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# The Relationship between Population Growth and Land Use Dynamics in Understanding Inward and Outward Migration in Southern Jordan

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**Abstract**

**Objectives**: The study aims to analyze changes in land use and land cover (LULC) in the southern governorates of Jordan—Karak, Ma'an, Tafila, and Aqaba—over the period 1994–2023. It further examines the extent to which these changes have been influenced by migration patterns, employing Geographic Information Systems (GIS) and time-series analysis.

**Methods**: The research methodology focused on understanding demographic changes. so, Time-series data were used to identify patterns and trends in population distribution, assisting in monitoring the influence of migration on demographic structure over time. Additionally, quantitative and qualitative analyses were combined to provide a comprehensive perspective, with quantitative analysis focusing on numerical data such as migration rates and population counts, while qualitative analysis explored sociological and cultural factors that affect land use and migration dynamic

**Results**: The results of the study indicate that migration patterns in southern Jordan are primarily driven by economic and spatial factors, with Where it is considered Aqaba governorate the primary receiving area for migrants while other regions (Karak, Ma'an, Tafila (experience negative net migration due to insufficient infrastructure and job opportunities.

**Conclusions**: Migration trends have significantly impacted receiving areas, leading to increased urbanization that strains infrastructure and services. This expansion has caused land-use shifts, with residential areas replacing agricultural and industrial lands, driving up housing demand and property prices. These changes underscore the need for strategic urban planning and infrastructure investments for sustainable development.

**Keywords**: Land Use, Migration, Geographic Information Systems, Population Growth, Southern Jordan

# العلاقة بين النمو السكاني وديناميكيات استخدام الأراضي في فهم الهجرة الداخلية والخارجية في جنوب الأردن

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**ملخّص**

**الأهداف**: تهدف الدراسة إلى تحليل التغيرات في استخدامات الأراضي والغطاء الأرضي (LULC) في المحافظات الجنوبية من الأردن—الكرك، ومعان، والطفيلة، والعقبة—خلال الفترة 1994–2023. كما تفحص الدراسة مدى تأثر هذه التغيرات بأنماط الهجرة، وذلك من خلال توظيف نظم المعلومات الجغرافية (GIS) وتحليل السلاسل الزمنية.

**المنهجية**: ركزت منهجية البحث على فهم التغيرات الديموغرافية. لذلك، تم استخدام بيانات السلاسل الزمنية لتحديد الأنماط والاتجاهات في توزيع السكان، مما يساعد في مراقبة تأثير الهجرة على الهيكل الديموغرافي بمرور الوقت. كما تم دمج التحليلات الكمية والنوعية لتوفير منظور شامل، فركز التحليل الكمي على البيانات الرقمية كمعدلات الهجرة وأعداد السكان، بينما استكشفت التحليلات النوعية العوامل الاجتماعية والثقافية المؤثرة على استخدام الأراضي وديناميكيات الهجرة.

**النتائج**: تشير النتائج إلى أن أنماط الهجرة في جنوب الأردن مدفوعة بشكل أساسي بالعوامل الاقتصادية والمكانية، حيث تُعتبر محافظة العقبة المنطقة الرئيسية لاستقبال المهاجرين بينما تشهد المناطق الأخرى هجرة صافية سلبية بسبب نقص البنية التحتية، وفرص العمل. التفاعل بين الهجرة واستخدام الأراضي وارتفاع التضاريس يشكل هذه الأنماط، مما يستلزم استراتيجيات متكاملة للتنمية الإقليمية المستدامة والمتوازنة.

**الخلاصة**: أثرت أنماط الهجرة بشكل كبير على المناطق المستقبلة، مما أدى إلى زيادة التحضر الذي فرض ضغطًا على البنية التحتية والخدمات. هذا التوسع أدى إلى تغيرات في استخدام الأراضي، حيث حلت المناطق السكنية محل الأراضي الزراعية والصناعية، مما أدى إلى زيادة الطلب على الإسكان وارتفاع أسعار العقارات. هذه التغيرات تبرز الحاجة إلى تخطيط حضري استراتيجي واستثمارات في البنية التحتية لتحقيق التنمية المستدامة.

**الكلمات الدالة**: استخدام الأراضي، الهجرة، نظم المعلومات الجغرافية، نمو السكان، جنوب الأردن

## 1. Introduction

Land use and land cover changes are critical for understanding changes in the environment at the regional, local, and global scales(Nedd et al., 2021). These two elements are interconnected: changes in land cover affect land use, and vice versa. Although not every change in land cover means land degradation(Rawat & Kumar, 2015). Land degradation is a product of both short-term and long-term processes. Land degradation is defined by the Dry Lands Millennium Ecosystem Assessment (MA) as "the reduction or loss of biological or economic productivity of dry lands"(Kago et al., 2019).

The pressure produced by population growth often results in land scarcity and changes in land use.(Mwesigye & Matsumoto, 2016) Understanding the relation between urbanization and cultivated land use efficiency is crucial for securing sustainable agricultural development (Wei et al., 2023). Urbanization, normally is measured through population density and urban expansion, has consistently increased throughout the 20th century. Projections predict that the global population will increase from 7.2 billion people today to 9.6 billion by 2050 and 10.9 billion by 2100 (Bagan & Yamagata, 2015). As an essential natural resource, land is considered the foundation for food production, housing, and other human necessities. Almost all food production worldwide depends on land, and the constant growth of population drives a continuous demand for more agricultural output (Lwanyaga, 2022), however, land use dynamics are complex and needs multiple layers of interaction. The study of the correlation between migration and the dynamics in land use and land cover is a useful tool in enhancing the management of natural resources, and also in justifying sustainable planning. It is thus important to understand population transition and the effect it has on agricultural and forest ecosystems to manage land successfully (Park et al., 2022). The combination of social, economic, demographic and environmental factors determines the land use changes in southern Jordan. Although these interactions are important, there are still very few in-depth studies that determine the combined impact of all these factors on land use change. In this regard, the satellite imagery to be used in this study is to study the land use and land cover changes as well as migration patterns and especially the relationship between population movement and environmental change.

## 2. Literature Review

There is an increasing amount of literature giving credit to the population growth as a key factor influencing land use patterns in Jordan. As an example, a research study that was carried out in Madaba sub-district has shown how population growth has led to major changes in land use patterns (Sarayrah et al., 2024). In the same case, the study of the Wadi Zaqlab, located between the highlands of north Jordan and the eastern side facing the Jordan Valley, has shown that the changes have been experienced around the population growth which covers an area of about 4,414 hectares which is equivalent to 42 percent of the total catchment area. Also among these changes were the increase in horticultural operations by 22.4 percent and the growth in urban tree planting by 6.2 percent, as well as the significant rise in field crops, forested land, and pasturelands (Mhawish & Saba, 2016). The Global level comparative studies also shed more light on the association between land use dynamics and migration. The internal migration in the past 25 years in the middle parts of the mountain ranges has shifted the settlement patterns in Nepal and redefined the landscape around the settlements (Coast, 2018). On the coast of Ghana, the migration process has led to the transformation of agricultural lands into residential and commercial areas, which raises significant issues associated with food security and the process of increasing the pace of coastal erosion (Kutir et al., 2022). Similarly, researches have been done along the northwestern coast of Egypt using the remote sensing and Geographic Information Systems (GIS) in order to track the land change and evaluate their social, economic and environmental effectiveness (Shalaby and Tateishi, 2007).Similarly, research in Pekalongan City, Indonesia, studied how urban intervention and high population density impacted land utilization and resulted in environmental and social challenges (Suharini et al., 2017). The study was confined in Hawalbagh block, Almora District, Uttarakhand, India, where human activities causing tremendous changes in the land uses and land covers become illegally usages.(Rawat & Kumar, 2015) Migration and land-cover change are closely connected phenomena that significantly affect rural areas, particularly in regions like Ohio, where agricultural landscapes and population trends have been in transition. The movement of more people into and out of these areas is considered to have significant implications for the local economy.(Park et al., 2022)

This study differentiates governorates in Jordan's southern region that attract or expel populations based on net migration data. Migration statistics were acquired from the Department of Statistics through the General Population and Housing Censuses for the years (1994, 2004, 2015) and estimates for (2023). By analyzing migration flows, the study intends to evaluate the relationship between migration and land use change. Detection of land use and land cover (LULC) change is essential in monitoring the environment as it directly affects the impacts on biodiversity, water resources, agriculture, etc. Remote sensing and Geographic Information Systems (GIS) are important tools capable of mapping, analyzing, and monitoring patterns of spatial changes through time.

## 3. Materials and Methods

### *3.1. Study area*

The southern part of Jordan is called by the names of Karak, Ma'an, Tafila and Aqaba, all of which are important in the administrative and economic framework of the country. Regionally, the southern part of Jordan borders: Karak is bordered to the north by Madaba with Tafilah to the south as well as its eastern neighbor The Southern Desert and Ma'an (Abadi, 2024). The total surface area of Karak Governorate is 3,495 km² and it is consisted of seven districts and three sub-districts. The population was 381900 in 2023 (Department of Statistics, 2024). Geographically, it is found between 31.0°–32.0°N latitudes and 35.5°–36.0°E longitudes. In proximity to Amman Governorate, Ma'an Governorate lies in the north whose southern edges border the Jordanian Saudi border. This Governorate covers the distance from 32, 831 kilometer squares southwards up to 191100 people populating it by now 2023.These locations include Ma'an latitude range from 30.0°–31.0°N as well as longitudes 35.0°–36.0°E. Tafila Governorate is in the southwest and is bordered by Karak to the north; Ma'an on three sides including south and east together with Wadi Araba and the Dead Sea on the western side. Its total landmass measures 2210 km², which have been divided into three districts with its human population standing at 116200 within this year (2023). It lies at 31.0°-31.5°N latitude and 35.0°-35.5°E longitude point respectively. On the Red Sea shore of Aqaba Governorate, Jordan's unique seaport is located, which is vital for its economic life because of its industrial parks and free zones , The total area of this region is 6903 km², divided into two districts with two sub-districts with a population estimate of 227000 during the year 2023, lying between 29.5° – 30.0° N latitude and 35.0° – 35.5° E longitude (Al-Saqarat et al., 2017). Overall, these governorates demonstrate diversity in their geographical features and economic structures, particularly in trade, industry, and administrative activities. (Figure 1)

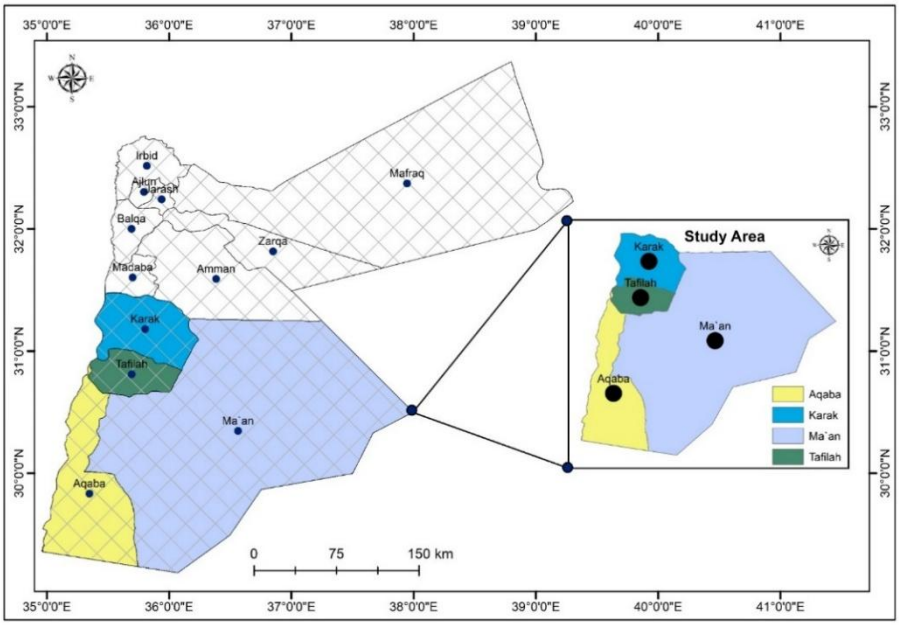



**Figure 1 Study Area Location in Southern Jordan**

*3.2. Methodology*

The research methodology focused on studying the use of land and population within a time frame, with an emphasis on migration data as a key factor in understanding demographic changes. Time-series data were used to identify patterns and trends in population distribution, assisting in monitoring the influence of migration on demographic structure over time. Additionally, quantitative and qualitative analyses were combined to provide a comprehensive perspective, with quantitative analysis focusing on numerical data such as migration rates and population counts, while qualitative analysis explored sociological and cultural factors that affect land use and migration dynamic.

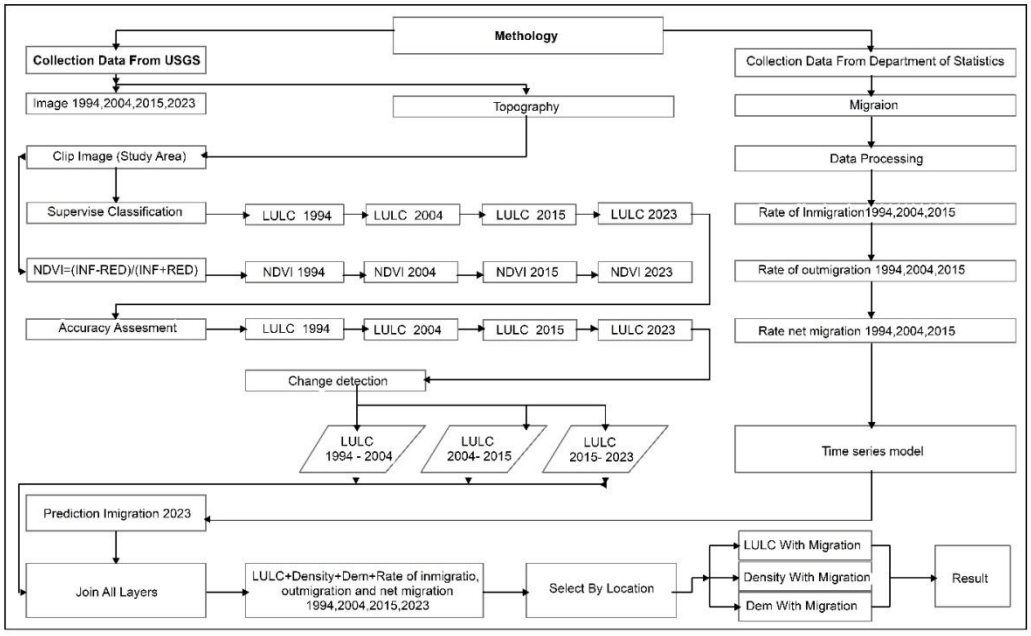



**Figure 2. Methodological Flowchart of the Study**

*3.3. Topography Data*

The Digital Elevation Model (DEM) depicted in Figure (3) shows the topographic differentiation across the southern region of Jordan, including the governorates of Karak, Tafila, Ma'an, and Aqaba. Elevation values range from -456 meters, in relation to the areas near the Dead Sea, up to 1829 meters in the higher mountainous regions. This variation explains the rough landscape, with Tafila and Karak containing multiple elevated areas, whereas the Aqaba region is located at much lower elevations, (Bar et al., 2018)consistent with its coastal location along the Red Sea. The map shows the major role of topography in forming settlement patterns and population distribution. For instance, Aqaba is strategically positioned at lower elevations, (Dammag et al., 2024)taking a part in its development as a vital economic center with industrial and trade activities. In contrast, the central parts of Ma'an are characterized by moderately elevated terrain, indicative of arid plains that challenge agricultural activities but still take in settlements and migration routes. (Rettberg et al., 2017)

The DEM marks how natural features such as valleys and mountains affect regional connectivity and migration. The elevation variation between the governorates is expected to influence internal migration flows, especially as higher elevations might experience less dense population groups compared to the lowland areas. This map serves as an essential tool in understanding the geographic restrictions that interact with socioeconomic factors such as land use and migration in southern Jordan.

**Satellite Imagery**: Retrieved from the **United States Geological Survey (USGS)** for the years 1994, 2004, 2015, and 2023

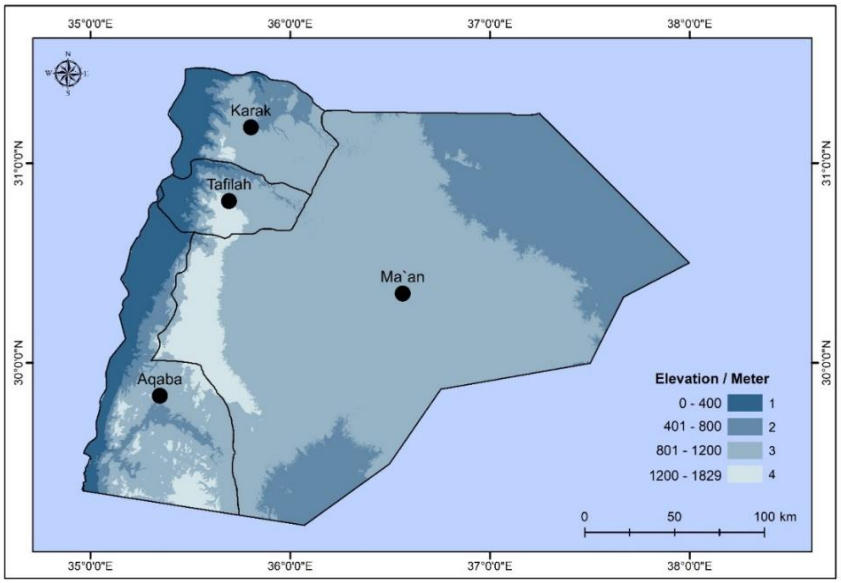



**Figure 3. Digital Elevation Model of the Southern Region**

**Table 1. Characteristics of the Landsat images used in this study.**

| No | Landsat Sensor | Path/Row | Date Acquired | Resolution |
|---|---|---|---|---|
| 1 | Landsat L5_TM | 174/38 | 29/5/1994 | 30 m |
| 2 | Landsat L7_TM | 174/38 | 24/5/2004 | 30 m |
| 3 | Landsat 8 OLI_TIRS | 174/38 | 8/6/2015 | 30 m |
| 4 | Landsat 9 OLI_TIRS | 173/39 | 19/5/2023 | 30 m |

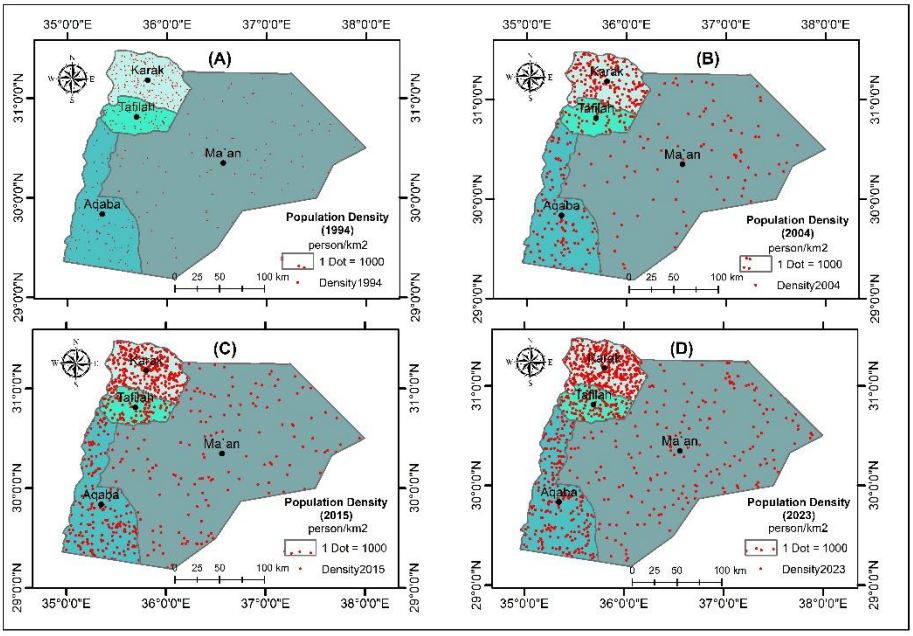



**Figure 4. Population data and density metrics for the years (1994, 2004, 2015, and 2023)**

**Population data and density metrics** for 1994, 2004, 2015, and 2023

Between 1994 and 2023, there was a significant growth in population density in the southern Jordan, with the highest density recorded in Al-Karak Governorate, while the lowest density was recorded in Al-Ma'an Governorate, but the situation is further exacerbated by the slow growth. These changes are connected to various factors, including internal migration, natural increase in population, and economic activities that attract residents to specific areas. This data is essential for urban planning, improving distribution of resources, and instructing government policies, requiring an efficient response to meet the rising needs of the population and obtain sustainable development

**Table 2. Population density of the study area from (1994 to 2023).**

| No | Governorate | Area km2 | Pop1994 | Density 1994 | Pop2004 | Density 2004 | Pop2015 | Density 2015 | Pop2023 | Density 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Karak | 3803.19 | 169770 | 44.64 | 185900 | 48.88 | 317500 | 83.48 | 381900 | 100.42 |
| 2 | Tafila | 2171.50 | 62783 | 28.91 | 56500 | 26.02 | 96600 | 44.49 | 116200 | 53.51 |
| 3 | Ma'an | 32753.96 | 79670 | 2.43 | 84600 | 2.58 | 144500 | 4.41 | 191100 | 5.83 |
| 4 | Aqaba | 6933.59 | 79839 | 11.51 | 110500 | 15.94 | 188700 | 27.22 | 227000 | 32.74 |
| Total | | 45662.23 | 392062 | 87 | 437500 | 93 | 747300 | 160 | 916200 | 192.50 |

The given data for the years 1994 through 2023 are subject to increases of up to two people for every meter squared mainly through Southern Jordan. Al-Karak Governorate is showing increased densities at (100.42) persons/km² which had increased from an estimated (44.64) persons/km² in (1994). This rise reflects internal migrations among citizens within the country, indicating that the area has become attractive to residents due to the increase in services provided and job opportunities. On the other hand, Al-Tafila Governorate have seen a decrease in population density from (28.91) persons/km² in (1994) to (26.02) persons/km² in 2004, but the situation changed for better to reach an estimate of as high as (53.51) persons/km² by (2023) which means that it has begun to attract people from outside its boundaries. (Za et al., 2012)

However, Ma'an Governorate, having recorded one of the lowest populations in the country, saw its density double from being 2.43persons/km² (1994) up to high as 5.83persons/km² (2023) which may indicate of external relocation where citizens move out due to the lack or inadequate jobs as in contrast with other districts where job opportunities seem promising. On the other hand, Aqaba Governorate have seen obvious increase in its dense areas rising from about 11.51 to 32.74 persons/km² over the last three decades; this may therefore imply that due to its economic activities, including but not limited to tourism, this might be a point of attraction for people (Bani Salameh & Aldabbas, 2024).

These data indicate that population density in southern Jordan is greatly affected by both internal and external migration factors. While some cities, such as Aqaba and Al-Karak, receive new residents, other places such as Ma'an may experience a decline in population due to emigration. The analysis shows that it is necessary to consider state policies aimed at improving sustainability within the region by creating and providing opportunities for people in sparsely populated parts in order to achieve balance between population growth, migration, and development (de Haas et al., 2019). Furthermore, this data emphasizes the importance of addressing the specific challenges posed by migration, including providing adequate services and creating employment opportunities in less populated areas to mitigate the outward migration trends observed in some regions.

*3.4. Image Preprocessing:*

, preparation of satellite images for classification is a crucial stage in order to understand internal and external migration dynamics (Sishodia et al., 2020). These preparations include obtaining highly detailed imaging data from satellites that would provide a comprehensive understanding of land use changes, urban sprawl and critical infrastructure, (Yu & Fang, 2023). After that, these images are then processed by image analysis techniques for classification, enabling the identification of population and distribution patterns in specific regions(Ventura et al., 2018), this information can be used to highlight regions undergoing population increases or decreases, aiding in the understanding of migration trends. Ultimately, these

analyses help in developing well-informed strategies for controlling migration and effective urban planning.

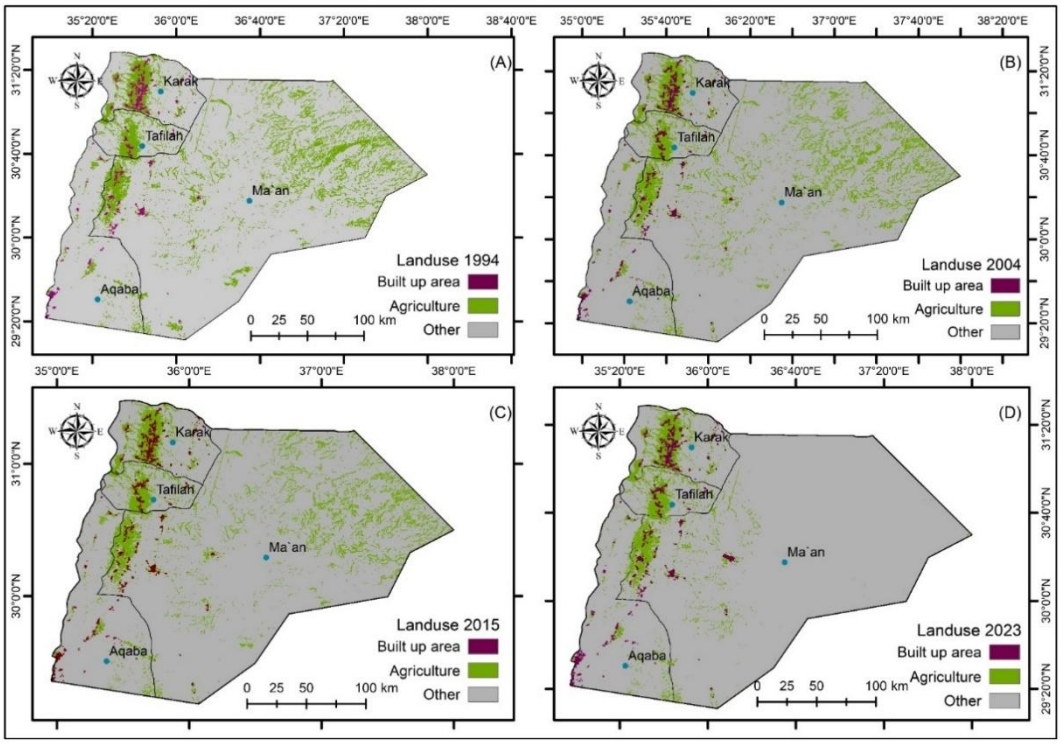



**Figure 5. Land use and land cover in Southern Region**

**Table 3. Land use evolved over time, particularly the urban area expansion and agricultural land reduction.**

| LULC | 1994 | % | 2004 | % | 2015 | % | 2023 | % |
|---|---|---|---|---|---|---|---|---|
| Built-up area | 139.38 | 0.31 | 157.67 | 0.35 | 170.09 | 0.37 | 216.71 | 0.47 |
| Agriculture | 577.75 | 1.27 | 512.01 | 1.12 | 486.15 | 1.06 | 419.56 | 0.92 |
| Other | 44945.10 | 98.43 | 44992.55 | 98.53 | 45005.98 | 98.56 | 45025.96 | 98.61 |
| Total Area km2 | 45662.23 | 100 | 45662.23 | 100 | 45662.23 | 100 | 45662.23 | 100 |

Table (3) and Figure (5) show the changes in land use and land cover (LULC) in a southern region over the years from 1994 to 2023, reflecting various classifications such as built-up area, agriculture, and other activities. The built-up area has witnessed a continuous growth from (139.38) km² (0.31%) in (1994) to (216.71) km² (0.47%) in (2023), indicating urban growth and the rising demand for infrastructure, which may partially be related to internal migration that increases the population and puts pressure on city services. In contrast, the agricultural area has decreased from (577.75) km² (1.27%) in (1994) to (419.56) km² (0.92%) in (2023), indicating changes in agricultural uses or urban violation on agricultural lands, which may affect food security in addition to rising populations. Meanwhile, other activities, which represent most of the area, have stayed nearly the same, rising slightly from (44945.10) km² (98.43%) in (1994) to (45025.96) km² (98.61%) in (2023). Overall, the analysis shows an obvious transformation in land use with an increase in built-up areas and a decrease in agriculture, indicating the obstacles and opportunities in urban planning and land management. This change in land use requires well-established strategies to address internal and external migration, ensuring sustainable land use and meeting the needs of the growing population. The need for balanced urban and rural development policies becomes crucial to mitigate the impacts of these changes on both the environment and the local communities, particularly considering ongoing population growth and migration patterns.

### *3.5. Accuracy Assessment*

Conduct a comprehensive accuracy assessment to validate the precision and reliability of Land Use and Land Cover (LULC) classifications across all analysed years. This evaluation should employ established methods, such as confusion matrices, to assess the classification's accuracy by comparing the derived land use categories against ground truth data or high-resolution reference images, ensuring the robustness and reliability of the results.

**Table 4. Accuracy assessment to verify the precision of LULC classifications for the years from (1994-2023)**

| LULC | Built up area | Agriculture | Other | Sum Row | User Accuracy |
|---|---|---|---|---|---|
| Built-up area | 35 | 2 | 1 | 38 | 89 |
| Agriculture | 2 | 36 | 1 | 39 | 97 |
| Other | 3 | 2 | 38 | 43 | 81 |
| Sum Colum | 40 | 40 | 40 | 120 | Kappa |
| Producer Accuracy | 88 | 90 | 95 | All Accuracy | |
| | | | | 90.13 | 0.82 |

The accuracy assessment of the Land Use Land Cover (LULC) classifications for the analyzed years shows important insights into the reliability of the classification results. The error matrix indicates high user accuracy, especially for agriculture (97%) and built-up areas (89%), while the other category shows lower user accuracy at 81%. The producer's accuracy further verifies the reliability of the classifications, with values of 88% for built-up areas, 90% for agriculture, and 95% for other categories. (Lehner & Blaschke, 2019).

The total accuracy of the classification values at 90.13%, ensuring a strong performance in detecting changes within the classified data, as supported by J. Wang & Han (Yu & Fang, 2023). The Kappa coefficient, calculated at 0.82, indicates a substantial agreement between the classifiers, which indicates that the classifications are reliable for assessing LULC changes over time. A Kappa value close to 1 mark the effectiveness of the classification process, while the inclusion of the error matrix provides a comprehensive evaluation of the actual versus expected classifications. This accurate assessment is necessary to ensure that the changes detected in LULC are reliable and can inform future planning and management strategies effectively. (Sarker et al., 2019)

### *3.6. Change Detection Analysis*

The change detection analysis, performed across the period from 1994 to 2023, reveals notable land cover transformations within the study area of Jordan. Using a geographic coordinate system with a spatial reference of latitude and longitude (shown on the map as degrees of north and east, respectively), this analysis identifies areas where significant shifts in land use have occurred. The analysis highlights transition between agriculture, built-up areas, and other land cover types. Specifically, it reveals instances where agricultural land has been converted to built-up areas, indicating urban expansion, alongside other transitions between land cover categories. This visualization allows for a clear understanding of the spatial patterns and magnitude of land use change, facilitating further analysis of their causes and impacts.

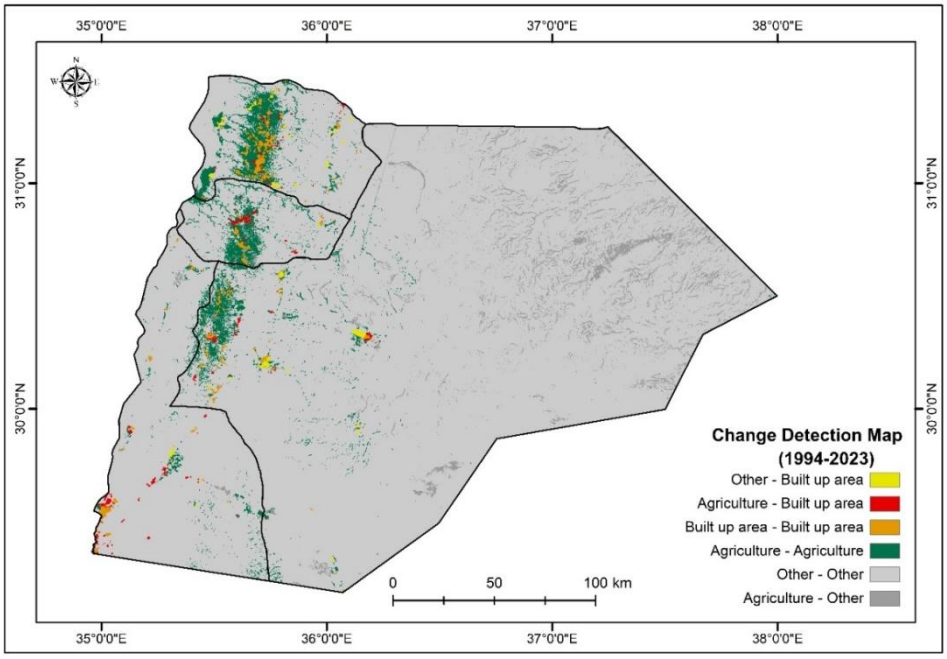



**Figure 6. Final map of change detection from (1994 to 2023)**

**Table 5. Change detection for study area from (1994 to 2023)**

| LULC | 1994 | 2004 | Change | 2015 | Change | 2023 | Change | Total Change |
|---|---|---|---|---|---|---|---|---|
| built up area | 139.38 | 157.67 | 18.29 | 170.09 | 12.42 | 216.71 | 46.62 | 77.33 |
| Agriculture | 577.75 | 512.01 | -65.74 | 486.15 | -25.85 | 419.56 | -66.59 | -158.19 |
| Other | 44945.10 | 44992.55 | 47.45 | 45005.98 | 13.43 | 45025.96 | 19.97 | 80.85 |
| Total Area km2 | 45662.23 | 45662.23 | 0.00 | 45662.23 | 0.00 | 45662.23 | 0.00 | 0.00 |

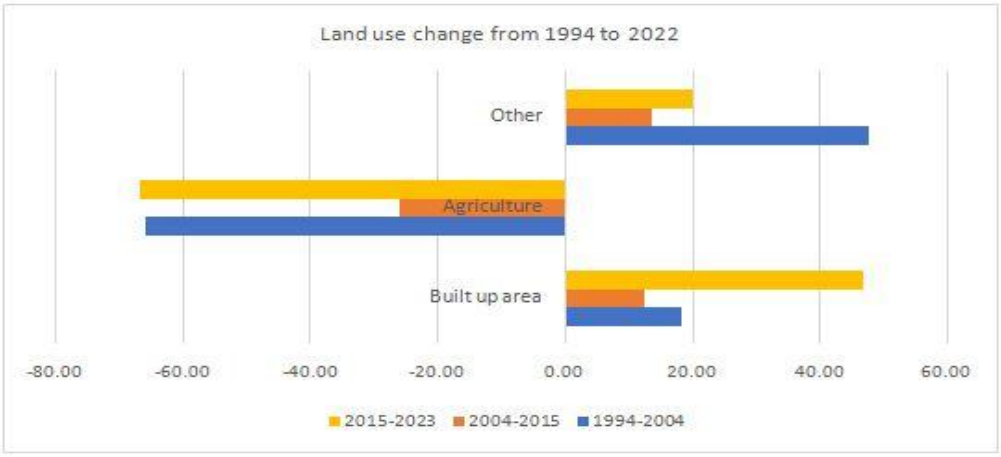



**Figure 7. Change detection charting study area from 1994 to 2023**

The table is explains How Land is Used in South Jordan from Past to Present focusing on three categories, developed areas, farming and any other human activities (Lwanyaga, 2022) (Obeidat et al., 2019) The study illustrates that developed area constantly expanded as land use shifts over years starting from (139.38) km2 in (1994) up to (216.71) km2 in (2023), highlighting an overall change of (77.33) km2.This shows increase in urbanization and growth in population due to internal migration that results in rise in demand for food and infrastructure. (Bell et al., 2015). Nevertheless, there was a remarkable

decrease in farmlands from (577.75) km2 back in time up until now and the total difference was (-158.19) km2, i.e., from 1994 through 2023 being reduced to (419.56) km2 only, which indicates the transition of agricultural land into urban settlements with rising pressures caused by urbanization and migration. As a result, this decrease of arable land may have a negative influence on food security within regions since it may push people to depend heavily on imported products.

Other activities have remained relatively the same, with a minor increase in area, indicating their continued use in different non-built or agricultural activities.

All in all, these differences in land use reflect the influence of urbanization and internal migration on land utilization, assuring the need for well-considered policies to ensure sustainable land use while maintaining agriculture and keeping food security in the future.

Over multiple decades show a consistent pattern of outward migration, especially from Karak, Tafila, and Ma'an, where net negative migration rates indicate that there is more people are leaving than people arriving. While Tafila briefly attracted migration in 1994 with only a slight change between inward and outward rates, this trend was reversed quickly.( Susser, A. 2021) In contrast, Aqaba has shown noticeable growth as it is considered a destination for migration since it became a special economic zone in 2001, which was a change that affected its net migration to increase from 2.8% between 1994 and 2004 to 12.9% in 2023, transforming it into a central economic and tourism hub

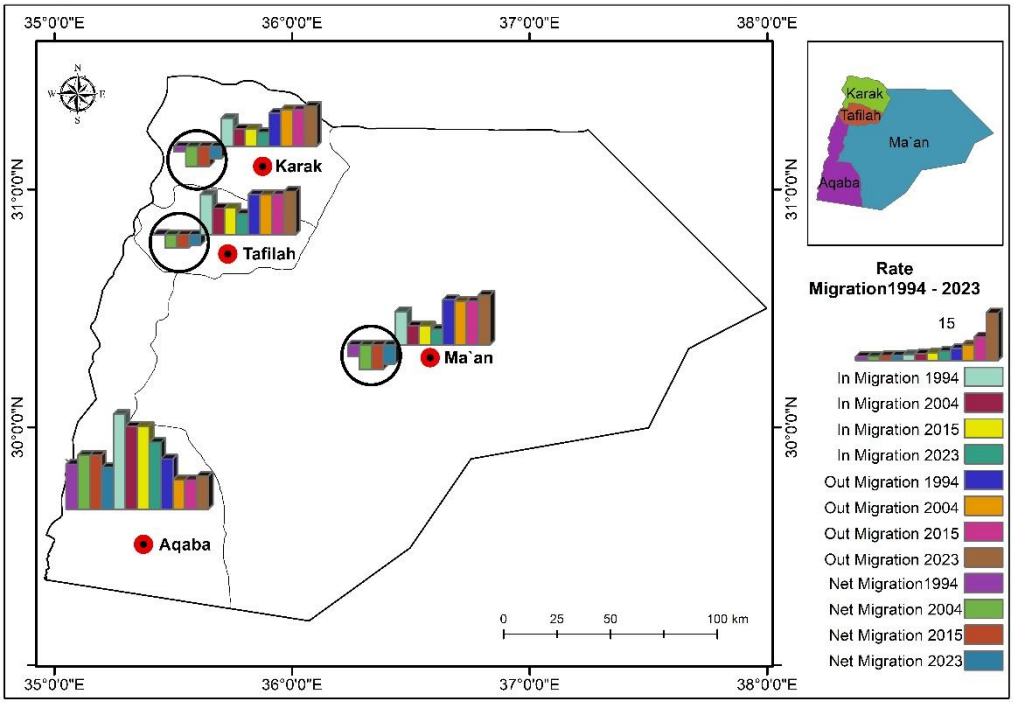



**Figure 8. Rate of all migration Data in study area from (1994 to 2023)**

The data from 1994 to 2023 shows that external migration in the region that is directly correlated with land use shifts, where urban areas expanded by 77.33 km², while agricultural land declined by 158.19 km², resulting in the reduction of rural job opportunities and leading citizens to search for employment in urban centers. This decrease in agricultural activities, along with creating limited job opportunities and services in rural areas, has promoted outward migration, especially from governorates like Ma'an and Karak(Department of Statistics, 2024). Conversely, the positive balance in migration in Aqaba illustrates its role as an economic hub, with urban expansion and tourism stimulating internal migration while other southern governorates face continued outmigration. Many socio-economic factors contribute to these trends, including urbanization, elevated living standards in larger cities, and insufficient investments from the government in rural infrastructure and services, which have increased negative migration rates in the south (Benghadbane & Khries, 2020) .

There is an evident need for sustainable development policies targeting these regions, with a focus on recommendations reviving agriculture, increasing job opportunities, and investing in infrastructure to reduce outward migration and promote balanced regional growth.

## 4. Analysis and discussion

### *4.1. The Reality of Internal Migration in Jordan from (1994 to 2015)*

The Department of Statistics performed the first specialized survey on internal migration and return migration in Jordan in 1986. This survey showed that 6.2% of the Jordanian population were found to be immigrants that have migrated during their lifetime, while approximately 9% were identified as immigrants based on their current and previous places of settlements. The census data from 1994 reveal that 10.4% of the total Jordanian population had changed their place of birth to settle in other governorates. It is worth mentioning that the capital governorates, Amman and Zarqa, are depicted as the most attractive and repellent areas for migrants, both gravitating 56% of incoming immigrants while responsible for around 50% of outgoing migrants.

The results of the 2004 Population and Housing Census revealed a small decrease in migration rates, with 9% of the Jordanian population changing their places of birth to live in other governorates. The Aqaba governorate recorded the highest rate of incoming internal migration at 25.7%, while Irbid had the lowest rate at 3.7%. (Social Trends in Jordan, 2006).

To analyze the differences between the rate of incoming and outgoing migration, as well as the net migration rate at the governorate level in southern Jordan, we can use the data from the 1994, 2004, 2015.and 2023 censuses. This analysis points out the visible variations in migration patterns across different governorates, showing trends in population movement within the southern region of Jordan.

**Table 6. Net Migration, In Migration, and Out Migration by (Southern Region) (1994-2023)**

| No | Name | Net Migration | | | | In Migration | | | | Out Migration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1994 | 2004 | 2015 | 2023 | 1994 | 2004 | 2015 | 2023 | 1994 | 2004 | 2015 | 2023 |
| 1 | Aqaba | 13.9 | 16.7 | 16.7 | 12.9 | 29.4 | 25.7 | 25.7 | 20.7 | 15.5 | 9 | 9 | 10.3 |
| 2 | Karak | -1.6 | -6.1 | -6.1 | -3.7 | 8.7 | 5.4 | 5.4 | 4.5 | 10.3 | 11.5 | 11.5 | 12.6 |
| 3 | Ma`an | -3.6 | -7.7 | -7.7 | -6.0 | 10.3 | 5.8 | 5.8 | 4.7 | 13.9 | 13.5 | 13.5 | 15.4 |
| 4 | Tafilah | 0.1 | -4.1 | -4.1 | -3.3 | 12.4 | 8.2 | 8.2 | 6.4 | 12.3 | 12.3 | 12.3 | 13.4 |

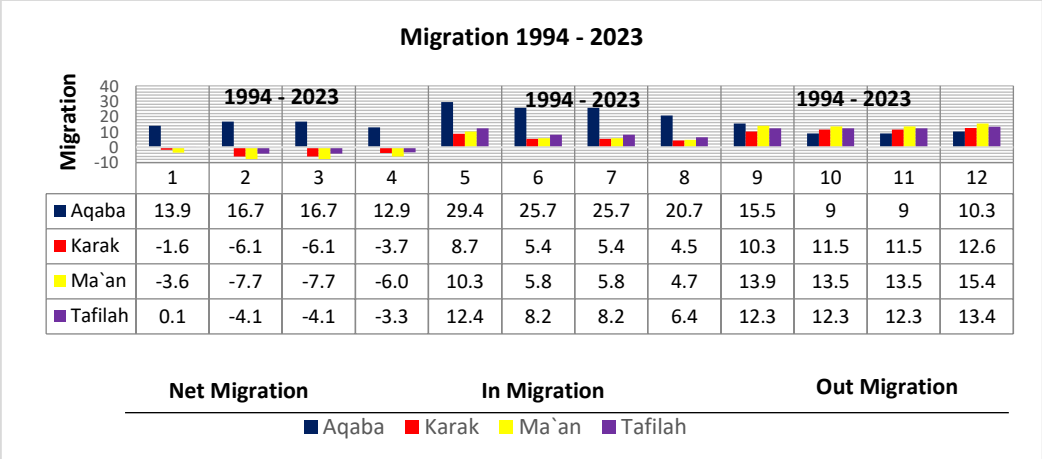



**Figure 9. Net Migration, In Migration, and Out Migration Chart by (Southern Region) (1994-2023)**

### 4.2 Analysis of External Migration and Land Use in Southern Jordan from 1994to 2023)

The analysis of external migration patterns in southern Jordan shows that there is an evident interdependent relationship of land use patterns, the terrain aspects and migration patterns. Utilization of land as well as its elevation is the key factor in determining the choices made by the residents to move out as both have a direct influence on the economic potential, living conditions and environmental appropriateness.

External Migration Trends Analysis

In Ma'an and Karak governorates, there was a rise in the rates of negative external migration, and to a large extent, this was as a result of the increasing economic pressures in these regions. The low availability of jobs and services prompted a significant proportion of the residents to find other avenues. This outer movement has been largely related with poor planning of land-use, which has been unable to adapt adequately to the changing demographic and economic demands of the people. On the contrary, Aqaba has continued to remain a comparatively attractive destination. The governorate has enjoyed a continuous investment and tourism growth since its designation as a Special Economic Zone in 2001 and offset external migration albeit by a modest reduction in net inflows in recent years. Nevertheless, Tafila still registered negative net migration especially relating to the shrinkage of farming activities and the meager scope of the accessible economic prospects.

The Leading Land Use and Terrain Elevation in Migration Pattern

According to land-use data, urban sprawl is also significant, with a total of about 77.33 km 2 in the period between 1994 and 2023 due to the presence of new economic zones. However, this expansion has not been adequate in absorbing rising demand to work and provide social services, a factor that has helped in escalating both internal and external migration. At the same time, the agricultural land area decreased to around 158.19 km 2, which further diminished the employment opportunities in rural regions and increased migration to urban regions. Also, the terrain elevation is significant in determining the settlement preferences. Places located higher in the elevation, especially within sections of Karak and Ma'an, possess more moderate weather and offer more comfortable living conditions, and thus, are more preferred over low-lying areas that have more severe weather conditions or less economic opportunities.

### 4.3. The Relationship between Net Migration and Land Use in Southern Jordan (1994 2023) Analysis

The net migration patterns in southern Jordan during 1994-2023 is analyzed and it indicates a close relationship with the land use changes. The total area of urban areas increased by 77.33 km 2 and agricultural territories decreased by 158.19 km 2 which had a considerable impact on the migration processes. Aqaba was the only governorate to register positive net migration in the entire study period which further justifies it as a regional economic centre which has been boosted by urban development and other tourism related services. Ma'an, Karak, and Tafila on the other hand had have recorded rising cases of negative net migration, with most of it being due to dwindling agricultural activities and lack of viable employment chances, which curtailed the long-term development possibilities.

The trends have been influenced by various dimensions that are interrelated. The changes in the economy mainly the decline in agricultural jobs as well as the uneven growth in urban areas have forced a lot of the residents to find more employment opportunities elsewhere. People have also been motivated to move by other socio and service-related reasons such as better living standards and availability of services in bigger urban areas. Besides, the lack of government funding in rural and peripheral regions has made outward migration worse in these regions.

To sum up, the migration trends identified contribute to the necessity to develop sustainable development solutions to enhance the living standards in southern Jordan. The revival of the agricultural sector, creating more jobs, improving infrastructure, and focusing specific investments on the governorates with negative net migration are the critical steps towards improving the stability of population and supporting the balanced development of the regions.

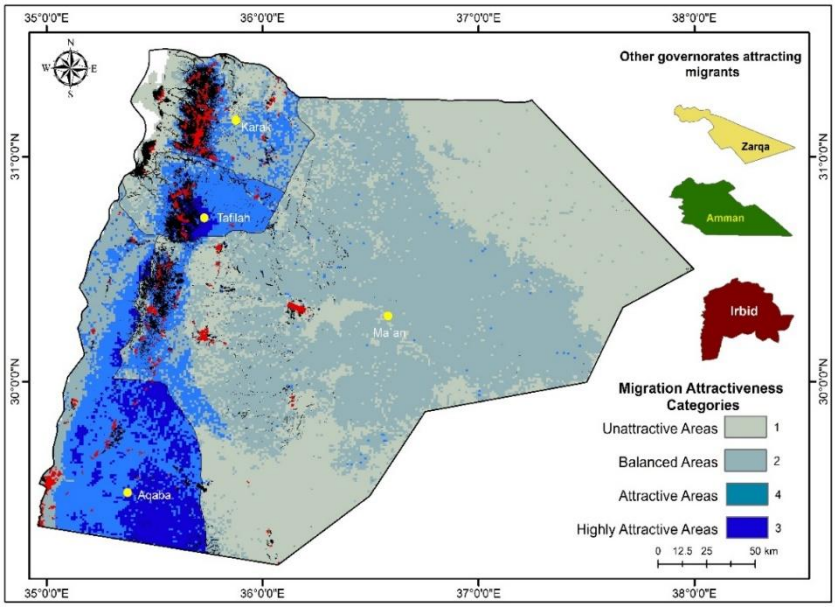
### *4.4. Results*

Figure (10) provides the major geographical and economic peculiarities of southern Jordan which is a decisive factor in the formation of trends of internal migration. The map has pinpointed some of the focal points which serve as major population magnet especially university centers like Tafila Technical University, Al-Hussein Bin Talal University and Mutah University. The institutions attract students in other parts of the country leading to population concentration and increased demands in the areas that have the institutions.

Besides the learning centers, there are several major tourist attractions in the southern part of the country, among them include a Dana biosphere reserve, the Wadi Rum, the ancient city of Petra and Red Sea reserve. The economic activity in these sites has been triggered due to growth of tourism related infrastructure and services thus drawing population inflows associated with employment and investment opportunities. Equally, the creation of industrial belts in places like Ma'an and Aqaba has created new employment opportunities, which makes the places more appealing and thus helps to boost population increase through migration of labor force.

In comparison, other regions in southern Jordan operate as regions of partial appeal, especially of border zones, including the Al-Munawwara border crossing, and the village of Rum in Aqaba Governorate. Although these localities have some economic prospects, they have structural limitations in terms of job prospects and access to basic services. Consequently, it would lead to more migration among the residents of these areas into urban and economically advanced centers with improved opportunities and living conditions.

In general, the map shows that there is a distinct spatial pattern between the regions with a strong pull factor such as university, tourism and industrial regions, as well as the border or peripheral regions where economic and social opportunities are not many and thus they tend to pull. The opportunity of a combination of educational institutions, tourism assets, and industrial activity makes Aqaba Governorate a very attractive destination. Karak, Ma'an and Tafila governorates are, conversely, defined as of relatively low attractiveness, in large part due to less developed economic and social infrastructures (Abu-Taleb, 2023).



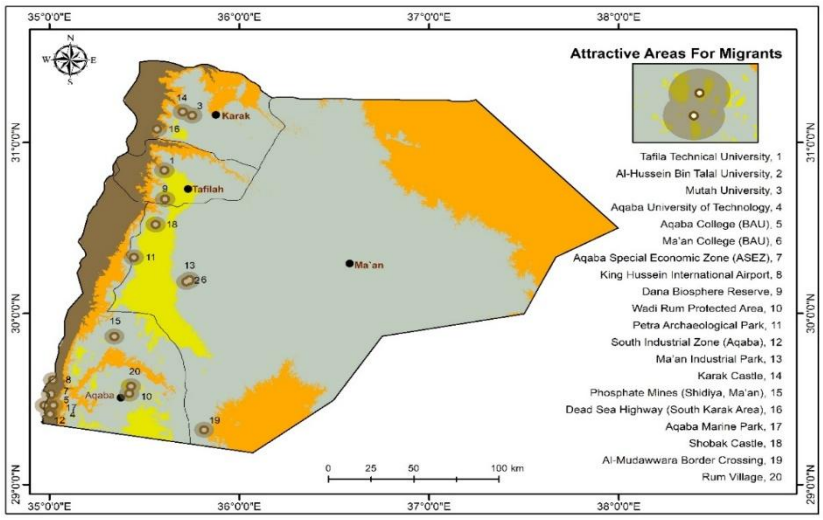



**Figure10. Core Categories Shaping Migration Trends in (Southern Region)**

**Table 7. Assessment of Migration Attraction and Repulsion over the Years from (1994 to 2023)**

| Governorates | 1994 | 2004 | 2015 | 2023 |
|---|---|---|---|---|
| Karak | Repellent | Repellent | Repellent | Repellent |
| Tafilah | Attractive | Repellent | Repellent | Repellent |
| Ma'an | Repellent | Repellent | Repellent | Repellent |
| Aqaba | Attractive | Attractive | Attractive | Repellent |

Moreover, as pointed out by the map, numerous areas in North and central Jordan such as Amman, Zarqa, and Irbid have much higher rates of attractiveness than the south governorates. This trend implies that migrants are strongly attracted to regions which can provide them with diversified economic prospects, well-developed infrastructure, and complete sets of services of the government. Various interconnected factors may be used to explain these dynamics of migration, but the availability of employment, clustering of industrial and tourism activities, especially in Aqaba, and the existence of well-developed transportation systems, educational establishments, and medical establishments can be listed among the key ones. Besides that, the social determinants of migration, including security, and stability are essential determinants (Madallah and Tarawneh, 2014).

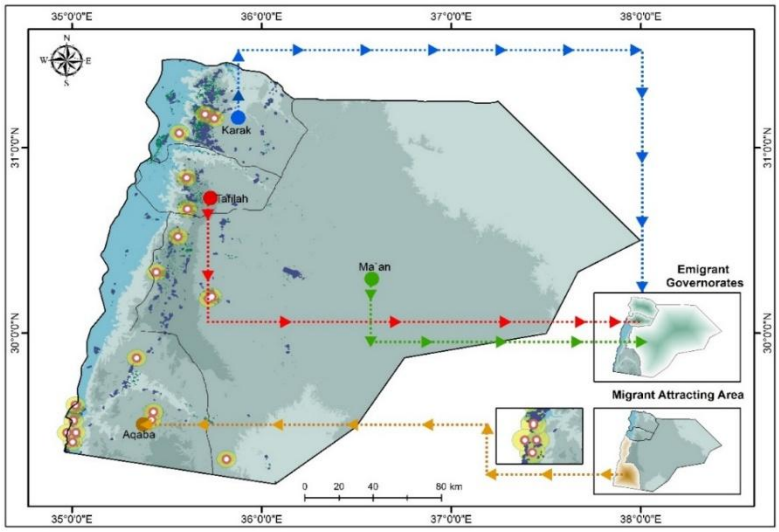



**Figure 11. Dynamics of Migration Attraction and Repulsion Categories in the Study Area**

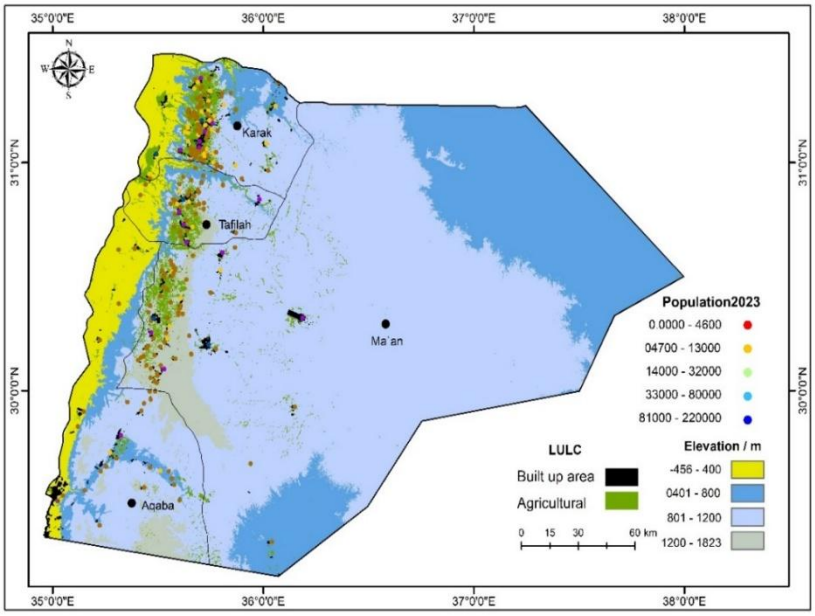



**Figure 12. Patterns of Net Migration in Relation to Land Use Dynamics, and Elevation in Southern Jordan**

**Table 8. Net Migration in Relation to Land Use Dynamics, and Elevation in Southern Jordan**

| No | Governorate | Area km2 | Pop2023 | Net Migration | Population in the elevation | | | | land use/ km2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | -456 - 400 | 401 - 800 | 801 - 1200 | 1201 - 1829 | Building area | Agricultural Area |
| 1 | Karak | 3803.2 | 381900 | -3.72 | 36496 | 32590 | 272516 | 40298 | 73.23 | 242.915 |
| 2 | Tafiela | 2171.5 | 116200 | -3.29 | 883 | 1978 | 73863 | 39476 | 17.334 | 75.911 |
| 3 | Ma'an | 32754.0 | 191100 | -5.95 | 0.00 | 1787 | 114601 | 74713 | 63.284 | 75.667 |
| 4 | Aqaba | 6933.6 | 227000 | 12.91 | 184891 | 270 | 38568 | 3272 | 62.683 | 25.061 |
| Total | | 45662.2 | 916200 | | 222269 | 36625 | 499548 | 157758 | 216.531 | 419.554 |

The results of this study provide a comprehensive analysis of the complex correlation between geographical and economic factors that have an impact on migration patterns in southern Jordan. By studying the governorates of Karak, Tafila, Ma'an, and Aqaba, it becomes clear that elevation, land quality, and economic opportunities play major roles in attracting or repelling residents. Where is the factor of natural population increase? In Karak, most of the citizens live at heights between (800) and (1200) meters, representing about (71.4%) of the population. Here, agriculture is a priority due to large areas under cultivation as well as lowlands indicating that there is only few economic opportunities available. Due to lack of employment opportunities, especially in farming, the region remains less competitive with other regions that are economically viable, hence pushing its residents to move elsewhere to earn a living. Similarly, in Tafila and Ma'an most of residents live at elevated areas, with (63.57%) settling in the range between 800-1200 meters for Tafila and (33.97%) falling within 1200–1800-meter elevations. Subsequently within Ma'an (59.97%) it resides at (800-1200) meters' formula whereas still others settle in more territories ranging (1200-1800) meters by (39.10%). However, they face some challenges that hinder their ability to keep population, including high terrains where investments are hard to locate, undeveloped areas and inadequate services availability, thus driving some residents to search for other places from where they can return home. On the other hand, Aqaba is an attractive economic hub, with (81.45%) of its population living in areas below (400) meters, benefiting from its strategic location along the Red Sea, ports, and industries associated with it. Although recent economic challenges have slightly reduced Aqaba's appeal, its advanced infrastructure and variation of economic opportunities in tourism, industry, and trade continue to attract residents and migrants from other regions. Furthermore, the

study also showed significant shifts in land use between (1994) and (2023), with urban regions increasing slightly from (0.31%) to (0.37%), indicating growth of (0.6%), while agricultural areas decreasing from (1.27%) to (1.06%), a decline of (0.20%). This change coincides with the migration patterns observed, where urban regions are becoming more attractive due to better services and employment opportunities, while the reduction in agricultural land indicating fewer job opportunities in rural areas, driving residents to migrate to cities looking for more stable ways to earn a living. These migration trends continue to intensity due to the economic differences between governorates caused be disparities in infrastructure and investments."

**4.5. Discussion**

In this work, the relationship between the migration, land use, and geographical elements is very intricate in the south of Jordan mainly in the governorates of Karak, Tafila, Ma'an and Aqaba. The analysis of internal migration patterns in the 1994-2015 period shows that there is a definite divergence in the region: Aqaba appears to be the main destination of the migrants, a process that is evidently connected to the establishment of its special economic zone in 2001. The status has driven investment and tourism resulting in a significant growth in the number of employment opportunities in various fields, industrial, tourism and services. At the same time, we also found that there is an alarming trend of population reduction in Karak, Tafila, and Ma'an because of the constant problems with the lack of employment opportunities, poor infrastructure, and the unavailability of essential services. This is especially seen in the migration rates analysis wherein Aqaba has a positive net migration whilst other governorates experience high rates of emigration.

Moreover, this paper has shown that attractiveness of different geographical areas is also determined by increased chance of education as seen by development of areas that support the Mutah University, Tafila Technical University and Al-Hussein Bin Talal University. Nonetheless, these institutions do not also appear to be a remedy to the economic crisis in the environs since the study identifies a distinct positive correlation between outward migration and lack of access to job opportunities. This unceasing exodus points to the fact that there is a dire need to subject to strategic interventions in order to enhance infrastructure and services throughout the south of Jordan. Such strategies involve enhancement of transportation, education, and healthcare systems which are key in the development of an economy.

The external migration is further analyzed in the study area and this provides some context. The rising negative net migration rates in Ma'an and Karak are provable connected to the rising economic strain in the regions, and consequently there is no wonder that people still seek their opportunities elsewhere. This trend is also confirmed by land use data where there was a substantial urban development of about 77.33 km2 in 1994-2023 with the number of investments in new economic zones being the main priority. This has not however grown to provide sufficient job opportunities to offset the loss of agricultural jobs. In particular, the research has indicated that agricultural areas have been diminishing by 158.19 km 2, thus probably reducing the opportunities in the rural parts, and relocating the population to the urban parts. These variations in land-use patterns are further aggravated by the physical factors of the area where elevations are a more moderate climate, but an investment hindrance, insufficient facilities, and, later on, flight.

In conclusion, the discussion has discussed the factor that has led to migration patterns in southern Jordan mainly because of economic and spatial factors with Aqaba being the main place of the migrants and other areas registering negative net migration as a result of inadequate infrastructure and employment opportunities. Migration, land-use, and terrain version interact in such patterns, and collective approaches to sustainable and balanced development of regions are required. Any policy making must consider enhancements in the service, employment and the agricultural sector in the more rural regions and promote new investments, in addition to assisting in the development of the urban ones.

**5. Conclusions**

Migration tendencies in the south of Jordan allow making several important conclusions with respect to the impact on the areas of reception. To begin with, the rise in the rates of urbanization, especially in those regions where migrants are

welcome such as Aqaba, has placed a huge burden on the available infrastructure and services to the people. As revealed in our land use analysis, this rapid urbanization has come with significant changes in land use trends where residential lands have been taking over and covering both agricultural and industrial lands. This trend shows that it is difficult to balance between economic growth and the imperative to conserve other important land uses. Therefore, with the migration that is taking place, the number of migrants is also commiserating a rapid increase in the demand on properties hence the rise in property prices and leasing rates in the regions that have been impacted. The changes in the housing market underscore the importance of making more strategic planning and interventions that would see the production of more affordable housing that could be afforded by migrants.

On the one hand, the challenges are evident in the study but on the other hand, one should note positive effects of migration in the area of the study. The human flow has also facilitated the economic activity in the host places by boosting consumption and supplying source of labour in the different sectors resulting in an economic activity in the receiving locations. But there have also been some significant gaps and deficiencies in the services provided to the people especially in education and health as well, and these are also found in our research. These service weaknesses require additional and more specific investments to address the various needs of the new residents. (Brunetti et al., 2020) Moreover, it is necessary to address these needs in order to maximize the potential of migrants as well as provide social inclusion.

Interestingly, this increased awareness of the local communities towards the positive and the negative side of migration was also observed in our study. This, in most instances, has allowed migrants to enjoy a more social support of long-term residents, which is a good thing on how the community has responded to migration. Nonetheless, this heightened social consciousness adds another point to the necessity of policy makers establishing effective regulations that not only meet the social but also the economic aspect of migration and its effects on land use with the aim of establishing sustainable growth and at the same time enhancing living standards of all residents. This is done through a close scrutiny of infrastructure and services planning, the formulation of sustainable housing policies, and the drafting of strategies of better economic opportunities that can help at least curb the causes of some of the factors that lead to migration and promote balanced regional growth.

## 6. Recommendations

The analysis of migration trends in southern Jordan leads to a complex of major conclusions that can support the need to employ well-coordinated and evidence-based policy responses. It is one of the main results of this research that there is an urgent necessity to improve systems of collecting and analysing data. Specifically, more focus needs to be put on producing credible and recent data on the migration flows and land-use changes, as proper policy-making requires proper availability of empirical data. These data sets can also be used to develop monitoring and forecasting tools that would help the decision-makers be proactive in terms of migration trends and not responsive.

Due to the migration-induced urban growth, the paper highlights the need to embrace more adaptable and receptive urban planning models capable of responding to the changing demographics. One of the most important concerns in this relation is the proliferation of affordable housing units to accommodate the growth of demand induced by the inflow of the population and to regulate the growth of the housing prices as the findings point at the latter. Unless such steps are taken, the urban development will be one-sided and socially isolating.

Meanwhile, the findings highlight the importance of the local economic development in defining population movements. A diversification of economic activities may help in enhancing the living standards and alleviating the migration problems. The meaningful progress can be achieved, however, when the coordination of the work of the governmental institutions occurs and the resources are strategically distributed to the governorates which are impacted by the process of migration the most, in particular, to Karak, Ma'an, Tafilah, and Aqaba. Simultaneously, healthcare access

and the sustainability of infrastructure as well as the expansion of education are critical measures intended to sustain the increasing population, as well as to maximize the social and economic benefit of migrants.

Such measures ought to be accompanied with well-planned migration policies that satisfy regional development goals. This involves bettering infrastructure and communal amenities in greater elevation regions which might admit new individuals, as well as specific economic projects in other parts of the state, like in Aqaba, which already has a fairly good presence of economic operation. Besides, as the findings indicate, long-term strategic planning is extremely important, especially with continuous investment in education and abilities growth, which will be the key to both regional sustainability and a better quality of life.

On the whole, the work recommends incorporating these suggestions into a unified and multi-dimensional approach based on the development of data-driven decisions, sustainable urban governance, sustainable economic growth, and investment in human capital. This would help southern Jordan to deal with migration in a more effective manner, manage land utilization, and enjoy more equitable regional development.

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