

# **Thirty years of urban expansion in Amman city: urban sprawl drivers, environmental impact and its implications on sustainable urban development: A review Article**

**By**

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## **Abstract**

The purpose of this research is to understand the current state of Amman city research on urban sprawl environmental impacts and their relationships to urban sustainability, with a focus on several indicators and drivers into a multi-level perspective of urban sprawl monitoring and management. We demonstrate how Amman addresses urban sprawl. The environmental impact of urban sprawl includes a number of indicators, including the impact on land use, which is primarily spent on agricultural land. The extent of settlements away from the urban area increases the need for increased use of cars, thereby increasing the air pollution levels and carbon dioxide emissions, as well as the level of noise from extensive car use as settlements expand. With the construction of individual houses and apartments with larger living spaces, there is a rising need for water consumption, particularly in households, and the price of communal tax payments rises, in addition to solid waste collection and disposal services, as well as infrastructure. All of these indicators were investigated in this paper.

**Keywords:** urban sprawl; environmental impact; policy; Sustainable urban development; multi-level approach; complex systems; Amman; population growth

## **Introduction**

Since the twenty-first century, global urbanization has been accelerating (Schneider & Woodcock, 2008). Urbanization has emerged as a key element of international development and the primary means by which human activities alter the natural environment and climate (Lin et al., 2010; Angel et al., 2011; Xia et al., 2019). Urbanization is a complex spatial activity influenced by various elements such as policy, population, economy, and natural causes and manifests itself differently in different places (Song et al., 2016; Silva & Li, 2017; Terfa et al. 2019). It is worth mentioning that such land use and cover changes are typically irreversible (Hardi et al., 2020). As a result, one of the focal points of global change studies has been the spatiotemporal evolution of urbanization. Many emerging countries are currently experiencing rapid urbanization. These areas' rapid economic development and increased industrialization have resulted in an influx of urban people. In this context, several issues have arisen, including the encroachment of precious agricultural resources, traffic congestion, and environmental deterioration, all of which have a negative impact on the efficient operation of urban systems (Jiang et al., 2013; Tian et al., 2011; Deng et al., 2008). Determining the existing issues and evolution patterns in the urban complex system is therefore crucial for predicting the development trend of urban land use and guiding the sustainable growth of cities.

The expansion of the geographical scope in which the division of land for individual use and the increased reliance on private cars in the transportation process is referred to as urban sprawl. The reason for urban sprawl is to absorb the increase in population in urban areas, as well as to increase living space and other housing facilities in urban areas (Hesse and Rafferty, 2020). In general, the phenomenon of urban sprawl leads to the gradual development of neighboring rural areas and an increase in their population density (Żróbek-Róžańska and Zadworny, 2016; Bagheri and Tousi, 2018). Urban sprawl is also associated with increased energy consumption, pollution, traffic congestion, the destruction of wildlife habitats, and the fragmentation of natural areas on the city's outskirts (Hesse and Rafferty, 2020). The horizontal expansion of a city caused by rapid population growth, which may pose a threat to the natural environment surrounding the city as well as an imbalance in the ecological balance, is known as urban sprawl.

Amman encountered the terrifying challenge of significantly increasing expenditures to extend infrastructure and services into low-density areas. Furthermore, rapid growth, an underdeveloped public transportation system, and a dramatic rise in automobile ownership were polluting the city's streets and negatively impacting businesses (Beauregard & Marpillero-Colomina, 2011; Potter et al., 2009; Al-Rawashdeh & Saleh, 2006).

Urban sprawl on agricultural lands is one of the main threats to the natural environment in major cities. This phenomenon poses a challenge to most countries of the world due to the population increase at high rates, the expansion of urban activity, and the consumption of resources away from the principles of Sustainability (Al Tarawneh, 2014). Agricultural land contributes to achieving food security, reducing air pollution, mitigating high temperatures, and controlling air movement and humidity. Urban regulations and requirements such as dividing agricultural lands into small areas play a role in facilitating encroachment on them (Al Tarawneh, 2014).

The phenomenon of construction in agricultural areas has increased due to natural population growth and a lack of construction areas within the city of Amman. This phenomenon has resulted in the loss of large areas of agricultural land as well as the conversion of some agricultural land within urban areas to residential, commercial, or industrial uses (Farhan and Al-Shawamreh, 2019). Since 1969, Amman has seen an expansion of the transformations that accompanied the economic boom as a result of urbanization.

The research directed by Tokula and Ejaro (2017), entitled "The impact of urban expansion on agricultural land and crop output in Ankpa, Kogi State, Nigeria," has focused on evaluating the percentage of agricultural land loss and the degree of the influence of this loss on crop production and growth in the research area. The data for the study came from a 29-year analysis of satellite images from the GLCF (Land-cover Global Facility), which included the study area and its surroundings. Area maps from 1986 with a 30-meter precision, maps from 2001 with a 30-meter precision, and the Landsat ETM picture from 2016 with a 30-meter precision have also been utilized. To measure classification efficiency, the researchers used GPS tools, ArcGIS 1.10, and the Kappa statistical coefficient, where the Kappa coefficient represents the relative decrease in error caused by the classification procedure. On the basis of shape, size, and pattern, standard visual interpretation approaches were utilized to describe, categorize, and classify divisions of land use and land cover. The research found that the studied area's land usage and land cover had changed dramatically over the time period studied. Urban areas had grown dramatically during the twenty-nine-year period under consideration.

Due to population growth and physical changes, agricultural lands, vegetation, and bare terrain have all been reduced. Farmland trend research from 1995 to 2016 revealed a downward trend.

In a study titled "The role of urban sprawl on the uses of Agricultural Land Surrounding the city of Baghdad," Al-Tamimi (2014) stated that the goal of the study is to determine the degree of the impact of urban expansion on natural Urbanization in Baghdad. The research used a historical and descriptive curriculum to understand better the elements that influence urban sprawl. Additionally, aerial images and maps were used to show the pattern of urban expansion and how it affects agricultural fields in the study area. The study showed that modifying urban laws, increasing population growth, and a lack of commitment strategies framework for the city of Baghdad played a role in increasing the amount of urbanization and encroachment on agricultural land, raising the proportion of built-up area, the lack of agricultural areas, and the expansion of the city of Baghdad's size by granting licenses to build in these areas and allowing overtaking on farmland. It reduces the amount of land available, leading to desertification. According to research, a variety of strategies can be used to solve the problem of crawling on agricultural land within the province of Baghdad, which necessitates taking proper measures to stop the problem and the right urban design.

## **Research gap and need of the study**

In the environmental, social, and cultural realms, urban development poses a number of concerns. Externalities of varying degrees and forms are associated with these risks, which are intimately tied to the local circumstances of socio-economic activities. The unregulated and continuous growth of urban areas might be attributed to an absence of urban development management (Guastella et al., 2019). Monofunctional spatial structures integrated into discontinuous functional and territorial systems are the immediate observable outcome of this. As a result, the question arises as to whether urban sprawl procedures should not be considered one of the stages in the evolution of densely populated areas. The present settlement patterns have been interpreted ambiguously in the scholarly literature throughout the last few decades (Albrecht, 2010).

Nevertheless, only a few studies have looked into the environmental effects of urbanization (Repaská et al., 2017). In order to increase stakeholder participation in the entire event and comprehend its impact on sustainable development in emerging nations like Jordan, there is a better possibility to analyze various urban sprawl processes.

## **Significance of the research**

The importance of this research comes in reviewing and analyzing the causes and impact of urban sprawl on the environment and agricultural lands and the implications on sustainable urban development. Thus, this research will help decision-makers develop guidelines to reduce the adverse effects of urban sprawl on the environment and agricultural lands within the urban area of Amman city and preserve and develop them.

## **Objectives of the research:**

- 1- Identifying the drivers of urban sprawl in Amman
- 2- Identifying the environmental impact of urban sprawl in Amman city.
- 3- Identify the implications of urban sprawl on sustainable urban development.

## Material and methods

This study relies mainly on secondary data and qualitative literature review, through previous studies published in refereed scientific journals and periodicals related to the subject of the study, especially those conducted in Amman and published in (Google Scholar, Scopus, and Web of Science) (Cox, 2015). In addition to policy papers published online by the Greater Amman Municipality, the World Bank, and UN-Habitat.

A literature review is required for structuring a research field, which is considered an essential part of any research. It aids in identifying the conceptual content of the research field and directs it toward theory development.

## The study area

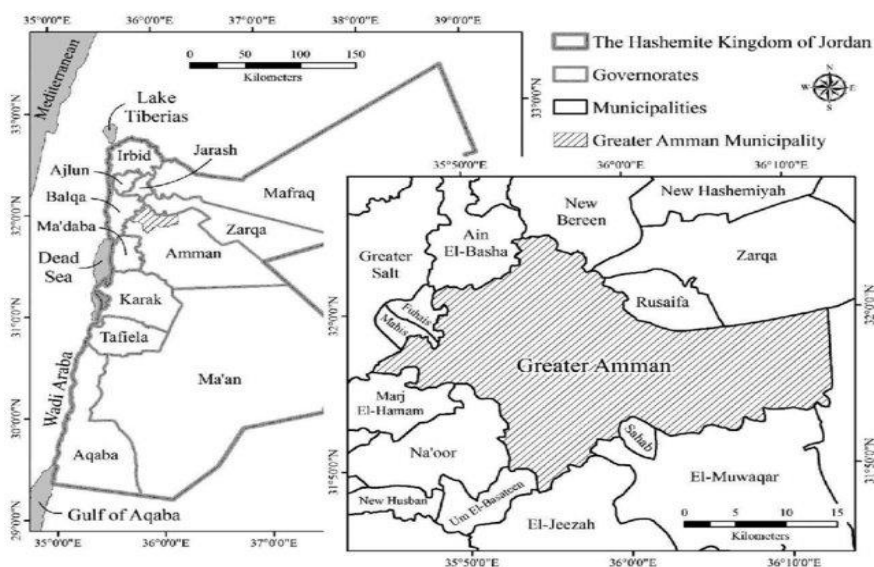
### *The capital of Jordan (Amman City):*

The study area is the country's capital, Amman, which spans 22 districts across a total area of 758.85 km<sup>2</sup> and is located in the middle of Jordan.

The city is located in the heart of the kingdom at latitude 31 north and longitude 35 east in a mountainous area.

More than a third of the population of the Kingdom resides in Amman, one of the Middle East cities with the fastest population growth. Greater Amman and its suburbs have a population of roughly 4 million now (Hurr & Tashman, 2019).

It is the largest governorate in terms of population and the third largest in terms of area after the governorates of Ma'an and Mafraq, the most important of which is the backbone of the Jordanian state. It contains the most important institutions of the Jordanian state, as well as all government departments and the House of Representatives, and is approximately 750 meters above sea level (Buhairi, 2001). Amman experiences aridity, a lack of renewable water sources, and energy dependence due to its semi-arid environment (Ababsa & Abu Hussein, 2020).



**Figure 1:** map of the study area

Source: Jaber, 2018

## Urban sprawl in the city of Amman

Urban sprawl is a broad, comprehensive notion that describes how a city and its suburbs grow at the expense of the surrounding area's land and natural resources. This effect causes rural areas next to big cities to grow and increase population density. Additionally, it encourages the expansion of contemporary modes of mobility like cars and causes the level of services in them to rise. Urban sprawl has a vague description, and there are many disagreements over its precise definition. Some characterize it as the growth of urban infrastructure at the expense of agricultural lands designated for agricultural exploitation and production (Khleifat, 2020).

## Amman population growth and urban expansion

According to Al-Asad (2005) in his paper titled "Ever-growing Amman," Amman had extraordinary growth in terms of population growth and geopolitical significance for the region from the latter half of the 20th century to the early 21st century. Amman is now a significant regional city with a population of more than 4 million people as of the end of 2021.

Amman, Jordan's capital city, grew from a rural city with a population of 2000-3000 people in 1920 to a major city with 4.5 million people in 2021 (Department of Statistics, 2022), resulting in a dramatic population increase. Amman city has experienced rapid unplanned growth, which has caused pressure on the environment and land degradation due to urban sprawl. This increase in population left an effect on the city horizontally and sacrificed hectares of natural open areas and agricultural lands to adapt to the fast growth of the population in the capital, leading to an increase in carbon dioxide emissions (Imam et al., 2020).

### *Population Growth and Urban Expansion in the city of Amman in the Past Thirty Years*

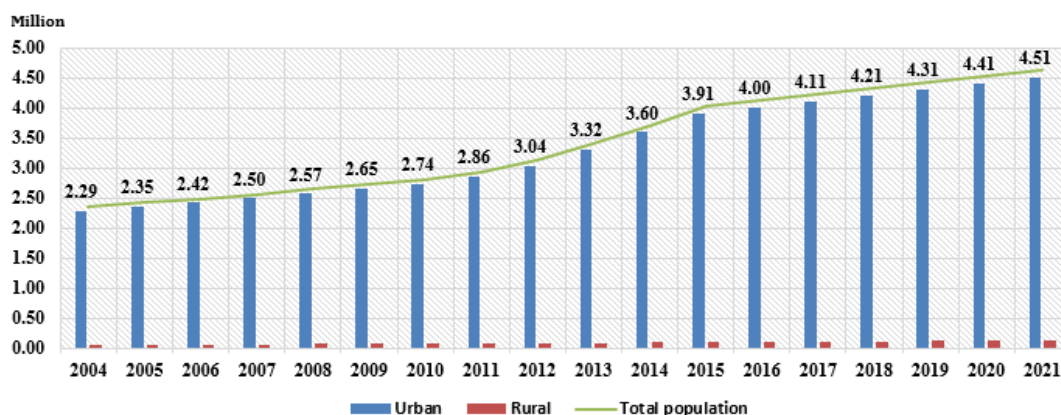
The city's population increased throughout the ninth decade of its existence, reaching (1.5) million at the start of the decade and (1.8) million by the end of 1999 because of the return of thousands of citizens working in Kuwait and the Gulf countries. By the end of the decade, the city's territory had grown to around 670 km<sup>2</sup>, and the two villages of Al-Maduna and Al-Manakher in the Al-Nasr region had also been added in 1999 (Manasreh, 2014).

Amman's population expanded over this decade following the influx of migrants that followed the 2003 invasion of Iraq, reaching (1.9) million in 2001 and (2.5) million in 2007. also advanced The city's boundaries steadily expanded to (678) km<sup>2</sup> in the year 2002 after the absorption of a group of lands in the Wadi Al-Seer region and the villages of Al-Abdaliah and Al-Khashafia in the Al-Quweismeh region. This region has expanded rapidly, and in 2007, following the inclusion of new territories into the Greater Amman Municipality, it reached an extent of (1680) km<sup>2</sup>, which had not happened in the city's modern history since 1909. Therefore, instead of having 20 districts, the areas that make up the Greater Amman Municipality now have 27 districts (Manasreh, 2014), And after 2014, the number became 22 districts (Moussa, 2019).

Three factors led to rapid urbanization. First, the government's 2007 decision to include five new districts in the GAM of the Metropolitan City of Amman resulted in the expansion of Amman's territory. The second factor was the forced emigration of Iraqis during the Third Gulf War, with the majority of them settling in Amman. The primary factor driving this issue is the ongoing influx of Syrian refugees into other countries, which began in 2011 and is still running strong today (Tawil & Khattab, 2020). (as shown in Figure 2). Due to this growth, the

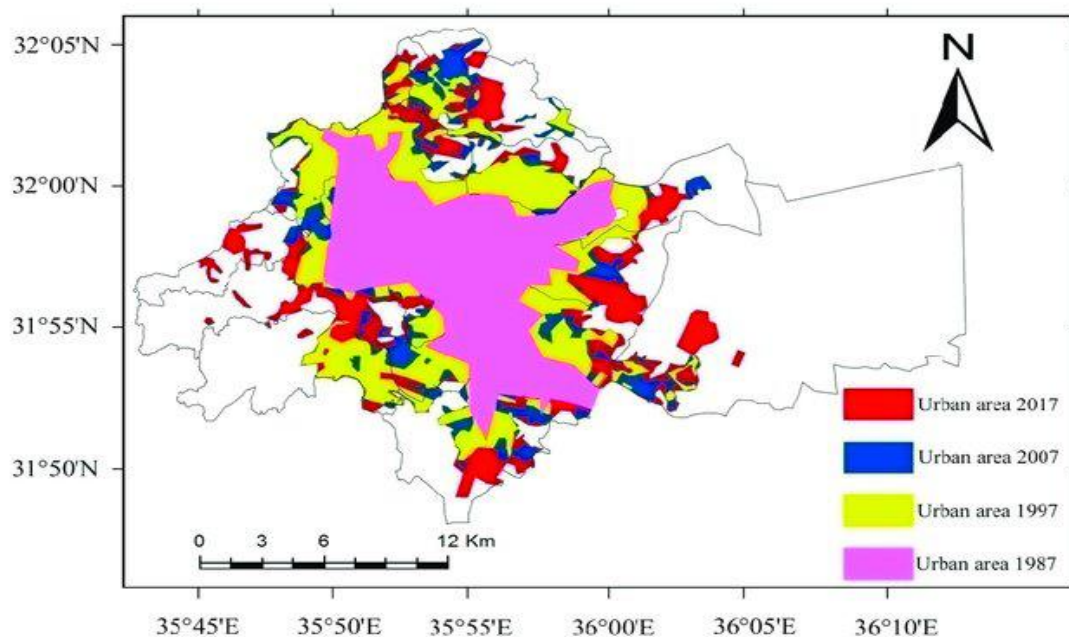


population of urban areas has increased while that of rural areas has decreased. This has also resulted in a marked rise in inflation in urban areas due to current services' inability to keep up with population and housing growth (Ahmad et al., 2013).



**Figure 2.** *Estimated Population of Amman Governorate Urban/ Rural 2004-2021*  
**Source:** Department of statistic, 2022

According to Al-Bilbisi (2019) research in Amman, Jordan, by employing the Concentric and Multiple Nuclei Model, urban growth in Amman happened in two phases between 1987 and 2017. According to the report, Amman grew from 147.08 km<sup>2</sup> to 195.98 km<sup>2</sup> at a 3.33 percent yearly pace between 1987 and 1997. During this time, most of Amman's initial core zone transportation routes were dominated by horizontal urban expansion and spread. The research found that urban expansion was largely vertical between 1997 and 2007 and between 2007 and 2017. With an annual growth rate of 0.97 percent, the city of Amman grew from 195.98 km<sup>2</sup> to 214.94 km<sup>2</sup>. The city of Amman grew from 214.94 km<sup>2</sup> to 237.88 km<sup>2</sup> between 2007 and 2017, with an annual growth rate of 1.07%. As a result of these factors, Al-Bilbisi (2019) determined that Amman's urbanization has been steadily increasing over the last two decades (as shown in figure 3).



**Figure 3.** *Amman population density (1990-2017)*  
**Source:** Al-Bilbisi, 2019

## Urban sprawl environmental impacts in Amman city

Amman is a prime example of urban sprawl; it has experienced rapid growth as a result of rural residents migrating to cities, particularly Amman, in search of employment opportunities and as a result of refugees fleeing war-torn surrounding nations (Moussa, 2019).

Due to the political issues that have plagued Jordan's neighbors for more than 70 years and still exist today, there has been a significant impact on the demand for natural resources, particularly water and agricultural lands, which has led to a fundamental shift in people's lifestyles and living conditions (Moussa & Hammad, 2016). Several studies (Rakad et al, 2016, Shaqour et al, 2009) confirmed this. Many groundwater wells in the Zarqa Basin have reached the critical consumption stage, as this water has become highly saline and suffers from pollutants from the elements of industrial waste and sewage surrounding the city of Amman (Odeh et al., 2022).

Agricultural lands are subjected to pressures and erosion resulting from urban sprawl, the urbanization process, and the high volume of human activities, Hence, the effects on agricultural lands affect the productive agricultural area. Jordan is witnessing an overall urbanization process, as 78% of its population lives in urban areas, and this urban growth leads to the depletion of many natural resources, including fertile agricultural lands. Hence, an urgent need to adopt comprehensive and integrated development plans to restore the balance between urbanization and its surroundings Agricultural land.

Amman city witnessed a tremendous urban expansion, especially at the expense of fertile agricultural lands located in the western, northwestern, and southern parts of the city. Studies indicate that the urban areas expanded 30 times between 1945 and 1994, where the urban area in 1945 was 4.4 km<sup>2</sup>, and it became 144 km<sup>2</sup> in 1994. The size of agricultural areas also decreased from 212 km<sup>2</sup> to 129 km<sup>2</sup>, thus adding 83 km<sup>2</sup> of agricultural land to urban centers during the same period (Al-Ghayalin, 2015).

**Table (1)** shows the annual urban growth rate for the city of Amman for the period between (1987-2017)

Year	Urban Area (km <sup>2</sup> )	Annual Growth(%)
1987	147.08	
1997	195.98	3.33
2007	214.94	0.97
2017	237.86	1.07

**Source:** (Al-Bilbisi, 2019)

In Table (1), a comparison of urban expansion statistics over a period of 30 years shows, where the results of (Al-Bilbisi, 2019) showed a significant increase. Over the past three decades, the urban area category has grown rapidly in Amman, increasing by 90.78 square kilometers from 149.08 square kilometers in 1987 to 237.86 square kilometers in 2017, with an average annual rate of increase of 2.06%. Therefore, in 2017, the urban area was 1.6 times the size of the metropolitan area in 1987. Where the city of Amman went through different stages of urbanization in the period between (1987-1997), and the expansion of the urban area was remarkably high. During this period and as a result of the first Gulf War in 1991. More than 300,000 people returned to Jordan from Kuwait and other Gulf countries, most of them settled in urban areas of Amman, which required the construction of more buildings and homes.

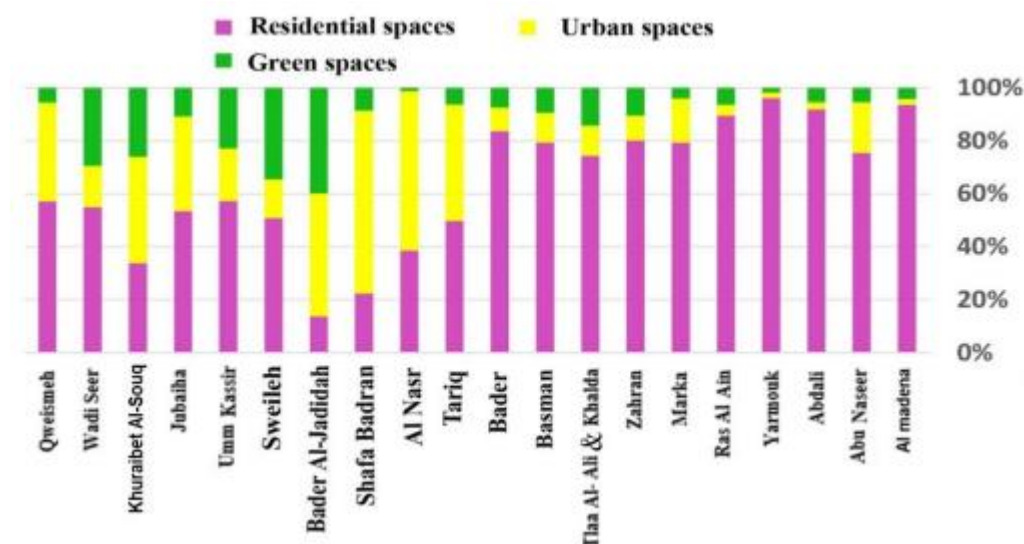
Quantitatively, the urban area category increased from 147.08 km<sup>2</sup> in 1987 to 195.98 km<sup>2</sup> in 1997, representing an increase of more than 6% of the total area.

The percentage of vegetation cover is one of the critical indicators in determining the level of water flow and the pattern of direct surface runoff. The increase in the percentage of toxic areas leads to an impact on the function of the soil as a filter medium, a regulator in the hydrological cycle, and an effective factor for absorbing harmful substances in areas. In urban areas, the infiltration of rainwater is limited to small areas through drainage networks with complex engineering conditions that require constant maintenance. These geometric shapes are ultimately related to land use and land cover (Bochum et al., 2016) within the study area.

The transformations that took place in the city of Amman during the past seventy years are evident, as experts and studies (Al-Farhan and Al-Shawamreh, 2019) point to the decline and absence of the Amman Blue Stream in conjunction with the growth and expansion of the city of Amman. This expansion in the built-up area had a significant impact on the level of groundwater in the center of Amman, specifically at the headwaters of the Amman Zarqa River in the Ras al-Ain region, where the flow of water from the source has been limited as a result of the increase in the urbanization process and the toxic space that prevents the annual recharge of the aquifer, and rainwater turns into surface runoff directly.

This is repeated in the case of the inability of the industrial drainage system to absorb it, so the downtown area pays the price of urban expansion in the city, through the recurring occurrence of floods in it almost annually. At the same time, green vegetation works to reduce the effects and risks of the previous phenomenon, in addition to the role it plays as a determinant and essential factor for the sustainability of the urban ecosystem (Niemel et al., 2011).

Figure (4) depicts the relative distribution of land use and land cover in all regions of the city of Amman, as well as the variation in the proportion of built-up areas.



**Figure (4)** Distribution of land cover areas in Amman districts for 2018.

**Source:** (Moussa, 2019)

According to the study by Moussa (2019), over the past thirty years, most of the lands with various uses have witnessed continuous confinement in favor of the built-up urban area. After it constituted 34% of the city's total area thirty years ago, it has become 55% of the city



area. It was a concrete block around the year 2019, which constituted more than half of the city's location before the expansion of the administrative borders in 2006 (GAM, 2007). Despite this significant increase in the development of the built-up area, the population growth rate witnessed booms, no less acceleration than the rate of urban sprawl, as the second is to meet the needs of the first.

This is reflected in the natural component of the urban environment in the city of Amman, as the high percentage of built-up areas at the expense of the open regions and green lands may constitute a burden on the quality of ecological services, such as air quality and public health, as the areas with high population density are the same as those that lack green spaces, which exacerbates the current challenge and complexity associated with traffic congestion; This limits the ability to move between the different areas of the city and between the center and the outskirts, in addition to the environmental dependencies resulting from overcrowding.

The city of Amman has witnessed significant population growth rates, so the population has multiplied about five times over the past thirty years, and the population in the city of Amman and its region in 1988 reached about seven hundred and fifty thousand people, rising in 2021 to nearly four million people (Department of Statistics The pastoral areas and rain-fed agriculture witnessed a decline of 11% during the past thirty years, which is the same period that witnessed an increase in the urban areas, and this percentage is considered to be in line with the state of continuous demand for residential real estate, and accompanying the population increase (Moussa, 2019).

As for urban irrigated agriculture, only 4% of land qualifies as agricultural land in Amman, which is a very modest percentage despite its great importance, as these lands are a strategic food source for the city. It is clear to mobilize energies to increase the effectiveness of this sector through vertical and horizontal expansion to ensure that the city's needs are met and to try to reduce the dependency on imports for water and food. This falls within the framework of endeavors to achieve sustainability in the city according to the criteria of urban theories such as the theory of cumulative circular development (Kafi, 2017).

Urban sprawl leads to an increase in the traffic of cars and trucks, which leads to a significant increase in air pollution and smog, and vehicles are the number one cause of air pollution in many urban areas, with severe impacts on public health, wildlife, and the ecosystem. According to the Union of Scientists, "Poor air quality increases respiratory diseases such as asthma and bronchitis, increases the risk of life-threatening diseases such as cancer, and overburdens the health care system with high medical costs."

As more time is spent in cars and more traffic congestion occurs in a larger area, this contributes to increasing greenhouse gas emissions and a further deterioration in urban air quality. More than 12 billion pounds of toxic chemicals per year, or roughly 50 pounds per person (Moussa, 2019).

The characteristics of air and its components constitute one of the most critical indicators adopted in measuring the levels of sustainability in an urban environment due to the importance of air in the urban ecosystem and the related climatic and biological processes that are intertwined between them (YCEP, 2018), and in the city of Amman available there are environmental monitoring stations spread throughout the city and number more than seven. They work under the supervision of the Ministry of Environment and provide round-the-clock measurements. According to Moussa's study (2019), which dealt with air quality in the city of Amman, such as nitrogen dioxide gas (NO<sub>2</sub>)

and dust particles suspended in the atmosphere with a size of (PM 10). These elements have been used as indicators of air quality in Amman, and they are as follows:

Nitrogen dioxide (NO<sub>2</sub>) is considered one of the indicators of air quality in urban areas because it is primarily caused by human activity, specifically from traffic emissions and home heating engines, which is the primary source of oxides and is one of the most important air pollutants, where it causes significant harm to human health due to toxicity and ozone formation (WHO, 2003). According to the study by Moussa (2019), there is a discrepancy in the distribution pattern and the amount of NO<sub>2</sub> gas concentration in Amman, where the highest values are concentrated in the downtown area, which is linked to dense traffic in the downtown area. Natural factors have a role in gas concentration in that area where the topography is lower than its surroundings. The direction of inactive winds effectively influences this spread pattern.

Traffic-related air pollutants such as airborne particles (PM<sub>10</sub> and PM<sub>2.5</sub>) vary according to topography and seasonal weather conditions. PMs concentration is also related to the natural characteristics of the city of Amman that are attributed to unplanned urban expansion (EPAV, 2016). PMs vary in size between (1, 2.5, or 10) and are detrimental to human health, as it enters into deeper areas in the lungs (YANG, 2010; WHO, 2005). According to Mousa (2019), the annual concentration of PM 10 in Amman was more than three times the international standard. The World Health Organization pointed out that the eastern part of Amman exceeds 80 micrograms/m<sup>3</sup> of air, which has a negative impact on human health, crops, and buildings.

The results of Moussa's study (2019) also indicated the noise level in Amman ranges between (45-90 dB), as it reaches the internal residential areas. Far from the arterial and main streets, about (55 dB) +/-10, while the intensity of levels doubles. The noise as we approach the main roads that cross the city and link with the neighboring cities to reach about (80 dB) +/-10, where this percentage is considered relatively high, and the World Health Organization believes sound intensity that reaches 45 (dB) is considered safe to the extent that it is not permissible (85 dB). Although there is the legislation regulating the issue of noise in the city of Amman, it still needs more follow-up and commitment.

According to Moussa (2019), the construction and urbanization sector are responsible for the use of a large amount of energy in the urban environment, and this sector also contributes significantly to the impact on the climate due to its role in consuming large amounts of electrical energy, which is often generated from burning fossil fuels (2014, Magnus),

In the city of Amman, the percentage of energy consumption in the domestic sector according to the year 2015 was about 51.3% of the total consumption from other sectors, such as the commercial, hotel, and other sectors (Department of Statistics, 2015). Urban energy use has become a topic of interest around the world in the last few decades, and Jordan is moving in the same direction with the slow speed of movement in this transformation, towards raising energy efficiency and achieving sustainability. The mechanisms and procedures that are used in relation to the thermal insulation of homes have not been taken into account in the practical application so far (Al-Hinti, 2016).

## **Great Plans for Amman**

### ***City Planning and Urban Growth Management of Amman***

Amman has been the target of many urban planning efforts. The first comprehensive development plan for the city of Amman was created by UN field planners and consultants

King and Lock-in in 1955 (Amman Municipality archives, 2019). This plan attempted to meet housing and employment goals in response to the large influx of refugees following the 1948 Palestinian–Israeli war. The idea aimed to protect and enhance nature through the creation of self-contained mountain neighborhoods. It adopted the concept of "green fingers," which created public open spaces by extending from the stream corridors into the city's heart. The proposal was for a "central park" in the city center, with a municipal building, a library, a theatre, and an art gallery (Abu-Dayyeh, 2004). Clearly, this concept was influenced by Ebenezer Howard's Garden City ideas and the 1640s British urban planning advances (Abu-Dayyeh, 2004). According to later plans by the municipality, this notion was not adopted or developed further in terms of land use management or spatial planning processes. The ecological city core and green fingers did not see the light. Piecemeal extensions supplanted the ambitious concept of 1955 in response to building boom cycles.

The Jordan Development Board (JDB) established the Planning Department in the 1960s when it affirmed the need to strengthen the agriculture and tourism sectors and encourage development in both sectors through a seven-year Jordan Economic Development Program (1964 to 1970). Due to deteriorating economic conditions in Jordan during the Israeli occupation of the West Bank in 1967, the Civil Center Development Plan (CCDP) was created in 1968, focusing primarily on tourism and the regulation of administrative activities, trade, recreation, and service land uses (Abu Dayyeh, 2004).

The 1960s policy of establishing a central commercial district downtown was not realized in the current land use. Changes in land use result in increased traffic congestion. As a result, the area's initial traffic difficulties were not resolved. Floods have been an issue far into the modern era. While the 1960s program was designed to alleviate traffic congestion and winter flooding to create a wealthier downtown, the effects have turned out otherwise. The land-use change influenced the social and perceptual components of the city's character.

In 1980, the Amman Municipality established an Urban Development Department (UDD) to direct growth through development centers and corridors and to limit urban sprawl.

Amman saw significant growth in management improvements after that. The Ministry of Planning and Development, for example, was founded to manage development at the national level. Moreover, one of the significant changes in urban management in the third world was the introduction of the Urban Management Program in Jordan, which was started in 1986 in collaboration with the World Bank, Jordan, the UNDP, and the UN Center for Human Settlements. This program offers technical instruments to enhance urban development and planning to maximize economic development (Amman Municipality, 1987). Such economic growth is required in municipal finance and governance, urban infrastructure management, urban land management, urban environmental management, and urban poverty reduction (Qtishaat & Abu Sabha, 2014).

The 1988 Master Plan for Greater Amman, created by GAM, was another planning intervention designed to regulate land use and shape the city's growth to accommodate a population of two million by 2005. Unfortunately, the authorities never accepted this idea, and as a result, it was never implemented. The lack of a planning framework in the 1988 master plan resulted in zoning rather than urban development planning. No feasibility studies were conducted for any of the new areas, and subdivisions were created without considering the effects. Whether social, economic, or environmental, that caused slums to continue to expand, the quality of services to deteriorate in some areas of the city, traffic jams, skyrocketing land and housing prices and the loss of agricultural land (Meaton & Alnsour, 2012).

The Amman Development Corridor project reduced the urban envelope between 2003 and 2014. However, land purchase expenses were relatively high.

The city of Amman initiated its sustainable urban development and resource efficiency project in 2018 to create a systematic strategy to adopt standardized and particular instruments and processes for measuring and creating reports for urban city development. This was run by the United Nations Development Program and implemented by the Greater Amman Municipality, which focuses on the importance of providing infrastructure and transport services through sustainable and innovative solutions that take into account energy savings and work on a renewable energy strategy with partners from the public and private sectors and representatives of the local community so that Amman will be a proactive city in preserving the environment.

The Green City Action Plan was launched in February 2019 and supported by EBRD. The World Bank launched the Amman Climate Plan in June 2019. The plan includes a green belt to limit urban expansion in east Amman (Ohoud) before Al Ghabawi solid-waste treatment plant (Amman Green City Action Plan, 2021).

Between 2006 and 2008, the Amman 2025 Master Plan was drawn up, and it aimed to be a multi-purpose tool and an ever-evolving document, not merely directing the city's urban development. However, the plan did not achieve its goals for several reasons, such as the failure of planners to control some major development projects in the city; implementation has always been an obstacle to the strategic planning of the city of Amman (Abdeljawad & Nagy, 2021; Cavoli, 2022).

Jordan is currently developing a national green growth strategy and a new national urban policy that will address environmental issues such as water scarcity, limited energy access, and waste management. Simultaneously, GAM is developing an action plan that includes updated resilience and climate action plans. Strategic planning and implementation will become more closely linked over time.

Although there are no guidelines for urban planning and institutional challenges in terms of financial, human, and technological resources, there are many positive changes, as Amman city planners are becoming more aware of sustainable urban development issues (Riad et al., 2020).

The main challenge for the sustainable development of the city of Amman is to work on changing the behaviors of citizens to reduce their negative impact on the environment. Everyone who can buy a car uses it as their primary means of transportation. Electricity is 90% fossil fuel, and water is not recycled or reused. Recent efforts to reduce the sales tax on hybrid vehicles have proven to be a strong and effective incentive.

The Greater Amman Master Plan 2025 was innovative in several ways. The first was its focus on public participation and strong stakeholder involvement through the mayor's roundtable sessions and citizen awareness campaigns. Such public consultation went into preparing the master plan itself, signifying a move away from authoritarian technical planning. The second was how the BRT system was implemented in 2007–2008, during the preparation of the master plan, to push the project as the cornerstone of all transportation plans. However, when the master plan was presented in 2008, the master transportation plan was not yet ready. It was only approved in 2010 and is currently being updated. It includes transport-oriented



development and development corridors to attract investors and promote a Bus Rapid Transit System (Ababsa & Abu Hussein, 2020; Abdeljawad & Nagy, 2021).

The Amman Municipality also launched its strategic plan 2022-2026, which included 212 projects and initiatives to achieve 15 strategic goals and 30 strategic goals with a total value of 918 million dinars over the next five years, and is in line with national objectives, sustainable development goals, and the vision of economic modernization.

The main objective of the strategic plan is to commit to quality projects to have a direct impact on services provided to citizens by developing legislation, promoting investment, raising the quality of citizen's lives, the environment, transportation, traffic solutions, and infrastructure, and addressing challenges such as climate change and population increase, in addition to other budgets allocated to sustaining traditional municipal work, operating expenses, and others. The strategic plan aims to develop public facilities and services, especially public transport, infrastructure, urban design, a clean and sustainable environment, and the rule of law, within four main axes; These are quality of life and environment, transportation, traffic solutions, infrastructure, investment, and legislation.

## Discussion

Urban expansion has been widely employed in the investigation of urbanization driving factors and mechanisms as a significant indicator of the urbanization process and a direct expression of urban land use (Ma & Xu, 2010). Previous research has found that urban expansion is influenced by a variety of elements, including ecological, socio-economic, and political factors (Shu et al., 2014). Furthermore, the forces that drive urban expansion frequently shift both spatially and temporally.

Much of the secondary research on Amman's geography concerns urban development and the effects of refugee influxes. Much study has been done on land use and land cover analysis utilizing LANDSAT data from the 1970s and 2000s. For example, Al Rawashdeh and Saleh studied urbanization's effect on the Amman environment. Their study revealed that between 1918 and 2002, Amman's metropolitan area grew by 162 km<sup>2</sup> and expanded to more than 509 times its initial size. This shift resulted in a 23% decrease in fertile land. They concluded that refugee influxes were responsible for much of the expansion and suggested that unplanned and unregulated urbanization destroys green spaces and water resources (Al Rawashdeh & Saleh, 2006).

Furthermore, the city's economic position has a role in increasing population density. According to Tewfik (2014), Amman accounts for 80% of Jordan's economic and industrial operations. The urban expansion of Amman lands was primarily at the expense of agricultural lands, with only minor alterations to undeveloped territories. By 2015, over half of the agricultural land area that existed in 2003 had been lost (Al-Kofahi et al., 2018). This amounted to a loss of 104 km<sup>2</sup> of agricultural land between 2003 and 2015, or around 8.7 km<sup>2</sup> per year. Amman's agricultural land area, which was 27 % of the total city land in 2003, was reduced to 14% in 2015 (Al-Kofahi et al., 2018) (a recession rate of 1.1% annually). Considering that the agricultural land recession rates do not increase, the remaining 14% of agricultural lands in Amman are predicted to reach zero in 13 years or less. This might deteriorate and deplete the city's limited agricultural areas, water resources, and biodiversity.

A study conducted by Khawaldah (2016) used a Markov model to anticipate future LULC in the area in 2030, concentrating on the expansion of Amman's built-up area. The findings suggest that the estimated increase in built-up area corresponds to Amman's population growth rate if the current fertility rate of 3.2 children per woman continues, which is considered a high fertility rate scenario. However, the findings show that if the fertility rate falls to 2.1 children per woman of reproductive age in 2030, Amman's population will not differ significantly. Furthermore, the influx of migrants from neighboring countries and other Jordanian cities and villages is predicted to push Amman's population to more than 4 million by 2030 (Khawaldah, 2016). As predicted in this analysis, a rise in the population will result in an increase in the built-up area. Hence, Amman's urban planners should take this into account as they prepare for the planned new urban areas.

Farhan and Al-Shawamreh (2019) narrow their study of land use and land cover to open space and ultimately create a stronger argument than their academic predecessors by tying open space to the cementing of social divisions (Farhan & Al-Shawamreh, 2019). When combined with other Jordanian neoliberal policies, these two components have reduced open, rural, and green spaces throughout the city and increased social stratification, particularly between the East and West (Hanania, 2019). Taken with other neo-liberal policies of Jordan, these two components have reduced open, rural, and green spaces across the city and increased social stratification especially between the East and West (Hanania, 2019). This study follows suit by tying social realities to the territorial elements of the city and including a direct examination of urban planning maps.

Some authors specifically study the importance of urban planning. Hanania argues that the traditional narrative of Amman's founding and rise excludes the impact of Ottoman planning and bureaucracy (Hanania, 2019). In reality, Ottoman directives greatly affected the city, since their favor of Circassians essentially created an upper class. She demonstrates how urban plans impact over time and cement socio-economic disparities in the city's landscape. Khirfan and Momani focused on the city's rebranding programs in 2002 and 2009 (Khirfan & Momani, 2013). Ultimately, they found that the 2002 outward-focused program had much less effect than the 2009 inward-focused program. What is essential in this case in particular is that city officials can give symbolic meaning to places.

A few authors combine this discussion of land use, city planning, and socioeconomic effects. Ababsa reflects on the growing divide between Amman's eastern and western halves, finding data as far back as the 1950 British zoning regulations (Ababsa, 2010). For example, city planning has favored western neighborhoods, like the Shmeisani business district and the Abdali shopping district. In the 1980s and 1990s, Amman became famous for developing its poor urban areas according to the developed mentalist norms that international organizations held. Jordan began focusing more on the supply of services to these areas in the 1990s while focusing long-term development strategies on middle- to upper-class neighborhoods. Resource allocation is essential in identifying the disparity between an urban planner's vision and on-the-ground reality. For example, El-Samen and Hiyasat find that shopping malls are clustered in West Amman, an area with too small of a population to provide enough demand (ELSamen and Hiyasat, 2017).

Like Farhan and Al-Shawamreh (2019), Albattah (2015) has used Landsat to study urban growth and target land use and land cover changes since 1972. He brings up two aspects: fragmentation of the landscape and differences between the center and the periphery Albattah (2015). The most interesting argument is that "spontaneous growth results in a homogeneous

and sparse spatial pattern, which contains more random components, whereas self-organizational growth results in spatial agglomeration pattern, which is combined with more socioeconomic activities.” Spontaneous growth is correlated with lower socio-economic activities and thus would be something for urban planners to avoid. He also finds that urban expansion follows the city's main roads (Albattah, 2015).

Albattah (2015) finds that “the urban expansion in Amman (the study region) is governed by the transport network. The main arteries along which the sprawl is taking place include the downtown, Sweileh, Naour, and the national highways connecting the major cities of the Kingdom.” This example shows how one component of an urban plan can affect others, even if the effects are seen decades later.

Abu-Dayyeh (2004) has conducted a series of studies on urban planning and Amman. He is the only author who lays out the process of each urban planning commission from the 1950s to 2004. He begins with the Development Plan for Amman (1955) and explains how the values and grand concepts established in this plan became a part of ensuing plans. After this came two 1968 plans, both sponsored by the United States. The 1960s saw a change in regional powers, as the British stepped back and the US stepped forward. The international influence continued with the IECA proposals of 1978, which the Japanese government conducted under an invitation from the Jordanian government. Then came the Greater Amman Comprehensive Development Plan (1988). These plans show both the persisting influence of international actors and the persisting vision of the 1955 plan. Although there are differences in scope and aim of the urban projects, all contain a discussion of “ring roads, open green areas in the heart of the city, street bridges, commandingly situated public edifices, [and] public plazas.” The feasibility of all these plans is questionable. However, Abu Dayyeh is of the view that the early ideas contained in the 1955 plan were implemented in later projects.

When taking a cumulative view of scholarly literature surrounding Amman and geography, there is some research on individual neighborhoods but nothing on communities. Overall, there is a lack of research connecting past urban plans to the physical structure of the city revealed through satellite imagery. Using the research of Hanania, Ababsa, Al-Battah, Makhamera, and Abu-Dayyeh as a springboard, this study investigates the relationships between Amman, urban planning, and the environment.

Other information gaps we uncovered are a lack of comparative studies between cities in and around Jordan; a lack of understanding of geographical differences in sprawl, and a lack of cost-benefit analysis to determine the actual impact of sprawl.

In addition, very little literature has used advanced tools for quantitative analysis of urban sprawl, making it difficult for policymakers and planners to find solutions for land use. We agree that the problem of urbanization and urban sprawl is multifaceted, and the list of research gaps is far from comprehensive. Thus, a comprehensive and integrated approach is needed to investigate urban sprawl and further research to understand better the challenges and opportunities associated with urban sprawl and to develop sustainable urban development policies.

The environmental impact of Amman's urban sprawl remains general in academic research, but other cities worldwide have gone into detail. For example, water supply and demand, air pollution, and their relationship to urban sprawl have been studied in certain countries' industrialized cities. For instance, Tu et al. (2007) examined the effects of urban

sprawl on water quality in Massachusetts and found that the results are caused by land use and population changes.

Other studies related to the environment and health are highly beneficial for achieving sustainable development in cities. The transportation sector has also received less attention. Few studies have focused on the relationship between road network improvements and urban sprawl. Studies conducted in the United States and Canada, for instance, have looked at the effects of increased vehicular use caused by urban sprawl on environmental pollution, emissions of greenhouse gases, physical activity, and health challenges. Such studies, which include the consequence of sprawl on non-motorized modes of transportation, are critical in Amman.

Based on the research papers we evaluated, in many cases, the developmental stage in peri-urban areas doesn't adhere to proper planning schemes, resulting in development that provides little or no attention to open spaces and makes no availability for walking or cycling areas that are important for our physical health activity.

From the literature, the techniques employed in the studies are varied. Few studies include advanced technologies in their data analysis, such as Remote Sensing and GIS, which can provide a deeper picture of urban sprawl when combined with other methods.

## **Conclusion**

The review revealed that there is a significant amount of literature on urban sprawl in Amman. The fiscal condition of local governments was adversely affected by urban sprawl into the periphery. The repercussions and consequences of urban sprawl in Amman have received little attention. Although the literature is not broadly diverse and sometimes not updated, urban sprawl has been studied through various lenses. Urban sprawl has impacted land use, water, the environment, and health. However, there is still plenty to explore. We identified different research gaps, most of which are relevant to the SDGs, and addressing them will help achieve the SDGs. First and foremost, we discovered some awareness of Jordan's urban sprawl. However, compared to Jordan, most studies on urban sprawl in Amman are still more generic, focusing on causes and effects at a broad level, while little is known about the correlation among particular components of global or national importance. While the industrialized world is concerned with the relationship between urban expansion and environmental impact, diabetes, or hypertension, Jordan is still researching the interaction with the environment.

If the current rate of urbanization in Amman continues, the fertile plains will be gone by the middle of the next century. The impact of less fertile lands on biological variety is unknown, but it translates to less available energy for the species that make up Earth's complex food web. The loss of highly fertile regions for farming also puts pressure on other resources to meet the growing population's food and fiber needs. New difficulties have plagued the city of Amman as a result of its rapid population growth. Traffic bottlenecks, air pollution, and acute water shortages plague the city. Due to the acute water shortages, the government was compelled to implement a rationing program, in which household supplies are pumped twice a week throughout the summer months. It is not necessarily a negative thing to live in a city. It's a fantastic opportunity for societies to connect and share resources. However, it would be preferable if it were coordinated with other environmental conditions.



Greater Amman needs to increase its green open spaces by modifying existing regulations through zoning and creating more public open spaces. Greater Amman must also properly enforce current rules and zoning policies to implement its 2025 master plan and stop urban sprawl.

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