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End of Master studies' project

In order to obtaining the master's two degrees in cities and spatial dynamics and management

Option: master's degree in cities and spatial dynamics and management

Theme:

Elaboration d'un algorithme pour système multi-agents pour prévoir les futures extensions dans la ville de Djelfa

Development of an algorithm for an agent-based modeling system to predict future extensions in Djelfa city

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Memoire Revue et Corrigée
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تم مراجعة المذكرة والتحقق منها
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1. General Introduction

Rapid growth of cities presents many challenges, especially with respect to land use planning, housing and transportation. For example, how will land-use change, where will people live, and how will the existing transport infrastructure cope with such increases? Urban systems are constantly changing due to natural processes such as the growth or decline of populations and economies with social and political considerations. Examining how they are affected by such change is a non-trivial task. These responses can be manifested in land-use change, the gentrification of neighborhoods, topographic factors, or residential segregation and equipment's location. Such processes are some of the core questions in understanding urban systems, especially how an individual's decisions impact other individuals (agents). It is evident that cities are in constant flux: the processes seen within them are dynamic, and all of them take place at different spatial and temporal and decisional scales. Only through modeling can one gain insight into these processes and their interdependencies.

the state is still the most important player involved in urban development, the socialist choice adopted since independence had charged the state with the fate of urban development and its development. thus, he had adopted several plans in order to satisfy the demand for housing and equipment, unfortunately the latter was not subject to national plans allowing better control of the urban area. overtaken by the delay of a bad national vision, the state had adopted national schemes in order to have a capable national strategy to better organize and develop the territory for a more controlled economic and urban development.

In Algeria we use a set of spatial and urban planning instruments, they were made by the urban planning policy for a better organization of space. These are the instruments of regional planning (National, Regional, and Prefecture), and urban planning instruments that concern a city or an agglomeration these instruments are:

- **The national land use plan NLUP (SNAT):** initiated according to Articles 07 and 08 of Law No. 01-20 of 12/12/2001, relating to the sustainable planning and development of the territory. The national land-use plan (SNAT) is nationwide. It is initiated by the central state. It regulates the distribution of activities and population across the national territory, aiming for an equitable distribution of wealth, in particular for the southern regions and border regions.

- **The regional land-use planning plan RLUP (SRAT):** Defined by Article 03 of Law 01-20 of 12/12/2001, initiated by the state and approved by law for 20 years and updated every five years. They distribute activities and population across the region, locate infrastructure and equipment and regulate the regional urban framework
- **The Wilaya Development Plan PDP (PAW):** It is the main tool which sheds light on the decision-making power with regard to the main orientations inherent in the micro-territorial space.
- **The master plan for development and town planning MPDTP (PDAU):** The PDAU is intended to be a legal and compulsory instrument for spatial planning and urban management. This master plan determines town planning forecasts and management rules. It sets the fundamental guidelines for the development of the territory of one or more municipalities.
- **The land use plan LUP (POS):** this document sets the general rules and land-use easements, within the framework of the guidelines of the master plans with which it must be compatible.

The instruments of development and town planning take care of the urban space in terms of organization and orientation of development but they do not allow to follow up the urban development effectively, which causes several problems in the urban planning and urban systems of the city, and with the technological development that we are witnessing, we need other, more effective means.

What are these advanced means that help us study the urban expansion of the city?

2. Methodology

In our study we will use the IMRAD approach (introduction, method, results and discussion), which seems to us to be the best method in order to identify the problem in order to better define it later. therefore, we will first of all take a tour of our case study and provide a background of the various factors and parameters involved in urban development in the city of Djelfa and which seem to us to be the most important. also, in Chapter two we will define the agent-based models and explain the mechanisms and their importance and finally explore the different open-source software that allow their application in an exhaustive way, so we will define the algorithm and give some examples on the latter.

in our last chapter (chapter 3) we will apply our algorithm to show its reliability and power as well as the results it can achieve under the conditions we are going to choose.

3. CHAPTER I

3.1. Introduction

Considering that the prefecture of Djelfa is a prefecture of more than one million inhabitants, and because of here important location we will present in this chapter Djelfa city, which is considered the capital of the prefecture, its location, history, topography, population, and its urban development.

we also going to see the future programs in the city, and give an overview of the economy in Algeria and the urban policy in the country, this is due to the importance of these factors in our study

3.2. Location of Djelfa prefecture

The prefecture of Djelfa is located in the central Algeria, (2.018---- 5.08, 32.848----35.832) Decimal degrees in GCS WGS 1984 and with a distance 300 km south of the capital. It is bounded by five prefectures which are:

- ✔ Medea prefecture in the north
- ✔ Tissemsilt Prefecture in the northwest
- ✔ Laghouat prefecture from the southwest
- ✔ Tiaret prefecture from the western side.
- ✔ Ghardaia prefecture from the south

On the eastern and southeastern side: Msila, Wadi Souf, Ouargla, Biskra

3.3. The location of Djelfa city

Djelfa city is located between longitudes 3.14 and 2.67 east of the Greenwich Line, and between 34.63 and 34.20 north of the equator. The area of Djelfa city is estimated at 54930 km2.

3.3.1. Administrative site

Djelfa city is bordered administratively by the following cities:

- **On the north:** the city of Ain Maabad
- **The South:** the cities of Zakar and Ain al-Ab
- **To the east:** the cities of Dar Al-chuyukh and Al-Medjbara
- **To the West:** the cities of Bin Ya`gub and Al-Zaafaran

Since prefecture of Djelfa is bordered by multiple prefectures, the city contains an important National and regional road which are:

- **National Road No. 1:** the link between Algiers and the south of the country, passing by Djelfa city.
- **The national road No. 46:** linking Djelfa to Bou-Saada, and after Biskra in the southeast, and Setif in the northeast
- **National road No. 40** in the north of the prefecture connects the prefecture of Tiaret to the west, as well as the railway line linking Blida and Djelfa, which will be used especially for the transport of goods and persons.

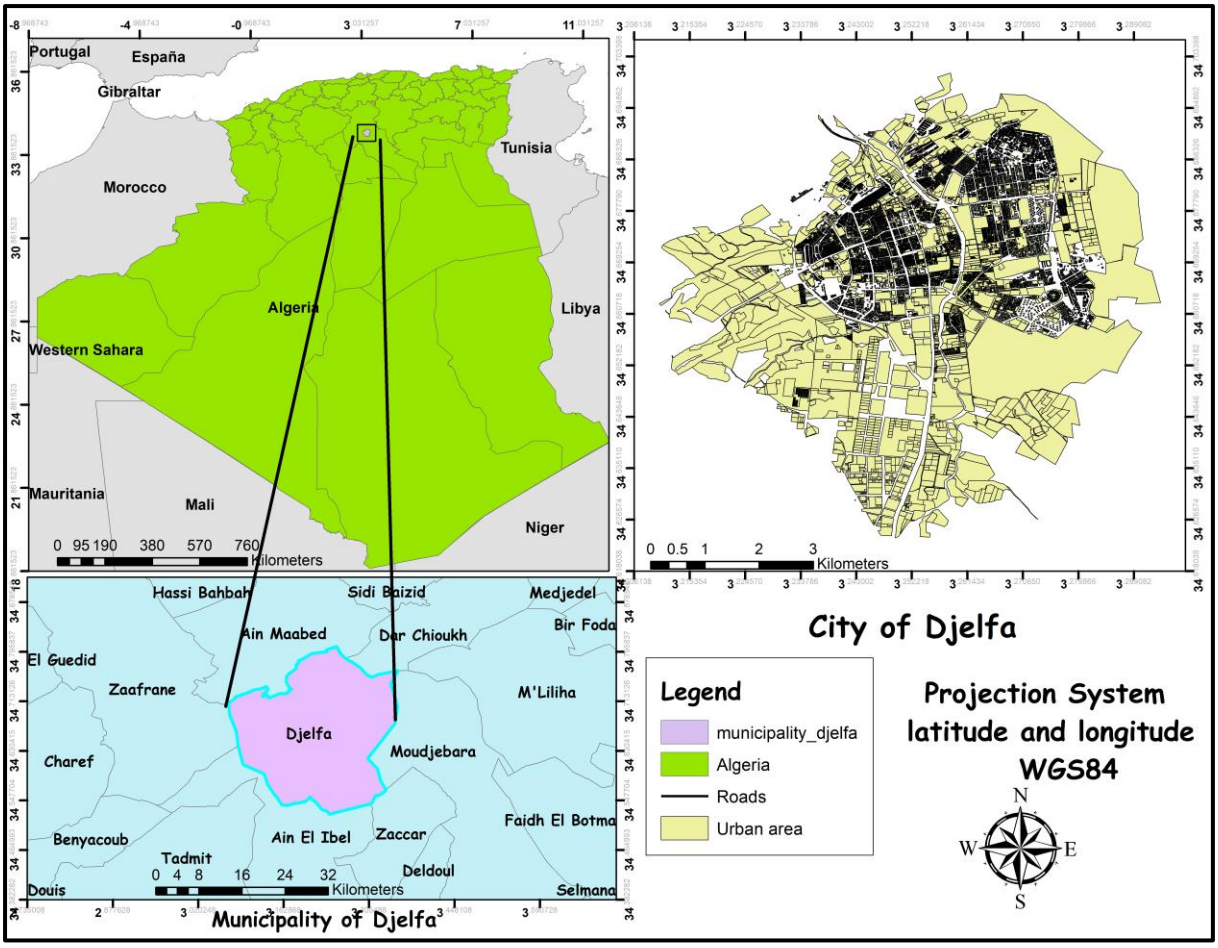

Figure 1 The location of Djelfa city

Source: student work

3.4. History overview

Because of the steppe nature of the Djelfa region, the people used to raise livestock and traveling between the Tell Atlas and the Saharan Atlas, the site of the city was considered as a meeting point between the residents of the regions, where livestock were sold and goods exchanged.

With the French colonization, and for considerations of defense strategy, the first nucleus of Djelfa city was born between 1850 and 1852. The French were encouraged to build a fort in Djelfa, to serve as a supply Post for their army and to control the entire territory of the surrounding steppe.

It was eminently strategic in the sense that it meets many criteria:

- It is located on a key crossing point between North and South, East and West, it therefore makes it Possible to easily control movements;
- It was placed on the plateau, with a largely unobstructed view to ensure the defense.

After having built the first fort, the colonial authorities saw the need to create a center of life nearby in order to facilitate the establishment of a garrison, in particular to accommodate the families of the soldiers and also some useful Arab houses to provide labor and allow the establishment of trade with the natives.

Figure 2. Djelfa city before 1900

Source: ONMD Djelfa

In 13-02-1861, Djelfa was established as a municipality and occupies a territory of 1776 hectares.

The agglomeration of Djelfa began to take on more importance with the construction of several administrative and religious facilities: a town hall, a provincial administration office (at the time called "Arab office"), a church and later, a mosque.

During the period which followed 1882, Djelfa experienced some local immigration, which came to strengthen its population, as well as the creation of other facilities such as school, the cattle market, and a market for the timber trade and salt (main resources of the region). After 1918, the famine which followed the first world generated a rural exodus towards the city which saw its first anarchic developments outside the rampart.

the Bordj district was created, sheltering poor rural people in precarious and unhealthy buildings. Shortly before, the turn of the century saw the arrival of the railway and the construction of a station in the North.

In fact, it was during the period from 1920 to 1950 that Djelfa city gradually changed from a village to a small town of over 20,000 individuals, following the incessant influx of mostly young rural people tempted by the chance to find a job in the young booming city driven by the trade in sheep and esparto which are now exported to France by rail.

We notice many extensions in several peripheral districts:

- **To the east:** The Bel-Ombrage, Saâadat, plantation, the Post office (1936) districts, mainly home to the European population;
- **In the West:** The Guenani, Bab Charef, Bendjerma neighborhoods built by the indigenous population.

The fast expansion of the built environment has long gone beyond the old urban perimeter delimited by the rampart; however, it was not finally demolished until 1960 to allow the homogenization of the city. During the war of national liberation, the growth of the city did not slow down, on the contrary. A massive exodus of rural populations fleeing the repression engendered by the war increased the urban population, which practically doubled a few years before independence.

Figure 3. Djelfa city 1961

Source: ONMD Djelfa

3.5. The topography of Djelfa municipal

The relief of the municipal territory of Djelfa is generally plane and high. Its altitudes vary from 1020m (minimum) to 1489m (maximum).

Three major morphological sets characterize the communal space; mountains, foothills and plateau.

3.5.1. The mountain

Represent 39.32% of the total area (or 21 318.12 Ha), we find:

Djebel Senelba which represents the largest group, with the highest peak in the whole region (1489 m); Djebel El Oust and Djebel Kef Haouas.

3.5.2. The hills

Represent 8.20% of the total area (4445.79Ha), where it's located in the South East and North of the town in 1988.

From the location of the relief, we can cite the most dominant in the municipality:

- The lands of the municipality are generally of low slope, varying from 0 to 8% with a predominance of the class (0-3%) which is found at the level of the lands at the South-West, East and North-East of the municipal territory. In the North and North-West find moderate to high slopes (over 12.5%);
- The medium slopes class (12.5-25%) is distributed especially at the bottom of mountains with dense plant cover
- The very high slopes class (more than 25%) is located especially along the ridges of Djebel Senelba and djebel of Kef Haouas.

3.5.3. The lands

Representing 52.48% of the total area (or 28,453.08Ha), it is part of the large plateau of Medjbara, Mouilah, it is located in 02 parts:

- The part going from the southwest (from C.W. 164) to the southeast and east of the town;

- The part located in the extreme northeast of the town.

3.5.4. Slopes

The municipality of Djelfa is made up of small plains whose altitudes vary from 900 to 1200m. The upper part of the depression is made up of mountains term of Ouled Nail. This chain-oriented South-West and North-East made up of the main mountains of the Prefecture. The land in the municipality is generally low varying from 0 to 8% with a predominance of the class (0-3%) which is found at the level of the plateaus in the South, South-West, East and North. East of municipal territory.

We found the (12.5- 25%) class, especially on the mountain slopes where the vegetation cover is dense. On the other hand, the class (more than 25%) is located all along the ridges of Senelba and Kef el-Haouas.

3.5.5. Hydrographic

The hydrographic network is made up of Oueds, subject to a regime
Seasonal. It is composed of: Oued Messeka, Oued El Hadid, Oued El kirane, Oued Meguennah, Oued Lezen, Oued Oum Defain, Oued Abga and Oued Sidi Slimane.

Most of these Oueds discharge their water into the Oued Mellah, which is considered the most important in the municipality, and which crosses the city from south-east to north-west to flow into the Zahrez basins. This Oued, which is dry during the summer, serves as an outlet for the city's wastewater; which Poses a pollution problem.

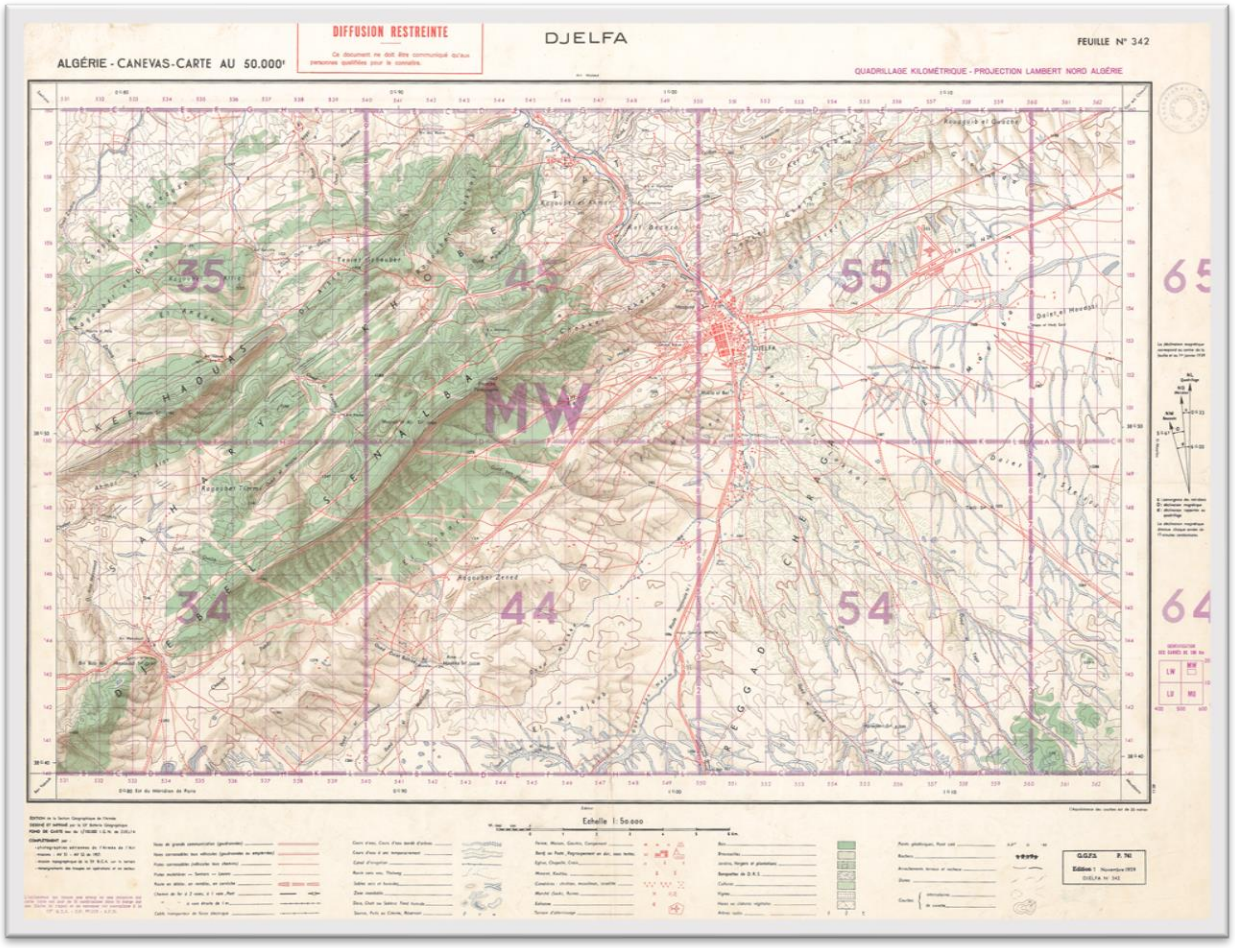

Figure 4. Topographic map of Djelfa region

Source: National institute of cartography of Algeria

3.6. Evolution of the population

3.6.1. Population evolution

Djelfa city has known according to the 05 censuses (1966, 1977, 1987, 1998,2008) a very important demographic growth. Because the population went from 25,628 inhabitants in 1966 to 374204 inhabitants in 2021. The following table shows this evolution.

Years	population	Growth	Rate of increase (%)	National growth rate (%)
1966	25628	/	/	/
1977	47435	21807	6,35	3,21
1987	83162	35727	5,77	3,08
1998	158644	75482	6,67	2,15
2008	311931	153287	7	1,41
2018	358811	218351	7	1.41
2021	374204	65506	7	1.41

Table 1. Population evolution of Djelfa city (1966-2021)

Source: monograph 2017 (DPSB) + student calculation

$$P_{future} = P_{present}(1+i)^n$$

T: the increase rate of the period (n, n0).

P_{future}: Number of populations during the period n.

P0: Number of populations during the initial period.

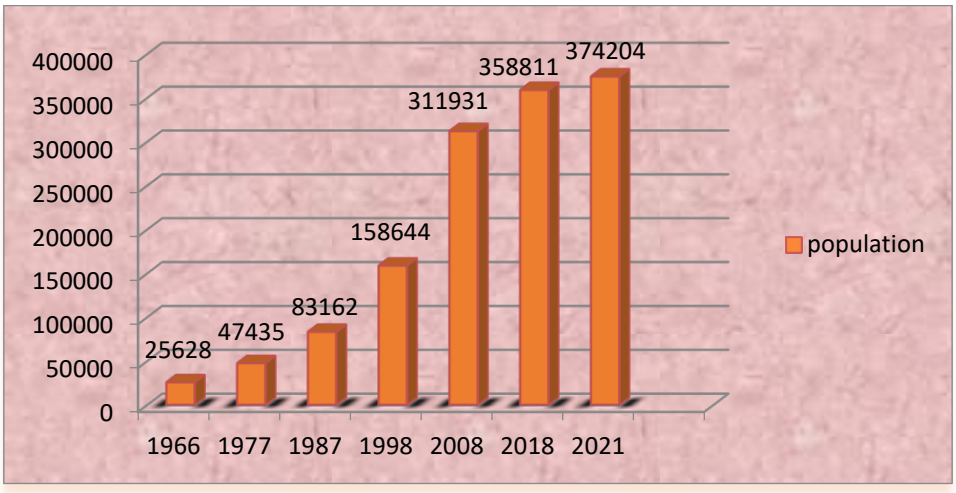

Figure 5. Population evolution of Djelfa city (1966-2021)

Source: Student work

Djelfa city has experienced a significant demographic growth. The Promotion of Djelfa city to the rank of capital of the prefecture (the administrative division of 1974) was the first parameter, then the population growth kept increasing and that was because of the following factors:

- Increase in births and decrease in mortality;
- Improvement of health and living conditions;
- Rural exodus to the city.
- The strategic location of the city which played a big role in attractiveness newcomers.
- Housing projects
- The existence of the industrial zone which caused the attraction of labor
- The improvement in the social condition of the population after the beginning of the crisis decade.
- Large housing programs and plots of land (fragmentation) that has attracted all this human mass.

3.6.2. The elements of population growth

The elements of population growth are the demographic events which influence the number of the population of a given society in such a determined period, since any transformation in the number of the population whether by increase or decrease called growth. We have two types of elements: the first is natural which appears by birth and death rate, the other is unnatural, which is migration, whether internal or external.

3.6.3. Natural Elements

These are the most important elements. They induce the change in the volume of the population because the population increases, because of births and decreases by their death at the same time, and this is where the natural increase appears as a difference between birth rate and death rate.

a) Births:

It represents a very important element in the evolution of the population. They are higher than mortalities and migrations under normal conditions.

Birth rates are known as the number of newborns born to a society in a year.

b) Mortalities:

They have been and will remain an element limiting the evolution of the population especially as a result of wars and natural disasters, and thanks to the development experienced by mankind the majority of these obstacles have been overcome.

year	Birth	Mortalities	Growth
1994	5785	903	4882
1995	5606	1029	4577
1996	5488	1053	4435
1997	5712	1185	4527
1998	5327	888	4439
1999	5214	929	4285
2000	4634	860	3774
2001	6425	1246	5179
2002	6733	1222	5511
2003	7215	1258	5957
2004	7510	1284	6226
2005	8431	1349	7082
2006	8751	1343	7408

2007	**8970**	**1335**	**7635**
2008	**9450**	**1382**	**8068**
2009	**10171**	**1481**	**8690**
2010	**9627**	**1427**	**8200**
2011	**10190**	**1428**	**8762**
2012	**11020**	**1581**	**9439**
2013	**11489**	**1696**	**9793**
2014	**12075**	**1548**	**10527**
2015	**13419**	**1817**	**11602**
2016	**13467**	**1671**	**11796**
2017	**12437**	**1695**	**10742**
2018	**12306**	**1619**	**10687**
2019	**12941**	**1865**	**11076**
2020	**12890**	**2247**	**10643**

Table 2. Growth of the population of Djelfa city between (1994-2020)

Source: civil status department of the town hall (2020)

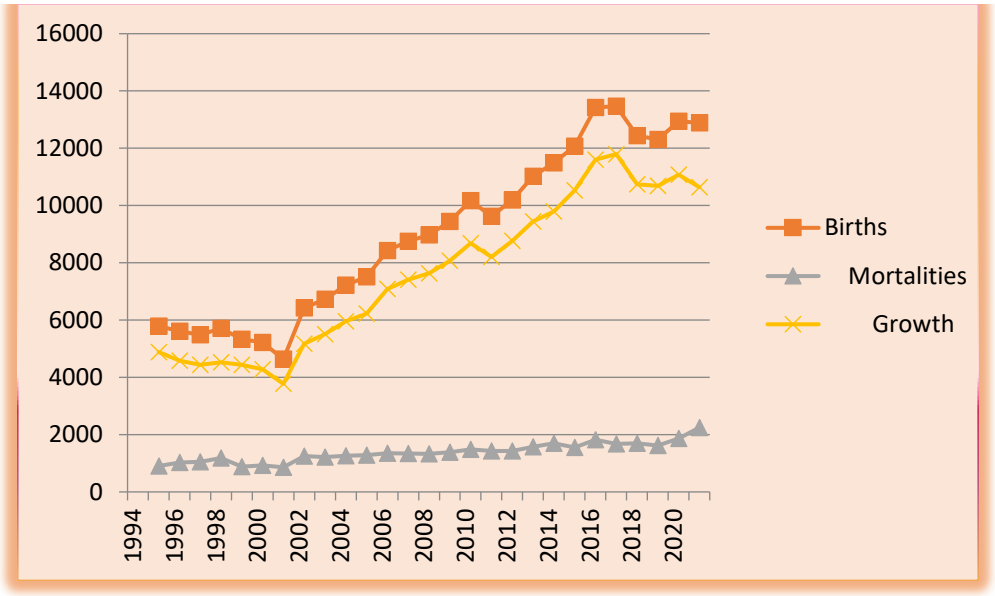

Figure 6. Growth of the population of Djelfa city (1994_2020)

Source: Student work

From Figure 6 and the Table 2, we note that the number of natural increases was small from 1994 to 2002 due to insecurity and difficult conditions. From 2002 to 2019, we observe an explosion in the number of natural increases due to improved living conditions and the availability of security. In 2020, we notice an increase in the number of deaths due to the spread of the covid19 virus.

3.6.4. unnatural factors (migratory)

- **Net migration**

Net migration is the difference between the arrivals (or entries) and departures (or departures) of inhabitants of a given territory. In other words, net migration is equal to the difference between entries and exits.

According to ONS data, we can distinguish two forms of net migration which are:

- **Internal migration**

Internal migration in the case of our study can be defined as the movement of migrants (from the prefecture of Djelfa) who have left their communes to settle in Djelfa city. Table 3 below shows us the number of entries into the city and the number of exits from the same city as well as their percentages and the migratory balance which is: number of entries - number of exits

	The arrivals		Departures		Net
	Number	%	number	%	migration
Total	13644	100	5968	100	7676

Table 3. Number of migrants from and to the municipality of Djelfa from the municipalities of the prefecture (1998-2008)

Source: GPHC (2008) ONS

According to Table 3: there is a total of 13,644 entries into the city of Djelfa and 5,968 exits from the municipality (Djelfa) to the other municipalities of the prefecture in the period between 1998 and 2008. All this with an estimated Positive migratory balance of 7676 people during these 10 years.

These figures were collected during the 2008 general census drawn up by the National Statistics Office (ONS).

External migration

These are the migration movements from/to other prefectures to/from Djelfa city. Table 4 shows us the main migration movements to where from the city of Djelfa from where to the prefectures of Algeria

Prefectures	Migrants to Djelfa	%	Migrants from Djelfa	%	Total
Total	6069	100	4618	100	1660

Table 4 Number of migrants from / to the city of Djelfa from / to the Prefectures of Algeria between (1998-2008)

Source: GPHC (2008) ONS

According to the Table 4, we deduce that during the period between 1998 and 2008, the number of entries to the city of Djelfa from the other Prefectures is 6,069 people and 4,618 people leaving the city (Djelfa) to the other Prefectures.

With an estimated Positive migratory balance of 1,660 people. These figures were collected during the 2008 general census drawn up by the National Statistics Office (ONS). the Built zone

3.6.5. Housing Evolution

The evolution of the housing stock has seen proportions in recent years in Djelfa city. To better understand the general housing situation, it is necessary to determine its evolution and its typology.

Years	**1987**		**1998**		**2008**	
Types of habitats	**Number**	**%**	**Number**	**%**	**Number**	**%**
collective	1546	13.87	3729	17.22	14386	35,07
Individual	1641	14.73	15298	70.60	22464	54,76
traditional	7212	64.73	1222	5.64	2472	6,02
precarious	477	4.28	1242	5.73	1698	4,13
Total	11141	100	21653	100	41020	100

Table 5. Housing evolution (1987_2008)

Source: DPSB Djelfa

From the above table, we find that the number of houses in 1987 was 11141, and in 1998 it rose to 21653, and the number reached 41020 in 2008, this increase is due to the demographic growth.

3.6.6. Typology of habitat

a) Collective housing:

This type of housing is generally supported by the State, local communities and the organizations concerned in particulate accommodating a big number of the population in a small space.

Two different periods marked by housing projects:

A slow period stretching from 1977 to 1987 when 1546 housing units were built, this period is marked by the demolition and elimination of the informal settlement created by rural migrants.

A second step at an accelerated pace lasts from 1987 until 2008, It is subdivided into two stages:

- 1987-1998: with 2278 housing units built in the ZHUN East (New Urban Housing Zone) and 745 housing units and individual dwellings in the West NUHZ, i.e., 3,603 housing units, this period ended with the construction of 3,729 housing units, or 17.22% of the total of 1998.
- Between 1998 and 2008 construction projects are across the city. We can mention the construction of the quarter of GARDENS 840 social housing units as well as the quarter of El WEAME and other projects are either completed or underway. These new cities are characterized by a more modern architecture and better designed and more equipped housing. They contribute to an increase of 2,149 housing units.

Figure 7. Collective houses

Source: student photography

b) Individual housing:

This type of housing represents more than half housing stock in Djelfa city (54.76% of the total).

It is found in all the territory of the city located mainly in the outskirts of the old core.

c) Traditional habitat:

it represents 2472 buildings or 6.02% in 2008 Table N °05 clearly shows that this type of houses has greatly regressed in 1998 it represents 5.64% of the urban fabric. There are two types of construction:

- An organized type (see DAÏA and AIN-CHIH quarters) this type has an interior surface on which a house with windows opens on a fence.

- The second type is the fragile, old and multifaceted traditional construction without a courtyard and with small windows.

Figure 8.Traditional houses

Source: student photography

d) Precarious housing:

These constructions have developed in an anarchic and illicit manner, or they escape any form of organization and do not even meet the basic conditions of urban life. The proliferation of these constructions is done on private or public land without any regulations and without obtaining a building permit.

In 2008, Djelfa city had 1,398 houses (4.13%), and in 2010, 2,332 houses, or a rate of 5.98%, and in 2013, 9,081 houses, or a rate of 7.26%.

Figure 9. Precarious housing

Source: student photography

3.6.7. Housing occupancy density

It is the relationship between the number of inhabitants and the number of houses.

This relationship is expressed by the ORH (TOL) which is the occupancy rate per house, and the ORR (TOP) which is the occupancy rate per room. These indicators allow us to measure the intensity of housing occupancy and therefore to assess the living conditions of the populations.

a) Evolution of occupancy rate per house (TOL) ORH

Years	Number of inhabitants	Number of houses	occupancy rate per house %
1987	83162	11141	7 ,46
1998	158644	21653	7,32
2008	311931	39322	7,9

Table 6. Evolution of the occupancy rate per house (ORH) of Djelfa city

Source: DPSB+GPHC (2008)

From Table 6, we note that the occupancy rate per housing in Djelfa city for the year 1987, was 7.46hab / house, in 1998, the occupancy rate per housing fell to 7.32 dweller / house and in 2008 it has risen to 7.9 dweller / house.

The occupancy rate per house (ORH) in Djelfa city is too high compared to the exemplary rate (ORH) evaluated at 6hab / log applied by the national center for the study and research in town planning NCSRAP (CNERU) because of the lack of habitats.

- **The occupancy rate per room (ORR):**

The ORR is the ratio between the number of the population and the number of rooms; it indicates with effective precision the housing spaces and makes it Possible to distinguish the situation and the living conditions of the inhabitants.

Number of inhabitants	Number of occupied houses	Number of rooms	Room occupancy rate in the house %	Occupancy rate per room
311931	39322	128976	3,28	2,42

Table 7. The room occupancy rate of housing in Djelfa city

Source: DPSB Djelfa

Table 7 shows the inhabitants of Djelfa city in number of 311931 in 2008 spread over 39,322 houses and 128,976 rooms, an average of 3.28% rooms per house and a TOP of 2.42 %people per room.

The latter is a discouraging rate since it is higher than the standard adopted by the national center for study and research in town planning estimated at 2 people per room.

b) Spatial distribution of houses

The population is not distributed evenly over space, so we notice some populated areas and others that are much less populated. This distribution is often done according to an urban planning logic of installation, where we notice, for example, that the collective housing areas contain a number of populations greater than those of individual dwellings, but also the concentration of residents is noticeable in the area's parts of space where certain types of equipment are grouped together, in particular those of services.

- In addition, the density also differs from one quarter to another according to the number of habitats it contains in relation to its total area, and according to these international standards have been established by the World Statistics Office in 1990, for which beyond, living conditions are considered difficult.

Based on data from the GPHC 2008 (general population and housing census) and the area of the city, we can identify the corresponding density.

Density = number of population / total area.

Density = 288228 / 542.17

Density = 531.6 inhabitants / Km²

This heterogeneity of population density in Djelfa city is due to several factors such as the typology of housing, the standard of living, concentration and location of services and activities, etc. (see Figure 10).

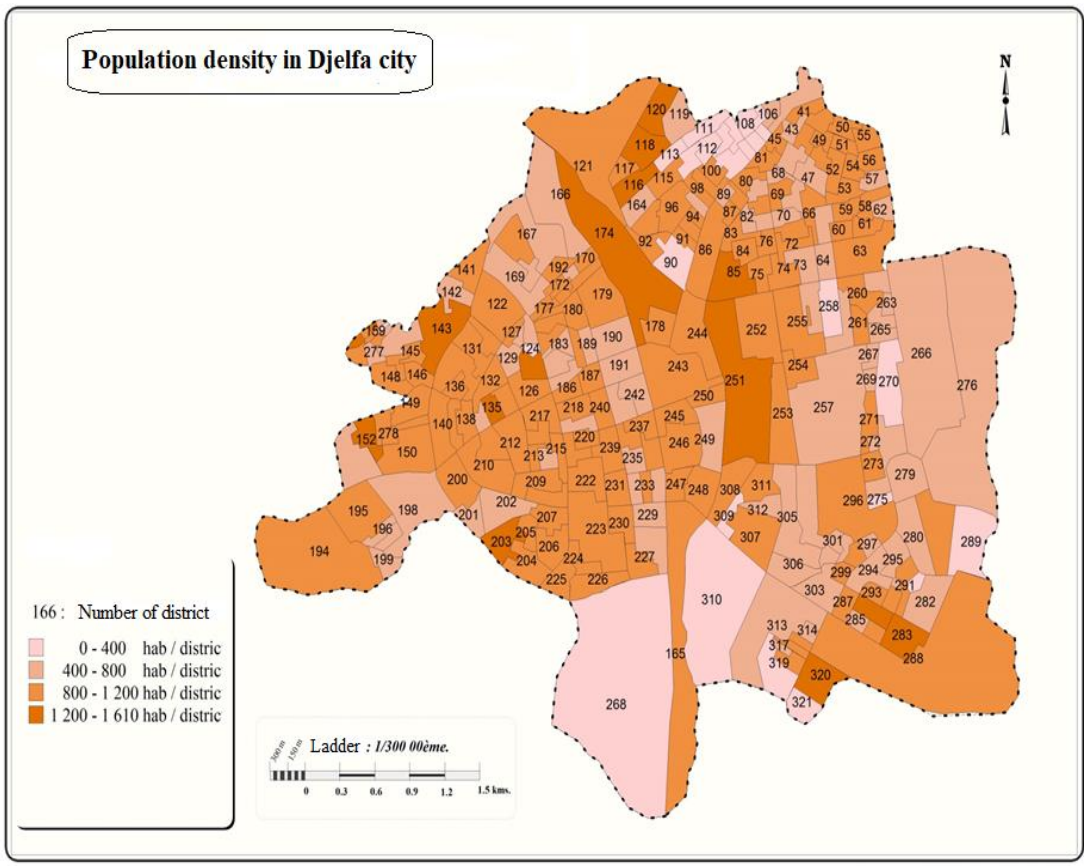

Figure 10. Population density in Djelfa city

Source: MPA Djelfa (GPHC2008)

3.6.8. Urban equipment

Equipment is a set of structures used for urban activities and population needs other than housing. The equipment of a city: shops and services, collective equipment of general interest, places of production and storage, green and leisure spaces.

Through the table below, we will try to specify the number and type of equipment in Djelfa city.

The nature of the equipment	The number
Administrative equipment	79
Sanitary equipment's	22
Cultural equipment's	56

Sports equipment’s	28
Leisure equipment’s	03
Educational equipment’s	184
Religion equipment’s	63

Table 8. Number and nature of equipment in Djelfa city

Source: Civil status department of the town hall 2020

Table 8 shows the number and type of the equipment in the city, as educational equipment constitutes the largest number with 184 facilities, followed by administrative equipment with 79 equipment, then religious equipment with 63 equipment, cultural equipment 56 equipment, sports equipment with 28 and health facilities, 22 facilities 56 equipment, and finally Leisure equipment with 3 equipment. They are distributed in the city according to the map of the distribution of equipment shown in the Figure 11.

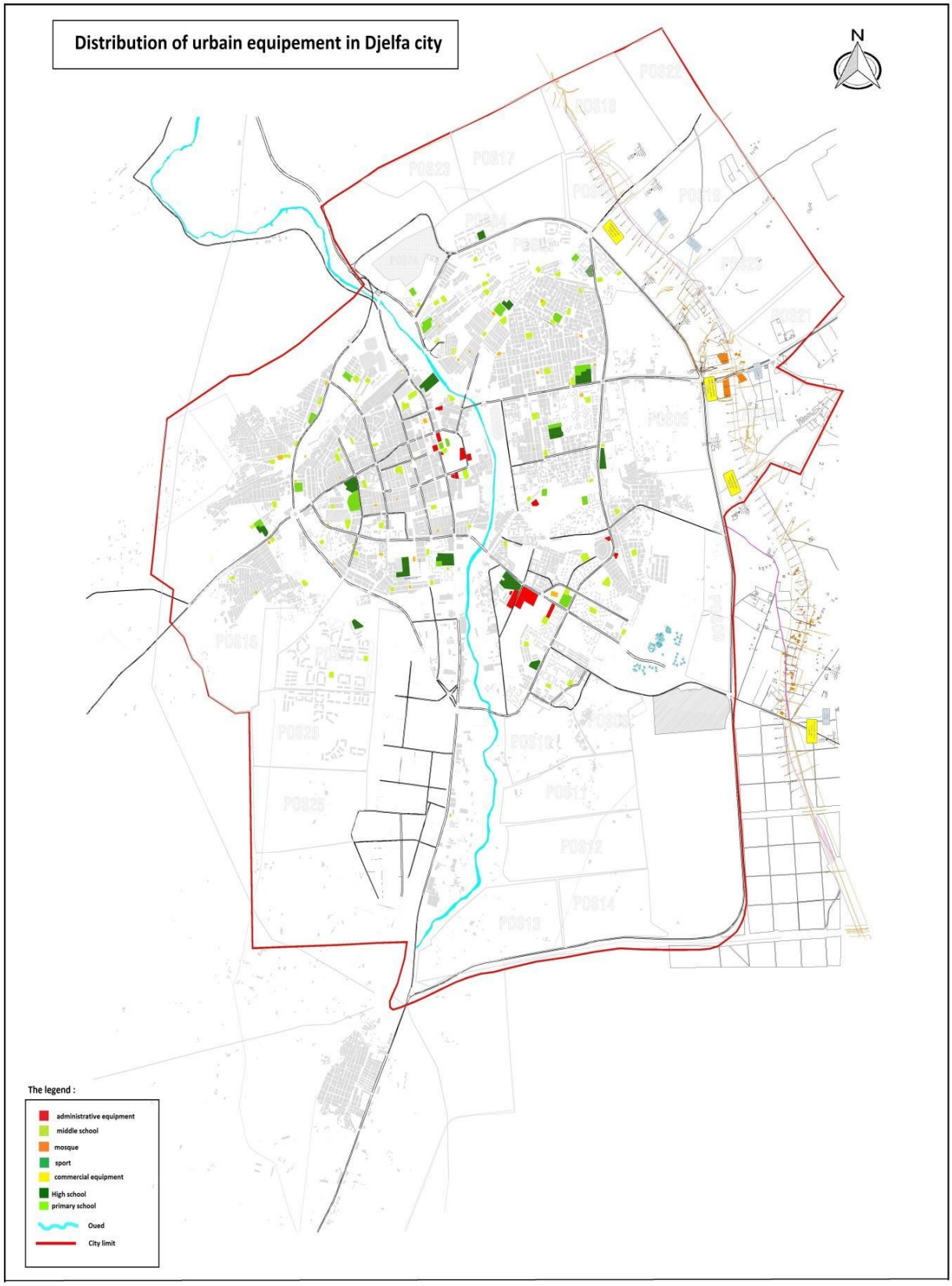

Figure 11. Distribution of the urban equipment in Djelfa city

Source: student work

Figure 11 shows us where the equipment's are located in the city, where this equipment's are distributed according to the needs of the population.

3.7. The non-built zone

3.7.1. Road network

The roads and the Transportation are the basis of economic development, the distribution of urban functions and activities, the layout of neighborhoods, the sprawl of urban space, the separation of places of work and those of residence, impose the mobility of people and the intra-urban relationship as well as outward connections

With regard to Djelfa city it should be noted that the existing roads are classified according to their importance and their state in Table 9

State	State Classes	Main roads	Secondary roads	Tertiary roads
Good	Length	590,20	374	128,2
	Rate%	58	73	34
Middle	Length	272,80	87	258,9
	Rate%	27	17	59
Bad	Length	147,50	49,50	421
	Rate%	15	10	106
	Total	1010,50	510,50	808,1

Table 9. State of the road network in Djelfa city

Source: DTP Djelfa 2020

From Table 9, we find that the main roads constitute 1010.50, and the secondary roads constitute 510.50, while the Tertiary roads constitute 808.1. They are distributed throughout the city as shown in Figure 12.

Figure 12.The set of roads in Djelfa city

Source: URBATIA

3.7.2. Electricity and gas network

Djelfa city is supplied with electricity through three lines coming from Hassid R'Mel, Barrouaghia and M'sila. These lines meet in the electrical transformer station if in the south of the city and from which several medium voltage lines leave to supply the various cities of the prefecture as well as all the districts of the city. As for town gas, it is supplied with gas at medium and low pressure from the main canal which runs east of the town.

3.7.3. Drinking water supply network (AEP)

The city is supplied by a 211.41 km long network connecting more than 81% of the city's districts. It has 19 water towers with a total capacity estimated at 29,450 cubic meters, where a share of 180 liters / day per person.

3.7.4. Sewerage network

The city has two unified system networks 136.41 km long, one serves the east side of the city (the east bank of Oued Mellah), the other serves the west bank to discharge into the main channel parallel to Oued Mellah. Both then flow into the sewage treatment plant north of the city.

3.8. Urban policies

The urban project must be translated today through two urban planning instruments: the master plan of development and town planning and the land use plans: (MPDTP-LUP) stipulated by law n ° 90-29 OF 01/12/1990 relating to development and town planning.

The establishment of MPDTP and LUP is an obligation for any municipality. A legal obligation imposed by law and a de facto obligation since no ambitious municipal project, in terms of town planning, can be carried out outside these town planning instruments, in particular with regard to the programming of equipment and land management measures (expropriation and preemption).

The development and town planning instruments are really a new leap in urban planning. They take care of the urban space in terms of organization and orientations of the

developments through the MPDTP and to give the smallest architectural and urban details through the LUP.

3.8.1. The master planning and urban planning plan (MPDTP):

The MPDTP is a spatial planning and urban management instrument combining both town planning and land use planning; it is also a technical and regulatory document, serving both for the local planning of the actions undertaken. and the management of the territory of the municipality concerned. (Nedjai, 2013)

The purpose of establishing a municipality's MPDTP is to provide local authorities with instruments for spatial planning and urban management. The MPDTP constitutes the medium and long-term urban planning instrument; it represents a document which fixes the fundamental orientations of the spatial planning of a municipality, a part of a municipality or a set of municipalities, in particular with regard to the extension of the agglomeration or agglomerations concerned. (Jacquignon & Danan, 1978)

The Master Plan for Development and Urbanism takes development plans into account and defines the terms of reference for land use plans. It supports the programs of the State, local communities and those of their establishments and public services.

The MPDTP master plan for development and town planning is defined considering the Law 90-29 of 1 December 1990. It is also an instrument for spatial planning and urban management. (Nedjai, 2013)

3.8.2. The different sectors of the master planning and urban planning plan

Each sector has a specific rate of urbanization. The MPDTP must lay down regulatory provisions in general. There are four sectors:

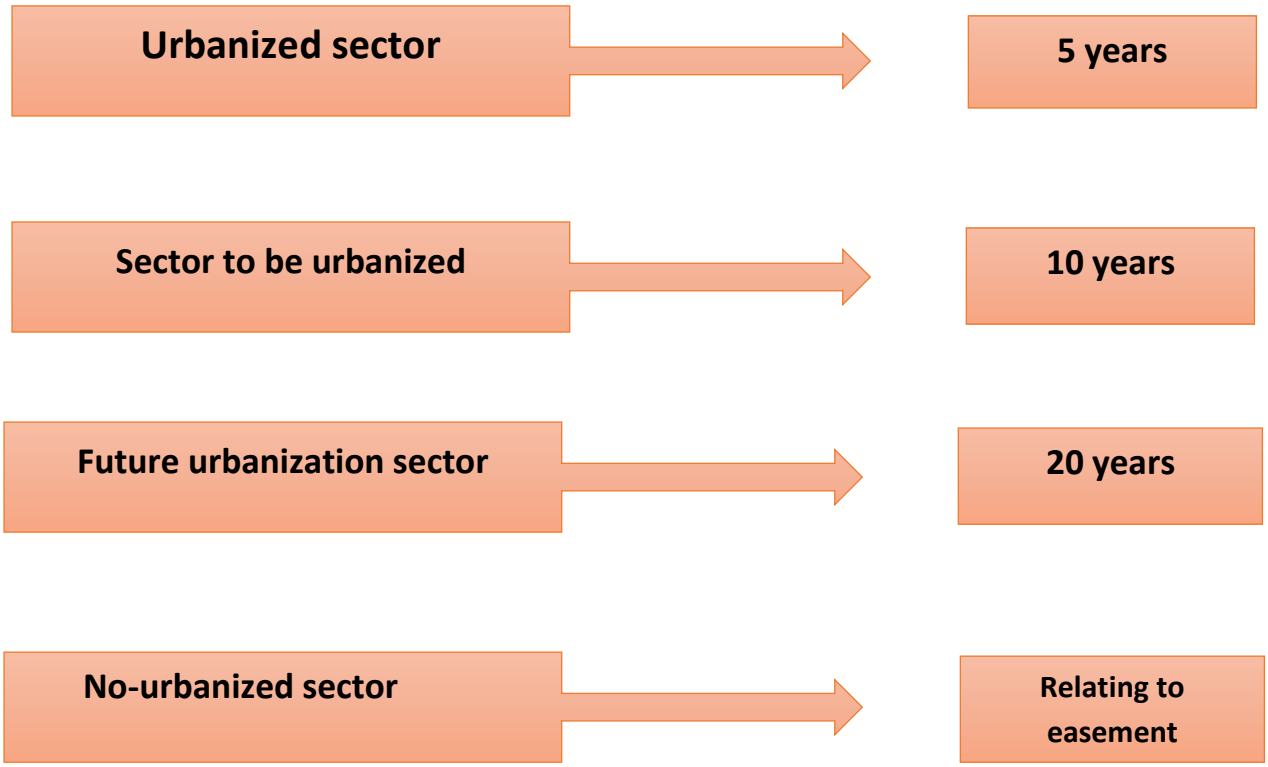

Figure 13. Organigram of the MPDTP sectors

Source: student work

The Lan use plans (LUP)

Unlike the MPDTP which is a master plan, the LUP is a detailed plan. It is at the last level of urban planning research. It constitutes an essential document of town planning regulations. It results from the orientations and prescriptions of the master plan of development and town planning. It defines the land use and construction rights for the plot. (Nedjai, 2013)

The LUP is an urban planning document drawn up in accordance with the laws and regulations aimed at the production or transformation of urban land and the built environment in compliance with the provisions of the MPDTP. The LUP is the second of the urban planning documents instituted by Law 90-29 of December 1, 1990 relating to development and town planning. (Nedjai, 2013)

The LUP is the urban planning instrument closest to the concerns of the architect and the Urban designer, by its scale, but also by its nature. Indeed, it defines the modalities of morphological and functional occupation of the plot, the main morphological characteristics of the building, even, in some cases, urban and architectural style elements. (Maouia, 2001)

3.9. Future programs to do

In order to know the future expansion programs in Djelfa city, we reviewed the reports of the LUP, which were made by the study offices.

3.9.1. LUP 08

LUP 08 is located on the eastern side of Djelfa city, due to its location at the intersection of major roads represented in State Road No. 108 leading to Fayd Al-Butma and the Western Avoidance Road (Algeria - Laghouat), its total area: 144.70hectares.

Suggestion of individual housing next to the village on an area of 96,200 hectares

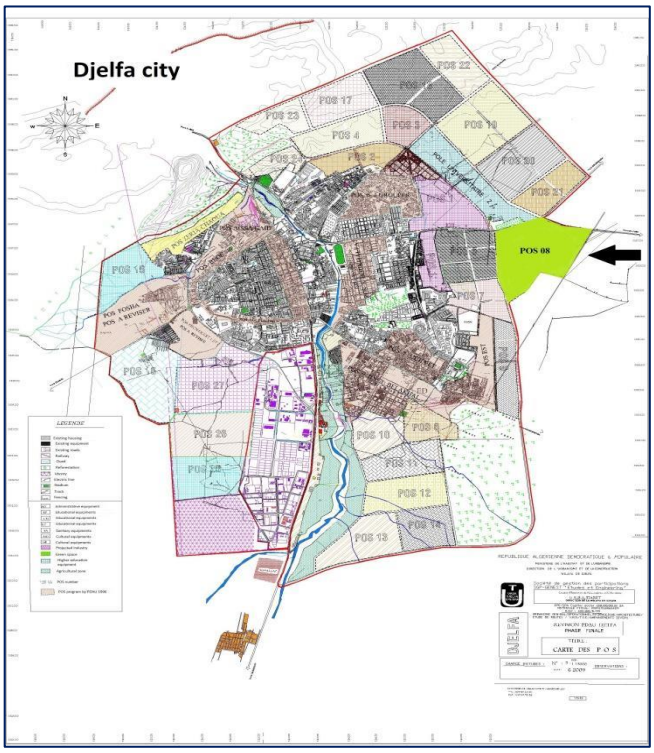

Figure 14. LUP 08 location

The programmed equipment's are shown in the following table:

Equipment	space	Number
hotel	31400	02
Shopping center	29500	03
entertainment center	16100	02
specialist clinic	11300	01
Conference Palace	13100	01

Convention Hall	1400	01
Business tower	5400	01
Business center	1500	01
Exhibition hall	3200	01
Mosque	4100	01
Urban security	5300	01
Bank	2800	01
multi-service complex	7200	01
Recreational spaces	48200	04
Café + restaurant + tea room	6100	03
Investments	35800	05

Table 10. Future programs in LUP 08

Source: Civil status department of the town hall

3.9.2. LUP 19

LUP19 is located on the northeastern side of Djelfa city, due to its location at the intersection of major roads represented by the national road No. 46 to Fayd and the eastern avoidance road (Algeria - Laghouat), its total area: 144.00 hectares

The total area of preparation for the second variable is estimated at 144 hectares, and the total area for housing and equipment is estimated at 94.12, including 79.63 hectares for housing and 14.48 for equipment where individual dwellings were programmed on an estimated area of 18.16 hectares and collective dwellings estimated at 6338 housing Collectively, on an area estimated at 61.47 hectares, several equipment have been programmed

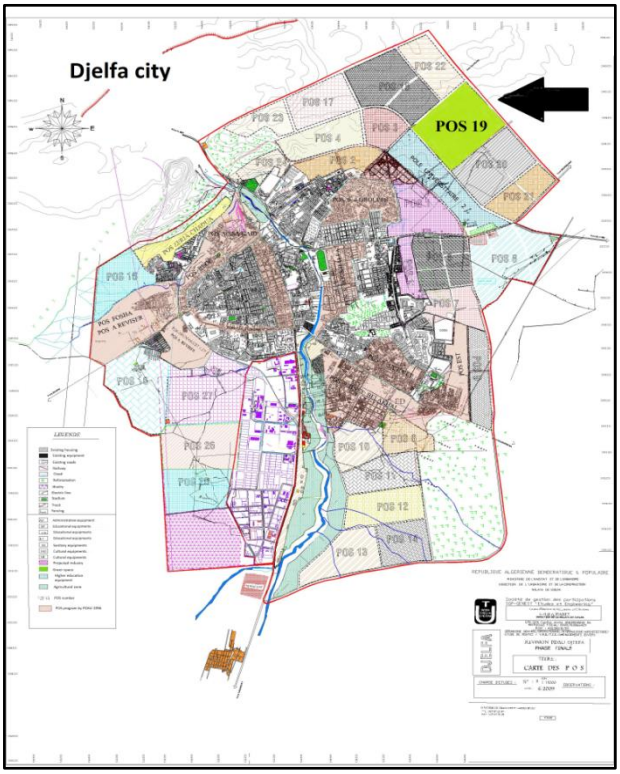

Figure 15. LUP 19 location

We illustrate this through the following table:

Equipment	Number
primary schools	6
Middle school	3
High School	2
nursery	4
clinic	1
maternity center	1
Health center	1

youth home	1
library	1
Mosque	1
urban security	1
Post office	1
multi-service office	1
Administrative branches	1
playground	1
public square	7
Stadium	1
covered market	1
swimming pool	1
Civil protection	1

Table 11. Future programs in LUP 19

Source: Civil status department of the town hall

3.9.3. LUP 16

LUP 16 is located on the western side of Djelfa city, south of the road towards the Scharf, with a total area of: 154 hectares.

The projects that have been programmed in the study area are rich and varied and have an effective impact on the development programs of the city.

Establishing collective and individual housing to fill the current housing shortage that the city suffers from.

Establishment of several equipment's in various fields in order to drop a distinct urban facade on the western side of the city, especially on the side of the road towards the Charef.

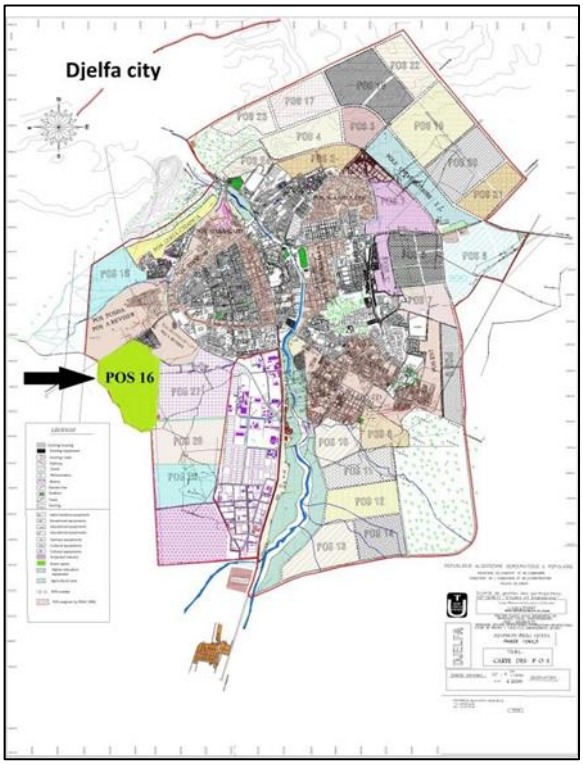

Figure 16. LUP 16 location

The programmed equipment's are shown in the following table:

Equipment	Number
nursery school	3
Elementary school	4
Middle school	2
high school	1
training center	1
Multiple clinics.	1

urban security	1
municipality branch	1
Various equipment	1
Bus stop	3
Mosque	2
Post office	1
Municipal library	1
Multi-sports hall	1
Shops.	1
Bank	1
Public square	1
Youth House	1
Cultural center.	1
Civil protection.	1
Open market	1
Public garden	2
Green space	3
Administrative equipment	1
Play areas	1

Table 12. Future programs in LUP 16

Source: Civil status department of the town hall

3.9.4. LUP 15

LUP 15 is located on the western side of Djelfa city on an area of 116.90 hectares.

The total area of housing is estimated at 41.38 hectares, or a total of 1863 dwellings, where all of them are programmed for individual residences.

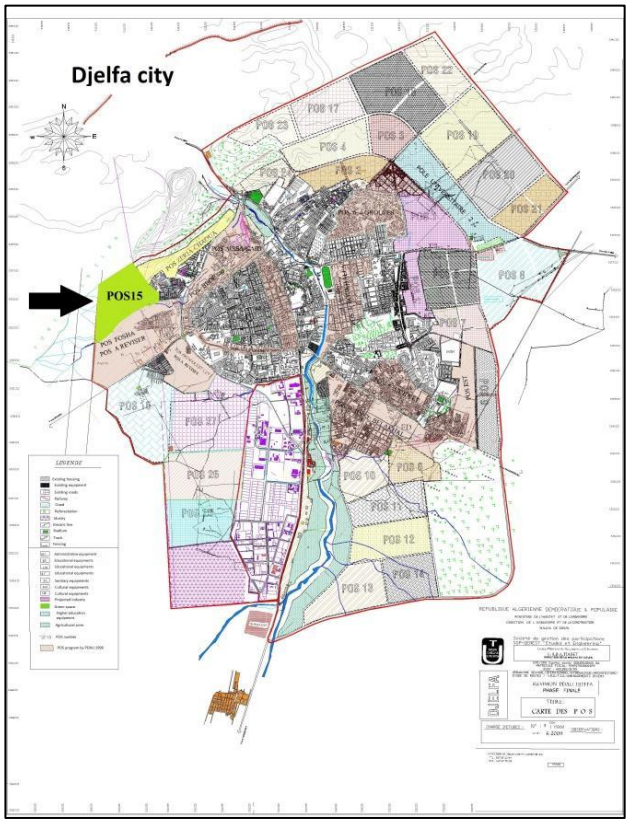

Figure 17.LUP 15 location

The programmed equipment's are shown in the following table:

Equipment	Number	Space (hectares)
Elementary school	5	12700
Middle school	2	9000
high school	1	7200
Mosque	1	6900
Various equipment	3	6300

clinic	1	8300
entertainment center	1	7000
nursery	3	4100
Stadium	1	3000
covered market	1	2200
public garden	1	1200
Green spaces	2	3100

Table 13. Future programs in LUP 15

Source: Civil status department of the town hall

3.9.5. LUP 20

LUP 20 is located on the eastern side of Djelfa city, due to its location at the intersection of major roads, represented by State Road No. 46 leading to Fayd Al-Butma and the eastern avoidance road (Algeria - Laghouat), its total area: 125.11 hectares

The total area of LUP 20 is estimated at 125.11 hectares, divided between individual and group housing and some necessary equipment for the area

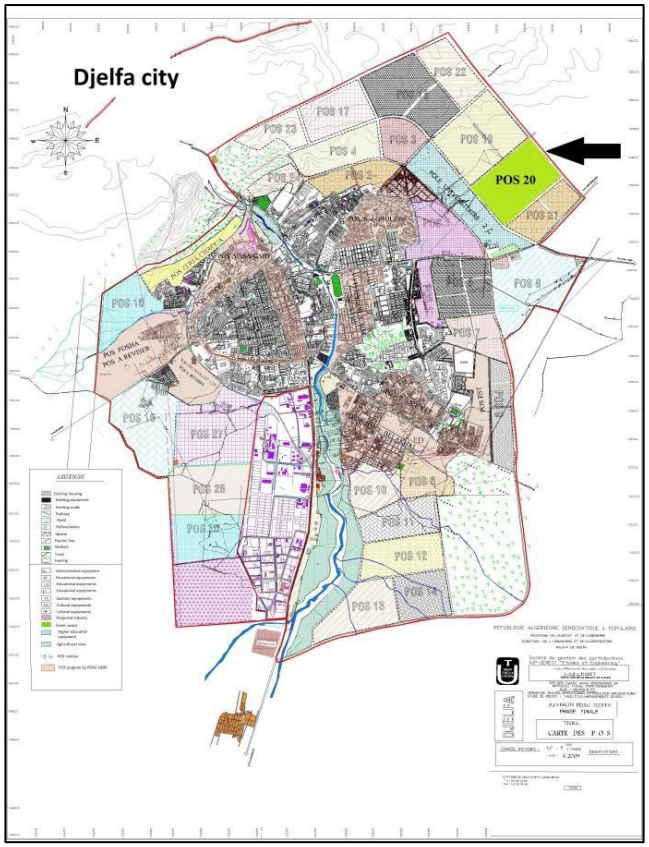

Figure 18.LUP 20 location

The programmed equipment are shown in the following table:

Housing /equipment	Space (hectares)
programmed single housing	19.13
Programmed collective housing	23.25
Administrative equipment	0.72
Sanitary equipment's	01.66
Educational equipment's	04.12
Religion/ Cultural equipment's	02.36
Commercial equipment	02.56
Green space	: 0.96

Table 14. Future programs in LUP 20

Source: Civil status department of the town hall

3.9.6. LUP 21

LUP 21 is located on the eastern side of Djelfa city, due to its location along the national road No. 46 leading to Bousaada, its total area: 100.13 hectares

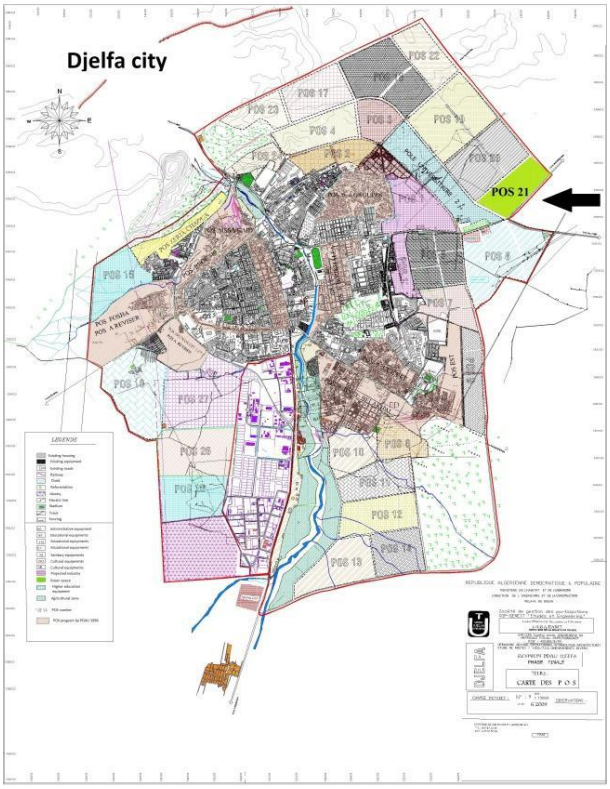

Figure 19.LUP 21 location

The programmed equipment's are shown in the following table:

The total area	961426 m^2
Existing housing area	1205 m^2
Suggested road space	168202 m^2
The proposed collective housing space	233277 m^2
Suggested individual housing space	214656 m^2
Equipment space	241912 m^2

Leisure space + green spaces + easements	103379 m^2

Table 15. Future programs in LUP 21

Source: Civil status department of the town hall

3.9.7. LUP 24

LUP 24 is located on the northern side of Djelfa city, which is located north of the main roads, represented by National Road No. 1, the eastern avoidance road.

(Algeria - Laghouat), its total area: 33 hectares.

The housing occupies about 12,228 hectares, and the area of the proposed equipment is about 4.41 hectares. The following table shows how the spaces are distributed between the two types of housing and equipment

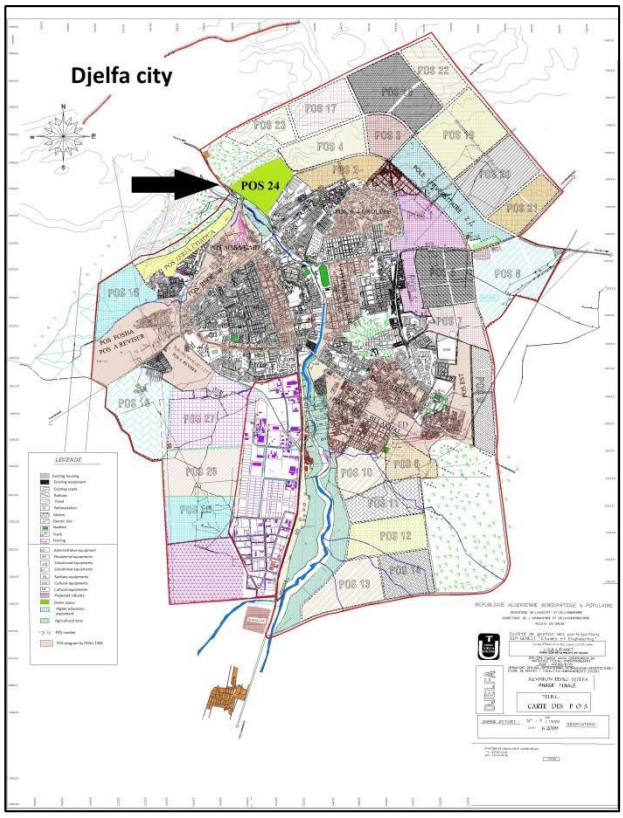

Figure 20.LUP 24 location

The programmed equipment's are shown in the following table:

Housing /equipment	Space (hectares)
programmed single housing	4.608
Programmed collective housing	6.768

public garden	0.1
Sanitary equipment	0.16
Educational equipment	1.72
Religion/ Cultural equipment	0.32
Commercial equipment	12
Investment	1.59

Table 16. Future programs in LUP 24

Source: Civil status department of the town hall

Due to the increase in the population of the city, housing programs and equipment's are prepared according to the needs of each LUP. As the population augments, the number of equipment and housing rise.

The tables above show us the number of equipment's and housing needed for each land along with the necessary space area. Also, the overpopulation of the city, housing programs and equipment are prepared according to the needs of each land. As the population increases, so does the number of facilities and housing.

The above tables show us the number of equipment and housing needed for each land, in addition to the required space.

3.9.8. Land use plans in the city (LUP)

The LUP	The area (hectares)	Region	Period
LUP 1	55	Ain srar	Short-term
LUP 2	83	Ain srar	Medium-term
LUP 3	81	Bahrara road	Close term
LUP 4	91	Boutrifis	Close term

LUP 5	87	Boutrifis	Close and medium term
LUP 6	36	Boutrifis	Close term
LUP 7	59	Eastern District	Close and medium term
LUP 8	165	Boutrifis	Close and medium term
LUP 9	67	Eastern District	Medium term
LUP 10	70	Belakehal	Close term
LUP 11	81	Belakehal	Close term
LUP 12	90	Belakehal	Long-term
LUP 13	96	Belakehal	Long term
LUP 14	72	Belakehal	Long term
LUP 15	187	Zeriaa	Close term
LUP 16	139	Charef Road	Long term
LUP 17	84	North	Long term
LUP 18	134	Bahrara road	Close and long term
LUP 19	144	Boutrifis	Close and long term
LUP 20	116	Boutrifis	Close and long term
LUP 21	64	Bousaada road	Close and long term

LUP 22	70	Bahrara road	Long term
LUP 23	48	North	Long term
LUP 24	33	North	Long term
LUP 25	55	Belakehal	Close term
LUP 26	128.72	West Industrial Area	Close term
LUP 27	225.12	West Industrial Area	Close term
Total	2657		

Table 17. The LUP in Djelfa city

Source: URBATIA

Table 17 shows the number of LUP in the city, which amounts to 27 lands and their locations, as well as the term (close term, long term, medium term) of each LUP, with a total area estimated at 2657 hectares. These LUP are shown in Figure 21.

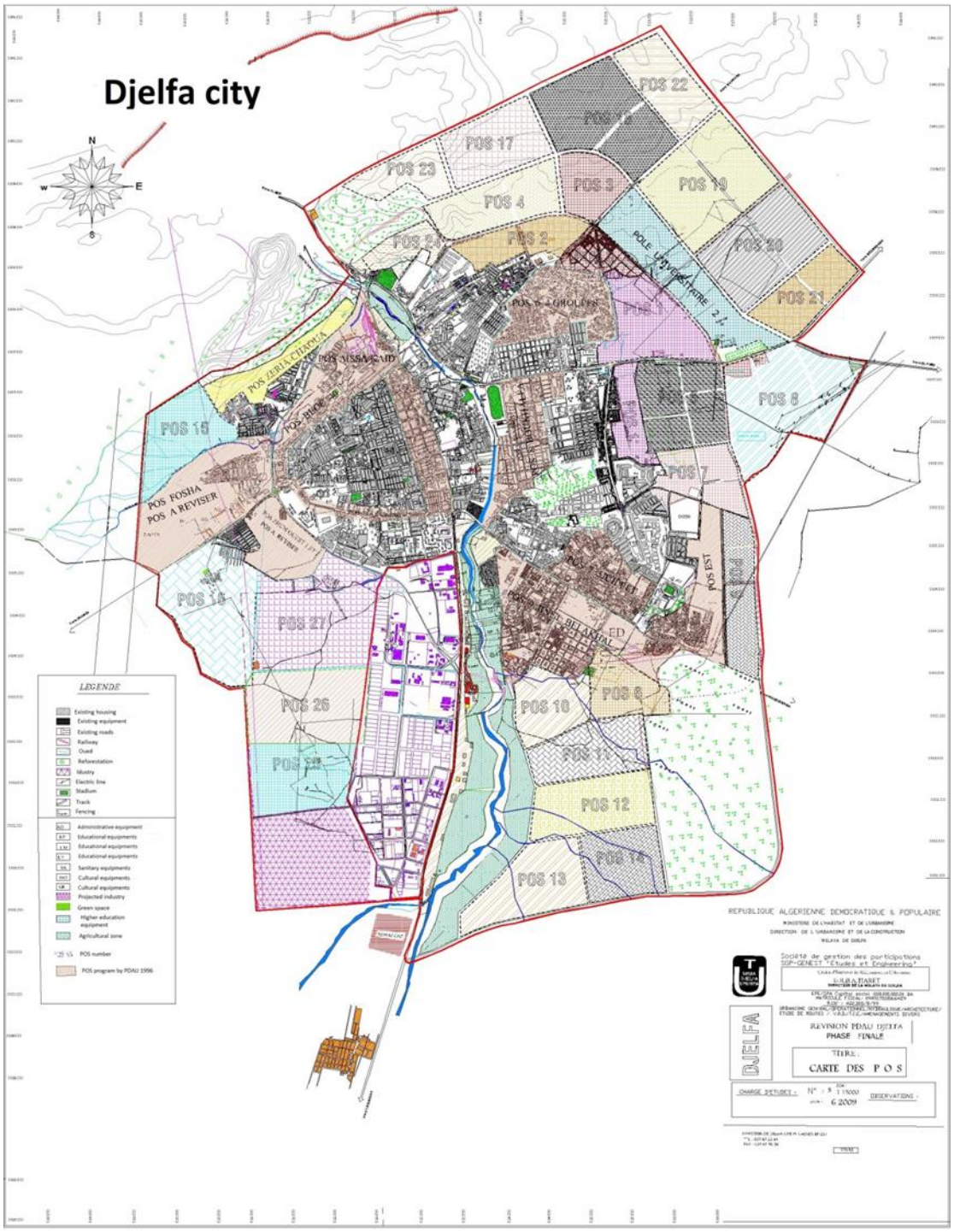

Figure 21.The MPDTP of Djelfa city

Source: URBATIA

The Figure 21 shows the MPDTP of Djelfa city, which includes the 27 lands and where they are located in the city, it presents also distribution of the equipment and the existing housing and roads. The MPDTP also helps to know the direction of expansion.

Also, through the PDAU instrument, and with our experience of the municipality of Djelfa, we used old google earth maps in order to know the different directions of extension of urban development in the city of Djelfa, we used the open-source software QGIS in which we vectorized the urban space on different dates (2012,2016,2020). after vectorization we were able to see the visual extension especially on the north-east and south-west. as this map shows:

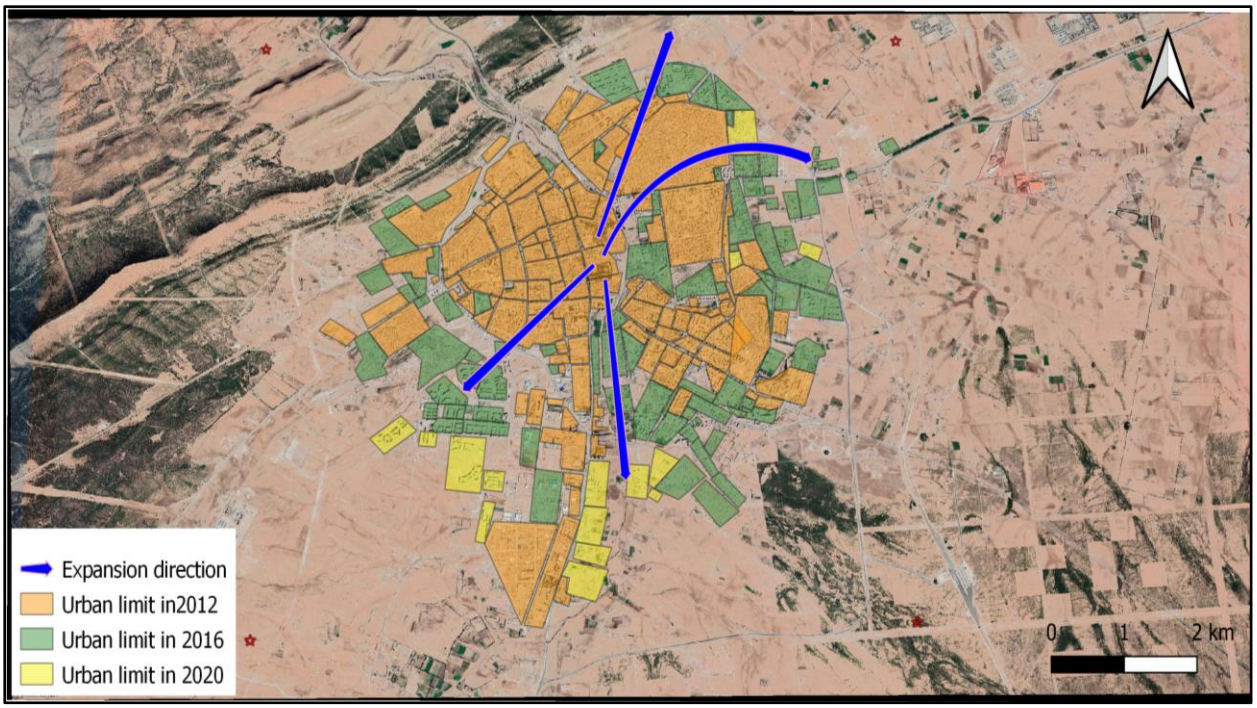

Figure 22The direction of expansion in Djelfa city

Source: student work

3.9.9. Residential Program

According to estimates derived from the master plan for preparation and reconstruction, the upward demographic evolution of the population of the city of Djelfa has caused a glaring lack of housing needs. We note that by 2024 the housing shortage will be estimated at 49,234 housing of all types.

period	2004	2009	20014	2019	2024	total
necessary housing	35311	46041	60031	68919	79123	/
Existing dwellings	29889	35311	46041	60031	68919	/
inability	5422	10730	13990	8888	10204	49234

Table 18. Evolution of housing demand until 2024

Source: URBATIA

From the above table, we notice that the number of necessary housings is rising constantly, because of the increase in the population and the lack of housing programs. As the total of this deficit will reach 49234 housing units until 2024.

3.10. The Algerian economy

By generating 93-95% of exports, hydrocarbons are classically the cornerstone of the Algerian economy. However, since 2014, the drop in oil prices gradually reduced the budget and melted foreign exchange reserves, as the outbreak of the popular anti-government protest movement "Hirak" from February 2019 led to the paralysis of much of economic activity (Switzerland, 2020). The Covid-19, along with the oil shock and the confinement of workers, only subsequently worsened this already very precarious situation. This is how after a significant decline in 2019, Algeria experienced, during the first half of 2020, a drop in exports of 26% (oil) and 37% (gas) compared to the same period of 2020. The balance deficit trade (Switzerland, 2020) led to a fall in foreign exchange reserves to 44 billion USD until July 2020 against 195 billion USD at the end of 2013. Note that GDP growth had already slowed down to settle at 0.7% in 2019, against 1.4% in 2018, while non-hydrocarbon growth

was 2.4% in 2019 against 3.3% in 2018. Despite the misgivings of the IMF, the inflation rate was at 1.9% in 2019, against 4.2 % in 2018, with a forecast of 3.5% for 2020.

	2018	2019	2020	2021
GDP growth (%)	1.4	0.7	-5.2	6.2
GDP (USD Billion) *	173.8	172.8	178.6	181.6
GDP per capita (USD) *	4’081	3’980	4’039	4’033
Inflation rate (%)	4.3	2.0	3.5	3.7
Unemployment rate (%)	11.7	11.4	15.1	13.9
Budget balance (% of GDP)	-4.5	-5.1	-15.0	-10.1
Total debt (% of GDP)	38.3	46.1	49.2	52.5
Current account (% of GDP)	-9.6	-9.6	-18	-17.1

Table 19. Main economic data

Source: FMI World Economic Outlook, April 2020: Algeria Economic Report

The percentages provisional calculated dates 2020 percentage are very low because of COVID-19 and its consequences such as the fall in the price of oil caused by a global economic slowdown and weak transport.

The percentages provisional calculated dates in 2021 have returned to the rise and this is due to a resumption of economic activities due to a possible end of the pandemic which results in a resumption of economic activity which will cause an increase in the price of oil.

3.11. Conclusion

In this chapter, we presented the study area to know its characteristics and took a glimpse of the most important factors that affect urban growth (demographic growth, demand for housing, the economy, the expansionist policy of cities and the topography of the region), which are parameters that we will address in the last chapter to study.

4. CHAPTER II

4.1. Introduction

The growth of cities raises many questions and challenges for urban planning including which cities and regions are most likely to grow, what the pattern of urban growth will be, and how the existing infrastructure will cope with such growth. One way to explore these types of questions is through the use of Agent-Based Models (ABM) that are able to modelling how individuals interact and how structures emerge through such interactions, in terms of both the social and physical environment of cities.

Our chapter is divided into two parts .in the first one we are going to give a general idea about the Agent-Based Models (what is an agent? what is a multi-agent system? And what are the advantages of it, after that we will see the application of the agent-based modelling in urban planning.

The second part is a general introduction to the computer algorithm, its definition in simple term, what is an algorithm used for and some examples about it.

4.2. Agent based modelling:

Agent-based modeling is a powerful simulation modeling technique that has seen a number of applications in the last few years, including applications to real-world business problems. After the basic principles of agent-based simulation are briefly introduced, its four areas of application are discussed by using real-world applications: flow simulation, organizational simulation, market simulation, and diffusion simulation. For each category, one or several business applications are described and analyzed.

In agent-based modeling (ABM), a system is modeled as a collection of autonomous decision-making entities called agents. Each agent individually assesses its situation and makes decisions on the basis of a set of rules. Agents may execute various behaviors appropriate for the system they represent—for example, producing, consuming, or selling. Repetitive competitive interactions between agents are a feature of agent-based modeling,

which relies on the power of computers to explore dynamics out of the reach of pure mathematical methods. At the simplest level, an agent-based model consists of a system of agents and the relationships between them. Even a simple agent-based model can exhibit complex behavior patterns and provide valuable information about the dynamics of the real-world system that it emulates. In addition, agents may be capable of evolving, allowing unanticipated behaviors to emerge. Sophisticated ABM sometimes incorporates neural networks, evolutionary algorithms, or other learning techniques to allow realistic learning and adaptation (Bonabeau, 2001).

4.2.1. What are advantages of ABM?

There is no strict definition about what an agent is. Literature offers a variety of definitions ranging from the simple to the lengthy and demanding ones. All available definitions are strongly biased by the background field interested in agent technology (main being: artificial intelligence, software engineering, cognitive science, computer science, engineering in general, etc.) (Glavic, 2006). Instead to list and elaborate different definitions, two definitions of the agent coming from (S. Russel, 1995) and (Maess, 1995) are given here since they seem to be rather general, widely accepted by different research communities, and closest to power engineering people perception of agents. In (S. Russel, 1995) , an agent is defined as follows.

4.2.2. How to Think About Agent-Based Modeling

1- Structure of an agent-based model

A typical agent-based model has three elements:

- Agents, their attributes and behaviors.
- Agent relationships and methods of interaction. An underlying topology of connectedness defines how and with whom agents interact.
- Agents' environment. Agents live in and interact with their environment, in addition to other agents. (North C. M., 2014)

Application Area:	Agent-based Model Focus:
Agriculture	A spatial individual-based model prototype for assessing potential pesticide exposure of farm-workers conducting small-scale agricultural production.
Air Traffic Control	Air traffic control to analyze control policies and performance of an air traffic management facility.
Archaeology / Anthropology	Trends in archaeological simulation including ABM. Prehistoric settlement patterns and political consolidation in the Lake Titicaca basin of Peru and Bolivia.
Biomedical Research	The Basic Immune Simulator, to study the interactions between innate and adaptive immunity.
Crime Analysis	A realistic virtual urban environment, populated with virtual burglar agents.
Ecology	Investigation of the trade-off between road avoidance and salt pool spatial memory in the movement behavior of moose. Predator-prey relationships between transient killer whales and other marine mammals.
Economics	Using agent-based models for analyzing threats to financial stability
Energy Analysis	A building occupant network energy consumption decision-making model, Application for the Smart Grid. Energy investment decision making. Oil refinery supply chain.
Environmental Planning and Policy	Overview of agent-based modeling for environmental planning and policy analysis.
Epidemiology / Infectious Diseases	Pandemic disease model accounting for individual behavior and demographics.

	Global-scale agent model of disease transmission.
Evacuation	Tsunami evacuation using a modified form of Helbing's social-force model applied to agents.
Healthcare	A systematic assessment of use cases and requirements for enhancing pharmaceutical research and development productivity through agent-based modeling.
Market Analysis / Marketing	Consumer marketing model developed with a Fortune 50 firm. Consumer airline market share. Simulation of the Possibilities for a future market in sub-orbital space tourism Overview of agent-based applications to marketing.
Social Networks	Model of email-based social networks. Individuals establish, maintain and allow atrophy of links through contact-lists and emails.
Social Psychology	Using ABM for theory building in social psychology.

Table 20. A sample of recent agent-based applications and overviews

Source: Introductory tutorial: agent-based modeling and simulation

A model developer must identify, model, and program these elements to create an agent-based model. A computational engine for simulating agent behaviors and agent interactions is then needed to make the model run. An agent-based modelling toolkit, programming language or other implementation provides this capability. To run an agent-based model is to have agents repeatedly execute their behaviors and interactions. This process is often but not necessarily modeled to operate over a timeline, as in time stepped, activity-based, or discrete-event simulation. In Table 20 we will show different ABM toolkits using different language and extensions. (North C. M., 2014)

4.2.3. What is an agent?

"An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors".

According to this definition an agent is any entity (physical or behavioral) that senses its environment and acting over it.

Also, there is Autonomous agents are computational systems that inhabit some complex dynamic environment, sense and act autonomously in this environment, and by doing so realize a set of goals or tasks for which they are deigned" (Glavic, 2006)

The key extensions in this definition with respect to first one is words: computational, autonomy, and goals. Word computational makes difference in agents that we are interested in engineering (computational agents) from interacted agents (humans, animals, bacteria) since from first definition this distinction is not obvious. Autonomy means that computational agents operate without the direct intervention of some other entities and have some kind of control over their actions. Assigning the goals to the agent means that acting upon environment should be done in order to achieve some specified objective (goal) and that the agents expose a sort of rational (an agent that minimizes or maximizes its performance measure) behavior in the environment. Behavior here means the action that is performed after receiving sensory inputs (or any sequence of sensory inputs) (S. Russel, 1995). A general single-agent framework is illustrated in Figure 23 (Glavic, 2006).

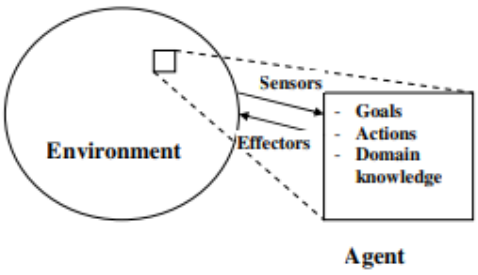

Figure 23.A general single-agent framework

In addition to the sensory inputs, actions, and goals an agent may include domain knowledge (the knowledge about particular environment or problem to be solved). This knowledge can be algorithmic, artificial intelligence (AI) technique based (rule-based, fuzzy, simultaneous,

neural networks, machine learning), heuristics, etc. In AI case an agent is often termed as intelligent one.

The notion of environment that an agent inhabits (is situated in or simply said placed in) include physical systems (as in engineering), in our case it could be houses, roads, mountains, rivers, or SLEUTH (Slope, Land use, Excluded, Urban, Transportation and Hill shade).

The various definitions of agents involve a host of properties of an agent and agents are usually classified based on those properties. (Glavic, 2006)

Table 21 lists several properties that can be encountered in literature and are given here for the reader just to have an idea what the particular term (often considered as a type of agent) means.

Property	**Other names**	**Meaning**
Reactive	Reflex, sensing and acting	Responds in a timely fashion to changes in the environment
Autonomous		Exercise's control over its own actions
Goal-oriented	Pro-active, purposeful	Does not simply act in response to the environment
Temporally continuous		Is a continuously running process
Communicative	Socially able	Communicates with other agents
Learning	Adaptive	Changes its behavior based on its previous experience
Mobile		Able to transport itself from one machine to another (this is associated manly with software agents)
Flexible		Actions are not scripted

- **Table 21. Some properties of agent**

Source: Agents and Agent-Based Models: A Short Introduction for Power Engineers

Figure 24 illustrates reactive and deliberative agents. Some of the authors do not assign any goals to reactive agents but the goals can be embodied in the sensory inputs processing or condition-action rules

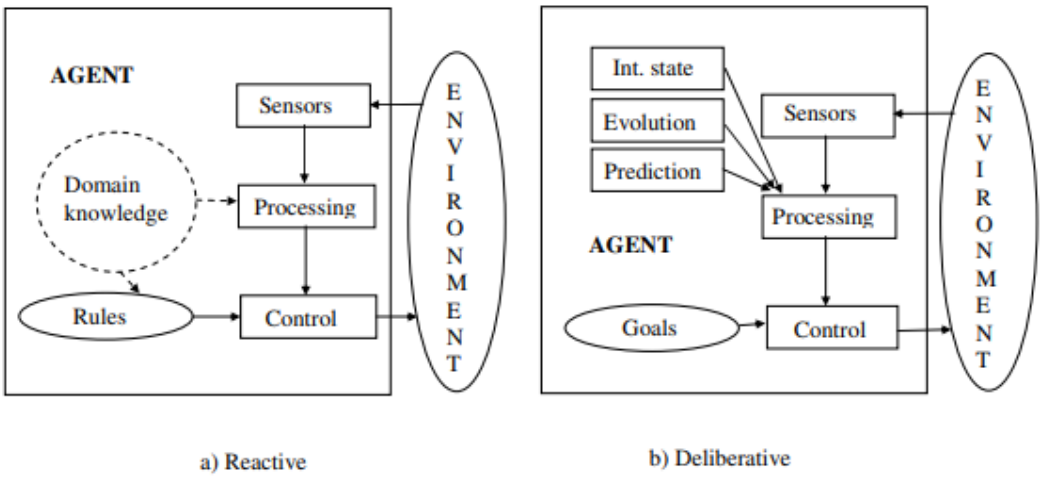

Figure 24.Reactive (reflex) and deliberative agents

The various definitions of agents involve a host of properties of an agent and agents are usually classified based on those properties. (Glavic, 2006)

Table I lists several properties that can be encountered in literature and are given here for the reader just to have an idea what the particular term (often considered as a type of agent) means.

4.2.4. How to do agent-based modelling?

a) Thinking Through an Agent Model

Agent-based model development follows the general steps of developing any model with the additions of agent-related tasks (Figure 25).

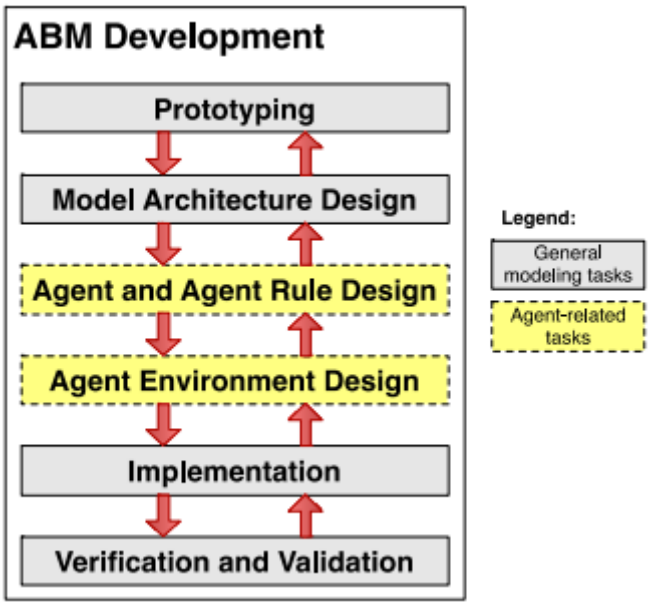

Figure 25.Agent –based model development process.

Source: (North C. M., 2014)

b) Modelling Agent Systems

Identifying agents, accurately specifying their behaviors, and appropriately representing agent interactions are the keys to developing useful agent models. One begins developing an agent-based model by identifying the agent types (classes) along with their attributes. (North C. M., 2010)

c) Advanced Agent-Based Modelling

Often, an agent-based modeler would like to include a variety of advanced capabilities in their model. These capabilities include distributed computing implementations, artificial intelligence and machine learning algorithms, geographical information systems (GIS), connections to relational databases, version control systems (especially if there are multiple developers working on a project), and integrated development environments (IDEs). It is often useful to first develop a core model that includes these capabilities as connections or "stubs" to ensure the core model design is acceptable and to verify that scaling up the design appears feasible. Agent-based modeling and software toolkits usually provide such advanced capabilities. (North C. M., 2014)

4.2.5. Why and when ABM?

We conclude by offering some ideas on the situations for which agent-based modelling can offer distinct advantages to conventional simulation approaches such as discrete event simulation (Law, 2007) , system dynamics (Sterman, 2000) and other quantitative modelling techniques (Axtell, 2000).discusses several reasons for agent-based modelling especially compared to traditional approaches to modelling economic systems. When is it beneficial to think in terms of agents? When any of the following criteria are satisfied:

- When the problem has a natural representation as being comprised of agents
- When there are decisions and behaviors that can be well-defined
- When it is important that agents have behaviors that reflect how individuals actually behave (if known)
- When it is important that agents adapt and change their behaviors
- When it is important that agents learn and engage in dynamic strategic interactions
- When it is important that agents have dynamic relationships with other agents, and agent relationships form, change, and decay
- When it is important to model the processes by which agents form organizations, and adaptation and learning are important at the organization level
- When it is important that agents have a spatial component to their behaviors and interactions
- When the structure of the system does not depend entirely on the past, and new dynamic mechanisms may be invoked or emerge that govern how the system will evolve in the future.
- When arbitrarily large numbers of agents, agent interactions and agent states is important
- When process structural change needs to be an endogenous result of the model, rather than an input to the model (North C. M., 2014)

4.2.6. Agent-Based Models for Urban Planning

The study of human behavior is completely different from the study of physics and chemistry because it cannot be studied or predicted. In order to solve urban problems such as sprawl, crowding, and segregation, the researchers decided to research the logic by which individual decisions are made, which led them to develop Agent-Based Models (ABM), which allows one to simulate the individual actions of a diverse group of agents, measuring the resulting system behavior and outcomes over space and time (Torrens, 2002) .

ABM models provide a good test bed for developing new models of cities. ABM and cities both operate on a cross-scale basis and are highly dynamic in both space and time. In cities interactions propagate through urban systems, from flows and relationships between individuals in space to regional scale geographies (Andrew T. Crooks).

4.2.7. The ability of Agent-Based Models in Urban Planning:

Agent-Based Models can not only raise awareness of the consequences of urban growth but also test out policy ideas (e.g., restricting growth on specific land-use types or promoting higher density development) to see how these policies might impact future land-use patterns (Andrew T. Crooks).

Agent-Based Models for Urban Planning models allow us to further explore the evolution of the system and account for other parameter's such as heterogeneous population, imperfect competition, and limited knowledge (Tesfatsion, 2006) which were not Possible to accommodate in past modelling endeavors.

ABM modelers are also able to explore how housing evolve from the bottom up. For example, (Gilbert N. H., 2009) modelled how house prices evolved from the interactions of buyers, sellers, and estate agents (realtors) within an artificial world. Moreover, such models can also incorporate macro-level parameter's such as economic conditions relating to interest rates, GDB, employment, availability of housing stock, government taxation, and legislation with respect to buying and selling a house (Andrew T. Crooks).

ABM models provide us with a means to explore not only how a city might grow but also why people make decisions on where to live. A greater understanding of both the potential growth trajectories and the Possible restructurings of cities could potentially help planners better anticipate what the future might hold (Andrew T. Crooks).

ABM has proved useful in exploring urban growth, we believe that it will be a useful tool to study questions about how slums come into existence, how they expand, and which processes may make some slums disappear. We believe this is especially true because ABM modelling is inherently dynamic and focused on the individual behaviors that manifest in the formation of slums. However, there has been little work with respect to slum modelling from the specifically ABM perspective (Andrew T. Crooks) .

ABM models have been used to explore many traffic related issues, as the methodology can be used to simulate thousands of individual cars and test the impact of various aspects of the system being modelled. Researchers have studied what the mechanisms of stop and go traffic are (Helbing, 2001) the impact of new radial highways on congestion (Makarov, 2008) the potential for accidents between cars and people (Banos, 2005) the impact of tolls for entering an area (Takama, 2008) how severe weather can impact the flow of traffic (Zhao, 2012) evacuation routing (Thorp, 2006) the effects of restricted parking (Benenson, 2008) the impact of a closure of a section of a road (Manley, 2011) or how one can improve the flow of traffic during the journey to-work by combining traffic light controls and speed limits (Nagel, 2003) . Once the dynamics of traffic are understood, one can then potentially link such models to other types of models such as urban growth models to explore what future urban development patterns might look like (Miller, 2004) and how these patterns will, in turn, affect commuting. Traffic models can also be linked to epidemic models since the transportation systems also play a role in the spread of diseases (Batty, 2005) . Thus, if we know how people move about an urban area, we can potentially model the spread of diseases as well.

Apart from dealing with population growth and the resulting expansion of urban areas in the coming decades, cities will also face the challenge of substantial aging within their populations as a result of rising life expectancies. This will be especially acute in the developed world. There are few ABM models that explore these issues, and such analysis tends to focus on micro simulation techniques developed for exploring issues such as future

pensioners incomes and their effect on the economy or how aging populations will affect the cost of health care services (Andrew T. Crooks).

4.2.8. Open-Source ABM toolkits

Agent-based modelling can be done using general, all-purpose software or programming languages, or can be done using specially designed software and toolkits that address the specific requirements for modelling agents.

No.	Name	Programming language	License	Description
1	**ActressMas**	C#	Open source	Used for teaching multiagent protocols and algorithms. offers implementations of various popular multiagent protocols and algorithms
2	**Agents.jl**	Julia	Open source	General purpose, grid based environments; 1D, 2D, 3D; distributed simulations
3	**AgentScript**	Javascript	Open source	General purpose, based on NetLogo semantics
4	**CoSMoSim**	GUI based	Open source (Java)	Component-based, modular, hierarchical modeling; DEVS, cellular automata and XML models
5	**DEVS-Suite**	GUI based	Open source (Java)	Rich visual modeling, component-based and cellular automata simulator, hierarchical models, superdense time data trajectories
6	**Evoplex**	C++	Open source	An agent is represented as a node in a network; Evolutionary Graph Theory, Evolutionary Dynamics, Game Theory, Cellular Automata,

				Complex Adaptive Systems.
7	**Gama**	Java GAML	Open source (Java)	Complete modeling and simulation development environment for building spatially explicit multiagent simulations
8	**FLAME**	C/C++	Open source	It generates a complete agent-based application which can be compiled and built on most computing systems ranging from laptops to HPC supercomputers.
9	**FLAME GPU**	C for CUDA, C-based scripting	Open source (C/C++)	Graphics Processing Unit (GPU) extension to the FLAME framework
10	**Insight Maker**	Runs in the browser and modeling is done through the browser UI	Open source (Qt)	System dynamics, agent-based modeling in the browser.
11	**JaCaMo**	AgentSpeak (Jason)	Open source	Autonomous agents, environment artifacts, multiagent organizations
12	**JADE**	Java, C# (JADE LEAP)	Open source (Java)	FIPA-compliant middleware, graphical debugging and deployment tools
13	**JADEX**	Java	Open source (Java)	Rational agents on top of JADE, BDI
14	**Janus, SARL**	SARL, interoperable with Java	Open source (Java)	Agent-oriented SARL language, fundamental abstractions for dealing with concurrency, distribution, interaction, decentralization, reactivity, autonomy and dynamic reconfiguration
15	**JAS-mine**	Java	Open source	Discrete-event simulation, including

				agent-based and micro-simulation models. Integration with RDBMS (relational database management tools
16	**MADKIT**	Java	Open source	AGR (Agent/Group/Role) organizational model: agents play roles in groups and thus create artificial societies.
17	**ABMON**	Java	Open source	Discrete event multiagent simulation; 2D and 3D visualization
18	**ABMS**	Java, C++, Cuda	Open source (Java, C++)	Parallel-computing library for multiagent and spatial simulation over a cluster of computing nodes.
19	**Mesa**	Python 3+, recent code,	Open source, Apache2 licensed (Python)	Python 3 alternative to NetLogo, Repast, ABMON.
20	**MOOSE**	C++	Open source (C++)	High-scale Multiphysics object-oriented simulation environment.
21	**Orleans**	C#	Open source	Distributed high-scale computing applications, without the need to learn and apply complex concurrency or other scaling patterns.
22	**Repast**	Java, Python, C#/.NET, C++, ReLogo, Groovy	Open source (Java, C++)	Agent-based modeling and simulation that can run on large computing clusters and supercomputers.
23	**SeSAm**	GUI programming	LGPL license (Java)	based modeling and Distributed agent simulation
24	**SLAPP**	Python	Open source	Swarm-like agent protocol

25	**SPADE**	Python	Open source	Multiagent and Organizations Platform based on the instant messaging XMPP/Jabber technology
26	**SpaDES**	R	GPL-3	Spatially explicit discrete event simulation models

Table 22. General purpose platforms - open-source, free software

Source : (Pal, Leon, Marcin, & Maria, 2020)

4.3. Algorithm definition

An algorithm specifies a series of steps that perform a particular computation or task. Algorithms were originally born as part of mathematics – the word "algorithm" comes from the Arabic writer Muḥammad ibn Mūsā al-Khwārizmī, – but currently the word is strongly associated with computer science. Throughout this book we'll examine a number of different algorithms to perform a variety of tasks. (Kuchling, 2017)

Algorithms resemble recipes. Recipes tell you how to accomplish a task by performing a number of steps. For example, to bake a cake the steps are: preheat the oven; mix flour, sugar, and eggs thoroughly; pour into a baking pan; and so forth. (Kuchling, 2017)

However, "algorithm" is a technical term with a more specific meaning than "recipe", and calling something an algorithm means that the following properties are all true:

- An algorithm is an unambiguous description that makes clear what has to be implemented. In a recipe, a step such as "Bake until done" is ambiguous because it doesn't explain what "done" means. A more explicit description such as "Bake until the cheese begins to bubble" is better. In a computational algorithm, a step such as "Choose a large number" is vague: what is large? 1 million, 1 billion, or 100? Does the number have to be different each time, or can the same number be used on every run?
- An algorithm expects a defined set of inputs. For example, it might require two numbers where both numbers are greater than zero. Or it might require a word, or a list of zero or more numbers.

- An algorithm produces a defined set of outputs. It might output the larger of the two numbers, an all-uppercase version of a word, or a sorted version of the list of numbers.
- An algorithm is guaranteed to terminate and produce a result, always stopping after a finite time. If an algorithm could potentially run forever, it wouldn't be very useful because you might never get an answer.
- Most algorithms are guaranteed to produce the correct result. It's rarely useful if an algorithm returns the largest number 99% of the time, but 1% of the time the algorithm fails and returns the smallest number instead.
- If an algorithm imposes a requirement on its inputs (called a *precondition*), that requirement must be met. For example, a precondition might be that an algorithm will only accept Positive numbers as an input. If preconditions aren't met, then the algorithm is allowed to fail by producing the wrong answer or never terminating. (Kuchling, 2017)

Informally, an **algorithm** is any well-defined computational procedure that takes some value, or set of values, as **input** and produces some value, or set of values, as **output.** An algorithm is thus a sequence of computational steps that transform the input into the output.

We can also view an algorithm as a tool for solving a well-specified computational problem. The statement of the problem specifies in general terms the desired Input/output relationship. The algorithm describes a specific computational procedure for achieving that input/output relationship.

For example, we might need to sort a sequence of numbers into none decreasing order. This problem arises frequently in practice and provides fertile ground for introducing many standard design techniques and analysis tools. Here is how we formally define the **sorting problem** (Sergey, 2021)**.**

4.3.1. Algorithm Examples

a) Examples N°1

Let's look at a very simple algorithm called `find_max()`

Problem: Given a list of Positive numbers, return the largest number on the list.

Inputs: A list L of Positive numbers. This list must contain at least one number. (Asking for the largest number in a list of no numbers is not a meaningful question.)

Outputs: A number n, which will be the largest number of the list.

Algorithm:

1. Set max to 0.
2. For each number x in the list L, compare it to max. If x is larger, set max to x.
3. max is now set to the largest number in the list.

An implementation in Python:

```
def find_max (L):
    max = 0
    for x in L:
        if x > max:
            max = x
    return max
```

There can be many different algorithms for solving the same problem. Here's an alternative algorithm for **find_max()**

1. If L is of length 1, return the first item of L.
2. Set v1 to the first item of L.
3. Set v2 to the output of performing **find_max()** on the rest of L.
4. If v1 is larger than v2, return v1. Otherwise, return v2.

Implementation:

```
def find_max (L):
    if len(L) == 1:
        return L[0]
    v1 = L[0]
    v2 = find_max(L[1:])
    if v1 > v2:
        return v1
    else:
```

So,

- ✓ for each blue agent, the algorithm (pseudocode) is as follows:
- ✓ Compute own affect (with term explosions as conditioning trials);
- ✓ Compute own local probability (relative frequency of term within spatial sampling radius);
- ✓ For each other agent in network Compute the weighted solo disposition;
- ✓ Add the above-computed numbers;
- ✓ Subtract own threshold; If the result is Positive, Act;
- ✓ otherwise, don't;
- ✓ Apply own extinction rate to own affect;
- ✓ Move;
- ✓ Repeat

4.4. Conclusion

The use of computer algorithms plays an essential role in research informatic area. by using the algorithm, we could develop the ABM's which is now used in many domains and can solve complex problems, including the problem of urban growth.

In this chapter, we have defined the ABM and its utilization and advantages and we could know how to do agent-based modelling. then we saw ability of the ABM in Urban Planning.

Also, we took an overview of the Algorithm (definition and examples).

5. CHAPTER III

5.1. Introduction

In this chapter we will carry out our algorithm following the example cited in the second chapter, as well as we will also choose the ABM software defined in this same chapter according to our needs. also, we will subtract the most important parameters elaborated in the first chapter in order to integrate them in our ALGO + ABM.

5.2. Gathering data's

according to the theoretical representation of the city of Djelfa, we were able to bring to light the various parameters which have a determining role in the evolution of the urban phenomenon. which leads us to realize the following table which represents these different parameters:

source	Parameters
National Office of statistic, general census 2008, student prognostic calculation	Population and growth
Table 18	Habitation demand
LUP and MPDTP	Future projects
Figure 4. Topographic map of Djelfa region	topography and land use
MPDTP and LUP	Urban policy
Algeria Economic Report August 2019 - July 2020	GDP
Equipment's map	equipment's

Figure 11. Distribution of the urban equipment in Djelfa city	
Transport map Figure 12.The set of roads in Djelfa city	Transportation

Table 23. The parameters

Source: student

5.3. Algorithm and it's applications

First, we will define the agents who intervene in urban development in the city of Djelfa:

according to our theoretical study in the first chapter and our experience we were able to define three main agents which intervene in this development, these three agents are as follows in order of the most important to the least important:

1. the authorities whether they are decision-makers or urban planners.
2. legal dwellers.
3. informal houses seekers.

5.3.1. the authorities whether they are decision-makers or urban planners

this agent is the most important, it plays a primary role because of the economic choice of the country (always socialist economy); thus, the role of the socialist choice induced by the state and the authorities has contributed the most in the urban space. the latter is composed of social housing as well as equipment's, PSH and PPH housing as well as other construction formulas, the authorities also programs from time-to-time distribution of land to applicants so that they can build their houses.

5.3.2. legal housing seekers

in addition to the consumption of housing and land issued and produced by the state, these researchers can also buy lands, from people owning land with building permits or build their

own houses on their land if they have one. finally, these inhabitants have the right to build mosques, shops and buildings related to their activities such as clinics, study offices ... etc.

5.3.3. informal houses seekers

informal houses seekers are often the result of a lack of housing and land available to the public, also, mismanagement plays an important role in its proliferation.
thus, informal houses increases when the supply decreases and stabilizes when the supply increases because of the presence of squatters and the black market.

5.3.4. Idea process of the agents

now we will discuss the decision-making process of these agents in order to diagram them afterwards in an algorithm:

our first agent which is the authorities; his role seems the most important, he intervenes in the territory by seeking land and spaces suitable for the realization of his projects, the latter must correspond to a schedule of conditions which defines the rules of town planning and the location of LUP according to the MPDTP, e.g., area, type of land, topography, distance from town, owners, population density, transport, etc.

logically, these decision-makers are not numerous and have information's which makes them fattest in their decisions, on the other hand the impact which they produce on the ground is more important, because after having chosen the ground, they quickly carry out large housing projects or equipment which accelerates the urban development.

therefore, our agents are dozens who travel the city which makes their task difficult, on the other hand when he finds a field it will have a greater and faster impact in the city.

this way of simulating this agent is quite logical, taking into consideration that decision-makers find difficulty in finding ground and carrying out projects. it is obvious that the number of agents depends on the simulation so that the numbers of lands found are closer to the reality.

the second agent, who are legal housing seekers, are often researchers who await the completion of the various housing projects carried out by the state, and who are the first to will have them, these researchers are characterized of being their middle-income earners and also by their large number. thus, we used them in the simulation by making them waiting for the projects carried out by the state, through this waiting they can find other ways and means of legal habitation, such as the self-construction on legal lands or the purchase of properties.

finally, the third agent supposed to be informal housing seekers are often researchers with low income or squatters who seek to trade their home or their status.

the latter are less numerous than the legal housing seekers, because of the informality and the irregular situation of which they are in.

in the simulation, we found these agents on the outskirts of the city and their number increases when the supply of legal housing becomes scarce

in addition to these agents, other parameters will be added to our algorithm and thus our ABM:

1. Growth rate.
2. Economy.
3. Topography.

we can add after the topography and the type of property of the ground as well as the type of ground or other parameter's which allow to get closer to reality.

5.3.5. Agents and parameter's

the evolution of agents in real life is often conditioned by factors governing their movement and development, according to table N °23, thus, to get as close as Possible to reality it seemed necessary to us to integrate the following parameters in our algorithm.

a) Agents with their environment's

in our algorithm the agents move in a random way with a precise distance for each type, this distance allows to limit the search time for a new location, during this search topographic conditions can considerably impact their seeking. during this search, they can face topographical conditions which limit their chance to access suitable lots of land, for example, the presence of a Wadi, Djebel, forest or hill. The transport parameter can also contribute Positively to the installation of a polygon. Concerning informal house seekers and from our observation we can deduce that this agent prefers to settle in the outskirts of the city far from the eyes of authorities and where land is cheaper.

b) Agents' economy and growth rate

As we specified earlier, access to land and informal houses for informal house seekers (IHS) is conditioned by the price of land so they are more often present in the peripheries of cities or towns were land and houses are cheaper; Regarding legal houses seekers (LHS), their standard of living and

their raw per capita income and the gross domestic product of the state plays a considerable role in the ability to shape and materialize these polygons (future projects) into real projects.

when these agents (LHS, IHS) find homes, they will automatically be deleted from the account in the algorithm, on the other hand it is important not to omit the contribution of the growth rate parameter which makes it Possible to automatically generate new agents each time period in our simulation.

5.4. The Algorithm

for our algorithm, we will choose the second example cited in chapter two. the latter will allow a better understanding of the code and its interoperability.

- ***Add vectorized polygons // buildings, mountains, forests, Oued and hills***
- ***Add vectorized lines // transport lines***
- ***Def authorities as agent***
- ***Def legal_housing_seekers as agent // using economic threshold (middle and high income)***
- ***Def informal_houses_seekers as agent // using economic threshold (low income)***
- ***Def growth_rate***
- ***Def min threshold_economy***
- ***Def topography***
- ***Def min threshold_authorities_polygon as sup***
- ***Def min threshold_LHS_polygon as sup***
- ***Def min threshold_IHS_polygon as sup***
- ***Def threshold_habitation_project = habitation_demand/ Provided houses***
- ***Authorities' agent looks for large polygons every step with no topographic constraint***

- ***After random steps***

- ***If Authorities' agent didn't find polygons:***
  - ***legal housing seekers agent look for less large polygons every step with no topographic constraint***
- ***After random steps***

- ***If legal_housing_seekers agent didn't find less polygons:***
  - ***informal houses seekers look for more less large polygons every step with no topographic constraint***
  - ***end***
- ***If Authorities' agent found polygons:***
  - ***Choose the closest with transportation***
  - ***Check housing demand and economy***
  - ***If housing demand > threshold_habitation_project and economy > threshold_economy***
  - ***Habitation_project = Polygon_sup /random int (2 ,3)***
    - ***else***
      - ***equipment_project = Polygon_sup /random int (2 ,3)***
  - ***number(legal_housing_seekers) = number (habitation project) – number (legal housing seekers)***
- ***if legal_housing_seekers agent found polygons:***
  - ***Choose the closest with transportation***
  - ***New_number (legal housing seekers) = Polygon sup / 100 //assuming superficies for each house = 100 m2***
  - ***number(legal_housing_seekers) = number(legal_housing_seekers) - New_number(legal_housing_seekers)***
- ***else***
  - ***If informal_houses_seekers agent found polygons:***
    - ***Choose the closest with transportation***
    - ***New_number(informal_houses_seekers) = num(polygon)***
    - ***number(informal_houses_seekers) = number(informal_houses_seekers) - New_number(informal_houses_seekers)***
- ***add growth rate formula as new_pop***
- ***def rand-number = rand int (1,5)***

- ***number(legal_housing_seekers) = new_pop / rand-number + number(legal_housing_seekers)***

- ***number(informal_houses_seekers) = new_pop / (1- rand-number) + number(informal_houses_seekers)***

- ***number(legal_housing_seekers) = number (legal_housing_seekers) + (number(legal_housing_seekers) * growth_rate)***

- ***number(informal_houses_seekers) = number(informal_houses_seekers) + (number(informal_houses_seekers) * growth_rate)***

5.5. ABM and it's applications

After the writing of our algorithm, it's execution in ABM allows to have the result below:

Figure 26 .ABM overview

The system shows us a map of Djelfa city with polygons which represent the constructions (houses and equipment), and colored dots that represent authority (orange), formal houses seekers(green), informal houses seekers(red) with a zoom button.

On the left side, we could see sliders represent the size of authorities, legal and illegal houses seekers also the seekers' growth rate. blow the map there is a Graphic curve represent the number of the LUP and the formal and informal houses.

after when we turn on the system, we can see the appearance of legal houses (yellow), illegal houses (brown), and the LUP (black) Figure 27 as their number increases with the passage of steps, at the same time the number of seekers decreases.

Figure 27. Appearance of the LUP, legal houses and illegal houses

By letting the program run in several steps, the figures below show the different results that our ABM had calculated, essentially the dwellings of the different types as well as the location of the agents.

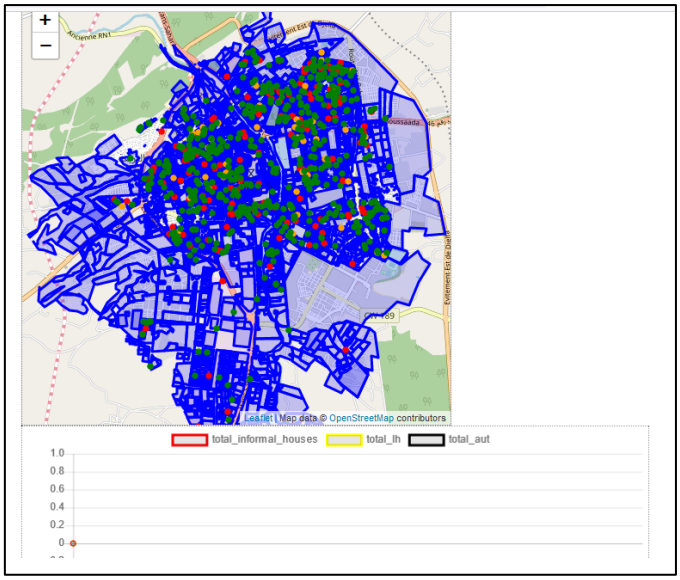

Figure 28. Step 01

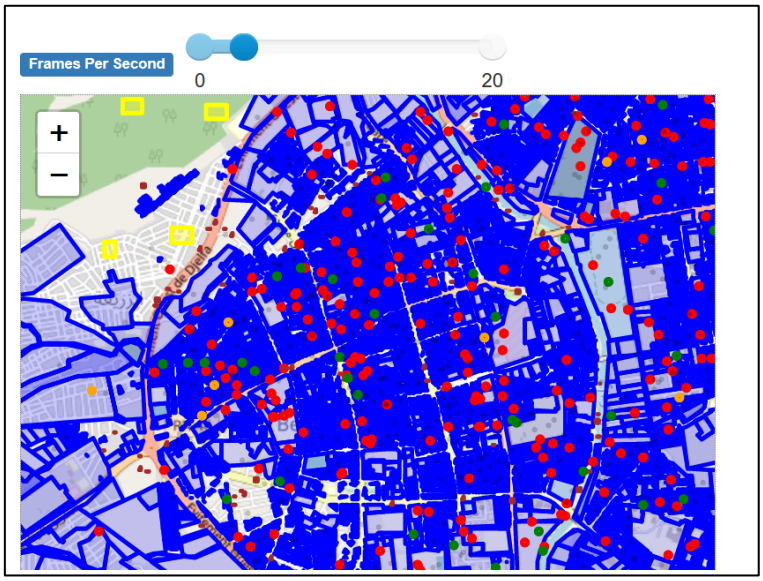

Figure 29. step 29

After passing several stages, we can see that the land chosen by our authorities' agents is on problematic places such as forests, mountains and wadis. this anomaly is intentional in order to allow the reader to notice it and also to notice that we can regulate them by another layer of polygons representing the topographic constraints and many others like that of transport.

it is possible easily to realize this layer of constraints as we did for the layer of the frame where it is impossible for the building agents to build on these polygons.

Finally, our ABM has the capacity to produce graphs which follow the evolution of agents' productions during each period Figure 30

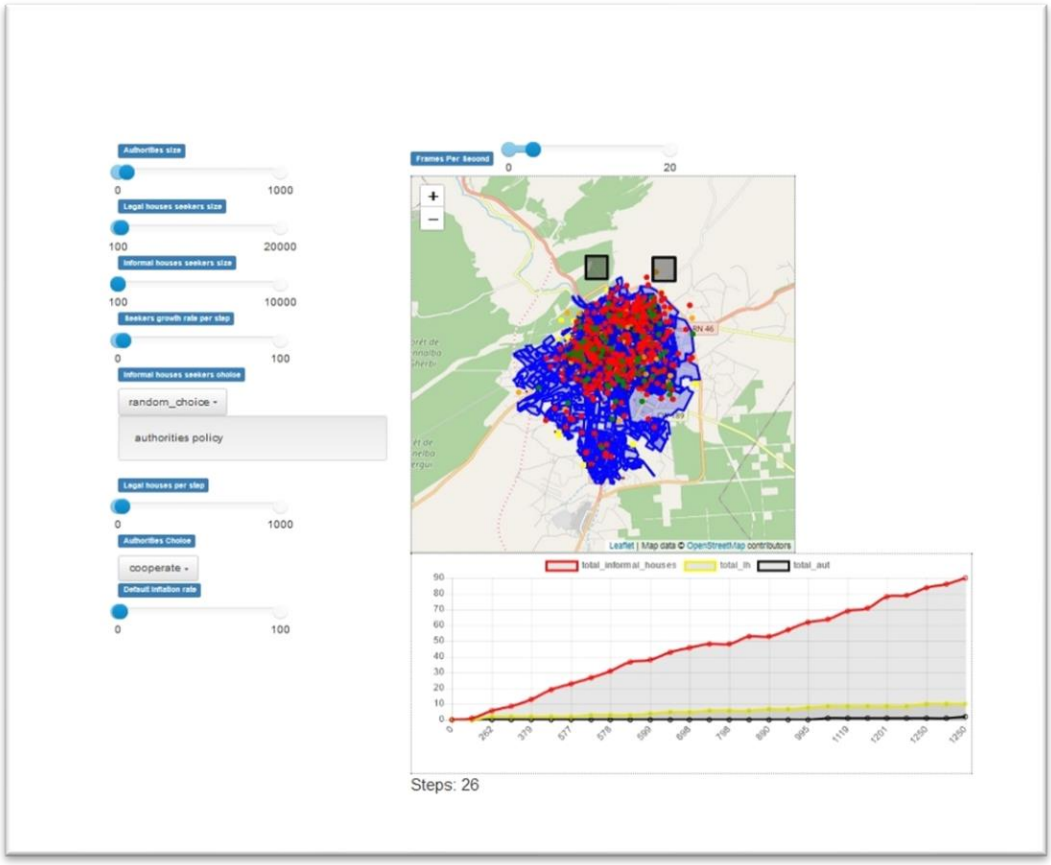

Figure 30. The appearance of graphs which follow the evolution of agents

5.6. Conclusion

during this chapter we were able to define the various parameters which interact in urban development, we also noted the various agents intervening in the municipality of Djelfa, these last are regulated by these parameters, and their interactions are represented by an algorithm which regulates their behaviors, finally we programmed our ABM with our algorithm to be able to visualize the results resulting from the various interactions and behaviors of our agents, these results are represented in figures to appreciate the urban development.

6. General Conclusion and Discussion

in our first chapter we used the different decisional tools (MPDTP,RLUP... etc.), and the different parameters which result in order to record them as variables conditioning our algorithm, the latter will be applied in an ABM chosen for our type of study where the need for spatial calculations (GIS) is essential, therefore; The expected results was very satisfactory and promising, opening up new horizons in the field of land use planning, and as decision-making tools with the capacity to encompass complex systems and thus predict the evolution of this development.

for our study we intentionally wanted to make a simple abstraction of the real in order to simplify the idea for the future reader or student in order to use this study as a basis of learning and a reference allowing him to work with these tools based on ABM.

It is quite possible to add other elements which by their complexity allow a better approach to reality, this will undoubtedly allow a more real vision and more precise forecasts. however, it should be noted the need to integrate artificial intelligence in the behavior of agents to refine the results.

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8. List of Figures

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10. Table of abbreviations

Abbreviation in	Abbreviation in	Meaning in French	Meaning in

English	French		English
GDP	**PIB**	produit intérieur brut	Gross domestic product
GPHC	**RGPH**	recensement générale de la population et de l'habitat	general population and housing census
LUP	**POS**	Plan occupation du Sol	Land use plan
MPA	**MPA**	Assemblée Populaire communale	Municipal People's Assembly
MPDTP	**PDAU**	Plan directeur d'aménagement et d'urbanisme	master plan for development and town planning
Municipality	**Commune**	/	/
NCSRAP	**CNERU**	Centre national d'études et de recherches en urbanisme	national center for the study and research in town planning
NLUP	**SNAT**	Le schéma national d'aménagement du territoire	The national land use plan
ORH	**TOL**	Taux d'occupation du logement	occupancy rate per house
ORR	**TOP**	Taux doccupation par pièce	The occupancy rate per room
PDP	**PAW**	LE SCHEMA DE COHERENCE	The Wilaya Development Plan

		URBAINE	
RLUP	**SNAT**	Le schéma régional d'aménagement du territoire	The regional land-use planning plan
Prefecture	**Wilaya**	/	/
PPH	**LPP**	logements promotionnels publics	public promotional housing
PSH	**LSP**	Logement Social Participatif	Participatory Social Housing