The Geographical Bulletin

Volume 63 | Issue 3 Article 5

2023

# GIS-based Spatial Analysis of Population Density in Kuwait, 1957 to 2020

Nayef Alghais
*Kuwait Unversity*, nayef.alghais@ku.edu.kw

Saad Algharib

# GIS-based Spatial Analysis of Population Density in Kuwait, 1957 to 2020

*Dr. Nayef Alghais* and Dr. Saad Algharib*

*Department of Geography, Kuwait University, State of Kuwait*

**Corresponding author: nayef.alghais@ku.edu.kw*

## ABSTRACT

Population density is among the most insightful demographical metrics for urban planners, land developers and researchers in the geography sector. In this article, a Geographical Information System (GIS) framework is designed to study the spatial and temporal population density trends and investigate whether any notable patterns may be attributed to the socioeconomic factors prevalent in each period. The methodology involves collecting spatial population data over time and using GIS to overlay the population density changes against various socioeconomic parameters in Kuwait. The results indicate that the population density is strongly correlated to the national and international economic and political conditions of each respective period. Furthermore, the population tended to form high density clusters. The findings suggest that future development shall aim to address the impacts of high population density, and the effects of the pandemic and global energy and economic turbulence on Kuwait's labor market and lifestyle over 2020-2022.

***Keywords*:** spatial analysis, population density, population changes, GIS, Kuwait

## INTRODUCTION

Population geography is a broad field that encompasses the study of various topics related to social phenomena and trends, such as fertility, mortality, migration, population structures and population distribution and density (Clarke 1980; Selya 2019). However, in some regions, such as the Arabian Gulf, population geography research is still in its infancy. Arabian Gulf countries have traditionally been of interest to geographers around the world due to their distinguishing history, unique economy and geopolitical situation (Ashwan, Salam, & Mouselhy 2012; Khraif, et al., 2015; Shah 2013; Valenta & Jakobsen 2016).

The Arabian Gulf region is home to the largest concentration of crude oil in the world, with more than 30% of the global proven reserves (Alqahtani, Bouri, & Vo 2020). Naturally, the national economies and prosperity of Gulf countries in the last decades have been tied to oil and its products (Fasano & Iqbal 2003). The era of modern urban renaissance (Al-Nahda) started in Gulf countries, such as Kuwait, the UAE and Qatar around the 1950s (Al-Nakib 2013; De Bel-Air 2018; Elessawy 2017). In stark contrast, before the discovery of oil, the regional economy was predominantly agricultural and relied on fishing, farming, grazing and trade of commodities such as pearl. At that time, the local community was limited in population and socioeconomically homogeneous (Crystal 1992; Nedjat-Haiem 2018).

The availability of newly acquired wealth, was sufficient to fund a new, different lifestyle with ambitious socioeconomic changes that converted the once small towns to modern global cities. Life was changing rapidly by the 1960s and 1970s, with evident consequences in urbanization, education, jobs, houses and sociocultural behaviors. The literature often describes this period of rapid and unprecedented change as a civilization shock. Besides the obvious economic and lifestyle benefits that oil wealth had brought to the region, it also introduced certain demographic challenges. The composition of the Gulf societies underwent a transition from being almost completely homogeneous into heterogeneous communities with the majority of non-citizens being economic migrants that often had low relative incomes and education levels compared to the locals (Fargues 2011). Furthermore, the population growth was much higher than urban planners expected and as such, the population density increased to a level that it put notable pressure on infrastructure. The economic and social impacts of the shift between pre-oil and post-oil eras in Gulf countries was studied in depth by numerous social and human geography researchers (Khalaf & AlShehabi 2014; Mohammed 2003). As of 2022, there are very few studies that examine the change of population density dependence on socioeconomic factors driven by the fundamental restructure of the economy in the Gulf countries.

The *Geographical Bulletin* 63(3): 114-132
ISSN 2163-5900 

One of the earlier generations of research on urban population density in the first stage of the quantitative revolution in geography field is Bruce Newling's work (1969). As, he examined urban population density gradients and how they related to different stages of urbanization. However, to study the population density trends over time, this article will rely on the geo-historical and spatial analyses using Geographical Information Systems (GIS) tools. This notion is relatively innovative in the field of population geography, with most relevant literature having been published in the last 7 years or so. Bonnier, Finné, and Weiberg (2019) used GIS data from an intensive survey in the Berbati-Limnes area, Greece to demonstrate and produce cluster-based density surfaces that may be linked to past land-use strategies. They asserted that GIS provides a useful tool that allows them to visualize changes in the spatial extent and shifts in the topographic context of possible land-use over time. Another study by Gomes (2017) utilized GIS to visualize wide variations in population density in mainland Portugal. It assigned three parameters: (1) spatial units; (2) spatial variation; and (3) map scale. It asserts that this method can play an important role in spatial planning issues. Weerakoon (2013) analyzed the spatial distribution of population in the Colombo Metropolitan Region with the help of GIS and developed an analytical framework to examine urban population distribution and spatial structure by visualizing urban densities in maps. Ottensmann (2015) studied the population density of large urban areas in the U.S. using census data for 1950 to 2010. His work identified some factors associated with density levels and changes in density such as sizes of areas, prior densities, rates of growth, and the presence of barriers to urban expansion.

Another important work that contributed towards the understanding of how to apply GIS in population density studies was published by Khatun, Falgunee, and Kutub (2015). The methodology used GIS and census data with two main objectives. The first objective was to analyze the population density gradient of Dhaka Metropolitan Area in Bangladesh and the second objective was to understand how this density has been changed over time and which were the factors driving any changes. Furthermore, they tried to associate the population density trends to the distance from the Central Business District (CBD). They found that the population density increased in the areas located further from the CBD than in areas adjacent to it and the obvious reason was attributed to the improvements in transportation and communications infrastructure.

Another piece in the literature that inspired the authors of the current article was published by Marti-Henneberg, Franch-Auladell, and Solanas-Jiménez (2016). In this study, they examined the changes in population density in Spain between 1877 and 2001 by using spatial analysis tools in GIS. To evaluate the spatial evolution of the concentration of population within the territory of study, both global Moran I and the local Moran I tools were utilized. Global Moran I was applied to confirm the spatial autocorrelation of data, whereas local Moran I was applied to determine the locations of the clusters of the highest and lowest values are concentrated within the territory.

Using the modelling tools and frameworks set by the aforementioned works and introducing certain innovations, the current article will conduct geo-historical and spatial analysis in order to study and visualize the trends in population density in Kuwait from 1957 to 2020. Geographic Information Systems (GIS) tools will be used to both compare the density differences across different periods, but also to extract possible explanations of those changes, as well as quantify their positive and negative impacts on the local contemporary society. The novelty value of this research lies on the fact that Kuwait is a unique case, with non-citizens outnumbering the locals; this creates an interesting dynamic in urban development and population density patterns, much different to those found in countries with majority local population that did not change much in composition over the last decades. The results can help decision makers in Kuwait and other Arabian Gulf Corporation Countries in their future planning.

## STUDY AREA BACKGROUND

Kuwait is a country in the Arabian Peninsula located in the northwestern corner of the Arabian Gulf with a total area of Kuwait of 17,818 km². The population of Kuwait increased notably after the exploration of oil in the 1950s, consistent with the trends observed in the region and described earlier (Fig. 1).

The population of Kuwait as of 2020 was 4.6 million, with 68% consisting of non-citizens (PACI 2021). This unusually high ratio of non-citizens is due to the high immigration rates for decades by laborers supporting the oil industry construction and operations. The percentage of non-citizens in late 1950s was 45% based on the first official census in Kuwait (Abu-Ayyash 1980). This percentage increased in the following decades, fueled by additional rounds of investment, which in turn were caused by the oil boom in the 1970s. Visual assessments of these trends are illustrated in figures 2-4.

## MATERIALS AND METHODS

### Data Preparation

The first stage for analyzing and visualizing the population density trends involves the collection and preparation of data. Two types of data were used in this study:

1. Population data, further classified as:
    a. Official census data collected via the Central Statistical Bureau in Kuwait for years: 1957, 1965, 1975, 1985, 1995, 2005 and 2011 tabular in JPEG format (CSB 2021).
    b. Latest population data of districts in 2020. The type of data was tabular in Excel format (PACI 2021).
2. 2GIS data for Kuwait districts in 2020 (GIS & RS Consultation Unit 2021).

Eight GIS layers were created, one for each census year. The population data was entered in the attribute tables for all districts as layers labelled by year: 1957, 1965, 1975, 1985, 1995, 2005, 2011 and 2020. The results can be seen in figure 5.

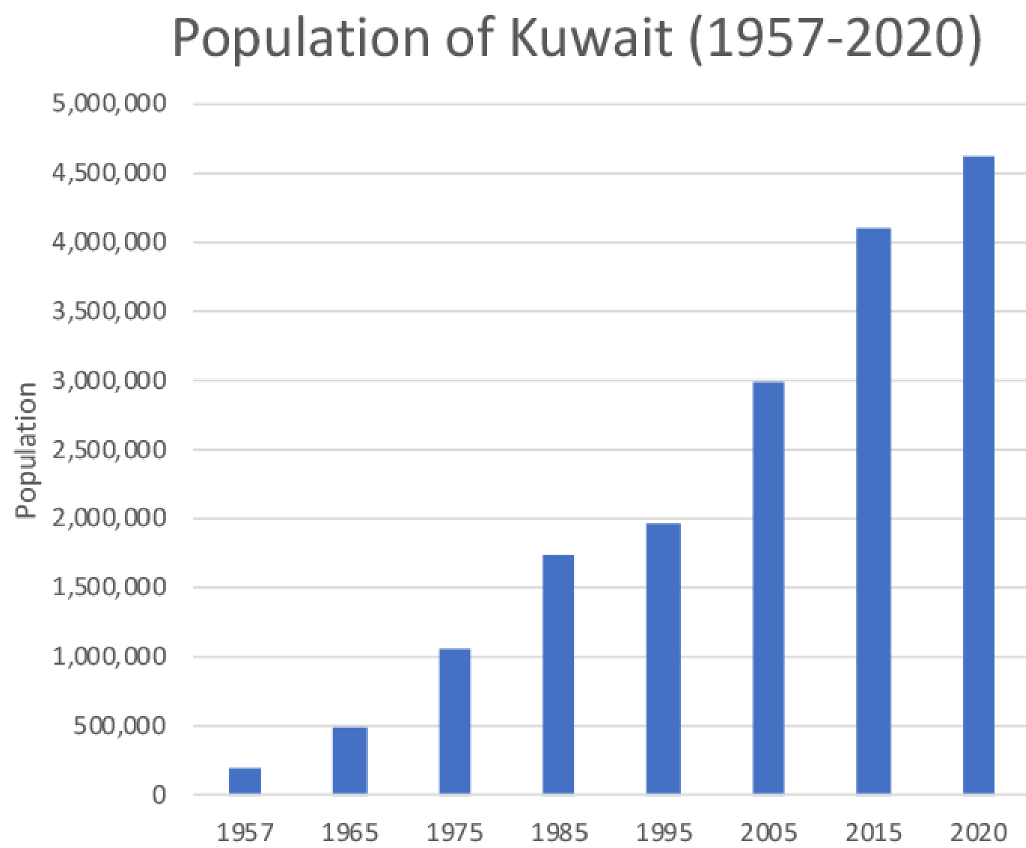


Figure 1. Population growth in Kuwait, 1957 – 2020, illustrating the almost tenfold population increase in 70 years.

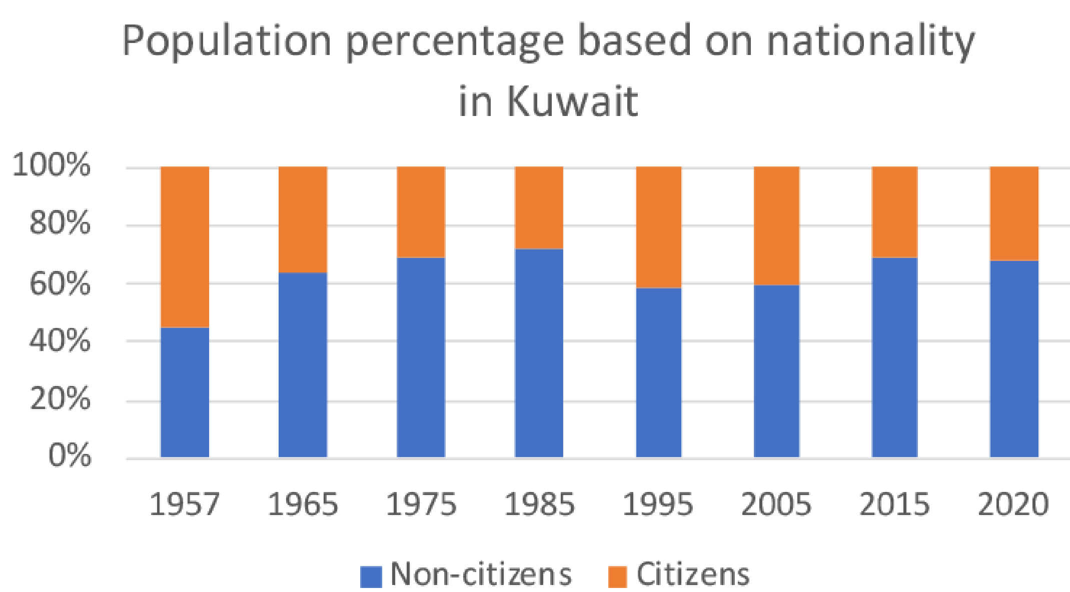


Figure 2. Evolution of citizenship status in Kuwait between 1957-2020.

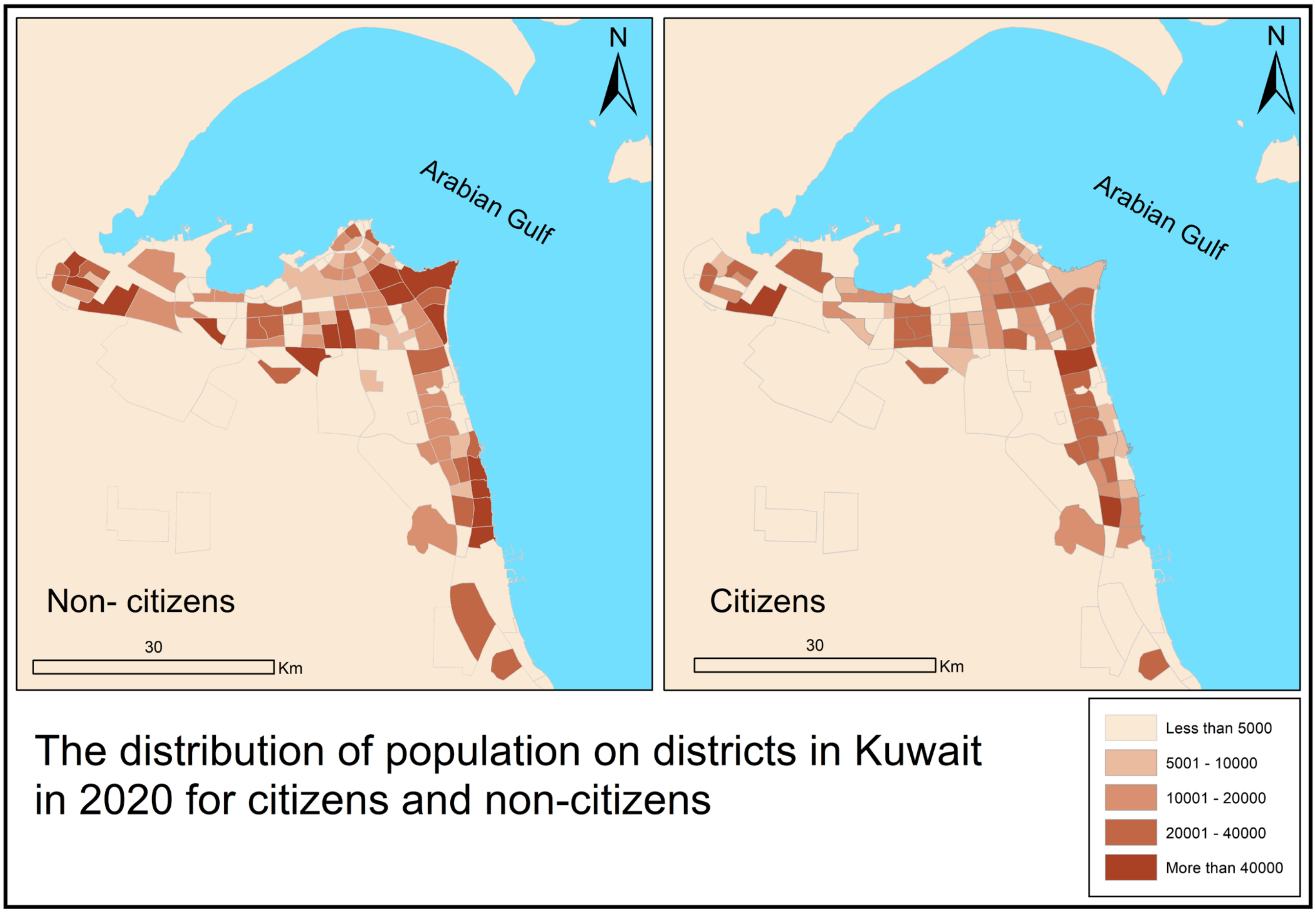


Figure 3. The distribution of population within districts in Kuwait in 2020 for citizens and non-citizens.


Figure 4. Kuwait's main/single urban area, including the administrative and economic capital of Kuwait City.

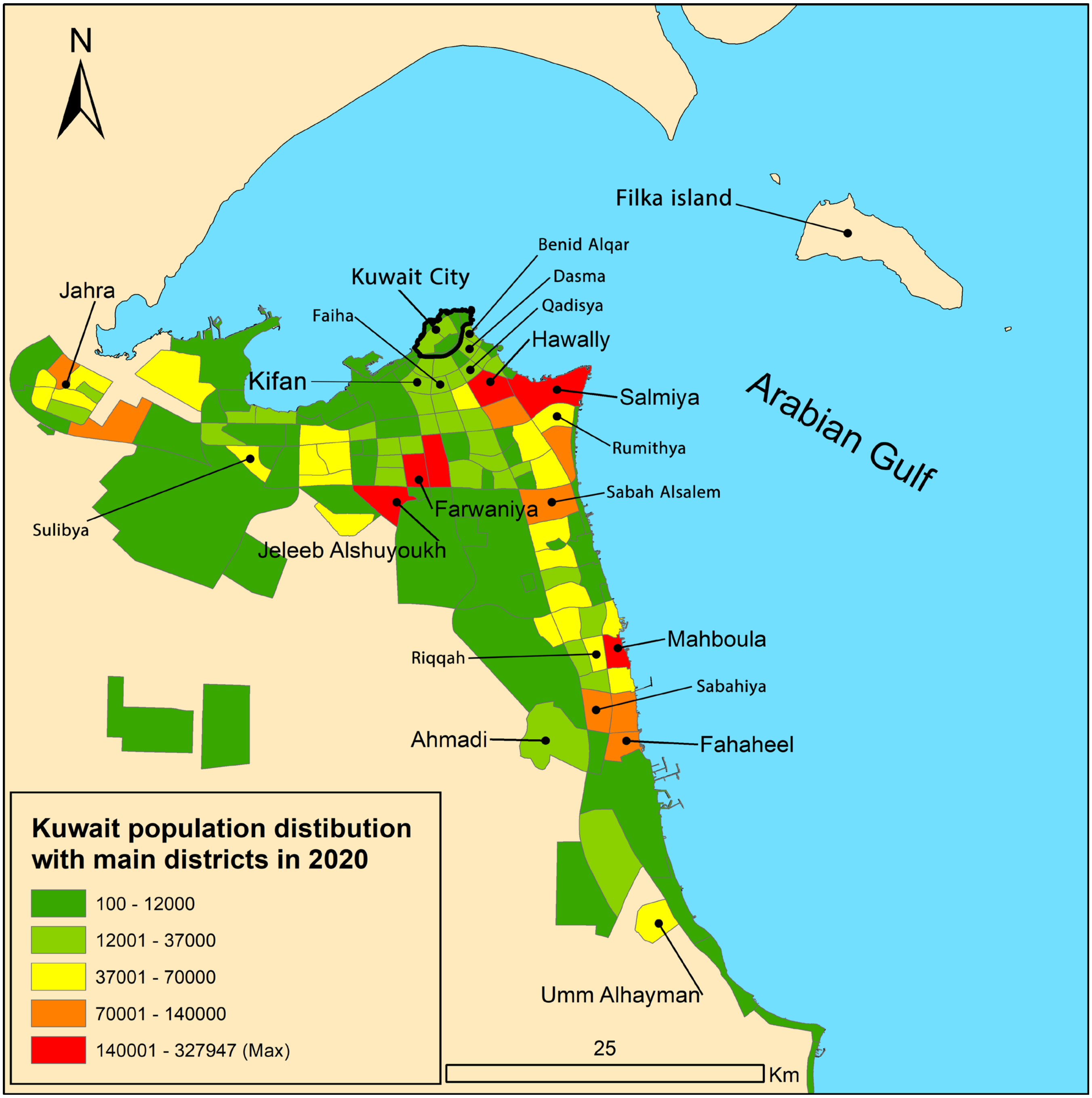


Figure 5. Population in districts within Kuwait's main urban area in 2020.

### Average Annual Population Growth Rate Calculation

After overlaying the population data on the map, the average annual growth rates were calculated for each time period. The change in population over each period spanning over $n$ years is equal to the difference between the population of each period minus the population of the previous period. The percentage population change over a period is calculated as the population change over the population in the previous period. Finally, the population change is divided by the number of years ($n$) in each period to obtain the average annual growth as seen Equation 1:

$$Average\ annual\ growth\ rate\ (n+1) = \frac{Population\ (n+1) - Population\ (n)}{Population\ (n)} \times \frac{1}{r_n},$$

$$where\ n = 0, 1, 2, \ldots, 7$$

$n$ represents the time interval where the data was taken, with 1957 being assigned the value $n$=0 and 2020 being assigned the value $n$=7. $r_n$ represents the number of years included in the respective time interval. For instance, for the interval $n$=7, the data spans from 2011 to 2020, and hence $r_7$=9.

### Population Density Calculation

The next step involved calculating the area of each district by using *Calculate Geometry Tool.* The population density was obtained for all districts ($i$) for each layer ($n$) by dividing the total population of each district at the respective period over its area as shown in Equation 2.

$$Population\ density(n, i) = \frac{population\ (n, i)}{area(i)}$$

### Spatial Analysis of Population Density

Two tools, the *Global Moran I* and the *local Moran I* were used for analyzing the distribution, concentration, and composition of population within the study area.

The Spatial Autocorrelation *Global Moran's I tool* is able to measure the spatial autocorrelation based on both feature locations and the attribute values of data at the same time. The global measurement of spatial autocorrelation is summarized by a value known as the Moran's Indicator, which can be utilized to model the spatial distribution of population density in all districts in Kuwait from 1957 to 2020. Using this information, it is possible to classify the districts depending on the way the population density changes over time, as either clustered, dispersed, or random manner. A positive Moran's Indicator means that similar values cluster together, in other words high density areas are close to high density areas and low-density areas are close to low density areas. A negative Moran's Indicator means dissimilar values are next to each other (dispersed population density, where high density areas are next to low density areas and vice versa). If the Moran's Indicator is close to zero, this indicates that data (and hence population density) is random; the high and low density areas are randomly distributed all over the region (ESRI 2021a). The null hypothesis of spatial autocorrelation assumes that the distribution of population in Kuwait evolved randomly and hence the Moran Indicator is equal to zero. The hypothesis will be tested based off the results presented in section 4.3.

The *Local Moran I tool* serves the purpose of determining the locations of the highest and lowest values within the study area. This tool creates a series of maps that show positive spatial autocorrelation, which means similar values are surrounded by similar values (ESRI 2021b).

## RESULTS AND DISCUSSION

### Population Growth Rate

As shown in Figure 6, the growth rate was the highest between 1957 and 1965. The reason for this was due to unusually numerous grants of citizenship status to immigrants at the time. From 1975 to 1990, the annual growth rate was slightly decreased (but still high by international standards). In contrast, in 1990, the total population decreased rapidly because of the reverse migration (first time in Kuwait history) due to the Gulf War. During this turbulent period, population decreased by as much as 10%. However, after the liberation of Kuwait, the population growth trend resumed and its annual growth rate picked up gradually. reaching 40% total growth between 2005-2011 and 60% between 2011-2020. Notably, the growth rate after the Gulf War was lower than before.

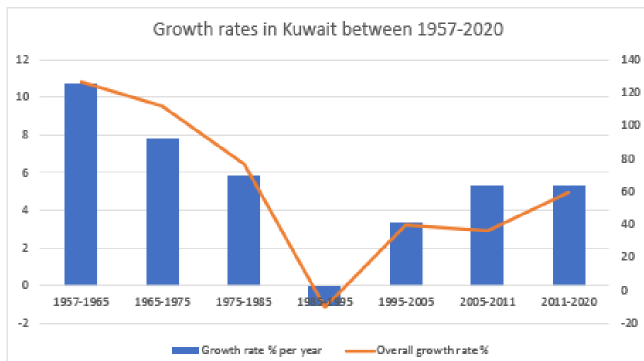


Figure 6. Average annual growth rates in Kuwait between 1957-2020.

To simplify the comparisons and analysis of the results, population growth was studied across three periods of interest: 1957-1965, 1985-1995 and 2011-2020. The periods were selected to be approximately 20 years apart from each other. This would broadly align with the different socioeconomic conditions each generation had to face; as such, it shall be possible to detect any population density changes and attribute them to the aforementioned factors. Consequently, maps were produced for each period using the data extracted with the method described in section 3, visualizing the aggregate population growth in each district.

Population growth was positive in all districts area during the 1st period except in Kuwait City and some other minor districts (Fig 7).

During the 2nd period, the second half of which is dominated by the Iraqi invasion and the Gulf War, the majority of districts experienced negative growth. Two districts, in fact,

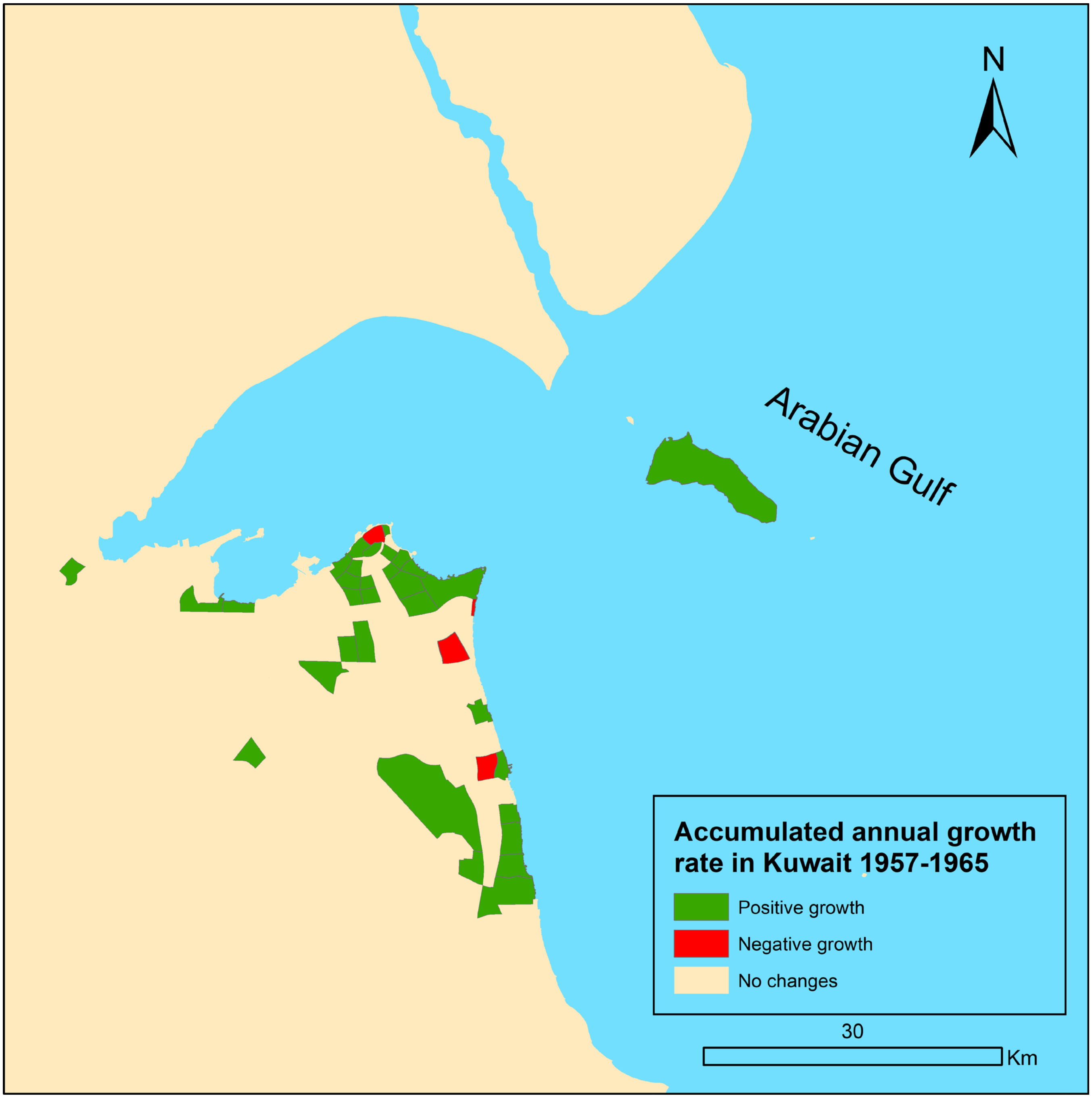


Figure 7. Aggregate growth rate in Kuwait's districts between 1957 and 1965.

were completely abandoned. Those were Filka island and Umm Alhayman in the south region of Kuwait. Filka island was never repopulated and Umm Alhayman took around 10 years to be rebuilt and start accepting new residents (Fig. 8).

In the last and most recent interval of interest in this study, all Kuwait's districts experienced an increase in population, except some non-residential areas (Fig. 9).

### Population Density

After calculating the population density in Kuwait from 1957 to 2020, the study found some interesting trends throughout the study period. In 1957, the highest density district was by far Kuwait City (old town). Following that, other high-density districts included Hawally, Farwaniya (right in the middle of the urban area), Ahmadi, Fahaheel (in the

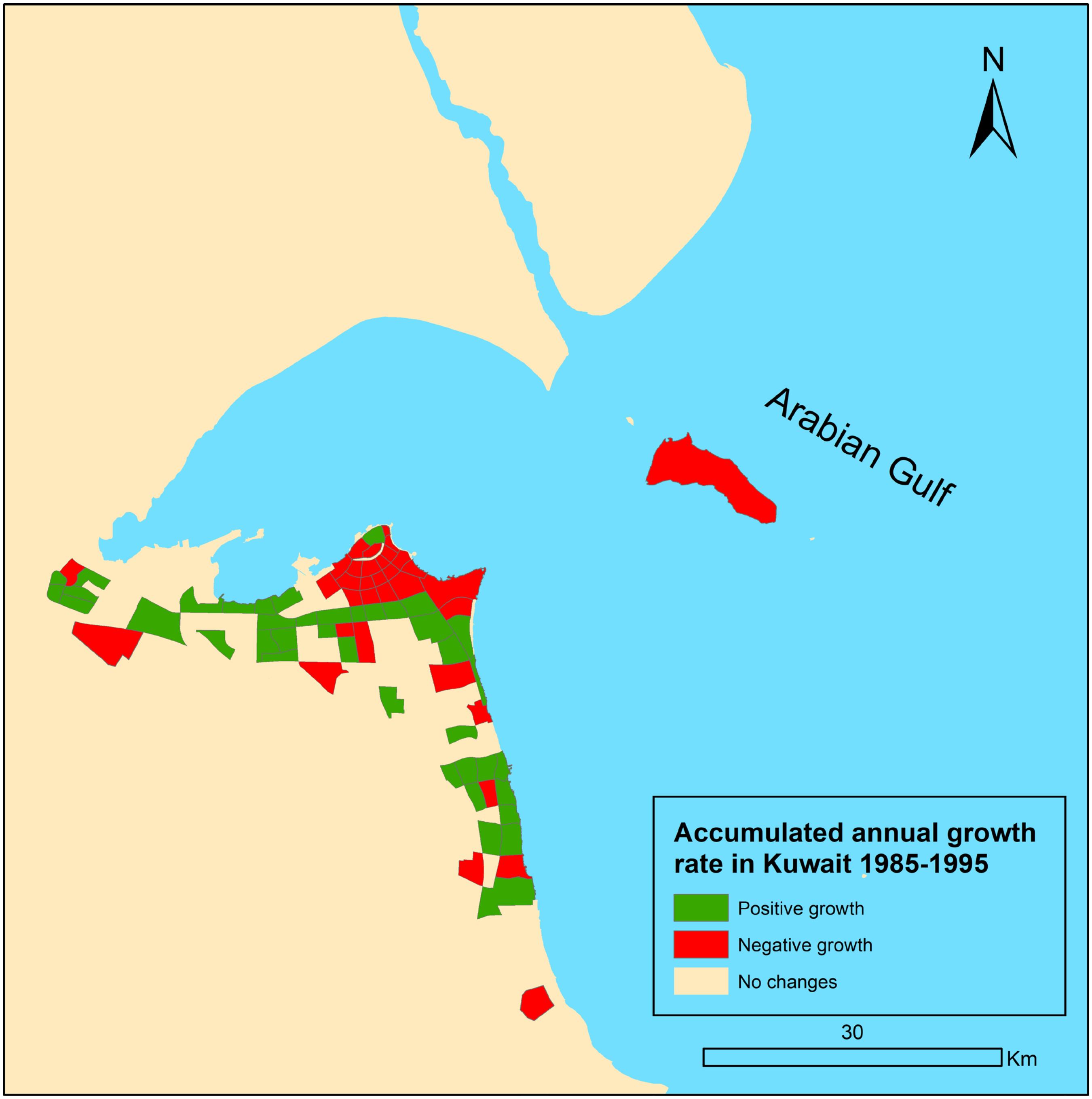


Figure 8. Aggregate growth rate in Kuwait's districts between 1985 and 1995.

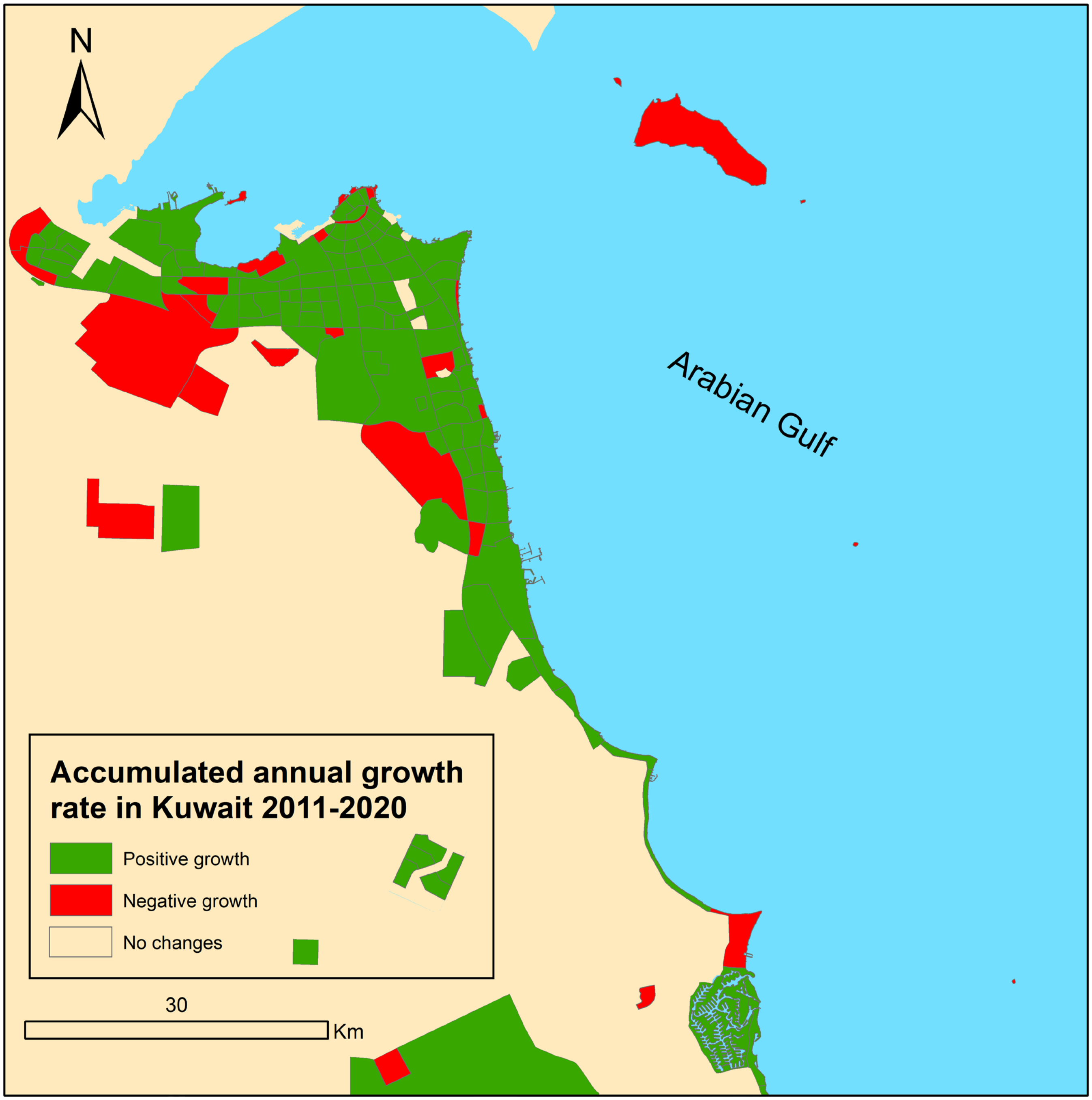


Figure 9. Aggregate growth rate in Kuwait's districts between 2011 and 2020.

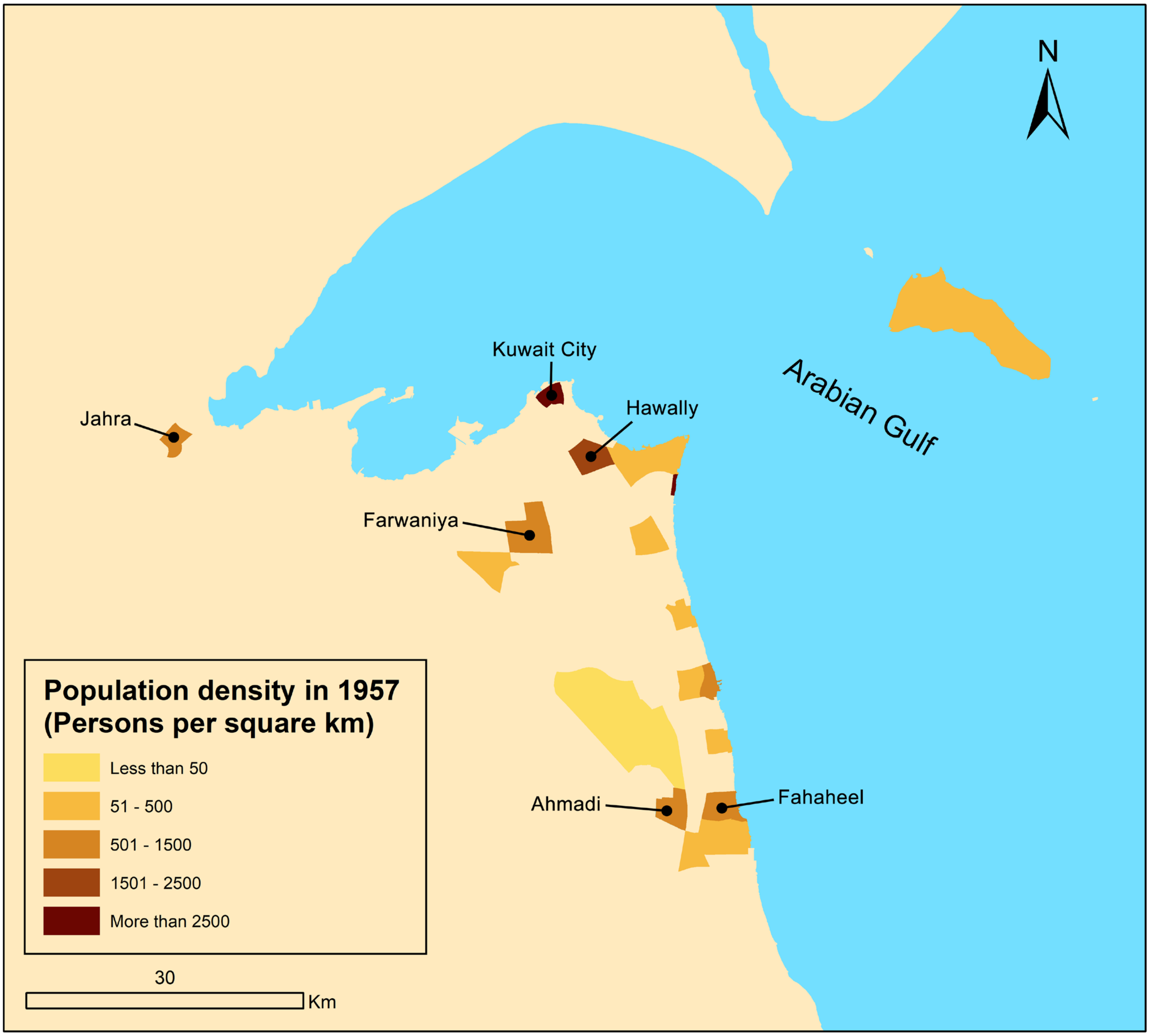


Figure 10. Population density by district in 1957.

south of Kuwait City) and Jahra (West side of Kuwait City; see Fig. 10).

This was the result of the contemporary urban revolution, which in turned was caused by significant oil revenues and the consequent arrival of many immigrants. Bedouins from the desert was an additional group that arrived and settled in the newly built districts at the time. Although Fhaheel and Ahmadi are located far from Kuwait City, they were strategically close to the main oil field (Burgan) so they accommodated many workers in oil sector, hence the high density.

By 1965, Kuwait City still remained very densely populated. Hawally increased in its density because of the further influx of immigrants working in the oil industry. Many new districts surrounding Kuwait City appeared and quickly reached high population density, including Faiha, Qadsiya and Dasma. Population pressure eased in Kuwait City, as some residents moved to the new nearby suburbs (Fig. 11).

In 1975, certain districts, such as Salmiya, Rumithya, Fahaheel and Benid Alqar reached very high population density. This can be attributed to the arrival of more immigrants which coincided with the oil boom of the 1970s. The previously high-density districts remained densely populated in the 1970s (see figure 12).

By 1985, the population density of Kuwait City dropped significantly as a result of the establishment of new districts which attracted many of the old town's residents. The districts with the highest population density in 1985 were Jahra, Salmiya and Hawally. Notably, new districts that quickly reached high

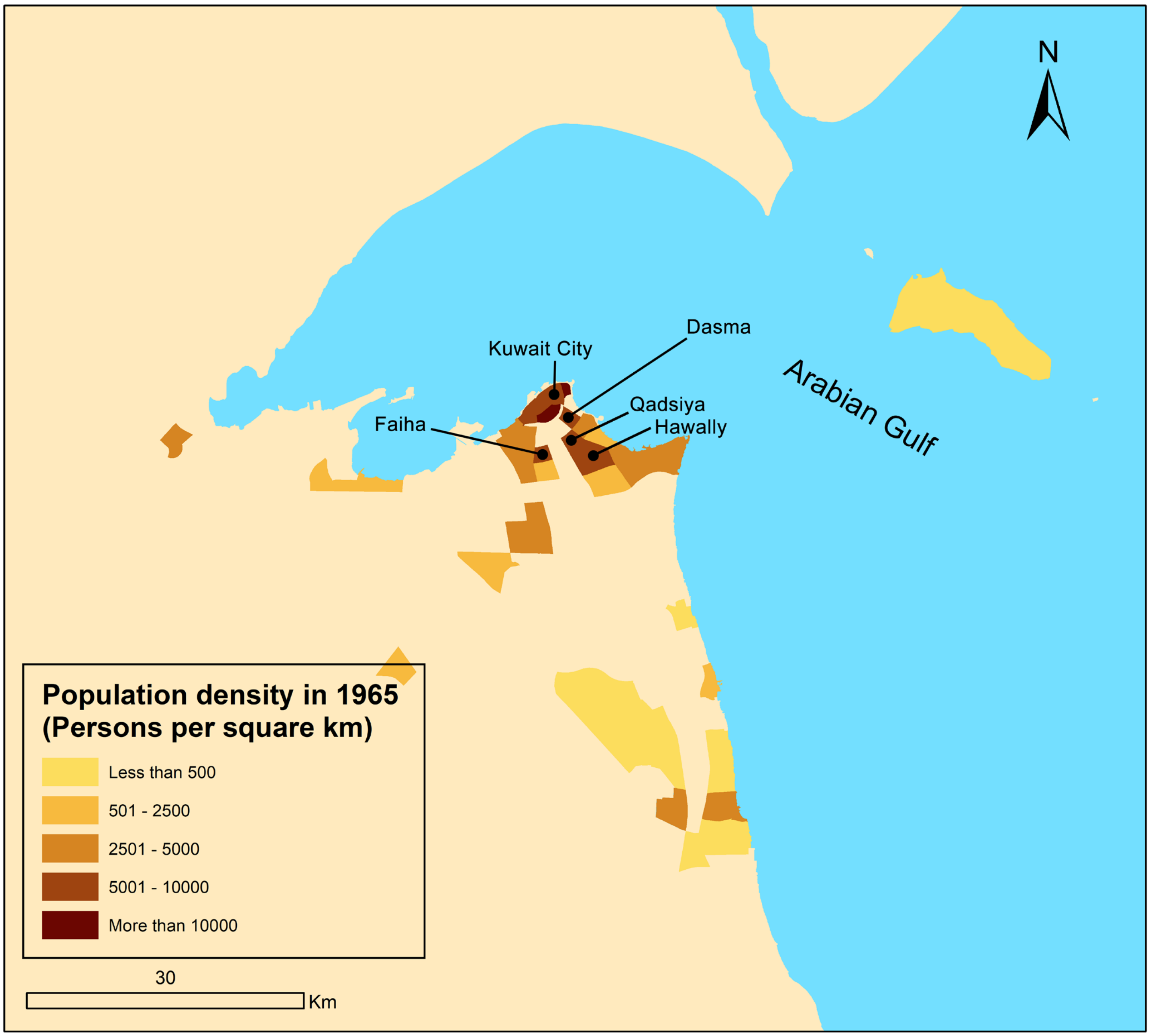


Figure 11. Population density by district in 1965.

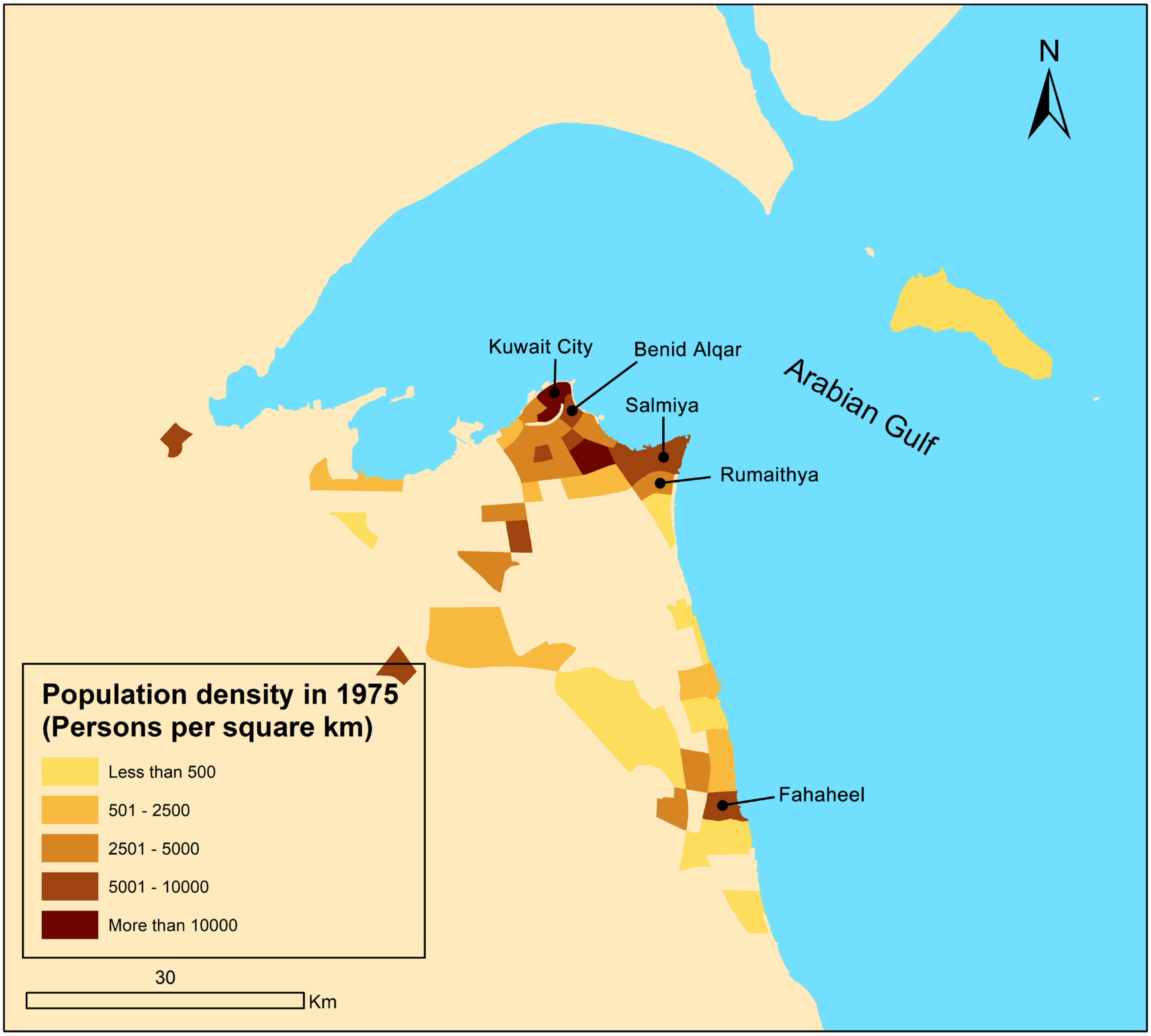


Figure 12. Population density by district in 1975.

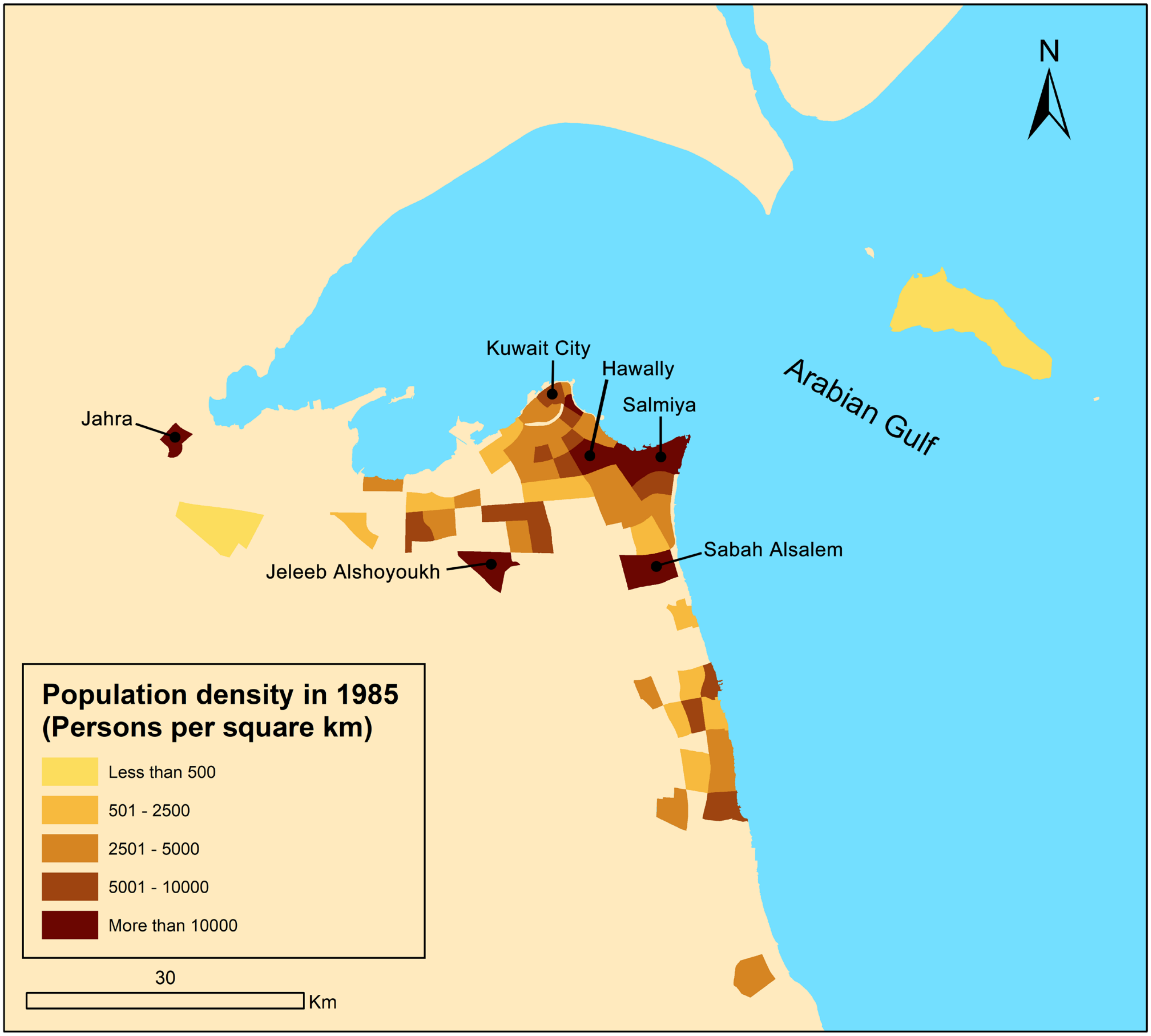


Figure 13. Population density by suburb in 1985.

density were Sabah Alsalem and Jeleeb Alshuyoukh (Fig. 13).

After the Iraqi invasion and the Gulf war in 1990-1991, the population growth decreased dramatically as discussed in the previous section. This negatively affected the population density in almost all districts in 1995 (Fig. 14). Some notable, new, and high-density districts that appeared during this period include Sulibya, Tima and Waha at the west side of Kuwait City and Sabahiya and Riqqah in the south side of Kuwait City.

Finally, from 2005 to 2020, Kuwait's districts underwent more density changes, illustrating the dynamic nature of the city. Hawally, Jeleeb Alshuyoukh and Farwaniya became the most densely populated districts during that time period. Mahboula is the newest district with very high density, mainly due to the concentration of non-Kuwaitis in it; a common observation for all high density population districts in this period (Fig 15).

## Population Density Distribution Evolution

Due to the barren nature of large parts of Kuwait and to avoid underestimating the results in some large districts, the population density (Fig. 16) was calculated only taking into account the urban areas instead of the total area. The Global Moran's indicator of the urban population density was calculated for each study period (from 1957 to 2020, see figure 17).

The results have shown that the Indicator's value was positive for all periods except in 1957. Hence, the null hypothesis

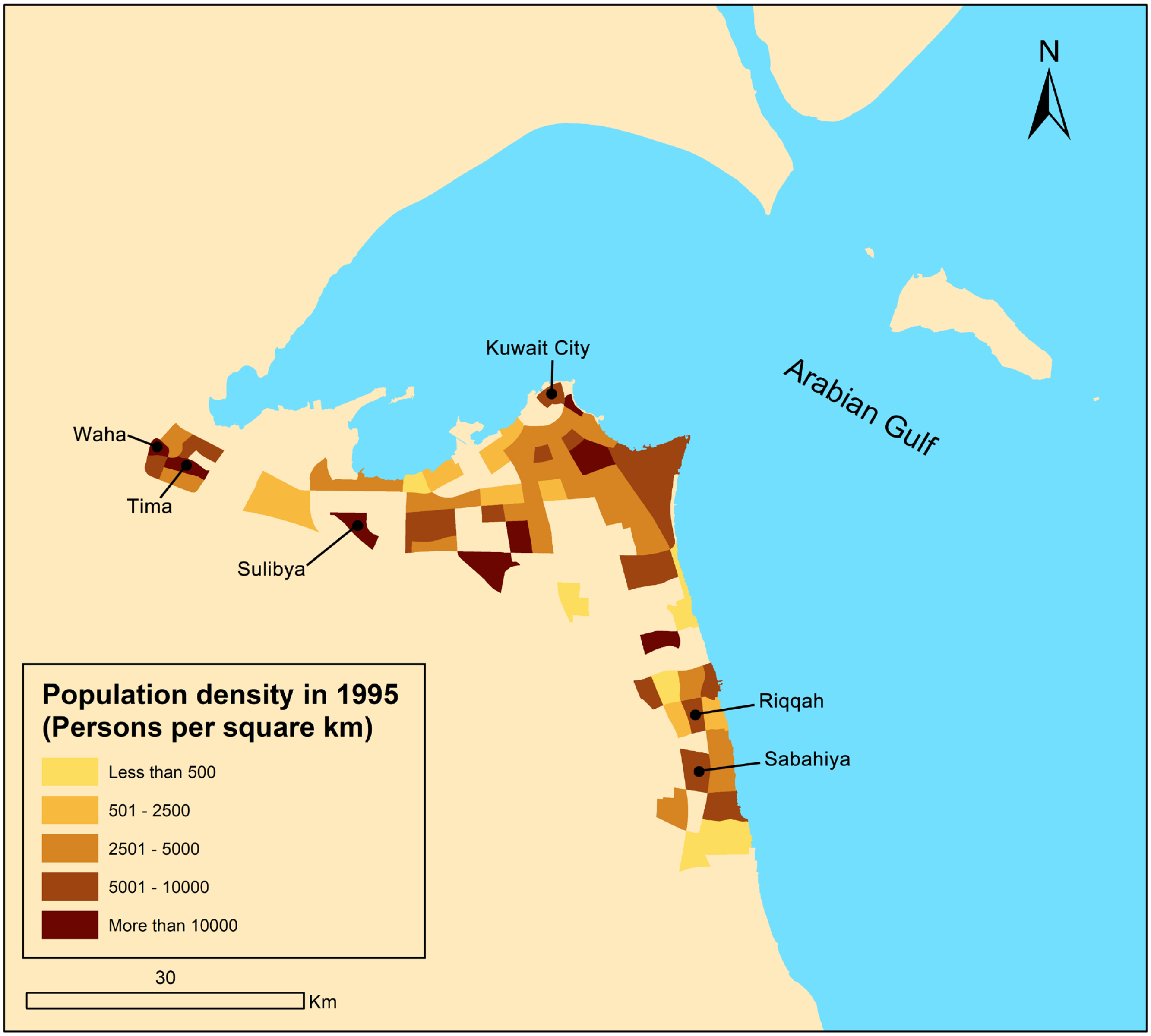


Figure 14. Population density by district in 1995.

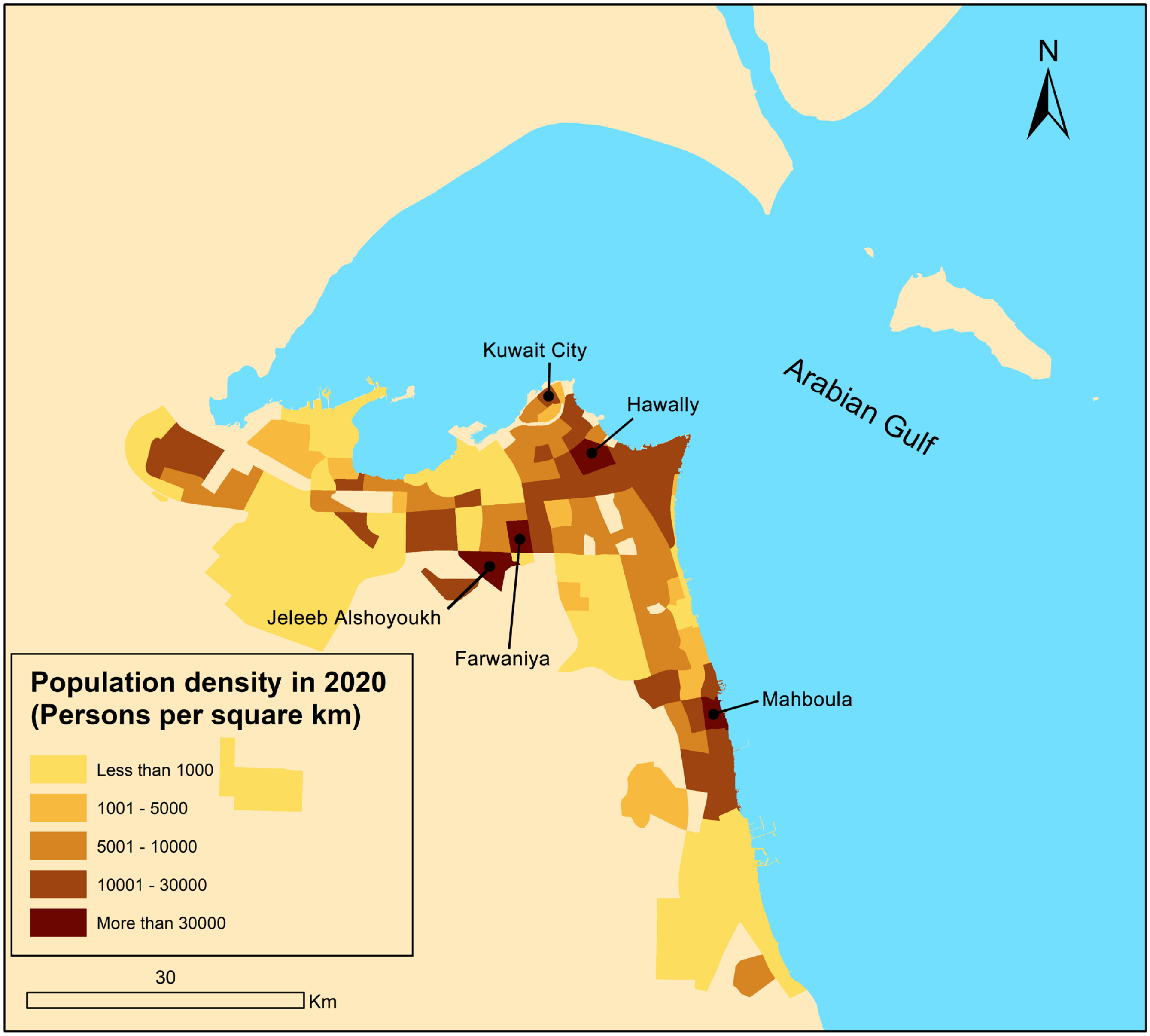


Figure 15. Population density by district in 2020.

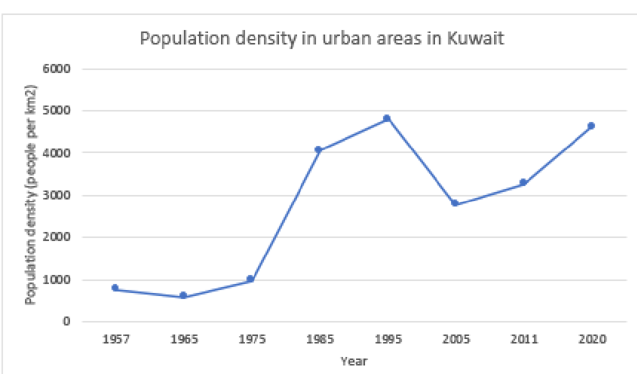


Figure 16. Kuwait's urban population density between 1957-2020

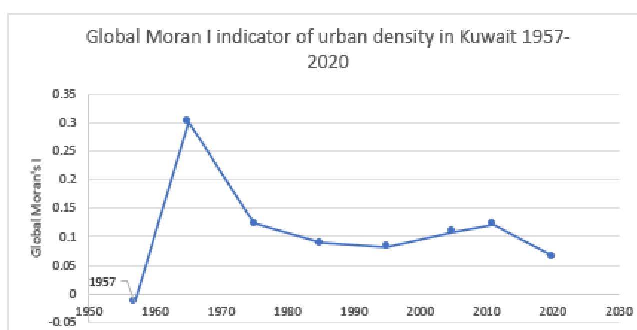


Figure 17. Trends of Global Moran Indicator for Kuwait's urban population density overtime.

of zero spatial autocorrelation (meaning random population density growth) was rejected. On the contrary, the zero value of Moran's Indicator in 1957 indicates that the population density was randomly distributed (this means the null hypothesis was accepted for this period alone, see Table 1).

Table 1: Summary of Global Moran' I results.

| Year | Index | Z-score | Remark |
|---|---|---|---|
| 1957 | - 0.013250 | - 1.247840 | Random |
| 1965 | 0.302167 | 7.401149 | Clustered |
| 1975 | 0.122928 | 5.283715 | Clustered |
| 1985 | 0.088253 | 8.175422 | Clustered |
| 1995 | 0.081992 | 7.317404 | Clustered |
| 2005 | 0.108564 | 9.598062 | Clustered |
| 2011 | 0.120916 | 10.636322 | Clustered |
| 2020 | 0.065388 | 5.818388 | Clustered |

However, the dominant trend and major conclusion by analyzing the Global Moran I Indicator, is that the distribution of population density is clustered from 1965 to 2020; in other words, the most densely populated districts are distributed close to each other, and the least densely districts are distributed close to each other respectively. The random distribution of population in 1957 can be explained by the fact that this was the first time of establishing new areas outside the Kuwait City border and the government encouraged people to move to these newly built districts. For instance, one of these new districts, which was populated quickly was Ahmadi, an oil worker city located in the south near main oil fields.

The spatial autocorrelation value presented in Figure 17 is the average across Kuwait. Within the area of study, there are certainly variations which are of interest to the analysis in this study. Anselin Local Moran's I tool was used to obtain series of maps of population density during the study period to identify locations with notably positive spatial autocorrelation showing high/low population density districts surrounded with high/low population density districts respectively. In addition, locations with negative spatial autocorrelation were detected,

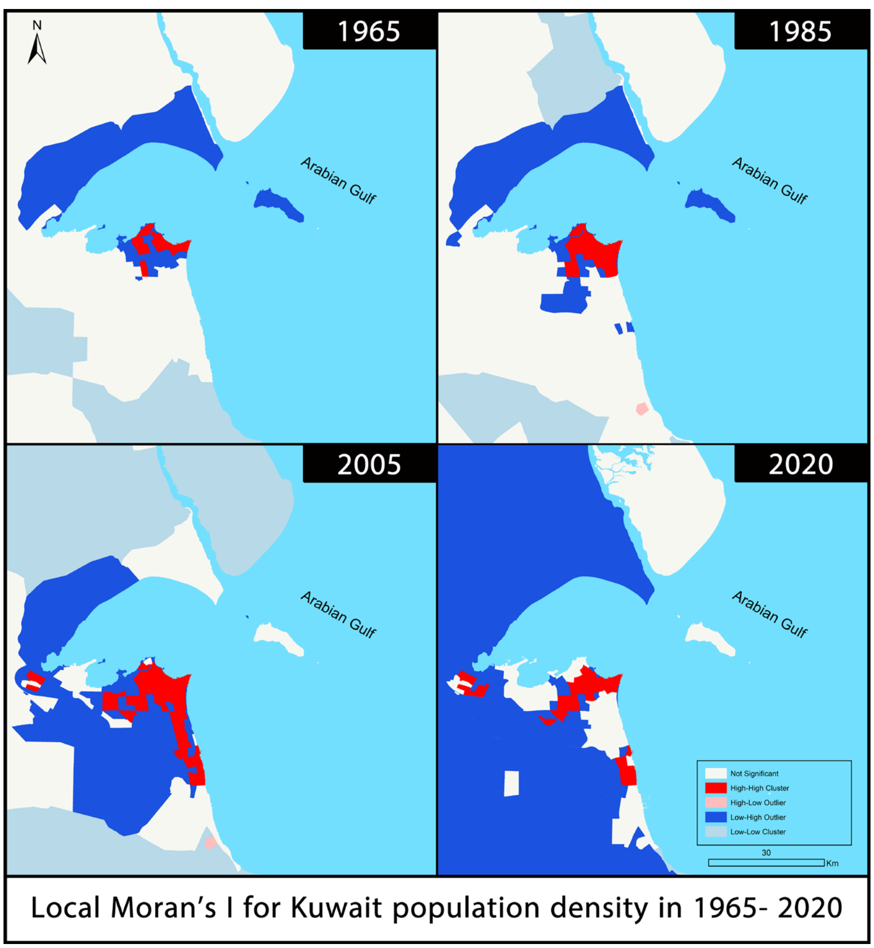


Figure 18: Local Moran's I Indicator for Kuwait population density between 1965-2020.

which consist of high population density districts surrounded by low population density districts or vice versa (Fig. 18).

It was found that during the period between 1965 to 1985 the high population density districts surrounded by other high population density districts were mainly located around Kuwait City, the Southeast (such as Salmiya and Hawally) and the Southwest (such as Farwaniya). During the period from 1985 to 2005, however, districts with high population density surrounded by other high-density districts became more common, as seen in the whole urban area in the West side of Kuwait City (Jahra district), and along the coastal line from Kuwait City to the south near to Fahaheel district with some districts in the southwest side of Kuwait City such as Jeleeb Alshuyoukh and Farwaniya.

In the period from 2005 to 2020, the most notable change was that Kuwait City saw its population density decreasing. Districts with high population density surrounded by other densely populated districts appeared in Hawally (East side), Farwaniya (Southwest of Kuwait City), Jahra (West side) and Fahaheel (South side).

By studying and overlaying the historical and planning decisions made in each respective period, it is possible to conclusively attribute any changes in population density to three major sociopolitical and geographical reasons. Firstly, the high income from oil exports allowed the Kuwait government to establish many new districts outside the center of Kuwait City and encourage people to move to these new areas. In parallel, Kuwait City was rebuilt as a modern capital city. Secondly, the high immigration rate from foreign countries, was funneled mainly in new districts with industrial and in commercial nature such as Salmiya, Hawally, Farwaniya, Fahaheel. Thirdly, most of the high population density districts are located by the coast and major highways, benefiting from easy commuting and relatively favorable climatic conditions to the inland regions.

## CONCLUSION

This paper investigated the historical population density in Kuwait between 1957 to 2020 using GIS. Population growth rates and population density were calculated based on official census data. Spatial analysis was utilized to discover any notable spatial patterns of population density and a series of maps were created to visualize the population density distribution evolution by applying Local Moran's I as a spatial analysis tool.

The study concludes in agreement with other recent works, that spatial analysis tools in GIS are essential for studying any changes in population density over time. Such tools provide researchers with a simple, yet powerful, comparison view for the population density distribution. Spatial pattern identification is important for urban planners and policy makers for infrastructure and services decisions in any country, and especially in Kuwait and similar Gulf countries with large population increases in short time due to oil.

The results of the study indicate that population density in Kuwait during the study period increased, whereas the population density distribution pattern changed from random in 1957 to clustered from 1960s until 2020. The interpretation of this trend is that population tends to form highly dense clusters in established areas or newly developed purpose-built towns that quickly attract large numbers of residents. Decision makers in Kuwait should take this spatial pattern in consideration whilst designing the new master plan in Kuwait (in 2040 to avoid any potential mismatch in service and public transportation infrastructure distribution.

The findings also showed that Kuwait City (oldest district) lost its relative desirability over time, due to establishment of new districts with equal or higher levels of infrastructure and job opportunities. The government rebuilt the city to be a commercial and administrative center, which further reduced its desirability as a residential district. As a result of that the population decreased in Kuwait City and increased the population density in the surrounding suburbs.

The most populated districts in the country are occupied by non-Kuwaitis. This demographic statistic is valuable to the Kuwait government, which should consider the social and economic impacts of this unusual dynamic in future planning decisions. It is not within the scope of this study to assess the potential decisions, but both redistribution and aggregation of non-citizens in certain districts may lead to major detriments to further socioeconomical development if not handled with care.

Finally, the authors recommend that the Kuwait government and the governments of other similar countries with high population density to incorporate GIS and its tools in population density related policy making, due to the benefits of detecting and modelling population phenomena graphically. Future work may focus on applying similar analytical methodology on studying the population distribution and density based on nationality and the spatial distribution of infrastructure and services. In addition, future research for Kuwait may study the mobility patterns across suburbs area and its correlation with population density.

## REFERENCES

Abu-Ayyash, A.-I. 1980. Urban Development and Planning Strategies in Kuwait. *International Journal of Urban and Regional Research* 4(4): 549-571. https://doi.org/10.1111/j.1468-2427.1980.tb00373.x.

AlShehabi, O. 2015. Histories of Migration to the Gulf. *Transit states: Labour, Migration and Citizenship in the Gulf* 3-38. https://doi.org/10.2307/j.ctt183p1j8.5.

Alqahtani, A., E. Bouri, and X.V. Vo. 2020. Predictability of GCC stock returns: The role of geopolitical risk and crude oil returns. *Economic Analysis and Policy 68*: 239-249. https://doi.org/10.1016/j.eap.2020.09.017.

Al-Nakib, F. 2013. Kuwait's Modern Spectacle: Oil Wealth and the Making of a New Capital City, 1950-90. *Comparative Studies of South Asia, Africa and the Middle* East 33(1): 7-25. https://doi.org/10.1215/1089201X-2072694.

Al-Nakib, F. 2016. 1 Pre-Oil Urbanism. In *Kuwait Transformed: A History of Oil and Urban Life*. pp. 21-42. Stanford University Press. https://doi.org/10.1515/9780804798570-005.

Abu Ashwan, M. J., A. A. Asharaf, and M. A. Mouselhy. 2012. Population growth, structure and distribution in Saudi Arabia. *Humanities and Social Science Review* 1(4): 33-46. ISSN: 2165-6258.

Bonnier, A., M. Finné, and E. Weiberg. 2019. Examining land-use through GIS-based kernel density estimation: A re-evaluation of legacy data from the Berbati-limnes survey. *Journal of Field Archaeology* 44(2): 70-83. https://doi.org/10.1080/00934690.2019.1570481.

Crystal, J. 1992. *Kuwait: the Transformation of an Oil State.* Routledge. https://doi.org/10.4324/9781315628776.

Clarke, J.I. 1980. Population geography. *Progress in Human Geography* 4(3): 385-91. https://www.semanticscholar.org/paper/Population-geography.-Clarke/2bc56eac1164ca80f006a2296655ee9760a98e18.

CSB. 2021. Population statistics: Main features of expatriate labour employment in the government and in the private sector. Kuwait Central Statistical Bureau. [https://www.csb.gov.kw/Pages/Statistics_en?ID=6&ParentCatID=1]. Last accessed 10 December 2021.

De Bel-Air, F. 2017. Demography, migration, and labour market in Qatar. *Gulf Research Center* 3: 3-24. https://gulfmigration.grc.net/media/pubs/exno/GLMM_EN_2017_03.pdf.

ESRI. 2021a. How Spatial Autocorrelation (Global Moran's I) works. [https://pro.arcgis.com/en/pro-app/2.8/tool-reference/spatial-statistics/h-how-spatial-autocorrelation-moran-s-i-spatial-st.htm]. Last accessed 15 October 2021.

ESRI. 2021b. How Cluster and Outlier Analysis (Anselin Local Moran's I) works. [https://pro.arcgis.com/en/pro-app/2.7/tool-reference/spatial-statistics/h-how-cluster-and-outlier-analysis-anselin-local-m.htm]. Last accessed 15 October 2021.

Elessawy, F.M. 2017. The Boom: Population and Urban Growth of Dubai City. *Horizons in Humanities and Social Sciences: An International Refereed Journal* 2(2): 26-41. https://doi.org/10.19089/HHSS.V2I2.60.

Fargues, P. 2011. Immigration without inclusion: Non-nationals in nation-building in the Gulf States. *Asian and Pacific Migration Journal* 20(3-4): 273–292. https://doi.org/10.1177/011719681102000302.

Fasano, U. and Z. Iqbal, (eds.) 2003. *Gcc countries: From Oil Dependence to Diversification*. International Monetary Fund. ISBN 1-58906-233-7.

GIS & RS Consultation Unit. 2021. GIS data. College of Social Sciences, Kuwait University. [http://kuweb.ku.edu.kw/COSS/ar/CentersUnits/GIS/index.htm]. 20 September 2021.

Gomes, E. 2016. Creating a dot density map: Resident population in mainland Portugal. *The Cartographic Journal* 54(2): 157-162. https://doi.org/10.1080/00087041.2016.1148106.

Khraif, R.M., A.A. Salam, I. Elsegaey, and A. AlMutairi. 2014. Changing age structures and ageing scenario of the Arab world. *Social Indicators Research* 121(3): 763-785. https://doi.org/10.1007/s11205-014-0664-0.

Khatun, H., N. Falgunee, and M.J.R. Kutub. 2015. Analyzing urban population density gradient of Dhaka metropolitan area using geographic information systems (GIS) and census data. *Geografia-Malaysian Journal of Society and Space*, 11(13): 1-13. ISSN 2180-2491.

Marti-Henneberg, J.X. Franch-Auladell, and J. Solanas-Jiménez. 2016. The use of digital tools for spatial analysis in population geography. *Frontiers in Digital Humanities 3*. https://doi.org/10.3389/fdigh.2016.00009.

Mohammed, N.S.A. 2003. *Population and development of the Arab Gulf States: the case of Bahrain, Oman and Kuwait*. Routledge. https://doi.org/10.4324/9781315246406.

Newbold, K.B. 2017. *Population Geography: Tools and Issues*. Rowman & Littlefield. doi.org/10.1080/07352166.2018.1470874.

Newling. B.E. 1969. The Spatial Variation of Urban Population Densities. *Geographical Review* 59(2): 242-252. https://doi.org/10.2307/213456.

Ottensmann, J.R. 2015. Density of large urban areas in the U.S., 1950-2010. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2881702.

PACI. 2021. *Statistical Services Systems*. Kuwait Public Authority for Civil Information. [https://www.paci.gov.kw/stat/Default.aspx.]. Last accessed 9 November 2021.

Pasin, B. and A.C. Oner. 2018. Mega-urban developments on the Arabian Peninsula for a post-oil future. In *Handbook of Emerging 21st-Century Cities*, K. Bezdecny and K. Archer (Eds.), pp 173-186. Edward Elgar Publishing. doi: https://doi.org/10.4337/9781784712280.00017

Shah, N.M. 2013. Labour Migration from Asian to GCC Countries: Trends, Patterns and Policies. *Middle East Law and Governance*, *5*(1-2): 36-70. doi: https://doi.org/10.1163/18763375-00501002.

Valenta M., and J. Jakobsen. 2016. Moving to the Gulf: an empirical analysis of the patterns and drivers of migration to the GCC countries 1960–2013. *Labor History* 57(5): 627-648. DOI: 10.1080/0023656X.2016.1239885.

Weerakoon, P. 2013. Geovisualization of urban densities using GIS: Case Study in Colombo Metropolitan Area, Sri Lanka. In *the 22nd GISRUK conference*, 3-5 April, Liverpool, UK. https://www.geos.ed.ac.uk/~gisteac/proceedingsonline/GISRUK2013/gisruk2013_submission_79.pdf.

**Nayef Alghais** is an assistant professor in the Department of Geography at Kuwait University since 2018. He obtained MSc. and PhD in geography from The University of Queensland, Australia. His research interests are in GIS, urban modelling, population geography, urban planning, and urban geography.

**Saad Algharib** is an assistant professor in the Department of Geography at Kuwait University since 2011. He earned his MA and PhD in geography from Kent State University, USA. His research field is in GIS, spatial analysis, urban planning and urban geography.