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Monitoring Agricultural Land Changes in Peri-Urban Oran, Algeria: A Mixed Methods Analysis

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Rabia Samah Choukri
ORCID: https://orcid.org/0000-0002-8073-3380
EGEAT – Laboratory for Geographic Space and Regional Planning, University of Oran 2 Mohammed Ben Ahmed, Algeria
E-mail: samahchoukri.r@gmail.com
Tatik Ghodbani
ORCID: https://orcid.org/0000-0001-5635-3516
EGEAT – Laboratory for Geographic Space and Regional Planning, University of Oran 2 Mohammed Ben Ahmed, Algeria
E-mail:ghodbani_tarik@yahoo.fr
Muhammad Salem
ORCID: https://orcid.org/0000-0003-1192-4412
Cairo University, Egypt, Kyushu University, Japan
E-mail: m.salem@cu.edu.eg

Abstract
The dynamics of agricultural land change in peri-urban areas are critical due to their significant impacts on agricultural productivity, food security, sustainable development, and socio-economic dynamics. These intricate processes require a robust methodological approach that can effectively identify, quantify, and analyze the drivers behind land-use changes. In the peri-urban areas of Oran, Algeria, the rapid conversion of agricultural land, particularly along the main highways in the south and southwest regions, underscores the urgent need for focused research. This study aims to map and analyze agricultural land changes between 1998 and 2019, exploring the underlying factors contributing to these shifts. Employing a mixed methods approach, the study integrates both quantitative and qualitative data to provide a comprehensive understanding of the phenomenon. The methodology encompasses five main tasks: (1) data collection and identification of significant temporal markers, (2) implementation of a Random Forest classification using medium resolution Landsat imagery, (3) assessment of the extent and patterns of agricultural land changes, (4) Evaluation of relevant planning documents, (5) field work, including stakeholders interviews and focus groups. The results reveal a persistent increase in built-up areas over the study period, leading to a corresponding decline in agricultural land. This pattern highlights emerging land-use conflicts among stakeholders. The study offers valuable insights for policymakers, suggesting strategies for more effective land use management, and the promotion of sustainable agricultural practices.
Keywords: Agricultural land. Google Earth Engine. driving factors. peri-urban area. Stakeholders. development plans

1. Introduction

Landscapes have experienced major changes throughout the course of time, driven by complex interactions between natural and human-induced factors (Plieninger *et al*., 2016; Salem *et al*., 2021). These transformations are considered as structural changes resulting from complex interactions of several variables (Antrop, 1993). Peri-urban regions, which retain rural characteristics such as natural landscapes and low-density development, are increasingly being transformed by urbanization, disrupting agricultural landscapes and socio-economic structures (Darly & Torre, 2013; Aguilar *et al*., 2022)

Peri-urban areas are zones are zones of rapid transformations (Simon, 2008; Doan & Oduro, 2012), marked by heightened vulnerability to alterations in land tenure, significant disruptions to socio-economic systems, and potential ecosystems degradation (Verburg *et al*., 2015; Verdú-Vázquez *et al*., 2021). The quality of the environment in these regions also faces deterioration (Radwan *et al*., 2019a). Moreover, the agricultural areas around metropolitan cities are undergoing notable changes (Elloumi *et al*., 2011), as peri-urban regions are increasingly targeted for their land availability (Serrano & Demazière, 2016). In addition, land-related concerns significantly intertwine with regional planning and development, and research on this subject spans a wide range of themes and levels of analysis (Gueringer *et al*., 2016).

The loss of agricultural land is a complex issue influenced by various factors (Bowie, 1993; Salem *et al*., 2019), and carries substantial environmental and economic consequences (Pimentel *et al*., 1995). Beyond reducing food security by diminishing available agricultural land, this loss also decreases biodiversity and habitat for species (Njungbwen & Njungbwen, 2012; Abd EL-kawy *et al*., 2019). The intersection of urbanization and agricultural land loss is inherently complex (Cui *et al*., 2019), with urbanization and industrialization posing significant threat to sustainable development (Liu *et al*., 2010; Deng *et al*., 2011). Therefore, quantifying the interaction between urbanization and ecosystems is crucial in the context of rapid urban growth to provide policy recommendations that mitigate potential environmental impacts (Luo *et al*., 2022).

Similar to major cities in developing countries, Oran metropolis in Algeria is experiencing broad urban expansion as a result of both exponential population increase and immigration flow and economic development (Kadri & Madani, 2015). This expansion has notably affected its agricultural land, particularly in peri-urban areas and along key transportation corridors (Tayeb & Kheloufi, 2019). Over the past three decades, Oran province has benefited from various housing programs, leading to rapid urban sprawl at a rate of 110 hectares per year (TRACHE S. Mohammed, 2010). The accelerated and concentrated development of the Oran agglomeration has profoundly impacted the agricultural sector in both the core and periphery of the city.

The studies of agricultural land dynamics in peri-urban areas increasingly employs mixed methods approaches, combining diverse datasets and methodologies to better understand the complex interactions between natural and human systems (Cheong *et al*., 2012; Salem & Tsurusaki, 2024) While quantitative approaches including geographic information systems GIS and remote sensing have shown to be effective for temporal and spatial land cover change assessment (Radwan *et al*., 2019; Rash *et al*., 2023), qualitative insights are equally valuable in comprehending human-environment (P. He *et al*., 2023). Such insights help to illuminate the roles of stakeholders and policy instruments in shaping rural urban dynamics.

Researchers note that combining quantitative and qualitative methodologies not only improves the rigor and comprehensiveness of land change research, but it also deepens our knowledge of complex processes like land dynamics (Cheong *et al*., 2012; Strijker *et al*., 2020). However, despite several studies focusing on peri-urban agricultural land in Oran province, none have integrated data from both quantitative and qualitative approaches. Additionally, Studies of Oran's peri-urban dynamics has primarily focused on its eastern extension, overlooking the significant transformations in the southern and western peri-urban areas.

This study aims to address these gaps by identifying the changes in agricultural land in the southern and eastern periphery of Oran province between 1998 and 2019. By examining these transformations, the study seeks to contextualize the land-use dynamics and explore the actors and drivers behind these changes. We employ a mixed-methods approach, combining GIS-based analysis and machine learning classification with participatory field observations, stakeholder interviews, and the analysis of development and planning documents.

2. Study area

Our study encompasses five municipalities: Misserghine Boutelilis and Oued Telilet, Sidi Chami, and El Karma, all located along the two main highways in the south and west of Oran metropolis in the northwest of Algeria (see Figure 1). The interest in peri-urban areas stems from their emerging and evolving nature, which increasingly draws attention from both public authorities and territorial research on a global scale.

The selection of the Oran metropolis as the study area was influenced by its regional significance and rapid growth, alongside the availability of general statistical data (e.g., surface area, population, housing) and management documents. Oran's urban area is a regional magnet, where industry and services are the structuring activities of the economic fabric. It is a city with command functions that enable it to extend its influence over the entire North-West region, the Western High Plateaus and beyond, to the edge of the Sahara towards the South-West region.

In addition, the literature review conducted along with recent observations of the phenomenon of peri-urbanization and the decline in agricultural land, have led us to choose the west/south periphery of the Oran metropolis, where construction activities (housing and infrastructure development) are accelerating.

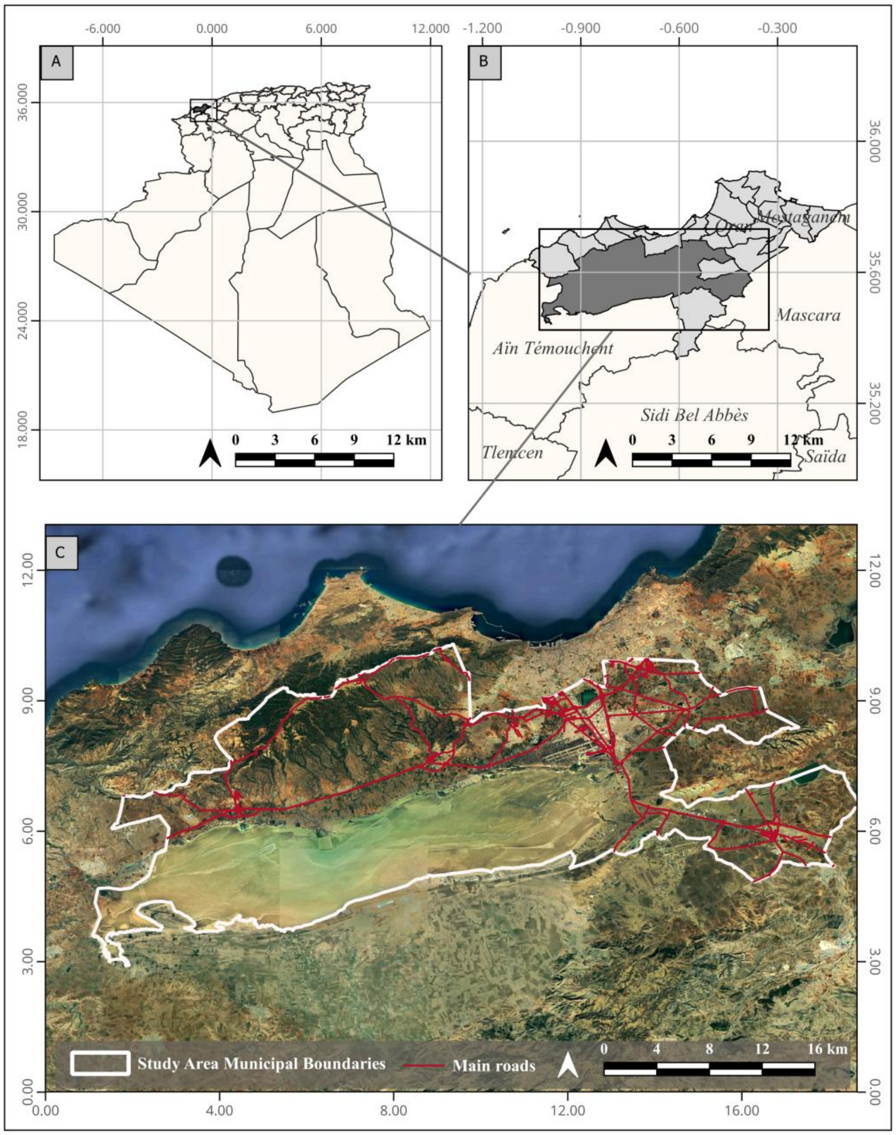

Figure 1. Location of the study area

The study area spans a total of 4,443,800 hectares, with considerable variations in the surface area across municipalities. The climate in this region displays transitional attributes between the Mediterranean climate and the semi-arid continental climate. The study area experiences mild and wet winters and hot and dry summers, with an annual mean rainfall of roughly 800 mm. The annual mean air temperature is 19 degrees Celsius, with a mean minimum/maximum of 8 degrees Celsius in January and 30 degrees Celsius in July.

The urban fabric of Oran has evolved over time, forming a large urban basin characterized by large built-up areas and urbanization corridors. The history of urbanization in Oran has been marked by the impact of colonization on the settlement system and the organization of the urban network, as well as by the profound transformation of the territory since independence.

Oran's contemporary urban form remains deeply influenced by its colonial past, particularly the "Triangle de Colonisation agricole" (Agricultural Settlement Triangle), developed in 1846 encompassing Oran, Mostaganem and Mascara. This area covered 80,000 ha and accommodating more than 20 agricultural settlement villages. From 1975 onwards, urbanization accelerated, influenced by new land-use planning guidelines aimed at redistributing industrial investment, promoting administrative centers, and developing infrastructure. These policies, alongside land reforms, triggered rapid population growth and urbanization, particularly after the collapse of the foundations of the colonial urban system (agriculture, exports).

In recent decades, the pressure on agricultural land has intensified, leading to its diversion from farming to urban uses. The reclassification of agricultural land for urban development has become increasingly common, particularly along major roadways. Following the liberalization of land policies in 1990s, the authoritarian expropriation procedure for private land by the Land Orientation Act (90-25); resulting in a surge of land speculation inflated land prices. This has disproportionately affected lands in the state's private domain, such as those under the management of the EAI and EAC.

3. Land historical context

Land policy has long played a pivotal role in shaping both agricultural and urban landscapes in Algeria. Analyses of socio-economic reports suggest that the land market is a key driver of urban dominance, with land prices acting as a critical factor in spatial organization and the transformation of spaces. Since the mid-1980s, Algeria's land policies have paralleled the redistribution and restitution approaches of Eastern Europe. It is noTable that public policy reform and changes in the role of the state have boosted the land market and accelerated the process of peri-urbanization (Elloumi, 2011).

In order to manage, regulate and control this evolution and its spatial effects, a number of urban planning instruments and master plans have been implemented (Toussaint, 1998; Bendjelid *et al.*, 2004). Nevertheless, these planning tools have failed to effectively manage urban expansion and its peripheral areas. Based on the Master plan for development and urban planning (P.D.A.U), it is estimated that additional land consumption is required for each urban area.

Looking at the history of Algerian land policies, we can distinguish three major periods that characterize the changes in land practices. From independence to 1974, there was no shortage of land and speculation was minimized, preserving farmland. Between 1974 and 1990, land reserve policies were introduced, encouraging speculative practices. Ordinance No. 74-26 of 20/02/1974 expanded land freezes from rural to urban areas, driving urbanization and supporting ambitious development goals. However, these policies also led to land wastage and chaotic urbanization.

The new land policy introduced after 1990 marked a break with the voluntarist, socialist model. Communes no longer held a monopoly on land ownership. The two major elements of the new policy are: the Land Orientation Act (90-25 of 18/11/1990) and the Urban Planning and Development Act (90-29 of 01/12/1990).

In summary, land issues are central to large-scale urban development projects in Oran, with land scarcity and rising costs shaping the trajectory of urbanization and contributing to a decrease of agriculture land.

4. Methodology

This study adopts a mixed-methods design, combining both quantitative and qualitative methods to comprehensively examine agricultural land changes in the study area.

Our choice of method is rooted in its ability to provide a multidimensional understanding of the subject matter. Combining the two methods in the research process enables the investigator to obtain more than one type of data slice. Since the 1960s, a growing number of researchers in various fields of the social sciences have advocated the combination of quantitative and qualitative approaches to the study of various social phenomena (Onwuegbuzie & Johnson, 2006**;** Creswell, J. W., & Plano Clark, V. L., 2007**;** Collins *et al*., 2007)

In this study, we employed a simultaneous multi-level design, in which both approaches are initiated concurrently. Quantitative data collection and analysis explored land use and cover transformations across multiple categories, capturing the shifts in agricultural land as it transitions into other land uses. Meanwhile, qualitative data collection and analysis focused on identifying the causes of agricultural land changes and key contributing factors.

4.1 Quantitative method

The quantitative approach in this study focuses on the objective measurement and statistical analysis of land use and cover changes in peri-urban Oran. By leveraging satellite imagery, geospatial analysis, and machine learning techniques, this method allows for the precise quantification of agricultural land loss over time. The following sections outline the details of each step in the quantitative process:

4.1.1 Classification and land cover maps

This work aims to assess agricultural land change in the municipalities of the southern periphery of Oran. To this end, we first classified the satellite dataset. We utilized Google Earth Engine (GEE) for the acquisition and processing of satellite images, as well as for the classification of land cover and land use. GEE is an online platform that provides vector data, cloud computing, global time-series satellite imagery, vector data, cloud-based computing, and tools, allowing researchers to conduct resource-efficient research opportunities across various scales (Kumar & Mutanga, 2018).

4.1.2 Data selection

For this study, multi-spectral Landsat satellite data was chosen due to its extensive temporal coverage, high spatial resolution, and free accessibility. Landsat offers one of the longest continuous time series from 1972 to the present (Howarth & Boasson, 1983; Potapov *et al*., 2020; Hemati *et al*., 2021). The surface reflectance images were obtained for three specific years: ETM for 1998, and OLI for 2019, based on Path-198 and Row-35. We utilized these two Landsat satellite images from 1998 and 2019 to track land use and cover changes, specifically focusing on quantifying the loss of agricultural land in the peri-urban municipalities of Oran. The analysis was further supported by the creation of land cover maps, enabling the detection of agricultural land changes between 1998 and 2019. These findings were validated through extensive field surveys.

4.1.3 Random Forest classification

Land cover mapping is an essential tool for monitoring the environment and managing resources (Ghosh *et al*., 2021). Remote sensing data for land cover monitoring need robust classifying techniques that allow for accurate mapping of complex land cover and land use categories (Rodriguez-Galiano *et al*., 2012). Based on the area assessment and field observation, six primary categories were determined: forest, agricultural area, and built-up area, wetland, and water surfaces. After the collection and the corrections of the satellite images of the three dates (1998, 2019), A supervised classification method using Random Forest (Figure 2) was used to classify the satellite images for each date. This algorithm was demonstrated to be effective for land use/land cover classification (Breiman, 2001, p. 29; Pal, 2005).

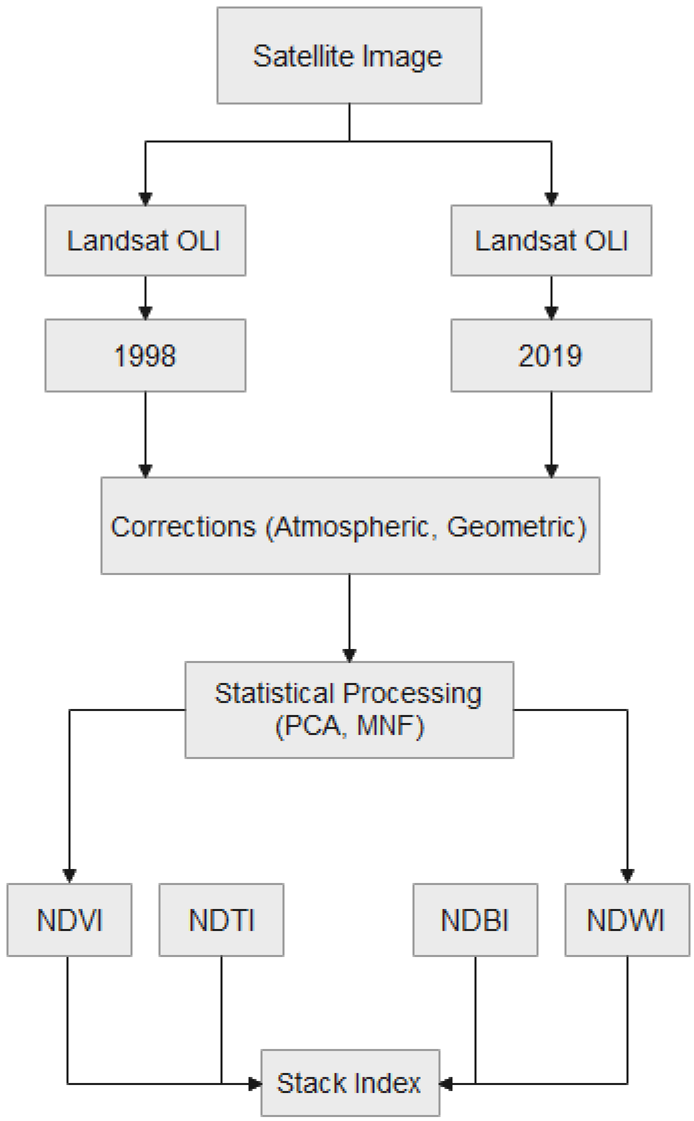

Figure 2. Flow chart of classification on Google Earth Engine (Phase I)

During the initial study phase, we enhanced classification accuracy by generating auxiliary data using a range of indexes (Table 1). These indexes improved the differentiation between vegetation, urban areas, and water surfaces, providing a more comprehensive analysis, aiding in a more comprehensive analysis of vegetation, urban and water surfaces by supplementing band features in machine learning tasks.

Table 1. Indexes utilized in the classification

Index	Use	Formula	Reference
NDVI *(Normalized Difference Vegetation Index)*	Monitoring vegetation	NDVI = (NIR - RED) / (NIR + RED)	(Hui Qing Liu & Huete, 1995; Pettorelli *et al*., 2011)
NDTI *(Normalized Difference Thermal Index)*	Detecting water turbidity, predicting drought	(RED-GREEN)/(RED+GREEN)	(McInerney & Lozar, 2007; McInerney & Lozar, 2008)
NDBI *(Normalized Difference Built-up Index)*	Highlights built-up areas and counteract terrain and atmospheric effects.	(SWIR - NIR) / (SWIR + NIR)	(Zha *et al*., 2003; C. He *et al*., 2010)
NDWI *(Normalized difference water index)*	Determining water components	GREEN-NIR/GREEN+NIR	(Gao, 1996; McFEETERS, 1996)

Additionally, we have applied Minimum Noise Fraction (MNF) which is a well-known method for hyperspectral imagery denoising, and Principal Component Analysis (PCA) which is multivariate statistical process monitoring techniques.

4.1.4 Training and Validation

The training and testing samples in this study were collected individually for each land use map utilizing the Google Earth Pro and field surveys as a reference. The samples were reselected from the prospective samples using a stratified proportional random sampling technique to assure a balanced spatial distribution of the samples and to avoid an over concentration of the sample in a particular area or a certain land cover class.

Consequently, 167 samples were selected. 70% (123) of the training samples were allocated to the training of the algorithm, and 30% (44) of the samples for the validation process (Goldblatt *et al*., 2016). The indexes and analysis techniques were then used along with the samples for the Phase II of the classification (Figure 3).

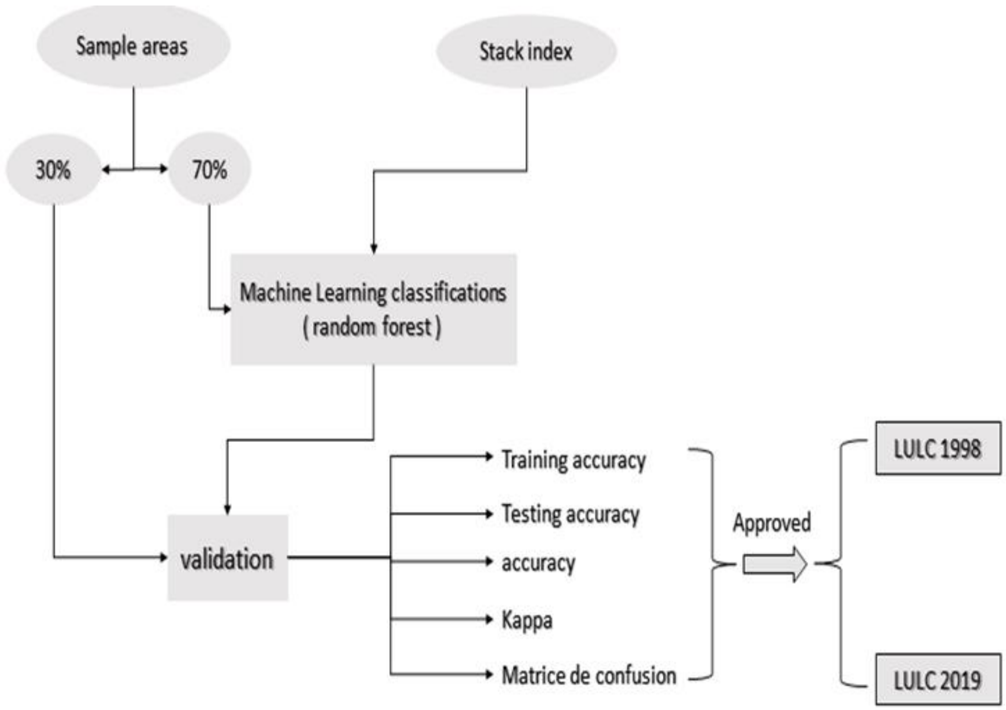

Figure 3. Flow chart of classification on Google Earth Engine (phase II)

4.2. Qualitative method

In geographic studies, qualitative research methods are commonly used with a range of approaches and techniques (Hay, 2001; Delyser, 2008). The collection and analysis of qualitative data allows for an in-depth understanding of diverse perspectives on land use issues. In this study, qualitative data were gathered to identify conflicting viewpoints among stakeholders and to gain insights into policy dynamics that influence land use in peri-urban areas. The following sections outline the details of the qualitative method:

4.2.1 Participant observation and field surveys

We conducted participant observation across all municipalities of the study area in order to identify the various dynamics of the land cover and land use components. Our research required numerous field trips in order to be able to compare the actual situation with development plans and management tools. Photographs were taken during field visits, some of which are included in this article (see Figures 7 and 8).

As part of the participant observation, the first author took an active part in various meetings with local representatives during the revision of the Master Plan for Development and Urban Planning (PDAU), which took place at the municipal assemblies of the municipalities of Boutelilis and Misserghine.

4.2.2 Data collection and interviews

Our work is also based on the collection and analysis of multi-source information related to the quantities of status of agricultural land, farmland withdrawal, and the nature of the land, the analysis of the various planning documents available, and on semi-directive surveys with the various stakeholders in the area. Expert interviews are considered a dependable source for data on complex issues like agricultural land use dynamics (Lone *et al.*, 2023). These interviews serve as a tool for collecting data directly from the stakeholders involved in the study area, and represent an important source of information.

Determining the stakeholders involved, and rigorously preparing interview guides, are the two key aspects of this method. In the peripheral agricultural land context, stakeholders are numerous and interrelated, so their identification is implicitly based on extensive reading of previous research on the study area and the theme in general. Between 2021 and 2022, we conducted twenty-two (22) semi-structured and non-structured interviews with various local, institutional and professional stakeholders. We have also conducted (4) focus groups with locals, focusing on farmers and land owners. Expert interviews contributed to understanding the significant drivers influencing agricultural land use.

The primary goal of the interviews was to examine the existing conflicts among the various parties, and to gain a better understanding of the dynamics and the planning process. These interviews lasted around an hour on average, while some lasted significantly longer.

Interviewing relevant individuals was a major part of this research. This involved exchanges with various stakeholders: local groups, landowners, farmers, technical and census officials, experts, planners and elected representatives. Through interviews, proximity with planners and local groups was established in order to better understand the dynamics in the study area.

After consulting various literatures on how to conduct interviews and design questionnaires, as well as previous studies on urban-rural dynamics in peri-urban areas, interview guides were produced. Three types of interview guides were developed:

1- Questions for urban planning project managers, architects and engineers responsible for project planning, implementation and monitoring

2- Questionnaires for managers overseeing the master plan study.

3- Questions for elected representatives, local authorities and local residents

5. Results and discussion

The results of this study reveal a significant transformation of agricultural land in the peri-urban areas of Oran, Algeria, over the period from 1998 to 2019. The changes are driven by various factors, including urban expansion, population growth, and infrastructure development.

5.1 Land Use Land Cover Change

Table 2 presents the classification results for land use/cover changes, showing the variation in different land cover categories over the 21-year period.

Table 2. Land use/cover changes in the study area (1998-2019)

category	Area (hectares)	
	1998	2019
Agriculture	30587.94	22929.57
Water	198.45	565.92
Bare land	5393.97	19885.77
Built-up	647.28	4988.25
Forest	11242.08	9605.25
Wetland	33865.56	23960.52

Land cover data shows substantial changes between 1998 and 2009. Agricultural land experienced a dramatic reduction, decreasing from 30,588 hectares in 1998 to 22,930 hectares in 2019—an average annual loss of approximately 364 hectares. Conversely, bare land expanded sharply, from 5,394 hectares in 1998 to 19,886 hectares in 2019, illustrating significant land degradation. Built-up areas experienced a substantial growth, from 647 hectares in 1998 to 4,988 hectares in 2019, indicating an accelerated rate of urbanisation in the study area. Meanwhile, forest cover declined from 11,242 hectares in 1998 to 9,605 hectares in 2019, suggesting a possible deforestation. Similarly, wetland area also declined reducing from 33,866 hectares to 23,961 hectares during the same period. These changes highlight the major effects of urbanization, land degradation, and environmental change on land cover.

5.2 Accuracy assessment

The Kappa index indicates high classification accuracy, with values of 0.93 for 1998 and 0.90 for 2019, ensuring the reliability of the land cover data. These metrics support the validity of tracking evolving land use/cover changes in the study area.

5.3 Agricultural land cover changes

The transition of agricultural land to other land use categories is outlined in Table 3. It highlights how urban expansion and environmental pressures have driven the loss of agricultural land.

Table 3. Losses in agriculture area to other land cover categories from 1998 to 2019

Category	Area (Hectares)
Total area	14168
Agriculture to Water	145
Agriculture to Bare land	9,527
Agriculture to Built-up	1,923
Agriculture to Forest	2,203
Agriculture to Wetland	370

The data shows that a significant area, 9,527 hectares, has been changed from agricultural land to bare land. In contrast, the conversion from agriculture to built-up areas accounts for 1,923 hectares, indicating significant urban expansion. Additionally, 2,203 hectares of agricultural land have transformed into forested areas, while 370 hectares have changed to wetlands. Figure 4 demonstrates the contributions to the net change in agricultural area (hectares).

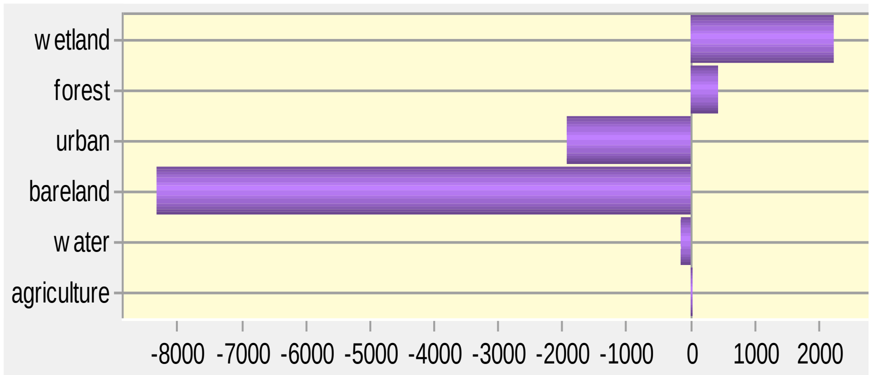

Figure 4. Contributions to net change in agricultural area over the period 1998-2019

Over the period from 1998 to 2019, the agricultural area experienced a significant loss of 14168 hectares. Figure 5 provides a comprehensive visual and spatial representation illustrating the change in land cover in the study area throughout the time frame of the study period.

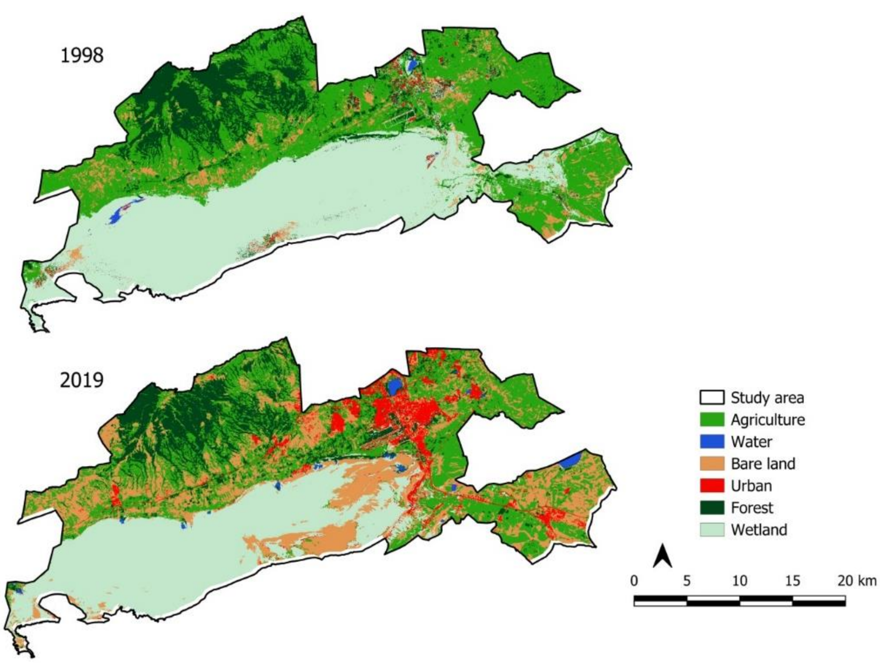

Figure 5. Land cover changes in the peri-urban area from 1998 to 2019

Most of the agricultural land on the periphery of Oran is public domain (Bendjelid, 2004), a finding that aligns with results. This property consisted of fertile land previously owned by the colonists and then nationalized by the Algerian state after independence. The abundant availability of this property and the possibility of its detour made it an excellent site for new urban dynamics (Maachou, 2012). This dynamic reflects the ongoing shifts in land use driven by policy changes and urbanization pressures in Algeria’s peri-urban regions.

5.4 Urbanization and Population Growth

According to the various interviewees, the population increase has a considerable impact on changes in agricultural land usage. This expansion directly influences the availability of land resources, with a variety of consequences. Notably, the rapid population growth has a significant impact on agriculture, particularly along the major highways in southern and western periphery, resulting in the irreversible loss of valuable land limiting its capacity to sustainably support the growing population.

The continuing demand for land in Oran's peripheral areas, which is both available and less expensive, is driven by a lack of buildable space in the urban center and the rising price of land. This demand is further amplified by the presence of major roads, which facilitate suburban sprawl toward the west (Misserghine, Boutelilis) and the south (Oued Telilet).

Additionally, The Provincial Management Plan (Plan d’Aménagement Wilayal) indicates that the high-pressure communes are those in the outer suburbs of the wilaya's main cities, with a ratio of between 0.15 and 0.25 ha per inhabitant: El Kerma and Misserghin are Oran's outlying communes.

5.5 Conversion of agricultural land

The land domain is more than just a spatial reserve based on the power of acquisition, utilization, and governance of land resources. It is also an arena of contestation, where the control of resources and usage rights generates competition and conflict between different sectors of activity and among stakeholders. These challanges are further complicated when studied in a peri-urban context characterized by blurred and evolving spatial boundaries (Nemouchi & Zeghiche, 2021). One of the major problems facing these areas is land tenure insecurity, which leads to complexities in managing land resources. The evolution of urban spaces is dictated by a series of interests, both organized and unorganized, revolving around local stakeholders and public authorities invested with the power to manage land.

The shifting vocation of agricultural land refers to the conversion of land from conventional agricultural methods to other uses such as urban development, industry, or reforestation. This shift may be attributed to a variety of causes, including urbanization, economic development, or policy changes. The pressures exerted on agricultural land in peri-urban areas often result in its reallocation for urban purposes, especially in the context of rapidly expanding cities like Oran.

The Table (3) and Figure (6) provide a detailed overview of the extent of agricultural land that has shifted its vocation to other land uses within study area. This data presents a comprehensive view of the spatial dynamics at play, illustrating how agricultural land has been converted into non-agricultural uses over the study period (measured in hectares).

Table 4. Area of farmland that has changed vocation in each municipalty

Municipality	Area (hectare)
Oued Tlelat	239120
El Karma	857883
Sidi Chahmi	66912
Misserghine	1981126
Es Senia	1695481
Boutelilis	3743519

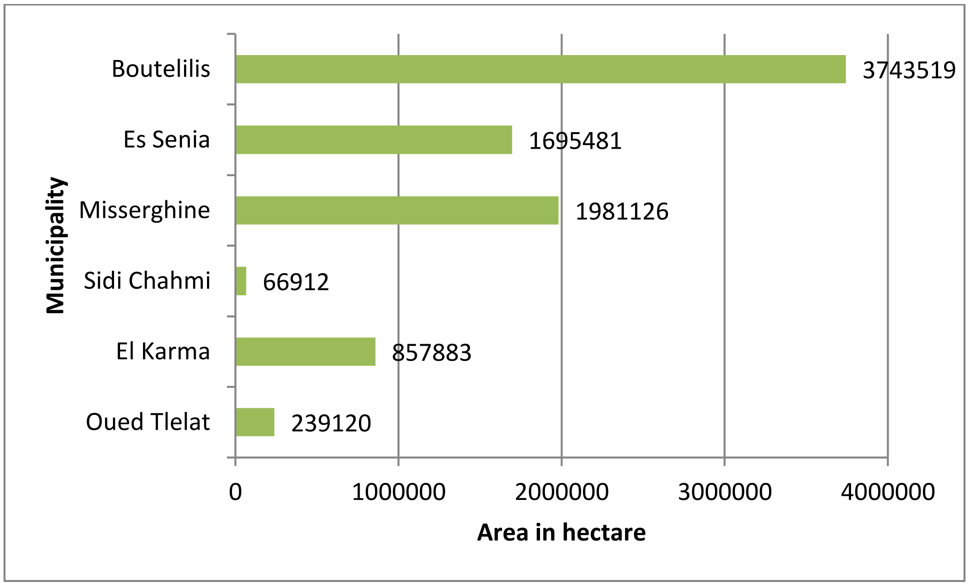

Figure 6. Area of farmland that has changed vocation in each municipality

Based on the statistics of direction of agricultural services of the municipality of Oran, the total farmland area that has been withdrawn and changed vocation based on the executive decree 03-313 in the five municipalities of our study area is 872.77 hectares mainly for different types of housing programs (Figure 7). Oued Tlelat, El Karma, Sidi Chahmi, Misserghine, Es Senia, and Boutelilis reported 239,120, 857,883, 66,912, 1,981,126, 1,695,481, and 3,743,519 hectares, respectively. This data highlights significant changes in land use patterns, reflecting substantial agricultural land conversion during the study period. The executive decree, which governs the conditions and procedures for acquiring agricultural land within the national domain for development purposes, has facilitated the incorporation of fertile agricultural land into buildable areas. However, our interviews with agricultural land investors reveal a contrasting perspective. These investors argue that the decision to withdraw these lands was unjust. They contend that the lands in question remain fertile and are actively being exploited and invested in for agricultural purposes. This sentiment underscores the tension between government-led urban expansion initiatives and the interests of those involved in agriculture, particularly in peri-urban areas where fertile land is scarce and valuable.

These conflicting views highlight the broader issues of land tenure security and the pressures on agricultural land in rapidly urbanizing regions like Oran. The clash between urban development and agricultural sustainability presents a challenge for local authorities, policymakers, and stakeholders who must balance the demands of growth with the need to preserve productive agricultural lands.

Figure 7. Example of agricultural land withdrawal for the benefit of a housing project (lPP), Boutelilis source: Authors (2022).

On the other hand, land pressure on agricultural land represents the detour of agricultural land from its original vocation; the change in land classification from agricultural to urban is increasingly being observed, allowing many parcels of agricultural land to be used for other, non-agricultural purposes. Following the liberalization policies of the late 1990s, the authoritarian expropriation of private land was largely suspended by the enactment of the Land Orientation Act (Law 90-25). This change opened the door to intense land speculation, with soaring land prices encouraging landowners, particularly those in areas likely to be urbanized, to sell their agricultural holdings. This trend is particularly pronounced along major roads and in peri-urban zones where infrastructure development enhances the attractiveness of such land for urban purposes. As a result, the lands most affected by urbanization are those in the state's private domain, represented by the EAI and EAC.

5.6 Relocation of population

Urbanization has been linked to economic development resulting in a trend toward urban growth. This orientation often results in the distortion of the social structure in the peri-urban and rural areas, as a consequence of population displacement and relocation.

Interviews with farmers and previous landowners revealed their attachment to land and their reluctance to relocate. One of the previous owners of the largest farm in Misserghine municipality stated that if given the option, his family would not have changed their agricultural vocation or transferred their property, emphasizing that the land is a part of their family's identity. This suggests a strong attachment to the agricultural practice and to the land, despite the compensatory transaction, which, notably, may take years to materialize. Whereas the main focus of the representatives of the authorities based on the interviews that we conducted, was to acquire more land for more housing projects, which elevates the conflict between the two parties.

5.7 Determining factors of agricultural land change

Recently, landscape research has focused on understanding the reasons for landscape changes, emphasizing the concept of "driving forces," which are the factors that drive these changes (Bürgi *et al*., 2005; Plieninger *et al*., 2016). Identification of factors influencing peri-urban agricultural land change is essential, and policymaking would be more effective when centered around these factors (Klijn, 2004). Recent landscape research has focused on understanding the reasons for landscape changes, emphasizing the concept of "driving forces".

5.8 Distance to roads and land availability

The agricultural pattern frequently shows decreased intensity with decreasing distance from the city (Sinclair, 1967). As the distance from major urban centres increases, the likelihood of agricultural land being transformed for urban purposes decreases. In other words, areas closer to a major city are more likely to see agricultural land converted into urban land (H. Wang & Qiu, 2017). In peri-urban areas, agricultural land prices decline with increasing distance from cities due to expectations of future urban conversion, which leads to higher premiums for land near urban areas (Cavailhes, 2003).

Similarly, distance from highways is regarded as an important spatial factor for urban growth, implying that non-urban regions near the city center are more likely to be developed (Hasan *et al*., 2020, p. 19; R. Wang *et al*., 2021, p. 2) as access to land is strictly linked to price, a look at price differences between urban centers can explain urbanization trends. Land prices are linked to the city's importance in the urban fabric. Prices are very high in big cities and lower in the outskirts or small towns. (Talha Mokhtar, 2013).

Based on field surveys and development plans (PDAU and PAW), the continuing demand for land in Oran's peripheral areas, which is both available and less expensive, stems from the lack of buildable space and, above all, from the rising price of land in the urban center. The demand for land in these peripheral areas is also influenced by the presence of major roads. In addition, the improvement in road access explains the sprawl of the suburbs towards the west (towards misserghine, boutelilis) and south (towards oued telilet).

According to the PAW, the high-pressure communes are those in the outer suburbs of the wilaya's main cities, with a ratio of between 0.15 and 0.25 ha per inhabitant: El Kerma and Misserghin are Oran's outlying communes. The saturation of land in the commune of Oran has obviously had the effect of first transferring all urbanization to the outlying communes and then to more distant communes, which consequently affected the agricultural land in these areas. The towns and neighbourhoods closest to Oran (communes du groupement) have grown excessively, while the outlying towns have doubled in size (as in Oued Tlélat and Gdyel). As the communes of El Kerma and Oued Tlélat are located on the southern road axis, their expansion underscores the strategic growth along the southern road axis influenced by urbanization pressures and spatial dynamics within the wilaya.

5.9 Planning instruments

According to current Algerian law, the Master Plan for Plan Directeur d'Aménagement et d'Urbanisme (PDAU) and the Plan d'Occupation des Sols (POS) are responsible for executing urban planning regulations that have the potential to preserve and maintain agricultural lands.

The land use plan is an urban planning document, drawn up in compliance with law no. 90.29 of December 01, 1990 relating to development and urban planning, amended and supplemented by law no. 04.05 of August 14, 2004. It aims to govern the production and/or transformation of urban areas and the built environment, while detailing land use and construction rights, in accordance with the provisions of the master plan for development and urban planning –Plan Directeur d’Aménagement et d’Urbanisme (PDAU) to which it is attached. The 1998 (PDAU) in the Oran group (groupement d’Oran), aimed to preserve agricultural lands and create a balance between urban, agricultural, and industrial zones by directing urban growth towards the east, conserving fertile lands in the west, south, and southeast. However, it did not anticipate a peri-urban agricultural development project (Maachou & Otmane, 2016). Figure 8 illustrates various housing program projects implemented on previously agricultural land across different municipalities within the study area, specifically Oued Tlélat, Misserghine, and Boutelilis.

Figure 8. Different housing programs projects on previously agricultural land in different municipalities of the study area (Oued Telilet, Misserghine, Boutelilis) source: field work, 2022

Since the early 1990s, with the introduction of a policy of urban planning and development, put into practice by Law 90-20 of December 1, 1990, the Oran periphery has witnessed an increase in the built-up area and a regression in the agricultural one. This law introduced a housing policy focusing on the development of participative social housing (LSP) and a hire-purchase system, as seen in the commune of Oued Telilet on the south-east road axis, which has a population of (40717) with a total of 19610 housings (Communes data by agglomerations and districts according to the new division and validation of the work of the 2nd Phase-RGPH 2020).

Despite the existence of the law 08-16 , which prohibits the conversion of agricultural land for non-agricultural purposes, enforcement has been lacking (Boudjenouia *et al*., 2008). Instead, authorities have prioritized urban expansion and housing programs, as evidenced by the limited focus on agriculture in the PDAU, the most important land use planning document. This reflects the clear policy orientation toward urban growth.

These observations underscore the importance of adopting a relational approach to land access through the use of planning instruments. These instruments should help structure the relationships between stakeholders and regulate the power dynamics among these interest groups (Baysse-Lainé, 2021).

5.10 Stakeholders' conflicts

Land production mechanisms in Algeria consistently involve three key actors: the State, local authorities, and social groups. The Algerian state plays a pivotal role in decision-making, particularly in pushing industrialization as a core driver of national development. However, this top-down approach often overlooks the complexities of local societies, applying uniform policies that fail to account for varying local conditions. While urban policies since 1974 focus on land regulations, the highly centralizing Algerian state seeks continuous legitimacy through discourse, practice, or force, particularly in land-related issues.

One of the primary urban policies of the Algerian state is the promotion of social housing. At the beginning of the 2000s, thanks to the favourable oil revenues that the Algerian economy benefited from, a variety of housing acquisition programs emerged, including social participative housing (LSP), subsidized public housing (LPA), housing for hire-purchase (AADL), public rental housing (LPL) and public promotional housing (LPP). These programs were all supported by state aid to provide low-cost housing accessible to all social strata. As a result, a massive production of housing has characterized the urban dynamics in the outskirts of Oran. Social housing, with its diverse real estate configurations, has become the dominant consumer of land in these areas.

Public-sector stakeholders influence land use through two main avenues: firstly, by dictating local urban planning and land regulations, and secondly, through direct intervention in space by investing in infrastructure or urban development, which strongly influence land prices. (Talha Mokhtar, 2013).

The conflicts of stakeholders in the study area arise with the distribution and location and choice of different projects. In the commune of Misserghine where the new urban pole is being constructed on what was previously agricultural land, the conflict around land among the various groups is evident. Local landowners, supported by the agricultural directory during field surveys, expressed a desire to retain their land for continued agricultural use. However, state representatives and local authorities selected this land for a new housing development project covering an area of 1,400 hectares.

6. Conclusion

The peri-urban areas are undergoing significant transformation particularly observed in the deceased of agricultural land. The process of urbanization and its effect on agricultural land is complex, involving a variety of geographical and socio- factors that require examination across various spatial scales, with active involvement from the local community. This paper utilized a mixed method research design, combining a GIS-based multi-temporal study with field surveys and instrument analysis. The findings revealed significant changes in the agricultural landscape structure of Oran southern and western peripheral area. Additionally, excessive peripheral urban sprawl increases demand for land, which in turn threatens the existence of farmland, often representing a land base for this urbanization, creating a conflict of use between the two urban and agricultural sectors. Effective management of these dynamics requires a participatory approach and better coordination between agricultural strategies and peri-urban settlement planning. Public policies focused on agriculture and environmental protection must be strengthened in light of Oran's ongoing metropolitan development.

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Conflicts of Interest
The authors have stated that they have no conflicts of interest to declare.

Data availability
The data collected and analyzed for this study can be shared upon request.

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