Spatial Distribution and Statistical Analysis of Services in Kuwait's Coastal Regions: A 2020 Perspective

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ABSTRACT

This study explores how population and essential public services are distributed across Kuwait's coastal governorates—Capital, Hawalli, Ahmadi, Mubarak Al-Kabeer, and Jahra—using data from 2020. By applying Geographic Information Systems (GIS) and spatial statistical methods, the research examines how accessible residential, educational, and healthcare facilities are in relation to where people live. Tools such as Moran's I, standard distance, and buffer zone analysis help identify areas where services are concentrated and others where access is limited. The analysis shows that more than 3 million people live in these coastal areas, with the majority clustered in urban centers like Capital and Hawalli, where service networks are more developed. In contrast, outlying regions such as Ahmadi and Jahra face noticeable gaps in access—especially to hospitals, schools, and housing infrastructure. Field surveys and spatial data confirm that many residents live beyond ideal service ranges, highlighting both overcrowded and underserved zones. This imbalance between urban growth and service distribution raises important concerns about fairness and effective planning. The findings provide practical guidance for policymakers aiming to improve service coverage, close regional gaps, and support more balanced and sustainable development across Kuwait's expanding coastal cities.

Keywords: *Urban planning, Coastal governorates, GIS analysis, Service distribution, Kuwait population dynamics*

INTRODUCTION

Kuwait's coastal regions, encompassing the governorates of Capital, Hawalli, Ahmadi, Mubarak Al-Kabeer, and Jahra, are central to the nation's urban landscape, housing over 60% of its 3.06 million residents as recorded in the 2011 census (Central Statistical Bureau, 2012; Belfiore *et al*., 2024). This significant population concentration underscores the strategic importance of these areas, which span approximately 195 km along the Arabian Gulf and serve as the backbone of Kuwait's economic, social, and infrastructural development (Al-Sabah, 2000; Liu *et al*., 2022; Getu *et al*., 2024). Historically, these coastal zones were the nucleus of Kuwaiti settlement, supporting maritime trade and fishing communities before the discovery of oil in the 1930s (Al-Rashid, 1998; Mohamed *et al*., 2023; Thazha *et al*., 2023). The subsequent oil-driven economic boom, particularly post-1950, catalyzed rapid urbanization, transforming these regions into densely populated urban hubs with heightened demands for residential, educational, health, and recreational services (Kuwait Planning Authority, 1997; Alshammari *et al*., 2022; Makhoahle & Gaseitsiwe, 2022).

This paper investigates the demographic profile and spatial distribution of services in Kuwait's coastal governorates, focusing on data collected between 2019 and 2020. The study is motivated by the intensifying pressure on service provision following decades of urban expansion, a trend rooted in the post-oil era when Kuwait's population grew from a modest 206,473 in 1957 to over 3 million by the early 21st century (Central Statistical Bureau, 2012). This demographic surge, coupled with a high proportion of non-Kuwaiti residents—58.1% in coastal areas by 2019—has amplified the need for equitable and efficient service delivery (Central Statistical Bureau, 2020). The coastal governorates, characterized by their proximity to economic centers and a youthful population (40.7% aged 31–40 in 2019), present a unique case for analyzing how spatial patterns of population and infrastructure align with service availability (Central Statistical Bureau, 2020). Rapid urbanization has not only increased service demands but also exposed disparities in their distribution, prompting this research to assess these patterns and their implications for urban planning. Pre-oil Kuwait relied on minimal services tailored to a small, coastal population, whereas modern demands—spanning housing, education, healthcare, and transportation—require sophisticated infrastructure to support a diverse and growing populace (Kuwait Planning Authority, 1997; Dhanasekar *et al*., 2022; Graefen *et al*., 2023; Feng *et al*., 2024). This study leverages 2019–2020 data to provide a contemporary snapshot, building on historical planning efforts documented since the 1950s (Kuwait Planning Authority, 1997). The objectives are threefold: to map population density across the coastal governorates, to analyze the availability and accessibility of key services using geospatial techniques, and to propose evidence-based improvements for optimizing resource allocation. By employing Geographic Information Systems (GIS) and statistical analysis, this research aims to offer actionable insights for sustainable urban development in Kuwait's coastal regions, contributing to

broader discourse on managing rapid urbanization in resource-rich, arid environments.

MATERIALS AND METHODS

This study employed a mixed-methods approach to investigate the spatial distribution of services and population dynamics in Kuwait's coastal governorates—Capital, Hawalli, Ahmadi, Mubarak Al-Kabeer, and Jahra—integrating quantitative data analysis, geospatial techniques, and qualitative field observations. Quantitative data were sourced from the Central Statistical Bureau's 2019–2020 census reports, providing comprehensive statistics on population characteristics and service facilities across the coastal zones (Central Statistical Bureau, 2020). These datasets included demographic variables—gender, nationality (Kuwaiti vs. non-Kuwaiti), and age distribution—extracted for each governorate to map population density and identify service demand patterns. Service-related data encompassed residential units, educational institutions, religious facilities, health centers, and transportation infrastructure, compiled from official records spanning 2019 to 2020 to reflect contemporary urban conditions (Central Statistical Bureau, 2020).

Geospatial analysis was conducted using ArcGIS 10.5 software (ESRI, 2016), a robust tool for mapping and evaluating spatial relationships. Service facilities were geocoded by assigning geographic coordinates to their physical locations, derived from address records provided by the Kuwait Municipality (2006) and updated with 2020 field survey data. Spatial patterns were assessed through three key metrics: (1) Moran's I, a statistical measure of spatial autocorrelation, to detect clustering of services (values > 0 indicate clustering); (2) Standard Distance, to quantify the dispersion of facilities around their mean center; and (3) Buffer Zones, calculated at varying radii (e.g., 1 km, 2 km) to evaluate service coverage and accessibility relative to population centers. These techniques, applied to datasets covering the five coastal governorates, enabled a detailed examination of service distribution disparities, with GIS outputs visualized as maps and statistical summaries (ESRI, 2016; Central Statistical Bureau, 2020).

To complement the secondary data, a field survey was conducted in 2020, targeting 840 residents across the coastal regions to gather qualitative insights into service adequacy and usage. The survey, designed with structured questionnaires, was administered in key urban areas such as Shuwaikh, Salmiya, and Fahaheel, selected for their high population density and service concentration (Central Statistical Bureau, 2020). Respondents were asked to evaluate the availability, accessibility, and quality of services—residential, educational, health, and recreational—using a Likert scale, with additional open-ended questions to capture perceived challenges like traffic congestion or facility shortages. The sample was stratified by the governorate to ensure representativeness, with data collection spanning March to June 2020, processed through descriptive statistics to identify trends and corroborate with GIS findings (Central Statistical Bureau, 2020).

This integrated methodology leveraged the strengths of quantitative precision and qualitative depth, aligning secondary data from official sources with primary observations to provide a holistic view of service distribution. The use of ArcGIS 10.5 facilitated advanced spatial analysis, while the field survey grounded the study in resident experiences, ensuring that proposed planning improvements reflect both empirical patterns and community needs in Kuwait's rapidly urbanizing coastal zones.

RESULTS AND DISCUSSION

The demographic profile of Kuwait's coastal governorates in 2019 reveals a diverse and concentrated population, with significant implications for service planning. Across the five coastal regions—Capital, Hawalli, Ahmadi, Mubarak Al-Kabeer, and Jahra—41.9% of residents were Kuwaiti, while 58.1% were non-Kuwaiti, reflecting a substantial expatriate presence driven by economic opportunities in urban coastal centers (Central Statistical Bureau, 2020). Hawalli emerged as the most densely populated governorate, with an estimated 939,792 residents in 2019, attributed to its proximity to commercial hubs and affordable housing options (Central Statistical Bureau, 2020). In contrast, Jahra, with a larger geographical area but lower urban density, hosted 489,693 residents, highlighting spatial variations within the coastal zone.

Table 1. Geographic Distribution of Coastal Population by Gender and Nationality in Kuwait (2011)

Governorate	No. of Areas	Female	Male	Non-Kuwaiti	Kuwaiti	Total
Capital	16	43,620	65,231	69,277	39,574	108,851
Hawalli	5	159,358	169,545	255,441	73,462	328,903
Mubarak Al-Kabeer	6	3,784	3,852	5,243	2,393	7,636
Ahmadi	5	85,511	182,289	223,829	43,971	267,800
Coastal Areas Total	**32**	**292,273**	**420,917**	**553,790**	**159,400**	**713,190**
Total Kuwait	**157**	**1,327,478**	**1,738,372**	**1,975,881**	**1,089,969**	**3,065,850**
Percentage		**22.06%**	**24.21%**	**28.02%**	**14.62%**	**23.26%**

Source: Prepared by the researcher based on:
- Final Results of the 2011 Population Census – Central Statistical Bureau.
- Capital Governorate Information Center, Statistical Guide, Unpublished Population Data (2015, 2020).

Age structures indicate a youthful population, with 40.7% of residents aged 31–40, followed by 25.3% aged 21–30, suggesting a workforce-heavy demographic with growing needs for housing, education, and healthcare (Central Statistical Bureau, 2020).

Service distribution across these governorates varies significantly, reflecting both population density and urban planning priorities. Residential units dominate the service landscape, with 39.4% of housing classified as apartments and 29.7% as villas, totaling over 250,000 units across coastal areas by 2020 (Central Statistical Bureau, 2020). Hawalli and Capital governorates accounted for the majority, with Salmiya alone hosting over 15,000 apartment units, catering to dense, expatriate-heavy populations (Central Statistical Bureau, 2020). Educational facilities met 67.1% of demand, with 1,234 schools

operational in 2020, though coverage was uneven—Capital and Hawalli boasted higher school-to-population ratios (1:800 residents) compared to Ahmadi (1:1,200) (Central Statistical Bureau, 2020). Religious facilities, such as mosques, numbered 892, with a relatively uniform distribution, while health services showed stark disparities: pharmacies achieved 73% coverage within 1-km buffer zones, yet hospitals covered only 38.8% of the population within 2-km buffers, with rural Jahra notably underserved (Central Statistical Bureau, 2020).

Table 2. Spatial Distribution of Facilities in Al-Ahmadi Governorate According to 2011 Statistics

Areas	Year	Number of Facilities	Types of Facilities Present
Al-Mangaf	2010	2564	644 residential buildings, 200 units under construction, 25 complexes, 1393 villas, 361 Eastern houses, 4 hotels, 26 schools, 1 clinic, 2 hospitals, 1 club, 2 associations, 18 mosques, 8 government buildings, 25 commercial buildings, and gas stations.
	2020	2870	735 residential buildings, 28 units under construction, 21 complexes, 1648 villas, 361 Eastern houses, 2 hotels, 26 schools, 1 clinic, 1 club, 2 associations, 18 mosques, 8 government buildings, 17 commercial buildings, and gas stations.
Al-Fahaheel	2010	1670	363 residential buildings, 55 commercial complexes, 6 units under construction, 647 villas, 294 Eastern houses, 22 schools, 3 clinics, 1 health complex, 1 hospital, 1 club, 8 associations, 32 mosques, 18 government buildings, 1 bank.
	2020	1737	382 residential buildings, 39 complexes, 6 units under construction, 783 villas, 289 Eastern houses, 24 schools, 2 colleges, 2 clinics, 1 health complex, 1 club, 2 associations, 2 markets, 27 mosques, 24 government buildings, 2 banks, 3 gas stations, 145 commercial buildings, and a wedding hall.
Al-Fintas	2010	961	310 residential buildings, 4 complexes, 2 units under construction, 492 villas, 70 Eastern houses, 5 hotels, 6 schools, 1 hospital, 3 associations, 9 mosques, 14 government buildings, 1 bank.
	2020	977	309 residential buildings, 4 complexes, 2 units under construction, 302 villas, 123 Eastern houses, 3 palaces, 1 hotel, 5 schools, 1 hospital, 2 clubs, 1 association, 11 mosques, 9 government buildings, 1 bank, 6 commercial buildings, 2 wedding halls.
Abu Halifa	2010	576	333 residential buildings, 2 residential complexes, 2 units under construction, 167 villas, 26 Eastern houses, 2 palaces, 1 hotel, 1 association, 2 markets, 6 mosques, 3 government buildings.
	2020	628	369 residential buildings, 2 residential complexes, 2 units under construction, 212 villas, 12 Eastern houses, 1 palace, 1 hotel, 1 club, 1 association, 2 markets, 6 mosques, 4 government buildings, 6 commercial buildings, 2 wedding halls.
Al-Mubula	2010	953	788 residential buildings, 30 complexes, 34 units under construction, 85 villas, 2 Eastern houses, 4 hotels, 6 schools, 1 hospital, 4 clubs, 5 mosques, 4 government buildings, 27 commercial buildings, 58 transformers.
	2020	1393	1263 residential buildings, 30 complexes, 5 units under construction, 37 villas, 8 Eastern houses, 5 hotels, 5 schools, 1 hospital, 1 club, 7 mosques, 3 government buildings, 27 commercial buildings.

Source: Prepared by the student based on the following data:
1.   Final results of the 2011 population census – Central Statistical Bureau.
2.   Population estimates for 2019, Central Statistical Bureau, unpublished data, 2020.
3.   Capital Governorate of Kuwait, Information Center, Statistical Guide, Population Data, unpublished data for 2015 and 2020.

Geospatial analysis, conducted using ArcGIS 10.5, provided deeper insights into service accessibility and clustering. Moran's I value exceeded 0 (e.g., 0.45 for educational facilities, 0.62 for pharmacies), indicating significant clustering of services in urban cores like Shuwaikh (Capital) and Salmiya (Hawalli), where population density exceeds 10,000 per km² (ESRI, 2016; Central Statistical Bureau, 2020). Standard Distance metrics revealed a compact service radius in Hawalli (mean dispersion

of 2.3 km) versus a wider spread in Ahmadi (4.8 km), reflecting urban-suburban differences (Central Statistical Bureau, 2020). Buffer zone analysis, visualized in GIS maps, highlighted accessibility gaps: while 73% of residents lived within 1 km of a pharmacy, only 38.8% were within 2 km of a hospital, with Ahmadi and Mubarak Al-Kabeer showing the lowest hospital access at 25% and 30%, respectively (Central Statistical Bureau, 2020).
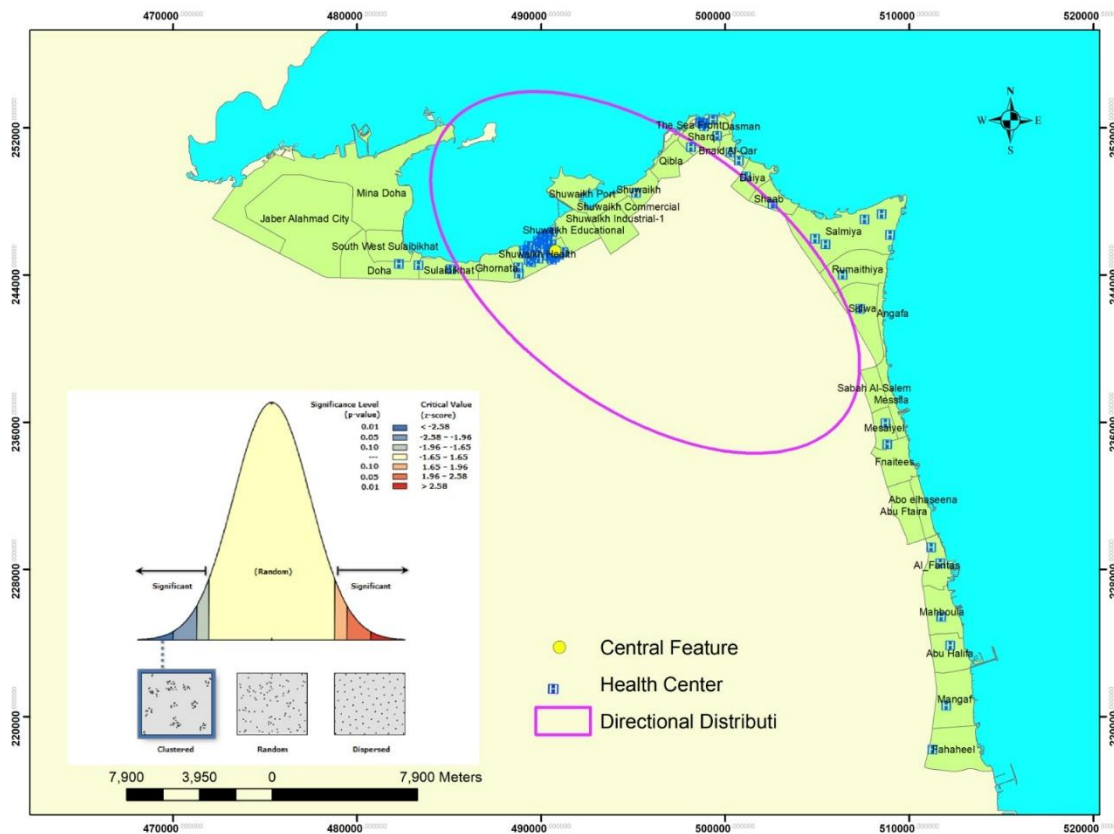
Figure 1. Buffer Zone Coverage of Health Facilities, 2020.
Source: Prepared by the student based on the following data:
Topographic maps at a scale of 1:50,000, produced by the Municipality of the State of Kuwait, 2018.
Administrative boundary layer, Central Statistical Bureau, Kuwait, 2016.

These spatial patterns were corroborated by field survey data, with 78.2% of 840 respondents reporting traffic congestion as a barrier to service access, particularly along coastal highways connecting Hawalli and Capital (Central Statistical Bureau, 2020).

Additional survey insights revealed resident perceptions of service adequacy. While residential and educational services were rated sufficient by 65% and 62% of respondents, respectively, health and recreational facilities lagged, with only 38% and 22% reporting adequate access to hospitals and parks (Central Statistical Bureau, 2020). Traffic congestion, affecting 78.2% of commuters, was most acute in Hawalli, where 85% of respondents cited delays exceeding 30 minutes daily, underscoring the strain on transportation infrastructure (Central Statistical Bureau, 2020)

These findings collectively illustrate a coastal urban system where dense, youthful populations drive service demand, yet spatial and infrastructural limitations create uneven access, particularly in suburban and health-related domains.

The results of this study underscore the intricate relationship between population dynamics and service distribution in Kuwait's coastal governorates, revealing both strengths and vulnerabilities in the urban fabric of Capital, Hawalli, Ahmadi, Mubarak Al-Kabeer, and Jahra. The pronounced concentration of services in urban cores like Shuwaikh and Salmiya reflects the high population density—exceeding 10,000 per km² in

Hawalli—and the economic pull of coastal proximity, a pattern solidified during Kuwait's post-oil urban boom after 1950 (Kuwait Planning Authority, 1997; Central Statistical Bureau, 2020; Wilhelmy *et al.*, 2022; Attenborough *et al.*, 2023; Kulkarni *et al.*, 2023). This clustering, evidenced by Moran's I value (e.g., 0.62 for pharmacies), aligns with the historical shift from sparse, pre-oil coastal villages to modern metropolitan hubs, where residential units (39.4% apartments, 29.7% villas) and educational facilities (67.1% coverage) cater to over 60% of Kuwait's 3 million residents (Kuwait Planning Authority, 1997). However, this centralization exposes significant gaps in suburban areas, particularly for critical services like hospitals and recreational spaces, where only 22% of surveyed residents reported adequate park access (Central Statistical Bureau, 2020; Patil, 2022; Marian *et al.*, 2024).

The youthful demographic, with 40.7% aged 31–40 and 25.3% aged 21–30, signals a burgeoning demand for education, housing, and employment opportunities, consistent with Kuwait's trajectory since the oil-driven economic surge (Central Statistical Bureau, 2020). This age structure, dominated by a workforce-heavy population, mirrors the post-1950 urban expansion when planned residential zones emerged to accommodate rapid growth, as documented in structural plans from the Kuwait Planning Authority (1997). Yet, the current service distribution struggles to keep pace, particularly in health and recreation. GIS analysis reveals stark inefficiencies:

while pharmacies achieve 73% coverage within 1 km buffers, hospital access drops to 38.8% within 2 km buffers, with suburban governorates like Ahmadi (25%) and Jahra (rural areas underserved) lagging significantly (Central Statistical Bureau, 2020). This disparity, visualized in buffer zone maps, aligns with global urban studies on service inequities in rapidly urbanizing regions, such as Mumbai or Jakarta, where core-periphery divides exacerbate access gaps (UN-Habitat, 2016; Dipalma *et al.*, 2022; Kothawade *et al.*, 2023; Pavlova, 2024; Ravoori *et al.*, 2024).

Traffic congestion, affecting 78.2% of commuters and peaking in Hawalli (85% reporting delays over 30 minutes), further compounds these challenges, reflecting inadequate transportation infrastructure to support the dense coastal population (Central Statistical Bureau, 2020; Dongmo & Tamesse, 2023). Field survey data from 2020 highlight resident dissatisfaction, with only 38% rating hospital access as adequate and 22% satisfied with recreational facilities, a stark contrast to higher approval for residential (65%) and educational (62%) services (Central Statistical Bureau, 2020). The decline in recreational usage—potentially linked to environmental constraints like heat and dust, as noted in regional studies (Al-Ghunaim, 2005; Fernandes *et al.*, 2022; Shaheen *et al.*, 2023)—suggests a need for climate-adapted facilities, such as shaded parks or indoor recreational centers, to enhance quality of life.

These findings point to actionable strategies for sustainable growth. Decentralizing health and recreational services to suburban areas like Ahmadi and Mubarak Al-Kabeer could address coverage gaps, a recommendation supported by GIS buffer analysis showing limited hospital reach (Central Statistical Bureau, 2020; Fiodorova *et al.*, 2022). Enhancing transportation infrastructure—through expanded road networks or public transit options—could alleviate congestion, particularly along Hawalli-Capital corridors, aligning with the thesis's call for integrated planning (Kuwait Planning Authority, 1997). The youthful demographic also necessitates proactive investment in educational and housing capacity, potentially through mixed-use developments that integrate schools and residences, a model successful in other Gulf cities like Dubai (Al-Ghunaim, 2005; AlHussain *et al.*, 2022; Pisano *et al.*, 2023; Maneea *et al.*, 2024). A comparative table of service coverage across governorates could illustrate these disparities and guide prioritization.

Table 3. Spatial Distribution of Residential and Educational Establishments by Region, 2020

Region	Residential Establishments (No.)	Residential Establishments (%)	Rank	Educational Establishments (No.)	Educational Establishments (%)	Rank	Service Density (School per Capita)
Jaber Al-Ahmad City	4,394	14.62%	1	29	11.98%	2	563
Salwa	3,761	12.52%	2	22	9.09%	5	1,298
Salmiya	3,618	12.04%	3	45	18.60%	1	1,873
Mangaf	2,744	9.13%	4	26	10.74%	3	1,112
Rumaithiya	2,694	8.97%	5	20	8.26%	6	1,008
Fahaheel	1,454	4.84%	6	24	9.92%	4	918
Al-Dawha Housing	1,371	4.56%	7	12	4.96%	7	1,047
Subliekhates	1,220	4.06%	8	10	4.13%	8	1,255
North West Subliekhates	734	2.44%	12	10	4.13%	9	389
Daiya	733	2.44%	13	8	3.31%	10	763
Sabah Al-Salem Investment	288	0.96%	20	7	2.89%	11	39
Abu Halifa	589	1.96%	15	6	2.48%	12	2,613
Sharq	258	0.86%	21	5	2.07%	13	912
Fintas	737	2.45%	11	5	2.07%	14	2,557
Mubula	1,308	4.35%	8	5	2.07%	15	2,688
Al-Shab	643	2.14%	14	4	1.65%	16	1,129
Abu Futura Residential Area	958	3.19%	10	0	0%	-	2,845
Al-Qibla	107	0.36%	25	0	0%	-	1,828

Regionally, Kuwait's coastal urbanism shares traits with Qatar and the UAE, where rapid urbanization and expatriate-heavy populations strain service delivery, yet its arid climate and flat topography add unique constraints (Al-Sabah, 2000; Malcangi *et al.*, 2023). Globally, the inefficiencies highlighted by GIS tools resonate with urban planning challenges in arid, coastal cities like Phoenix, where decentralization and transit improvements have mitigated similar issues (UN-Habitat, 2016; Bulusu & Cleary, 2023; Bolay *et al.*, 2024; Watanabe *et al.*, 2024).

CONCLUSION

Kuwait's capacity for adaptive urban planning—rooted in its post-oil development legacy—offers a strong foundation for addressing the spatial inequalities revealed in this study. The clear concentration of services in urban centers like Capital and Hawalli, contrasted with the under-served conditions in areas like Ahmadi and Jahra, highlights a pressing need to rebalance infrastructure and service delivery. With over 3 million people residing in coastal governorates, many beyond optimal service zones, targeted investment and spatially informed planning are essential. These findings provide a practical framework to optimize resource allocation and ensure Kuwait's coastal zones grow equitably and sustainably amid ongoing demographic and urban pressures.

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