



RESEARCH ARTICLE

The Impact of Urban Growth in The City of Jijel on The Urban Water Management Process (Rainwater and Wastewater)

BOUANANI Abdelmadjid^{1*}, GHACHI Azzedine²¹L'arbi Ben M'hidi University, Urban Technology Management Institute, Natural Resources and Development of Sensitive Environments Laboratory (RNAMS), Oum El Boughi, Algeria² Urban Technology Management Institute, Salah Boubnider University Constantine 3, Algeria**ARTICLE INFO**

Received: Jun 2, 2024

Accepted: Aug 13, 2024

Keywords

Jijel

Urban growth

Urban water

Sewage system

***Corresponding Author:**bouanani.abdelmadjid@univ-
oeb.dz**ABSTRACT**

Jijel is a coastal city located in the northeast of Algeria with a Mediterranean climate characterized by a large amount of precipitation. The city is characterized by a steep topographic surface in the south and flat along the coastal strip in the north, as well as a significant hydrographic network, the most important of which is the Kantara valley. The city of Jijel witnessed rapid urban growth, especially after independence and its elevation to the status of the state headquarters and the accompanying development programmes that led to the growth of the city both spatially and demographically. This rapid urban growth has had a major impact on the management of rainwater and wastewater in the city, where many negative repercussions have emerged in this process, most importantly the pollution of waterways and the exposure of some areas of the city to the risk of flooding, as well as the complexity of the sewage system, which consists of 7 collection basins, where each basin is equipped with a water lift station, which increases the cost of the management process

INTRODUCTION

After the industrial revolution and the accompanying improvement in economic, social and health conditions, cities around the world witnessed rapid urban growth. Many studies indicate that The population of urban and semi-urban areas is expected to reach 67% in 2040. (Bakshi- Arpita , Md. Esraz-Ul-Zannat, 2023). This urban growth led to a significant increase in the number and size of cities and urban areas at the expense of the natural environment and the depletion of its various resources in order to meet the needs of the rapid population growth, which was the result of natural increase and rural migration due to the attractiveness of these cities as factors that attract people to work, housing, education, health, and transportation. This rapid urban growth has created many issues related to the management of the urban space and various infrastructure networks, as a result of which cities live under the threat of many natural and man-made hazards, especially pollution and flooding, mainly related to sanitation and sewage systems.

The city of Jijel, like other cities in the world, has experienced rapid urban growth, especially after independence and after its promotion to wilaya in 1974 and the accompanying housing and development programmes. The area of the city has multiplied more than 24 times since independence to the present day. This rapid urban growth has led to the expansion of the city through regular expansion through various spatial planning programmes and schemes and irregular expansion through informal construction.

Problematic

Urban growth refers to the increase in the population of cities and urban agglomerations through natural increase and migration and the accompanying increase in the area and number of urban agglomerations, which leads to significant impacts on various urban management processes, especially the management of rainwater and wastewater. This prompted us to pose the following question: What are the different impacts of urban growth in Jijel on the management of rainwater and wastewater, and what are the ways to minimized these impacts?

METHODOLOGY

In preparing this research, we relied on the methodology of description and analysis based on GIS, where we collected information related to the research topic through various references and visiting various bodies related to the research topic, especially the National Bureau of Sanitation ONA, and then we edited the information and findings we reached in this research paper.

RESULTS

The most important findings of our research are as follows:

- The urban growth of Jijel has complicated the management of urban water in the city, due to the nature of the steep topographic surface and the number of catchment basins associated with the large number of valleys. The urban growth on this surface has divided the sewage system into seven catchment basins linked by seven re-pumping stations, which increases the cost of collecting and transporting rainwater and wastewater, which increases the cost of collecting and transporting rainwater and wastewater.
- Jijel's urban growth has led to a significant increase in the amount of wastewater collected and filtered, which increases the cost of maintaining the networks and the cost of filtering this collected water.
- Jijel's urban growth has made it very difficult to establish a drainage system that separates wastewater from rainwater.
- Jijel's urban growth has led to an uncontrolled and unregulated urban expansion, especially near Oued El Kantara and Shaaba Ben Achour, making it difficult to establish disinfection networks in these areas, as wastewater is discharged directly into these waterways, which leads to their pollution, as these waterways spread liquid waste and foul odours, which negatively affects Jijel's tourist attraction.
- Jijel's urban growth has led to an increase in built-up areas and an increase in the area of roads and pavements, thus increasing the area of surface water runoff by a large percentage compared to the area of water penetration.
- Parts of the city are under the threat of flooding, especially in places with no steep slopes and below sea level, especially Al-Rabta, Rouibeh Hussein, Soumam Street and the passenger station.
- The need to apply modern and alternative technologies to collect and drain rainwater in a system that is separate from water capacity to minimized the amount of filtered water and thus reduce the cost of filtration, as well as preserve rainwater from pollution.

- Creating large water reservoirs under roads, under open spaces and under the passenger station to collect rainwater in order to store rainwater in times of high rainfall and then gradually discharge it in order to protect areas prone to floods from the risk of floods.
- Valorise the outputs of the water purification process by using the filtered water to irrigate the city's green spaces as well as using the extracted sludge as an organic fertiliser.

DISCUSSION

The theoretical framework

In this element, we will define some of the terms that are the basis for understanding and guiding the research in order to achieve the results we want to achieve.

City

is any urban agglomeration characterized by a certain population size and whose inhabitants are engaged in activities and functions outside the agricultural sector such as service, social, commercial, industrial and cultural functions.

Urbanization

Warren THOMSON defined urbanization as the movement of people from societies based on agricultural activity to larger, more organized societies based on urban activities such as commerce and industry. (ZENATI, 2015, p. 16)

"Urbanization is the rapid increase in the percentage of human population living in urban areas. It is a global phenomenon with varying rates and trends across different geographical regions". (Birhanu&all, 2024, p.1)

Urbanization is the acquisition by rural and village populations of a new lifestyle outside of agriculture and based on various civic activities.

Urban growth (Dr Mohammed Wahiba, p. 147)

It means increasing the population of urban communities through natural increase or migration from rural areas and neighboring cities, as well as increasing the size of these communities spatially through urban expansion to meet the population's needs for multiple land uses, whether residential, service, commercial, industrial, etc. Urban expansion has taken two forms: Random expansion and planned expansion.

Random expansion: it takes two forms, cumulative shape and multi-core shape.

Cumulative expansion

The simplest expansion that cities have ever known by filling spaces within the city or by building on its edges.

Multi-core expansion

It is the opposite of cumulative growth and in its simplest form means the emergence of a new city in close proximity to an old one, with relationships between them.

Planned expansion

The expansion approved by the State through programmes and schemes that regulate and regulate reconstruction processes such as the PDAU and POS.

Sewerage systems

are technologies used to collect, transport and treat wastewater and rainwater for a community or individual before disposal or reuse in the natural environment. (ZEKIOUK, 2008-2009, p. 4)

Study area

Any geographical study must be based on the knowledge of the various elements that make up the field of study, especially the natural and human elements, hence this element will address the natural and climatic characteristics of the city of Jijel as well as its urban growth.

City Location

Jijel is one of the most important coastal tourist cities in Algeria, located in the north-east of the country, bordered to the north by the Mediterranean Sea, to the south by the municipality of Kaous, to the east by the municipality of El Ami Abdelkader, and to the west by the municipality of El Awana. It's 11 kilometres from Jin Jin International Port and 14 kilometres from Farhat Abbas Airport. The city of Jijel extends longitudinally on the national road No. 43 linking Skikda and Bejaia. The city is also located at its eastern entrance at the intersection of National Road No. 77 between Jijel and Batna and National Road No. 43.

Astronomically, Jijel is strategically located between 36.50° and 36.47° north of the equator and between 5.42° and 5.49° east of the Greenwich meridian.

The area of the city is 2360 hectares, which constitutes 38.06% of the municipality's area of 6201 hectares, and the city's population reached 175,255 in 2022 with a growth rate of 2.05%, which is the largest city in terms of population density at the state level.

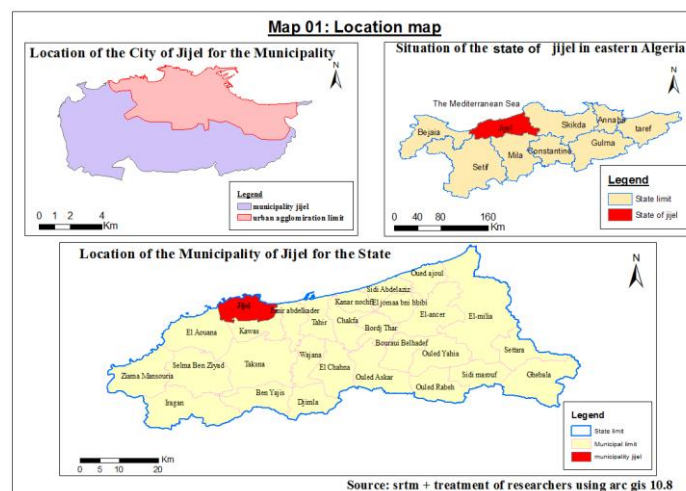


Figure 1: location map

Position

Position is the geographical space occupied by the city within the framework of its location, which is the main determinant in defining the urban structure and urban form and defining the conditions for the construction of various basic structures and infrastructures and determining their components, especially the sanitation system.

The city of Jijel is located along the coastal strip of the Mediterranean Sea and along National Road No. 43. The city is located in its northern part on a flat plain not exceeding 50 metres above sea level with an area of 1261.26 hectares or 53.44% of the city area, while the city is located in its southern and southeastern parts on a plateau between 50 and 150 metres above sea level, and the location of the city is permeated by an important network of watercourses, the most important of which are Valley kantara, Valley Moutas, Valley Jin Jin and Ben Achour.

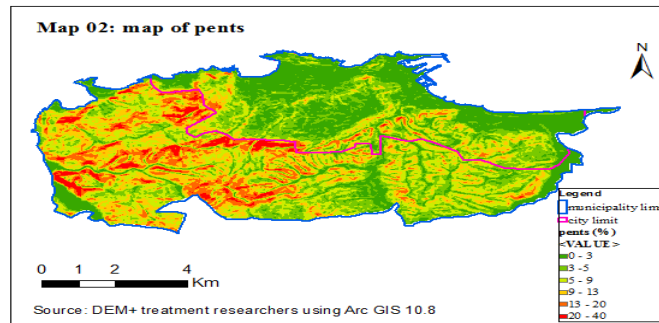


Figure2: map of pents

Precipitation in the city of Jijel:

Precipitation is one of the most important climatic elements affecting various human activities, most importantly agricultural activities, in addition to the role it plays in raising the level of ground and surface water, and the amount of precipitation is considered large in the state of Jijel, exceeding 1000 mm/ year.

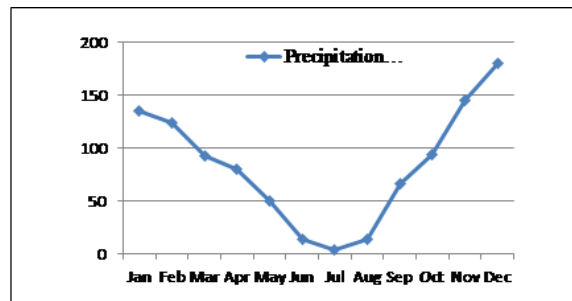


Figure 3: Average Monthly Precipitation 1988-2017

Source: Ashwat Meteorological Station - Farhat Abbas Airport - Jijel

From the above graph, we can see that the city of Jijel has a large amount of precipitation of more than 1000 mm per year, with the average amount of precipitation in December reaching more than 11 million m³.

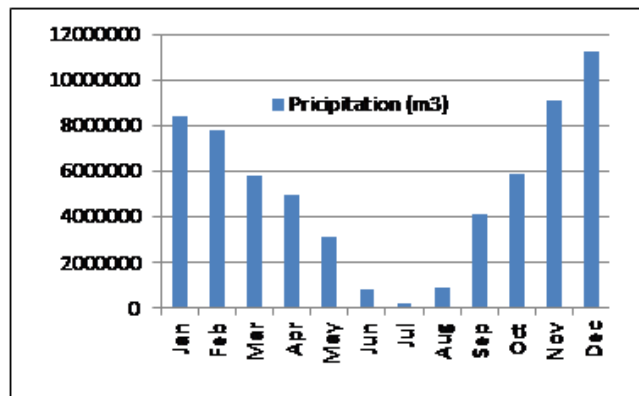


Figure 4: Graphical representation of the average amount of precipitation 1988-2017

Source: Ashwat Meteorological Station - Farhat Abbas Airport - Jijel.

City Hydrographic Network:

The city of Jijel is characterised by a dense hydrographic network due to its location and position, as it is located in a climatic range dominated by the Mediterranean climate, which is characterised by

large precipitation rates exceeding 1200 mm per year, and the most important watercourses in Jijel are: valley El Kantara, Valley Moutas, Valley Jin Jin and Ben Achour.

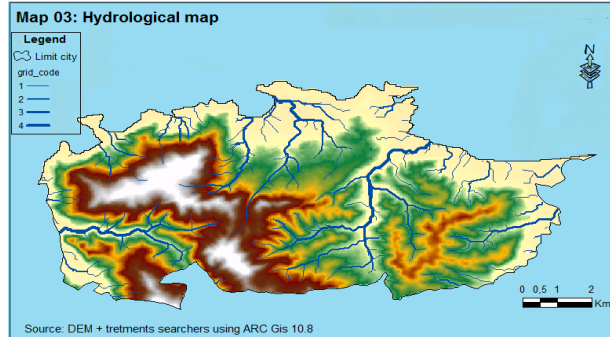


Figure5: Hydrological map

Urban growth of Jijel

The city of Jijel witnessed rapid urban growth like other Algerian cities after independence as a result of the vacuum left by the French colonialists in the city and the rural migration from the countryside and neighbouring villages as well as the improvement of social, economic and health conditions, especially after the promotion of the city to the capital of the state in 1974 and the housing, industrial and service programmes it witnessed as well as benefiting from the housing and real estate policies adopted by the state since independence to this day, especially the residential quotas and new urban residential areas. Today, thanks to the city's location and its tourist attractions, it continues to witness rapid urban growth, especially during the summer season.

Urban expansion

The city of Jijel has expanded rapidly, as the area of the city has multiplied about 24 times since independence to the present day. The city of Jijel witnessed a proliferation of informal housing on the outskirts of the city between 1962 and 1974 due to rural migration, while during the period from 1974 to 1990 the city experienced rapid expansion through three groups of new urban residential areas and a large group of informal housing and housing estates according to the urban policies pursued by the state during this period. During the period from 1990 to 2022, the city expanded within the framework of the guiding plans for urbanisation and reconstruction in the south, southwest and east sides of the city. This period also witnessed a large spread of informal settlements, especially in the Rabia area, which is in the form of a pit located below sea level and on the banks of the Kantara valley, especially after 2008. (GASOUM, 2012, pp. 157-167)

Population growth

In terms of population growth, the city of Jijel has witnessed significant population growth throughout the statistical periods conducted by the state, where the population growth rate of Jijel has been greater than the national population growth rate.

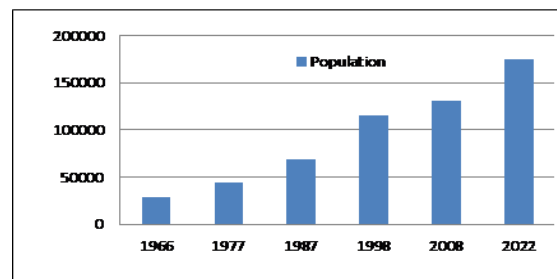


Figure 6: Graphical representation the Evolution of population in the city of jijel

Source : Jijel Municipality + processing researchers

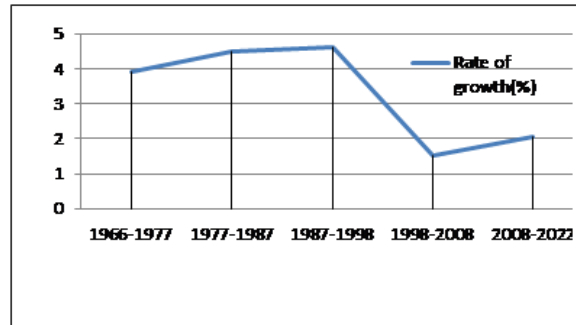


Figure 7: Graphical representation of growth rate of population in the city of Jijel

Source : Jijel Municipality + processing researchers

The effects of urban growth in the city of Jijel on its urban water management (rainwater and wastewater):

The urban growth of the city of Jijel has greatly affected the urban water management process, especially with regard to the sewage system, its components, its size and the volume of water collected in it, making it difficult to manage, in addition to causing some areas of the city to fall under the threat of flooding and pollution of beaches and waterways.

Jijel city sewage system:

The sewage system in the city of Jijel is a unified system, combining rainwater and wastewater, characterised by a network of multi-diameter canals of 300ø, 400ø, 500ø, 600ø, 700ø, 800ø, 1000ø and 1200ø.

The urban expansion of the city of Jijel, whose location is characterised by a topographic surface with multiple directions of slopes, has led to the division of the sanitation system in the city of Jijel into 7 wastewater collection basins based on the slope and gravity of the land, where these basins contain 7 lifting stations. The water from each catchment basin is pumped towards the filtering station.

Jijel's sanitation system also includes a capacity plant at the level of the Rabia neighbourhood, which filters the capacity water and then pours it into the sea without reuse. The aim of this plant is to protect the coastal strip from pollution.

Table 01: Detailed table of the sewage system of Jijel city

Lift Station	Location	Number of Pumps	Pumping capacity (l/s)
1	El-Rabta	3	520
2	Boudis	2	760
3	El-Chat	3	521
4	Ouleb bounar	2	70
5	Ras El-Afia	2	36
6	Mencha	3	139
7	El-Arayach	3	170

Source: ONA - Jijel, 2019

Increasing the amount of wastewater in the city of Jijel:

The amount of wastewater is directly related to urban growth, both population growth and urban expansion, as the larger the population, the larger the area of the city and the greater the demand for potable water (80% of water use is diverted to sewage), thus increasing the length of the sewage network and increasing the amount of water discharged into it. The city of Jijel is witnessing a significant increase in the level of wastewater, where 4.11 million m³ were collected in 2010 and the volume of water collected increased to 12.11 million m³ in 2022, i.e. the volume of water collected

tripled in 12 years. This increase in the amount of collected water has led to a deficit in the operation of the treatment plant, as 6.96 million m³ of the 12.11 million m³ of collected water was filtered in 2022, meaning that the treatment plant was unable to filter almost half of the collected water.

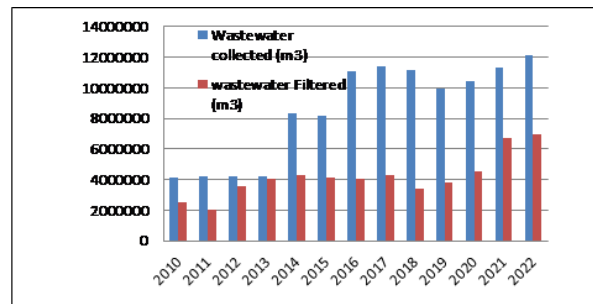


Figure 8: Graphical representation to the Evolution of wastewater collected and filtered

source: ONA - Jijel, 2023

Valleys Contamination

During our field trips to the study area, we discovered that the waterways in the city of Jijel, especially valley El Kantara and Shaaba Ben Achour, are polluted with dirty water due to the lack of sewage network in the neighbouring houses, as dirty water is discharged directly into these waterways, with the final destination being the seashore. The lack of sewage networks in these areas is due to the difficult topographical characteristics of the area.



Figure 9: Two photos showing the pollution of valley Al Kantara

Source: Photo by researchers

The urban growth of the city of Jijel and its role in creating flood-prone areas:

The great urban growth of the city of Jijel has created many areas at risk of flooding as a result of the rapid, unregulated and sometimes ill-considered construction process that included many areas where land occupation plans stipulated the prohibition of all construction operations, especially on the banks of valleys, which led to the narrowing of their paths, especially after they were prepared and covered, and due to the fact that these valleys originate from the high mountains of Jijel, they bring with them dust and gravel. As these valleys originate from the high mountains of Jijel, they bring with them dust and gravel, and with citizens throwing their solid waste into their streams, this led to the blockage of these valleys at times, especially when large amounts of rain fall, which led to floods, especially the flooding of the Kantara Valley on the passenger station in 2021 and February 2023, and the flooding of Somam Street, which occurs periodically whenever the rain falls in large quantities.

In addition to the above, the urbanisation of the 'Association' area located in the northwestern part of the city after 2008, which is an unbuildable area due to its topographical shape as it comes at a level below sea level, which leads to floods in this area due to the stagnation of water in it.

The urban growth of the city of Jijel has led to the creation of seven catchment basins for potable and rainwater, which are connected to the filtering station in the Rabia area through seven lifting stations, and when the rain falls in large quantities, these stations are unable to pump large quantities of water, especially the lifting station in Boudis, which leads to flooding in this area.

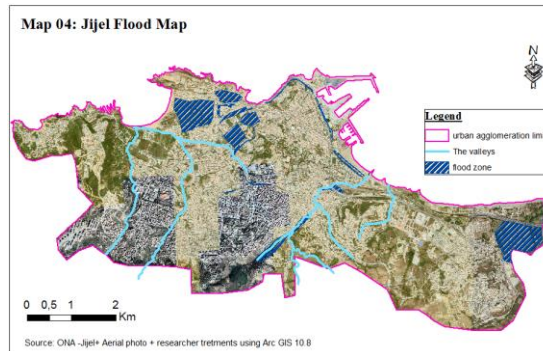


Figure10: Flood map

CONCLUSION

Through this research, we found that the urban growth of Jijel has had negative repercussions on the management of rainwater and wastewater, including the pollution of waterways and beaches with dirty water and the creation of many areas at risk of flooding due to construction on the banks of valleys and the expansion of built-up areas, which increases the amount and speed of water runoff as well as complicates the collection of wastewater and increases the cost of filtering it. All these repercussions threaten the urban life of Jijel and make the region suffer from a lack of attractiveness. Therefore, urgent solutions must be developed, the most important of which is the application of alternative techniques in the field of rainwater management through the construction of roads with reservoirs in the Rabta, the construction of earthen dams in the Kantara Valley if possible, as well as the construction of new channels to drain rainwater directly to the sea, in addition to preventing the discharge of potential water into the valleys by citizens.

BIBLIOGRAPHICAL REFERENCES

- Dr Mohammed Wahiba, A. F. *In the Geography of Cities*. Beirut, Lebanon: Dar al-Nahda al-Arabiya.
- ZENATI, J. (2015). *Urban growth and its impacts on the urban environment*. Amman : Al-Manhajia Publishing and Distribution.
- Bakshi- Arpita , Md. Esraz-Ul-Zannat. (2023). Application of urban growth boundary delineation based on a neural network approach and landscape metrics for Khulna City, Bangladesh. *Heliyon* (9), 1-23.
- Birhanu Tadesa Edosa, Mosissa Geleta Erena, Bayisa Nagasa Wolteji, Guta Tolossa Werati, Milkessa Dangia Nagasa. (2024). Urban growth assessment using machine learning algorithms, GIS techniques, and its impact on biodiversity: The case of Sululta sub-city, Central Oromia, Ethiopia. *City and Environment Interactions* , 23 (100151), 1-11.
- GASOUM, W. (2012). *Urban sprawl and the problem of presenting coastal tourist areas - the case of the city of jijel*. magister thesis. L'Arbi Ben M'Hidi University , Oum El Boughie.Algeria.
- ZEKIOUK, T. (2008-2009). *Construction of a tool for Assessing the Sustainability of an Urban drainage system - application to the city of jijel*. magister thesis. Abderrahmane Mira University, Bejaia, Algeria.