

The Fate of Sustainable Development Goal 11 Amidst Growing Environmental Challenges in Developing World Cities: Insights from the Yaounde Metropolis

Prisca Ntemngweh, PhD

University of Yaounde 1, Cameroon

DOI: <https://dx.doi.org/10.47772/IJRISS.2024.8080347>

Received: 14 August 2024; Accepted: 22 August 2024; Published: 24 September 2024

ABSTRACT

In the face of a rapidly urbanising world and growing environmental concern, achieving sustainable development goal 11 (SDG 11) in developing world cities poses a significant challenge. The article examines the fate of SDG 11 which aims to create inclusive, safe, resilient and sustainable cities. The study employs a mixed-method approach to unravel the complexities of sustainable urban development in Yaounde. Using quantitative analysis and qualitative inquiry the study explores urban environment challenges and their relationship with SDG 11. Findings revealed that Yaounde grapples with rapid and unplanned urbanization, poor waste management system, poor air quality, climate change vulnerability and overall environmental degradation which are impeding progress towards SDG 11. By addressing these challenges through enhanced urban planning, community engagement and effective governance, more progress can be made in creating inclusive, safe, resilient and sustainable cities.

Keywords: Sustainable Development Goal 11, rapid urbanization, Yaounde, sustainable cities, urban environment

INTRODUCTION

The goal of sustainable development is to balance human development and environmental protection (Mensah, 2019). The challenge of reconciling environmental, social and economic outcomes, as requested by the proponents of sustainable development becomes more apparent when sustainability is applied to the urban systems. This is because over half of the world's population now resides in the urban areas (UN, 2018) and cities are perceived as transformative arenas and hotspots for driving socio-economic and environmental changes at multiple scales (Grimm et al., 2008). In this rapidly urbanising world, the national and international communities have started to focus attention on the issue of urban sustainability. In September 2015, the UN member states gathered and adopted a universal plan for global cooperation on sustainable development for the period 2015 to 2030. This became known as "transforming the world: the 2030 Agenda for sustainable development". The agenda defined 17 goals known as Sustainable Development Goals (SDGs) and 169 targets. SDG 11 aims at "making cities and human settlements inclusive, safe, resilient and sustainable". Target 11.6 which is the main focus of this study aims at reducing the adverse impacts of cities on the environment.

According to the United Nations report on the progress towards sustainable development goals, more than 3 billion people in the world do not have access to waste collection services or lack access to controlled waste disposal facilities (United Nations, 2019). This situation is worst in Sub-Saharan African countries like Cameroon with unplanned and chaotic urbanization (Ndam et al., 2023; Juma et al., 2020). The United Nations report noted that 9 out of 10 people in 2016 living in urban areas still breathed air that did not meet

the World Health Organization's 'air quality guidelines value for particulate matter' and more than half of the world population experienced an increase in PM_{2.5} from 2010 to 2016. However, amidst these challenges, the city of Yaounde is also a home to innovative strategies aimed at promoting urban sustainability and improving liveability of the urban residents (Awah-Manga et al., 2023). This article aims at investigating the reality of SDG 11 by 2030 in the face of increasing environmental challenges in the capital city of Cameroon, Yaounde.

METHODS AND MATERIALS

The study made use of a mixed-methods approach, combining quantitative analysis and qualitative inquiry to comprehensively examine urban sustainability challenges and the status of sustainable development goal 11 (SDG 11) in the city of Yaounde. Quantitative data were sourced from municipal databases, relevant literature and field survey. Statistical analysis, including trend analysis and descriptive statistics were conducted to analyse the quantitative data. That is, environmental indicators of urban sustainability and perceptions on the status of SDG 11. Semi-structured interviews and field observations were employed to gather qualitative insights into environmental sustainability challenges and perceptions on the status of SDG 11 in the Yaounde metropolis. Thematic analysis was employed to identify reoccurring themes and patterns from the transcribed interviews and expanded field notes. Excerpts were extra from the transcribed data to represent respondents' opinions in their own words.

STUDY AREA

Yaounde is the part of the western sector of the Southern Cameroon plateau. It is located between latitudes 3° 45' 50" and 3° 59' 55" North of the equator and longitudes 11° 22' 40" and 11° 30' 25" East of Greenwich meridian. Yaounde is bounded to the North East by Mefou and Afamba Division, to the North West by Lekie Division and to the South by Mefou and Akono Division. It is the administrative and political capital of Cameroon and also doubles as the regional capital of the Centre Region. It is divided into seven subdivisions; Yaounde 1, Yaounde 2, Yaounde 3, Yaounde 4, Yaounde 5, Yaounde 6 and Yaounde 7. The climate of Yaounde is humid and mild with moderate and constant temperatures throughout the year. Primary due to the altitude, temperatures are not as quite as hot as one would expect for a city located near the equator with average temperatures being 24°C. However, rapid population growth and urbanization is altering the temperatures resulting to heat islands within the city. The temperatures typically vary between 18.9°C to 30.5°C over the course of the year. The wind experienced in Yaounde varies with the seasons and the topography of the area and other factors. The windier period of the year is from mid-June to mid-September with an average wind speed of about 3.1 miles per hour. The city of Yaounde (nicknamed the city of seven hills), is located on a network of hills dominated by the Mbam Minkom mountains (1,295 m) and Mount Nkolodom (1,221 m) in the northwest sector of Yaoundé, and Mount Eloumden (1,159 m) to the southwest. It also comprises of other set of hills ranging from 600 to 700 m above sea level. Plateaus and valleys are also major relief features in Yaounde. Yaounde is the second most populated and urbanized city in Cameroon after Douala. The population of the area has been increasing rapidly since 1950 and reached its first million in the year 2000. The 2020 estimate by the World Population Prospects shows that the population of Yaounde is about 3.9 million inhabitants, about 4.3% increase from 2015.

FINDINGS

For development to be pursued in a sustainable manner, humans have to live in a non-hazardous living and working environment. The growth of the Yaounde urban area driven by rapid population increase has been accompanied by far-reaching environmental implications. Major environmental sustainability challenges identified during the study included: poor waste management, local climate change, air pollution, flood risk, green space coverage and biodiversity loss. The Respondents' perceptions on these aspects of environmental

sustainability were sampled using a 5-likert scale (strongly agreed (SA), agreed (A), neutral (N), strongly disagreed (SDA) and disagreed (DA). Table 1 shows the views of the respondents regarding the condition of the environmental dimension of sustainable urban development in Yaounde.

Table 1: Perceptions on environmental sustainability aspects

Sustainability aspect	Ranking (%)				
	SA	A	N	SDA	DA
The level of air pollution is acceptable	3.1	17.3	22.8	10.2	46.6
Solid waste is regularly collected and adequately disposed of	4.4	9.3	16.4	30.1	44.2
Noise pollution is acceptable	4.6	11.5	13.1	23.6	47.2
There area is well drained and flood levels are acceptable	11.3	10.7	17	20	42
Average temperatures are rising and are getting unacceptable	14.5	29	21.4	14.8	20.3
Availability and accessibility of green space is adequate	8	7.1	20.9	36.7	27.3

Source: Fieldwork, (2020)

Statistics on table 1 show that the respondents’ perceptions on the environmental dimension were to a greater extend negative. For example, a majority of the respondents (56.8%) were of the opinion that the level of pollution was not acceptable and waste was not regularly collected and properly disposed as perceived by 74.3% of the respondents. Also, 62% of the sampled population perceived the study area to be drained while 43.5% noted that temperatures were rising and thermal discomfort is becoming evident. The amount of green space was also perceived as inadequate as perceived by 64% of the respondents.

Solid waste management

A clean and healthy environment is required for sustainable development to be achieved. Urban dwellers produce a substantial amount of waste that needs to be collected regularly and properly disposed so as to maintain a healthy environment and to ensure healthy living now and in the future. Unfortunately, only a small fraction of the waste generated in Sub-Saharan cities including Yaounde are collected and disposed of. Table 2 shows the daily amount of waste generated by the inhabitants of the Yaounde metropolis and the percentage collected each day.

Table 2: Evolution of solid waste generated/collected in Yaounde from 2010-2022

Year	Population	Waste generated (tons/per/day)	Amount collected
2010	2,482,205	1985.764	297.87
2011	2.582.000	2065.6	309.84
2012	2.623.000	2098.4	314.76
2013	2.773.000	2218.4	332.76
2014	2.930.000	2344.0	351.6
2015	3,272,870	2618.2	392.73
2016	3.273.000	2618.4	392.76
2017	3.459.000	2767.2	415.08
2018	3.656.000	2924.8	438.72
2019	3.822.000	3057.6	458.64

2020	3,992,411	3193.9	479.085
2021	4,164,167	3331.3	499.695
2022	4,337,000	3469.6	520.44

Source: Yaounde city council (2022), Barthelémy et al. (2016)

From table 2 it can be deduced that daily solid waste generated in Yaounde has increased with increase in the population over the years. However, there has not been any substantial increase in the daily amount of waste collected over the years. On an average 3,469.317tons of municipal solid waste were generated each day by the population from the year 2010 to 2022. Of this daily production only about 15% (520.398tons) were properly collected and disposed of each day.

To substantiate these statistics, the respondents were asked to indicate if waste disposal was an environmental challenge in Yaounde. Figure 1 shows their perceptions as to whether or not waste disposal is an environmental challenge in Yaounde using a 5-liket scale.

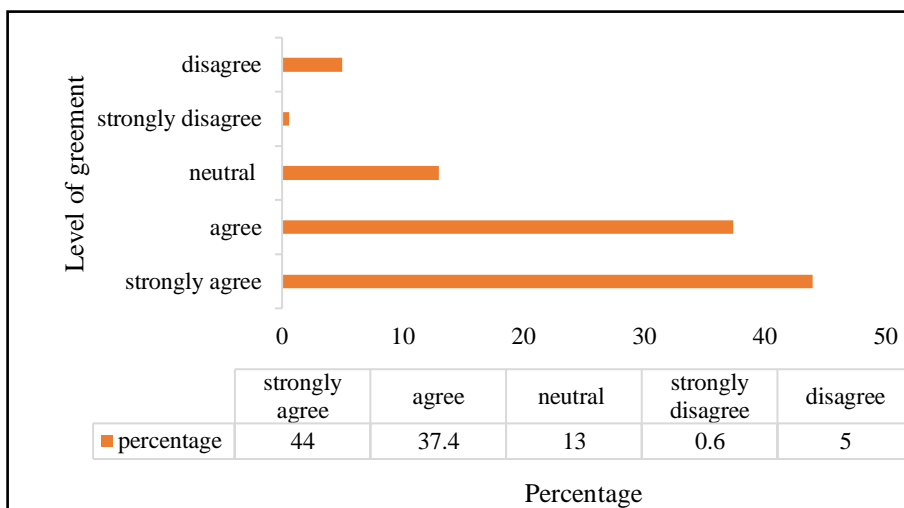


Figure 1: Perceptions of waste as an environmental challenge in Yaounde

Source: Fieldwork, (2020).

Figure 1 illustrates that 44% of the respondents strongly agreed and 31.4% agreed to the statement ‘waste disposal is an environmental challenge in Yaounde’. Only 0.6% strongly disagreed while 5% disagreed with the statement. However, 13% were undecided as to whether or not waste disposal was a challenge in Yaounde. An overwhelming majority of the respondents agreed or strongly agreed to the statement meaning that waste disposal is an issue of concern in Yaounde.

In Yaounde the HYSACAM Company is the main body responsible for the collection and disposal of solid waste. Despite the efforts being made by the waste collection body, tens of thousands of tons of waste are being discharged into the environment every day in Yaounde. About 212 illegal dumping sites were counted during field study and this was just a small percentage compared to the overall number of such sites in the Yaounde urban space. Waste disposal is therefore an obvious and visible problem in the city. Much of the wastes produced remain uncollected and the inhabitants use alternative ways to dispose of their waste.

Further investigations were carried out to find out how the respondents dispose of their waste. The research findings revealed that the Yaounde urban dwellers used diverse ways to dispose of their waste as seen in Table 3.

Table 3: Waste disposal channels used by the inhabitants of Yaounde

Waste disposal sites	Frequency	Percentage
Public Dustbin	28	7
Private waste collectors	24	6
Water body (drain)	92	23
Ground (street, unused lots)	256	64
Total	400	100

Source: Fieldwork, (2020)

Statistics in table 3 reveal that about 64% of the respondents interviewed disposed their waste on the ground, mainly on the streets and unused lots, 23% disposed waste into water bodies, while 6% either paid private waste collectors to collect their waste or they treated their waste by themselves (burning and converting some to compost). Just about 7% disposed their waste in the dustbins which are either trash cans placed by the waste collection company at designated points or they come out with their waste at the signal of the waste collection truck. Most of the wastes disposed of in the dustbin still constitute a nuisance to the environment as the waste is usually left on collected for a very long time (plate 1). These areas often produce unpleasant smell and pose health hazards to the residents around the vicinities.

Plate 1: Improper waste disposal in the Biyem-assi and Simbock Neighbourhoods



Photo 1: Littered of used tyres and other Refuse in Biyem-assi

Photo 2: Littered household Refuse in Simbock

Coordinates: 3°50'55" N, 11°29'7"E

Height above sea level: 710m

Source: Fieldwork, (2020)

Plate 1 shows poor waste disposal in Biyem-assi and Simbock neighbourhoods in Yaounde. In Photo-1, note HYSACAM trash can filled with refuse "A", littered-refuse "B", used tyres "C", gutter blocked by refuse "D", a nearby habitat "E" and a township taxi plying the road linking Carrefour Biyem-assi and Carrefour Etoug-ebe "F". In Photo-2, note a partial view of Simbock "A" and a large pile of refuse littered on the environment "B". The delay in waste collection by HYSACAM has made many neighbourhoods in Yaounde to have mal-odour, proliferation of flies and breeding grounds for mosquitoes, which are harmful to neighbouring communities.

Some of the respondents who come out with their waste at the signal of the waste collection truck complained of the irregularity of such service. Collection days are not often respected and some areas often go for weeks without the collection truck passing by. As such people often left their waste at the roadsides

with the hope that the truck will pass by to collect. This sometimes takes weeks for the waste to be collected. Table 4 shows the perceptions of the population on the regularity of waste collection by HYSACAM.

Table 4: Perceptions on the regularity of waste collection by HYSACAM

Regularity	Agreed (%)	Disagreed (%)	Neutral (%)
Very regular	9.7	73.1	17.2
Regular	21.4	67	11.6
Very irregular	71.2	8.3	20.5

Source: Fieldwork, (2020)

Table 4 shows that waste is very irregularly collected in most areas in Yaounde with about 71.2% of the participants attesting to this. Very few neighbourhoods have very regular waste collection services with only about 9.7% of the participants agreeing to this. Improper waste disposal does not only affect the quality and perception of the urban landscape but also have a multiplier effect on other aspects.

The quantitative results were substantiated by qualitative inquiries as one of the respondents mentioned:

“Every day, we wake up to the sight and smell of garbage piled up along the narrow lanes of our neighbourhoods. As we do not have well-coordinated waste collection and disposal services, residents resort to burning or dumping waste indiscriminately.” (Rosa, a resident Ekounou neighbourhood)

This view indicates that the city’s infrastructure for waste collection and disposal is insufficient to keep with the pace of the growing population. As such littering and illegal dumpsites are widespread in the city, leading to accumulation of waste in public spaces and drainage channels. The results of the study revealed that illegal dumping of solid waste often blocks the drainage as seen in plate 2.

Plate 2: Blocked drainage systems by waste in the Medong-Simbock neighbourhoods



Photo 3: Blocked Drainage System in Mendong
 Coordinates: 3°53’34” N, 11°30’37”E
 Height above sea level: 730m



Photo 4: Blocked Drainage System in Simbock
 Coordinate: 3°53’34N, 11°30’41”E
 Height above sea level: 710m

Source: Fieldwork, (2020)

Plate-2 shows blocked drainage systems in Mendong and Simbock in Yaounde. In Photo 3, note business premises “A”, and piled-up non-biodegradable plastic bottles in a drainage system “B”. In Photo-4, note nearby habitats closed to a drainage system “A”, and garbage from nearby habitats and elsewhere blocked the drainage system “B”. During intense precipitation, the outcomes of these drainage systems blockages are devastating on neighbouring communities and include inundations, roads blockage by wastes from

drainage systems and disruption of traffic flow and movement of people.

As seen in plate 2, the drainage has been filled with waste. The waste trapped in the water drainage system together with paved surfaces often result to heavy flooding when it rains. Its affects water quality and the decomposition of the waste results to air pollution. Inappropriate waste disposal also result to public health issues as the dumping sites form breeding grounds for disease vectors (for example mosquitoes, rats) and it also generates significant greenhouse gases when burnt or when the waste discomposes. All these affect the quality of life of urban dwellers as well as the urban landscape and therefore affect the overall sustainable urban development process. Waste production is an unavoidable consequence of human activity and dealing with it constitutes a major challenge to the realization of SDG 11.

Local climate change and thermal discomfort

The sampled population was asked to assess temperature changes in the Yaounde urban area. The result revealed a strong perception of changes in the temperatures of Yaounde and the temperatures have been increasing as shown on figure 2.

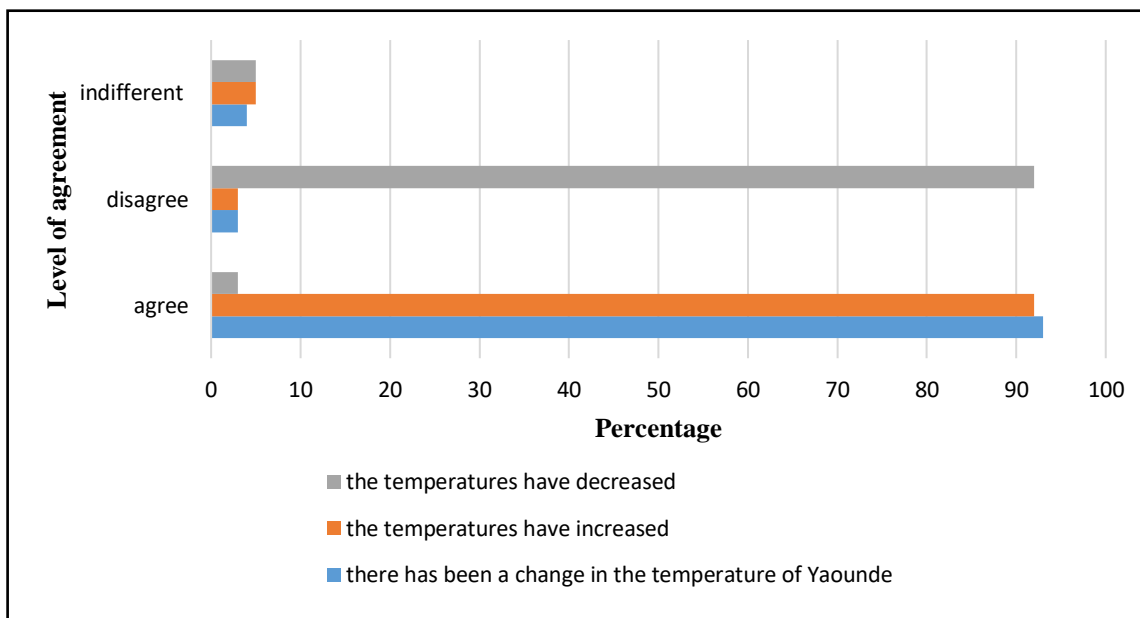


Figure 2: Perceptions on temperature changes in Yaounde

Source: Fieldwork, (2020)

From figure 2 it is clear that Yaounde has witnessed a change in it temperature as a vast majority (93%) of the respondents agreed to the statement that there has been an increase in temperature of the area.

Further analysis using the characteristics of the urbanized areas indicated that temperatures were very high in the city centre where buildings and other concrete surfaces and human activities were highly concentrated and the temperatures turn to reduce as one moves towards the peripheries where we have disperse settlement patterns and vegetation is still the major land cover type. The highly built-up areas are characterised by building made of cement blocks and concrete while most of the roofs are made of corrugated and coloured roofing sheets. All these have low albedo and are high heat absorbers. These materials coupled with other anthropogenic activities increases the temperature of the urban area. Also uncontrolled construction has resulted to dense and haphazard spatial development, and coupled with the high rise building which characterise the Yaounde urban space obstruct air circulation. Figure 3 shows the percentage of the built environment affected by different degrees of temperatures.

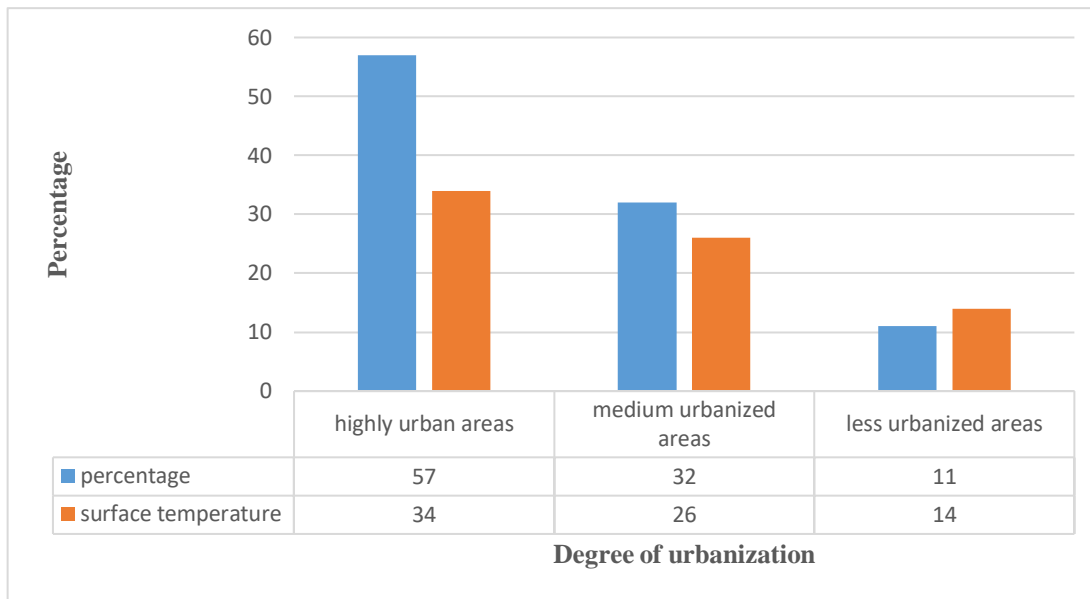


Figure 3: Temperature distributing following the nature of the degree of urbanization

Source:

Temperatures at the city centre were up to 34°C compared to 14°C in the peripheries. That is the highly built-up and congested areas (57% of the city) experience high temperatures of about 34°C, moderately built environment (32% of the city) experience mean temperature of about 26°C while least built-up and less congested environments (11% of the city) have low temperatures of about 14°C.

The results of the study revealed that rapid population growth has resulted to major land use transformation in Yaounde and these changes in land use have an impact on the local climate of Yaounde. The population of Yaounde grew by 2,641,823 persons between the year 2000 and 2020. The built up area (non-vegetated surfaces) increase from 5649.4537ha in 2000 to 9916.93ha in 2010 and from 9916.93ha in 2010 to 18009.2921ha in the year 2020. The Yaounde urban space has witnessed a decline in its vegetated area over the years due to conversion to build-up areas. All these have resulted to increase temperatures and the incident of local climate change is already apparent in Yaounde. The reduction in the vegetation cover and expansion in the build environment have resulted to the temperatures in Yaounde urban space to be warmer than that of the surrounding countryside – a phenomenon known as the urban heat island effect.

Warmer temperatures which come with increase population and changing landscape of the city has resulted to a change in the weather patterns. For example, the past few years in Yaounde have witnessed increase in the duration and intensity of sunshine with the consequence being thermal discomfort and heat stress. As mentioned earlier, increase in the population and expansion of urban activities has resulted to less green space and more high-density areas. As a consequence, a majority of the respondents living in these high-density areas reported to have experienced thermal discomfort and heat stress over the last few years. This was evident by the increase use of air conditioners and fans by high and medium income groups. Spending time out door, increase water intake, consumption of cold drinks, and sleeping on the floor especially in the months of December, January and February as reported by poor households are all indications of increase heat thermal discomfort and heat stress in Yaounde. Others mentioned for haven been victims of heat cramps, sleep deprivation, heat stroke and other heat related diseases. Therefore, rapid urbanization resulting from increased population, expansion of urban activities and changing urban landscape does not only result to local climate change but this has a multiplier effect on the economy as it affects people’s productivity, health, raise cooling costs for building and deteriorates air quality. Also, lower temperatures experienced in the more vegetated areas are indications that the greenery of an area has an important role to play in its

temperature and the overall sustainability of that area.

Air pollution

Air quality is one of the indicators of sustainable urban development as it has an impact on the environment and the human health. Rapid urbanization has a strong influence on the air quality as population increase is often accompanied by increase car ownership, increase consumption and waste production, increase economic activities, increase energy use and reduction in the vegetation cover. All these result to increase emission of greenhouse gases, less absorption and the resulting consequences of these green gases on the environment and the health of the population in Yaounde. For example, the results of the study reveal that in the 2020 there were more than 197,600 registered automobile vehicles in Yaounde, a majority of which are run by diesel engines. Most of these cars are used cars of about 10 to 15 years old imported from Europe and North America. The age of the cars plays an important role in the amount of carbon monoxide and carbon dioxide released to the atmosphere. Apart from the cars there are uncountable numbers of motorbikes which run on the streets of Yaounde contributing highly to the amount of gaseous waste emitted.

Increase population necessitates increase energy need for cooking and running of electrical appliances. Though almost all households interviewed own domestic gas, most homes in Yaounde still use charcoal, sawdust and firewood to meet some of their cooking needs which release a substantial amount of carbon dioxide into the atmosphere. Also, poor waste management which characterises the city is a major source of air pollution. The breakdown of waste releases excess gases such as methane which pollutes the air and is a major factor in local and global climate change.

The research respondents were aware of air pollution in Yaounde and recognized it as one of the environmental challenges faced by the Yaounde urban dwellers and acknowledged the following (figure 4) as major sources of air pollution in the study area.

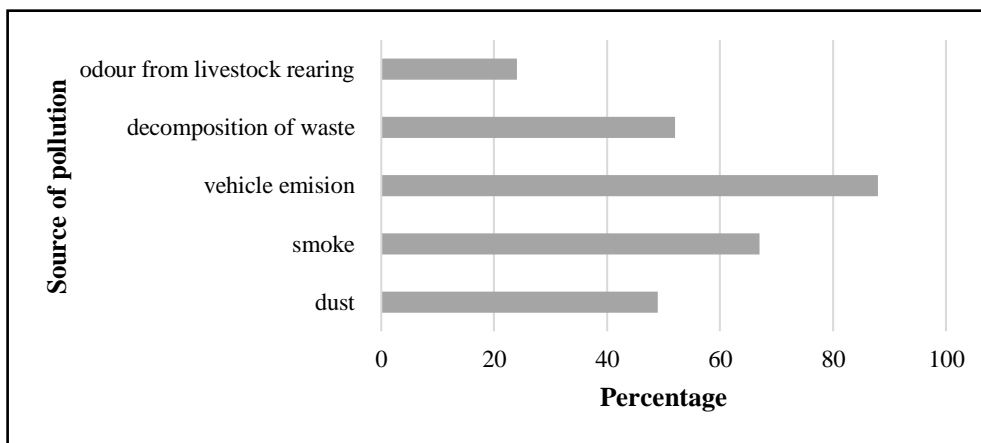


Figure 4: Perceived sources of air pollution in Yaounde

Source: Fieldwork, (2020)

Based on figure 4, about 88% of the respondents perceived emission from vehicles as the major source of air pollution while 67% noted that smoke was a source of air pollution. The decomposition of waste was also seen by 52% of the respondents as source of air pollution whereas to 49% of the respondents, dust was a source of air pollution.

Though the word air pollution was not frequently used by most the interviewees, they often referred to odour, dust, and smoke which are elements related to air pollution. The type of air pollutant mentioned was influenced by the respondent's location. Those who lived in quarters characterised by unpaved roads

perceived dust as the major air pollutant. Unpleasant smell which constituted an element of air pollution was related to piggeries, poultry farming and indiscriminate dumping of solid and liquid waste near dwellings.

Of frequent occurrence in the views of the respondents was the notion of ‘good’ and ‘bad’ air. Most respondents (51.6%) especially those living around landfill areas and unpaved roads rated the air quality in Yaounde as ‘bad’. The respondents also associated the quality of air to seasons. To some respondents, the air during dry season is bad because there is solid waste piled up everywhere in town and stagnant domestic water in gutters and pot holds produce bad odour. Also the air is dusty and still during the dry season making breathing difficult. Other respondents perceived the air quality during the rainy season to be better. This is because to them, water and the abundant vegetation cleans the air and makes it fresh. In addition, much of the garbage and stagnant water is being washed away by the rainwater. Hence, cleaning the environment in general and the air in particular. However, some of the respondents mentioned that bad odour is usually felt at the beginning of the rainy season as many residents discharge their domestic waste into the gutters and the early rains facilitate the decomposition of piled up waste. However, this gradually disappears and the air becomes clear and cleaner as the rainy season advances.

Loss of biodiversity

Urbanization comes with the conversion of vegetated surfaces to settlements and other paved surfaces. This results to loss of habitats, habitat fragmentation and loss of food sources. Field observation, survey results and the analysis of satellite images of Yaounde indicated that much of the vegetated area has been converted to human settlements and other infrastructural development over the past years.

Figure 5 illustrates the spatial evolution of the vegetated surface of Yaounde over the last 2 decades.

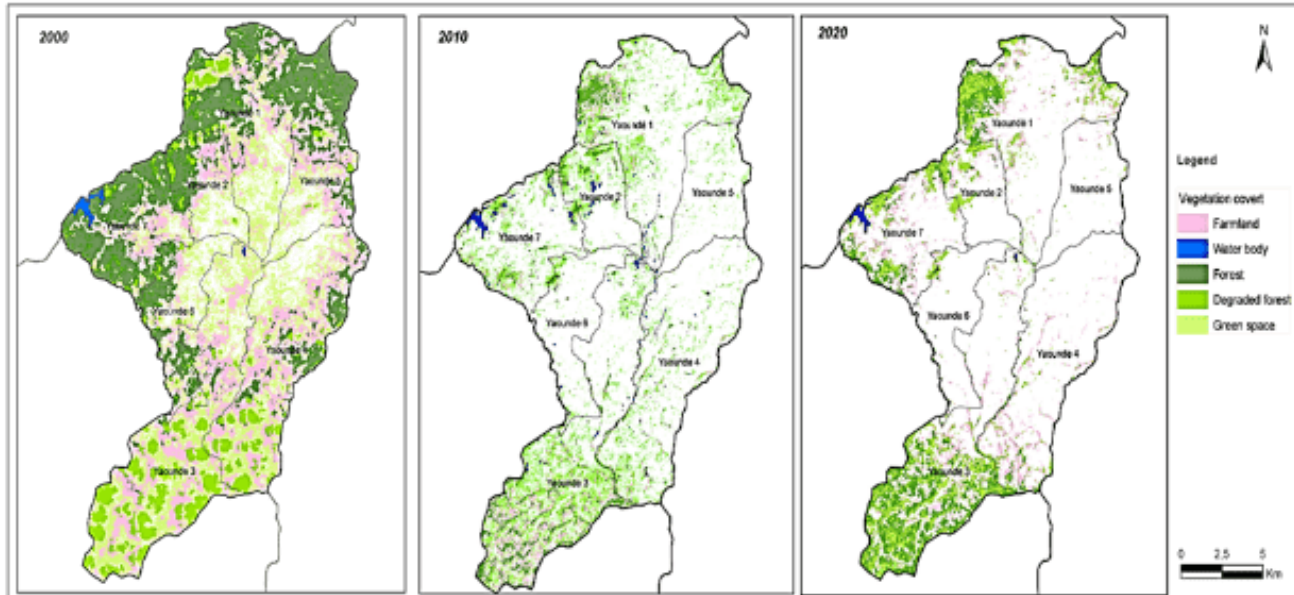


Figure 5 shows that by the year 2000 much of Yaounde was still covered by vegetation. About 22396.7ha were covered by at least one type of vegetation. As the city grew, the vegetation was eventually giving way to other land uses and by 2010 about 4,117ha had been lost to other land uses. Rapid urbanization has continued to put pressure on the vegetation cover in Yaounde and by 2020, much of the floral biodiversity had been lost and their spaces taken over by other prioritized land uses. The loss of vegetation implies loss of habitats and food sources for the fauna biodiversity as well. This explains why it is difficult to see live animals within the city apart from the zoo and other green patches. Figure 6 illustrates the evolution of vegetated and non-vegetated surfaces in Yaounde.

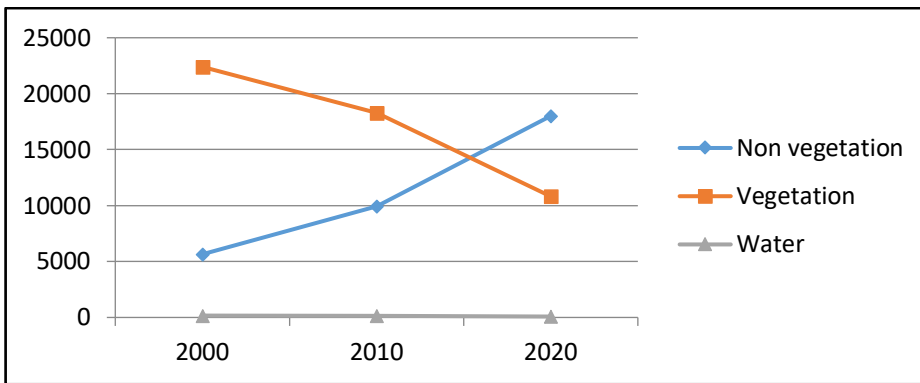


Figure 6: Evolution of vegetated and non-vegetated surfaces in Yaounde from 2000-2020

Source: Derived from figure 5

Figure 6 shows a negative relationship between the built environment (non-vegetated surface) and the vegetated surface over time. That is over the years, the vegetated surface has gradually given way to the non-vegetated surface. As a result of expansion of the built environment, the vegetated areas decreased from 22396.7ha in the year 2000 to 18276.4ha in 2010 and from 18276.4ha in 2010 to 10818.17205ha in the year 2020. This indicates a 218.8% increase in non-vegetated surfaces from the year 2000 to the year 2020 and a 51.7% decrease in vegetated areas from the year 2000 to the year 2020.

The respondents were asked to state their views regarding the relationship between urbanization and biodiversity, figure 7 illustrates their views.

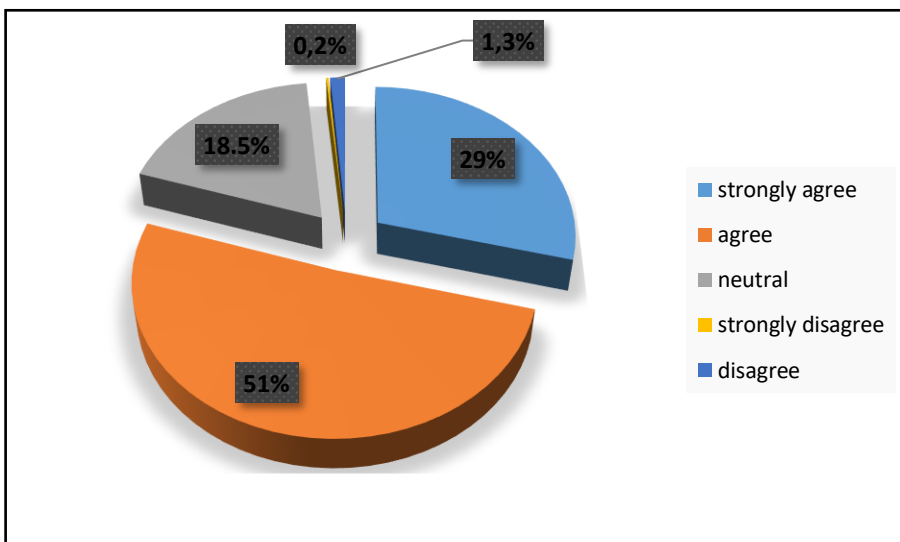


Figure 7: Perceptions on the relationship between urbanization and biodiversity loss

Source: Fieldwork, (2020)

During field survey the respondents were asked to state their level of agreement with the statement ‘urbanization results to biodiversity loss’, figure 7 shows that a majority of the respondents held a positive view that urbanisation has resulted to loss of biodiversity in the study area with about 80% either strongly agreeing (29%) or agreeing (51%) to the statement. About 18% had a neutral view regarding the relationship between urbanization and biodiversity loss while a minute number (1.5%) of the respondents mentioned that urbanization has no negative impact on biodiversity. The results indicate that urbanisation has greatly affected the plant and animal species in the study area.

The quantitative results were fleshed out with the results from the semi-structured interviews. During an interview with a 75-year-old resident of the Mendong neighbourhood who had been in Yaounde for the past 40 years he narrated:

“When I came to Yaounde in the early 1980s, the town then ended at Obili and the rest of the area beyond that was thick forest. It was common to see wild animals crossing the roads at nights. What we bought as plots then were dense natural forest with huge trees in them. But today all that is gone, you have to be very lucky to even see a live rat mole in this town. Everywhere now are houses and few available plots now a just relics of agricultural lands”

A study carried out by (Anguh & Louis, 2021) indicated that urban expansion has degraded the dense forest that served as homes for many wildlife species. Also biodiversity population is also inhibited by toxic substances emitted in the urban environment.

DISCUSSION

The results of the study indicate that the Yaounde metropolis faces significant environmental challenges which are impeding its progress towards the achievement of SDG 11 which aims at creating inclusive, safe, resilient and sustainable cities. However, achieving this goal is particularly challenging for developing cities like Yaounde, where rapid urbanization and environmental challenges poses a significant threat to achieving SDG 11 in general and target 11.6 in particular. This goal serves as a roadmap guiding policy makers, urban planners and other stakeholders to address sustainability issues in cities including Yaounde. Following this guiding framework, the city of Yaounde has implemented some initiatives aimed at improving sustainability. For instance, there have been investments in public transportation infrastructure such as the Yaounde-Douala auto-route project which seeks to improve sustainable mobility reduce traffic congestion and air pollution and promote sustainable mobility. In addition, the city has made efforts to create green spaces in order to enhance the urban ecosystem. However, despite these efforts, Yaounde still faces persistent challenges towards the realization of SDG 11.

The study identifies inadequate waste management systems, air pollution, and local climate change, including extreme events and rising temperatures as factors that strain the city’s resilience. In addition, land degradation and loss of biodiversity further exacerbate the vulnerability of the urban ecosystem in the Yaounde metropolis.

Proper waste management is required for sustainable urban development, aligning with target 11.6 of SDG 11 which seeks to reduce the environmental impact of cities including waste generation and management. An analysis of waste management in Yaounde revealed that much of the waste generated by the population remains uncollected and the waste is often littered everywhere around the city. Ngnikam et al. (2017) carried out a study on the evolution of solid waste characteristics in Yaounde from 1995-2015, and concluded that the amount of solid waste generated in the city has increased over the years but much of the waste remain uncollected. A similar study carried out by Misganaw (2022) in Bahir Dar city, Ethiopia, showed that more than 58% of the waste generated by the city inhabitants remained uncollected. The uncollected waste is disposed into the open dumpsites which emits about 46Gg/year of greenhouse gas. Poor waste management in Yaounde has been attributed to inadequate waste management infrastructure and civic irresponsibility. A study by Kamdem et al. (2017) and Joel et al. (2019) cited inadequate infrastructure, limited institutional capacity and socio-economic disparities as major barriers to effective waste collection and disposal in Yaounde. Improper waste management undermines efforts to create sustainable and liveable cities, hindering progress towards SDG 11’s objective of promoting inclusive and sustainable urban areas.

The research findings revealed that Yaounde is susceptible to the impact of climate change, as evident by increased frequency of extreme weather events such as heat waves, heavy rainfall, floods and landslides.

Increasing frequency and intensity of these extreme weather events, exacerbate environmental challenges, disrupt livelihood and threaten infrastructure posing threat to the inhabitants and their environment. Macchi (2014) recognized incremental climate stress in African cities and suggested adaptation strategies to climate change in these urban areas. Climate change accompanied by reoccurrence of extreme events impede progress towards SDG 11's objectives of building safe, and resilient cities and ensuring sustainable urban development. These findings concord with those of a study by Fozong et al. (2023) who highlighted that, Yaounde is experiencing increasing frequency and intensity of climate related hazards such as floods and heat waves. This is increasing the vulnerability of the urban population, exacerbating poverty and inequality in the urban areas.

In addition, the results of the study reveal that air pollution poses substantial threat to environmental quality in Yaounde. High levels of pollution and poor air quality resulting from industrial activities, vehicular emissions, and poor waste management threatens public health, undermines urban liveability and slows down efforts to ensure a safe and sustainable city. Nducol et al. (2020) attributed the high levels of air pollution in Yaounde to vehicular emissions, industrial activities and biomass burning. In line with the findings of this study, United Nations Environmental Program noted that, poor air quality and high levels of pollution in urban areas contribute to adverse health outcomes and environmental degradation, posing significant challenges in achieving SDG 11 (UNEP, 2020; Feuyit, 2019). Similarly, the World Health Organization postulated that, air pollution affects the quality of life of urban inhabitants and undermine efforts to promote healthy and resilient cities (WHO, 2019). Qu et al. (2024) and Lockwood (2016) emphasized that pollution-reduction strategies are crucial milestones towards a sustainable environment. Achieving the 2030 agenda for sustainable development requires transitioning into a pollution-free world which can improve the ecosystem integrity needed for survival.

The research results showed a negative relationship between urbanization and biodiversity. The most visible impact of urbanization in the study area was land cover change. The expansion of the Yaounde urban area comes at the expense of the natural ecosystem where deforestation for the urban built-up environment results to habitat degradation and biodiversity loss. The vegetation which accommodates the flora and fauna diversity in the urban area plays a crucial role mitigating climate change impacts, providing recreational facilities and enhancing urban resilience. However, much of this vegetation has been traded for other urban land uses, therefore, degrading the urban environment and undermining efforts to create sustainable and resilient cities. The results of this study support the views of Ntemngweh (2023) whose research highlights the extensive deforestation and habitat loss occurring in Yaounde due to urban expansion and land conversion leading to biodiversity loss and ecosystem degradation. (Lepczyk et al., 2017) in their study on 'biodiversity in the cities' noted how urban expansion has resulted to loss of urban green space and emphasized on the role urban green space in providing habitats that support biodiversity in these urban areas. Obrecht et al. (2021) in the study on 'achieving the SDGs with biodiversity' identify the conservation of biodiversity as one of the most potent levers to achieve sustainability especially in urban areas.

CONCLUSION

Yaounde is plagued by environmental challenges which pose barriers in achieving SDG 11, undermining efforts to create a safe, resilient and sustainable urban environment. While there have been initiatives to improve urban infrastructure and enhance the living environment, the pace of development in Yaounde lags behind the rapid urbanization rate. The study illuminated how improper waste management, air pollution, vulnerability to climate change and loss of biodiversity hinder efforts to achieve SDG 11's objectives in Yaounde. The experiences of Yaounde offer valuable insights and lessons for other developing world cities grappling with similar challenges. These study suggests that, in order to address the environmental challenges facing Yaounde and other similar developing world cities, there is need for concrete efforts, innovative approaches, political will, and cross-sector collaboration. There is need to prioritize climate

resilience, inclusive urban development and environmental sustainability. The study suggests improved strategies and efforts to reduce air pollution, mitigate the effects of climate change, enhance waste management and promote resilience of the urban ecosystem. Moreover, to make meaningful progress towards sustainable urban development in the Yaounde metropolis, there is need for a strong political will, community engagement and effective governance.

REFERENCES

1. Anguh, n., & louis, D. (2021). Urban Sprawl and the Effects on the Zoogeography of the Yaounde Metropolis, Cameroon. *The International Journal of Science & Technoledge*, 9(2). doi: 10.24940/theijst/2021/v9/i2/st2102-004
2. Awah Manga, L. A., Kamga, R. T., Bidogeza, J.-C., Afari-Sefa, V., & Mono, J. B. (2023). Effects of urbanisation on urban residents' perception of vegetable production in Yaoundé, Cameroon. *Landscape Research*, 48(6), 725–740. doi:10.1080/01426397.2023.2189694
3. Barthelemy, n. D. O. N. G. O., fru, f. M., ludovic, n. J., & stephane, l. M. (2016). Residential solid waste management in cities with developing economies: case study of Yaoundé, Cameroon. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) e-ISSN*, 2319-2402
4. Feuyit, G., Nzali, S., Lambi, J. N., & Laminsi, S. (2019). Air Quality and human health risk assessment in the residential areas at the proximity of the Nkolfoulou landfill in Yaoundé Metropolis, Cameroon. *Journal of Chemistry*, 2019, 1–9. doi:10.1155/2019/3021894
5. Fozong, T. D., Tiafack, O., Tchakonte, S., Ngeumo, C. G., & Badariotti, D. (2023). Analysis of weather anomalies to assess the 2021 flood events in Yaounde, Cameroon (Central Africa). *American Journal of Climate Change*, 12(02), 292–320. doi:10.4236/ajcc.2023.122014
6. Grimm, n., faeth, s., golubiewski, n., redman, c., wu, j., bai, x., & briggs, j. (2008). Global Change and the Ecology of Cities. *Science*, 319(5864), 756-760. doi: 10.1126/science.1150195
7. Joel, S., Ernest, M. L., & Ajapnwa, A. (2019). Application of analytic hierarchy process decision model for solid waste management strategy in Yaoundé, Cameroon. *The Journal of Solid Waste Technology and Management*, 45(4), 502–517. doi:10.5276/jswtm/2019.502
8. Juma, K., A. Juma, P., Shumba, C., Otieno, P., & Asiki, G. (2020). Non-communicable diseases and urbanization in African cities: A narrative review. *Public Health in Developing Countries - Challenges and Opportunities*. doi:10.5772/intechopen.89507
9. Kamdem, S. D., Njoya, A., & Mouncherou, O. F. (2017). Analysis of Solid Waste Management in Cameroon: A Case Study of Yaoundé City Council. *International Journal of Environmental Science and Development*, 8(4), 262-266. DOI: 10.18178/ijesd.2017.8.4.983
10. Lepczyk, C. A., Aronson, M. F., Evans, K. L., Goddard, M. A., Lerman, S. B., & MacIvor, J. S. (2017). Biodiversity in the city: Fundamental questions for understanding the ecology of urban green spaces for biodiversity conservation. *BioScience*, 67(9), 799–807. doi:10.1093/biosci/bix079
11. Lockwood, A. H. (2016). Air Pollution, air quality, and climate change. *Heat Advisory*. doi:10.7551/mitpress/9780262034876.003.0007
12. Macchi, S. (2014). Adaptation to incremental climate stress in urban regions: Tailoring an approach to large cities in Sub-Saharan africa. *Springer Climate*, 3–18. doi:10.1007/978-3-319-00672-7_1
13. Mensah, J. (2019). Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review. *Cogent Social Sciences*, 5(1). doi:10.1080/23311886.2019.1653531
14. Misganaw, A. (2022). Potential impact of municipal solid waste: Case study of bahir Dar City, Ethiopia. *The Journal of Solid Waste Technology and Management*, 48(3), 450–458. doi:10.5276/jswtm/2022.450
15. Ndam, S., Touikoue, A. F., Chenal, J., Baraka Munyaka, J.-C., Kemajou, A., & Kouomoun, A. (2023). Urban governance of Household Waste and sustainable development in Sub-Saharan africa:

- A study from Yaoundé (Cameroon). *Waste*, 1(3), 612–630. doi:10.3390/waste1030036
16. Nducol, N., Tchunte Siaka, Y. F., Younui Yakum-Ntaw, S., Saidou, Dika Manga, J., Vardamides, J. C., & Simo, A. (2020). Ambient air particle mass concentrations in the urban area of the capital city of Yaoundé (Cameroon, Central Africa): Monthly and seasonal behaviour. *International Journal of Environmental Analytical Chemistry*, 101(15), 2909–2925. doi:10.1080/03067319.2020.1715378
 17. Ngnikam, E., Naquin, P., Oumbe, R., & Djietcheu, K. B. (2017). Evolution of household solid waste characteristics in Yaoundé City, Cameroon (1995-2015). *Environnement, Ingénierie & Développement*, N°74-septembre 2017. doi:10.4267/dechets-sciences-techniques.3654
 18. Ntemngweh, P., (2023). Sustainable urban development challenges and nature-based solutions: the role of green spaces in the Yaounde metropolis, Cameroon. PhD thesis. Yaounde, University of Yaounde 1
 19. Obrecht A, Pham-Truffert M, Spehn E, Payne D, Altermatt, F., Flischer, M., Passarello, C., Moersberger, H., Schelske, o., Guntern, J., Prescott, G., Geschke, J., & de Bremond, A., (2021) Achieving the SDGs with Biodiversity. *Swiss Academies Factsheet* 16 (1). <https://doi.org/10.5281/zenodo.4457298>
 20. Qu, J., Hao, J., & Qian, Y. (2024). Together towards a pollution-free planet. *Frontiers of Environmental Science & Engineering*, 18(6). doi:10.1007/s11783-024-1826-1
 21. United Nations, Department of Economic and Social Affairs (2019). *World Urbanization Prospects 2018: Highlights*. doi:10.18356/6255ead2-en