack of different types of capacities, such as political will, human resources, expertise, knowledge and information, which deter the ability to adapt to climate change [1]. Another important barrier to the implementation of climate change adaptation and mitigation is the application of a ‘business as usual’ attitude, which limits the commitment to be adaptive. Therefore, there is a need for a change in ideology in the way governments think and address climate change.

Fig. 1. Phases and sub-processes throughout the adaptation process

Sources: Moser and Ekstrom, [15]

The promulgation of policies without capacitated personnel to implement them deters the capacity of cities to adapt to climate change. Moser and Ekstrom [15] developed phases, through which the implementation of climate change adaptation and mitigation can be achieved. Fig. 1 demonstrates that adaptation to climate change is not a project but a never-ending process that goes through continuous phases, such as understanding, planning and managing processes. A thorough understanding of climate change
adaptation and mitigation, which takes place through problem detection, gathering information and the ability to define a problem, is imperative [15]. Since climate change adaptation is context-based, the understanding stage is important to be able to derive what is needed and what municipalities are adapting to. This figure shows that the local municipalities should follow the stages, due to the potential that they provide in ensuring that climate change policies are implemented. Though these phases do not take place without the presence of barriers, the involvement of the national, provincial, local governments and other stakeholders will assist to limit and control budgetary and capacity constraints that municipalities are confronted with [13]. Furthermore, this climate change adaptation process requires municipalities at the local level to have adequate capacitated personnel at every phase to foster the effective implementation of the policy. The inculcation of national, provincial and local governments within climate change discourses will assist to bridge the capacity challenges at the local level [19]. Therefore, municipalities must create networks of stakeholders to gain traction when addressing climate change issues.

**Aim of research:** the study aims to evaluate the dynamics of implementing climate change at a local municipal level.

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**Fig. 2. Integrative framework: smart cities-big data and supply networks**

*Sources: Graham Tachizawa, Alvarez-Gil and Montes-Sancho [23]*

Integration within climate change discourses has always offered the potential to deal with complex phenomena. The integrative framework in cities or urban areas tries to explore the opportunities that big cities offer [23]. This framework was proposed by Graham et al. [23] to analyse the interplay between big-city data and networks. Fig. 2 shows that the integrative framework encompasses two components, which are network characteristics and governance mechanisms that are both linked to big-cities data. The provision of data within cities is important to gather and keep abreast with the contemporary climate change discourses [1]. This helps the municipality to continue to be adaptive through time. It is argued, that the use of big data in the current technological sphere assists to ensure the use of technology to solve the contemporary problems, confronting societies. However, within urban planning and management, Artificial Intelligence (AI) or big data has not been fully utilized to address societal problems. Though the notion of a smart city has been debated by various scholars [23], its implementation, especially in developing countries, remains a pipe dream. The components of smart cities are the introduction of the smart economy, smart mobility, smart environment, smart people, smart living and smart governance [21]. Therefore, big data can be used as an important source of data that can be used to ensure that urban planning is kept abreast with current trends. However, the implementation of smart cities is not a straightforward process. In developing countries, the multiplicity of challenges within the local government has a huge potential to derail the implementation of smart cities. Lack of adequate financial resources, capacitated employees and infrastructure can derail the implementation process [17]. Although it cannot be denied, that big data in the modern era is important, its implementation in urban planning in developing countries remains a large grey area.
2. Materials and Methods

The paper adopted a normative research design to explore and examine the effectiveness of implementing climate change adaptation measures in South African cities. The paper employed both qualitative and quantitative approaches to comprehensively evaluate the barriers to implementing climate change adaptation. The target population was based on the development planning practitioners, such as the Integrated Development Plan (IDP) manager, environmental planning and the Director of Development and Planning within Polokwane Local Municipality. The paper sampled a total of 185 respondents, located in Legae la Batho, Emdo Park, Serala View and Flora Park. The qualitative data was analysed through a thematic analysis technique, while quantitative data was manipulated through Statistical Package for Social Sciences (SPSS). The ethical clearance to collect data was collected from the Turfloop Research Ethics Committee (TREC) TREC/226/2018 on the 27th November 2018. Additionally, the participants were requested to consent to participate in the study. They further informed that the participation in this study is on voluntary basis.

3. Results

3.1. Burning of fossil fuel (coal) that contributes to climate change

Fig. 3 presents the perceptions of the respondents about high electricity consumption and traffic congestion, which will increase the burning of fossil fuel (coal); thereby contributing to climate change. Fig. 3 shows that only 1.1% and 4.3% of the respondents strongly disagree and disagree respectively that high electricity consumption, coupled with traffic congestion, contributes to the changing climatic condition, while only 12.4% remained undecided. Fig. 3 shows that the majority (42.7%) and 39.5% of respondents strongly agree and agree respectively that the high consumption of electricity and traffic congestion results in the increment in the burning of fossil fuels. The finding suggests that the respondents perceive the increasing electricity consumption to have deleterious effects in an attempt to mitigate climate change. There is an overwhelming awareness of the effects of high consumption of electricity and traffic congestion on climate change. This awareness is significant in reducing electricity consumption within the municipality and the shift from over-reliance on private cars towards the usage of a public transport system. This demonstrates the potential to address the persistent effects of climate change. However, the minority of people disagreeing with this notion demonstrates that there is a need for awareness and workshops about climate change.

![Fig. 3. High electricity consumption and traffic congestion contribute to climate change](image)

3.2. The use of solar geysers within the household

Fig. 4 shows that 3.2% and 7.0% of the respondents stated that they strongly disagree and disagree respectively that they will feel good using solar geysers within the households, 19.5% of the respondents remained neutral. On the other hand, Fig. 4 shows that 25.4% of the respondents...
stated that they agree that they will prefer using solar geysers within the households for heating water, while 44.9 % strongly agree. The majority (70.3 %) of people prefer using solar geysers for heating water. The finding is that the majority of people will prefer using solar geysers to reduce the consumption of electricity. The preference to use solar geysers is very important to introduce mixed methods of energy generation. Those who remained neutral stated that they do not have solar geysers in their households, while others said they are expensive to procure.

3. 3. Using of solar systems within the household

Fig. 5 presents data to assess the perceptions of the respondents about the reduction of electricity consumption through the use of a solar system, which includes solar geysers, solar panels and a battery (hybrid system) within the households. Fig. 5 shows that 3.8 % and 5.4 % of the respondents strongly disagree and disagree respectively that they are responsible to reduce electricity consumption by employing a solar system, 14.6 % of the respondents remained undecided. However, 33.0 % and 43.2 % of the respondents agree and strongly agree respectively that they would prefer to reduce electricity consumption by using solar systems. The finding is that there is a preference to use solar systems (solar geysers, solar panels and batteries) as clean energy sources to reduce electricity consumption, generated from the combustion of fossil fuels, and thus has the potential to reduce GHG emissions. The literature demonstrates that a vast amount of GHGs emissions are produced during the burning of fossil fuels to generate electricity and emissions from traffic congestion. Therefore, households have the potential to play a critical role in the reduction of electricity consumption through the implementation of an energy mix at a micro-level, thus, contributing toward climate change mitigation. On the other hand, few people do not feel responsible for using solar systems to reduce the consumption of electricity. This is attributed to the high prices of procuring solar systems and solar geysers.
3.4. Local communities, involved in climate change adaptation and mitigation planning processes

It is indicated in Fig. 6, that 1.1% and 3.2% of the respondents strongly disagree and disagree respectively that local communities should be involved in climate change adaptation and mitigation processes, while only 8.1% remained undecided. Fig. 7 shows that 44.3% and 43.2% of the respondents agree and strongly agree respectively that local communities must be part of climate change adaptation and mitigation processes. This demonstrates that the majority (87.5%) of people believe that the local communities must be part of the climate change adaptation and mitigation processes. The finding is that local people believe that they must be allowed to participate in climate change adaptation and mitigation processes. Only a small proportion of people stated that local communities should not be involved in climate change issues. This connotes that some of the respondents are not interested in taking part in the municipality and climate change issues.

Fig. 6. The involvement of local communities in climate change adaptation and mitigation planning processes

3.5. Multilevel governance in climate change policy formulation and implementation

Fig. 7 shows that 0.5% and 2.2% of the respondents strongly disagree and disagree respectively that national, provincial, local government and other stakeholders (multilevel governance) should take a central role in climate change policy formulation and implementation, while 9.7% remained neutral. On the other hand, 36.2% and 51.4% of the respondents agree and strongly agree respectively that multilevel governance must be used during climate change policy formulation. This is based on the fact that policies have been recognised as important mechanisms to ensure climate change adaptation. The finding is that there should be an implementation of multilevel governance in the formation and implementation of climate change policy. The integration of all affected stakeholders within the municipality has the potential to address the undying effects of climate change.

Fig. 7. Multilevel governance in climate change policy formulation and implementation
The City of Polokwane has been demonstrating various signs of their lack of adaptation to climate change over the past years. This is because it was stated that, after heavy rains, the city will be flooded due to blocked drainage systems. One of the participants reflected this notion as follows:

“The road is been destroyed because of their inability to withstand climate change.”

“In Polokwane, if it can rain for 20 minutes, the town will be flooded. This is because of blocked drainage systems that are not cleaned or maintained regularly. This can also be attributed to poor planning”.

According to the participants, lack of capacity and poor planning within the Polokwane Local Municipality is responsible for the construction of poor roads and the inadequacy of the drainage system to drain the runoff around the city. The drainage systems around the city function without proper maintenance, which can be used as an adaptation strategy toward climate change. The inability of the City of Polokwane to absorb perturbation demonstrates that it is not resilient. The city must develop systems and maintain them to ensure that it is resilient post any perturbation. Poor planning to anticipate the future in terms of climate change within the City of Polokwane poses deleterious effects on the ability of the city to become resilient to climate change. The Capricorn District Municipality stated that even though they are not responsible to ensure climate change adaptation around the city, they are currently engaging in educating citizens about the importance of adapting to climate change. Although public education is important, without action, it is insignificant. This was reflected by a respondent from the Capricorn District Municipality as follows:

“In term of adaptation to climate change, the municipality (Capricorn District Municipality) only serve to educate local communities about climate change adaptation”.

The local communities are educated, concerning different ways to adapt to climate change. This demonstrates the significance of the community toward climate change.

“The adoption of solar geysers, solar, gas stoves and septic tanks are good strategies to reduce electricity consumption and manage urbanisation. However, the installation of private solar reduces the amount of revenue that the municipality receives. Netcare Pholosho hospital has roofed its parking lot with solar panels, which reduced the amount, paid to the municipality, by half”.

According to the participant, the shift by the communities to install their solar systems and septic tanks within the households has affected the municipality in terms of the revenue collected. This demonstrates that the municipality is concerned about the increase in municipal revenue without considering the positive effects of climate change mitigation.

4. Discussion

The findings of the study suggest that the City of Polokwane has reduced the number of green places around the city. It can be concluded, that there must be planting of green spaces, such as green parks and trees around the city, as a management strategy to increase the infiltration of rainwater and reduce soil erosion. However, local communities have always been encouraged to use pavements as opposed to lawns within the households and this has increased runoffs. The implementation of pavements was used as an adaptation strategy toward climate change. On the other hand, the plantation of lawn and green spaces within households can be nurtured through re-used water. Furthermore, retrofitting households with gutters will increase the amount of water harvesting. The water can be used for watering the gardens or lawns within their yards. Therefore, it can then be concluded, that green spaces can serve as both an adaptation and mitigation strategy against climate change. This is important because plants use carbon dioxide during photosynthesis, which reduces the amount of GHG emissions in the atmosphere. Drawing from the findings of the study, it can be concluded, that in the Polokwane Local Municipality, urbanisation is not effectively planned and managed in such a way that it presents the potential to mitigate climate change. This is based on the fact that the City of Polokwane continues to experience traffic congestion during
pick hours, depends on electricity, generated from fossil fuels, lacks public participation and has growing industries. Furthermore, the majority of citizens around the City of Polokwane are without solar geysers and gas stoves for cooking, which increases their dependency on electricity, generated from the burning of fossil fuels. Hence, this multiplicity of factors, interplaying within the City of Polokwane, demonstrates ineffective planning for and management of urbanisation in an attempt to mitigate climate change.

**Limitation of the study:** The limitation of the study was that it was undertaken on a small scale due to funding problems. The study could have targeted the cities and all the Town in Limpopo. Many respondent in the areas and some of the people within the Polokwane Local Municipality were not present during the data collection period.

**Prospects for further research:** Due to the challenges that the developing countries, especially South Africa, are facing, further research needs to assess some of the institutional barriers that hinder the municipalities from implementation strategies that attempt to mitigate climate change. Furthermore, further research should be aligned to all the municipal departments in terms of their ideology towards climate change in South Africa.

5. Conclusion
In recent years in the City of Polokwane, heavy rainfall has resulted in overflowing roads and at times the water encroaches into the shops. The findings of the study show that these negative events were due to the blockage of the drainage system or the inability of the system to drain all the runoff. Therefore, it can be recommended, that there should be routine maintenance of the drainage system to avoid blockages, so that the city can operate optimally even after heavy rainfall. Resilience theory asserted that the city should have the ability to bounce back post any perturbation, such as heavy rainfall. A well operational and improved drainage system around the city of Polokwane will enable it to be resilient post heavy rainfall. Therefore, the maintenance of the drainage system can be seen as an adaptation strategy to the effects of climate change. Proper implementation of adaptation strategies around the municipality is very important for climate change mitigation.

**Conflicts of interest**
The authors declare that they have no conflicts of interest.

**Acknowledgments**
I would like to acknowledge the University of Limpopo for all allowing me to understand this study. Furthermore, I would like to thank the citizens from Legae la Batho, Emdo park. Flora Park and Serala Viw and the Polokwane Local Municipality for agreeing to participate in the study.

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