

# Coastal Cities, Rapid Transformation and Unsustainable Development Practices: the case of Qatif Oasis, Saudi Arabia

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**Abstract**—This paper aims to examine the environmental impacts associated with the urban expansion and rapid transformation of three coastal cities in the Qatif Oasis over the last 60 years and to assess the current and future challenges facing these cities. Particular attention is paid to the unsustainable development practices associated with rapid transformation that have resulted in environmental problems. The rapid loss of agricultural areas and the devastation of marine life along the shores of these three cities (because of landfilling activities along the western shore of the Arabian Gulf) are the most severe environmental problems facing these coastal cities. The results of this study suggest that if the current pattern and rate of changes in land use continue, all agricultural land will possibly disappear forever in the next 25 to 30 years. Similarly, if the seashore reclamation activities continue at the same rate, marine life will become extinct, forever harming the viability of the fishing industry and ecosystem. Therefore, legal regulations and environmental protection legislation toward preserving agricultural lands and protecting the marine environment need to be revised, improved, and adopted. Further, public participation through community awareness programs and voluntary work toward protecting agricultural areas and the marine environment needs to be encouraged and maintained.

**Keywords**—Coastal cities; sustainable development; urban expansion; environmental impacts; agricultural land; marine life; Qatif oasis; Eastern Province; Saudi Arabia

## 1. INTRODUCTION

More than half of the world's population is now living in urban areas, and this trend is projected to continue. According to a recent estimate by the United Nations (UN), the urban population in the world is expected to rise from 3.6 billion in 2011 to 7.2 billion in 2050 [1]. Currently, more than 40% of the world's population lives in coastal cities, which is a large demographic concentration on a small part of the Earth's surface [2-4]. In fact, coastal areas comprise 20% of the Earth's surface yet contain over 40% of the entire human population. By the year 2025, coastal populations are expected to account for 75% of the total world population [5]. This high population concentration in coastal areas causes serious damage to the dynamic and fragile coastal-marine ecosystems, often leading to major environmental problems and socio-economic conflicts due to the loss of important ecosystem services [2,4,6-9]. Additionally, the scale and speed of urban expansion on the coast has generated hitherto unseen changes in land use, especially in the last three decades or so, such as in the case of US coastal counties [10], Chinese coast [11], Australian coast [12], Latin American coastal countries [4], Irish coast [13], Bangladesh coast [14-15], western and eastern Indian coasts [16-17], and the Arabian Gulf coast [18].

Although coastal areas currently comprise about 20% of the total Earth's surface [5], environmental impacts in relation to urban growth have become a major concern around the world. The impacts of coastal land use changes associated with urban expansion have been investigated and documented in a number of empirical and theoretical studies. For example, the urban heat island (UHI) phenomenon is found to be spatially correlated with changes in coastal land use [19-20]. The dramatic loss of coastal marine habitat and biodiversity and the loss of valuable and productive arable lands and farmlands along the coastline are significantly associated with the urban expansion process [14-15, 21-26]. According to Dewan and Corner [9], in order to mitigate these impacts of urban expansion on the coastal environment and marine ecosystem, timely and accurate information on the spatiotemporal patterns of urban development and the factors influencing this growth are essential to support urban planners, resource managers, economists, and environmentalists in solving the problems associated with such rapid and unplanned growth. Despite blossoming interest in the impacts of urban expansion on the environment and marine ecosystems of coastal areas in many parts of the world, coastal areas and their environmental impacts in relation to urban growth in the Arabian Gulf countries are rarely studied. Therefore, by focusing on Saudi Arabia as a Gulf country, this research paper adds to the rather sparse body of knowledge on the impacts of urban growth on the coastal areas of the Arabian Gulf region in general and Saudi Arabia in particular.

This paper aims to document the environmental impacts associated with the urban expansion and rapid transformation of three coastal cities located in the Qatif Oasis of Saudi Arabia over the last 60 years and to assess the current and future challenges facing these cities. In addition, particular attention is paid to the unsustainable development practices associated with rapid transformation

that has resulted in serious coastal-environmental-and-marine ecosystem problems. The paper is primarily based on published literature, secondary data, and related statistics from relevant organizations. It systematically addresses the source, dimensions, and implications of the environmental problems in these three coastal cities. A discussion and recommendation of possible measures for the mitigation and management of environmental problems are put forward.

The remainder of the paper is organized as follows: section 2 presents a brief background of the study area, its historical growth and urban development. Section 3 presents the impacts of rapid urban growth on agriculture lands and marine-ecosystem along with the cause and consequences associated with the urban expansion and rapid transformation over the last 60 years. Finally, section 4 draws some conclusions and policy recommendations

## **2. COASTAL CITIES: LOCATION, HISTORICAL GROWTH, AND URBAN DEVELOPMENT**

The three largest coastal cities in the Qatif (Al-Qatif) Oasis are Qatif, Anak (Anik), and Saihat (Seahat). They constitute this region's seafront and together form the gateway to other towns and villages in the oasis (Figure 1). These three cities are located in the Eastern Province of Saudi Arabia, along the western shore of the Arabian Gulf, between 26° 29' 0" N and 50° 1' 0" E. They lie along the Arabian Gulf and are about 22 km north to Dammam (the capital of the Eastern Province) and about 30 km south to Ras Tanura (serves as an oil operations center and a port for Saudi Aramco). These cities are rich with agricultural soil and surrounded to the west by a jungle of palm trees. In the past, they were separate entities with farms and fields lying between them. Over the last 60 years, the agricultural lands between them gave way to urban invasion, resulting in the merging of these towns into one contiguous linear coastal city that extends into the south and merges with the Dammam Metropolitan Area (DMA).

Qatif city is one of the most ancient cities in history; it can be historically traced back to 3500 B.C. This city is currently considered as the administrative center of the entire oasis. Anak (Anik) is also a historical city as can be confirmed by archaeological evidence and its architectural buildings. A famous Portuguese castle was located near the town's seashore. Saihat (Seahat) is also an ancient place of civilization; the city's historical documents can be dated back to more than 400 years. Saihat functioned as a seaport from where fishing, pearling, and trade boats used to sail to East Asia [28].

Before the discovery of oil, these towns played the traditional agricultural role of supplying food, particularly dates, vegetables, and fish, and pearl from the gulf waters. Until the 1930s, the populations of these towns were primarily dependent on agriculture and fishing. However, since the discovery of oil in the Eastern Province in 1937, the economic structure of these towns has been undergoing radical changes, exerting pressure to transform the traditional roles, functions, and character of land use. The oil industry boom and related economic activities triggered the process of urban transformation [29-31]. Several road connections were constructed between these towns and the region's main urban centers (i.e., Dammam, Dhahran, and Khobar). The reason behind constructing these road connections was to serve the needs of the oil industry and to simultaneously facilitate the movement of oil drilling equipment, oil workers, and food supply (from oil wells located within these coastal cities to Dhahran's oil station). These coastal towns thus became exposed to the forces of conurbation and metropolization. Moreover, the establishment of Aramco housing areas within the region's main cities triggered a process of progressive population influx and consequently a demand for housing accommodation [32-34].

Due to the limited town boundary, the residential density of these coastal cities dramatically started to rise to very high levels. During the 1955-1975 period, the residential density increased from about 363/ha in 1955 to more than 517/ha in 1975 [30]. This situation inevitably raised the demand for urban and residential land, accompanied by generous loan offers from the Aramco Oil Company as well as the Saudi Real Estate Development Fund (REDF). Consequently, land value inordinately increased ranging from \$800 to \$2650/m<sup>2</sup> in Qatif city and between \$250 to \$650/m<sup>2</sup> in the other two cities [28,30]. As demand for housing and urban development and the value of land increased, owners of farms and agricultural lands saw a chance of obtaining better economic returns from their lands, which in turn created immense pressure on farms and agricultural lands to be converted to residential land use. This resulted in owners deliberately destroying their farms and agricultural lands to easily obtain permission for converting their lands, thus initiating the conversion of agricultural land. During this period (1955-1975), however, the urban area increased by 2.7 times, while the population of these coastal towns increased by almost 4.0 times (Figure 2).

The 1975-1995 period witnessed a rapid pace of development when overwhelming growth took place and the three coastal towns exploded into 17 times their total size and about 3.7 times their total population (Table 1). The overall residential density drastically dropped during this period. Land value witnessed a dramatic increase, ranging from \$3500/m<sup>2</sup> for residential land use to more than \$8000/m<sup>2</sup> for commercial land use [28,30,35]. Numerous publications have referred to the fact that the 1975-1995 period is said to be the peak period of urban growth and development in Saudi Arabia and that the pressure for the conversion of agricultural land into urban land reached its peak during this period [32-33,35,39-40]. A total of 1018 ha of agricultural land were lost during this period. However, the maximum loss took place during the period of 1985-95, when a total of 710 ha of highly productive agricultural land were lost [41-43]. The urban expansion process went beyond agricultural areas to encroach upon the coastline.

Large offshore areas were subjected to landfill. By 1995, altogether 1750 ha were reclaimed from the seashore (Table 2). During the 1985-1995 period alone, more than a thousand hectares of new land were reclaimed from the sea [28,34,44-45].

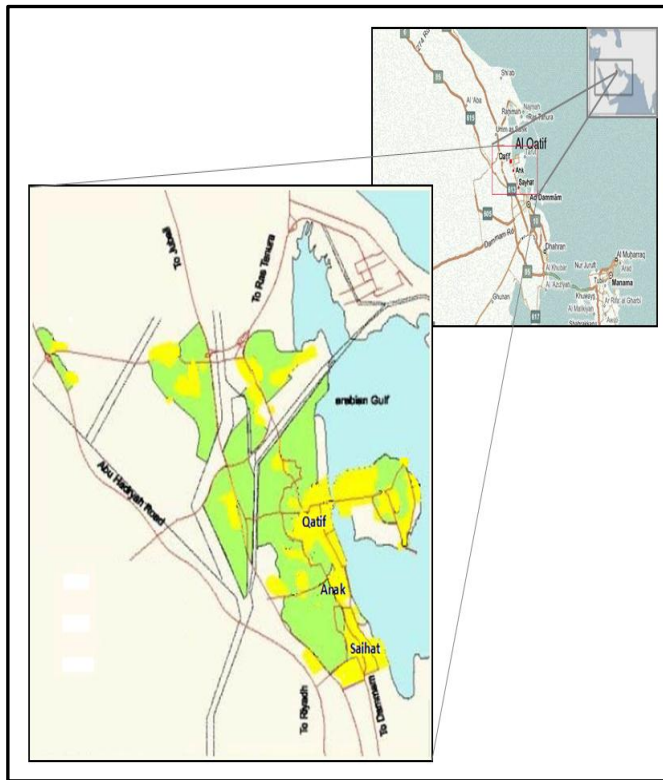


Fig. 1. Location of coastal cities of Qatif oasis [27]

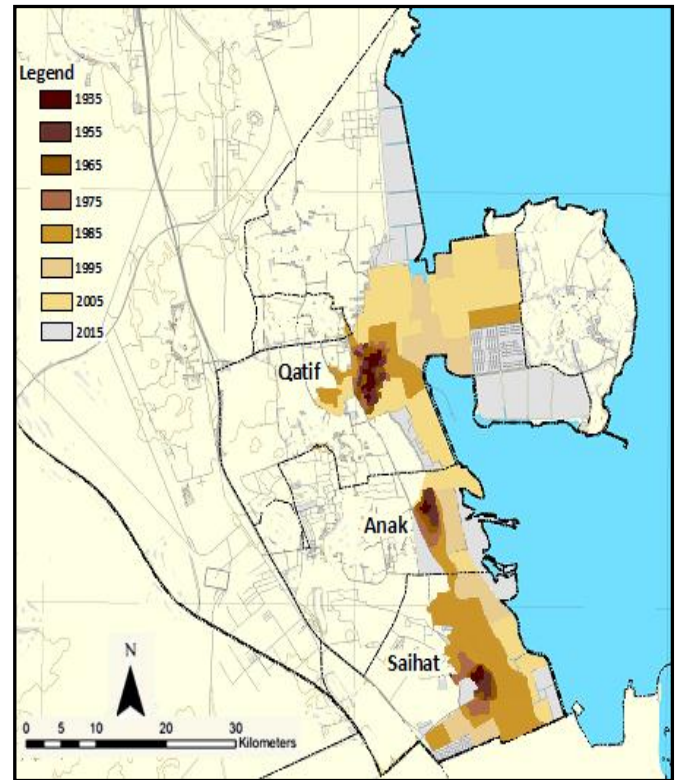


Fig. 2. Historical growth of coastal cities of Qatif oasis [27, 38]

In addition to the phenomenon of urban invasion, the human problem of negative attitude towards agriculture also surfaced. As oil revenue started to pour in and the economy expanded, a widespread neglect of agricultural activities began in favor of other economic sectors, especially oil and oil-related activities and public sectors. According to a survey carried out by the Dammam Municipal Authority in 1994 [47], a relatively large percentage of workforce in these three coastal cities worked in oil-related industries. Oil and mining was the third largest employment sector accounting for 15.2% of all workers, after government services (37.5%) and trade and related activities (23.3%), and followed by fishing and related industries (14%) and agriculture (10%).

The period from 1995-2015 witnessed a slow growth of urban development in these three coastal cities. One reason behind this slow growth was the re-oriented development policies by the government towards urban and rural communities that lagged behind, especially the northern and southern part of Saudi Arabia [34,40,48]. Another reason was that the rapid development potentials and investment opportunities in terms of government projects and programs allowed many investors to re-direct their investment toward these regions [34,39-40,48]. The population increase continued but the rate was slower than that in the previous periods. The annual growth rate was 2.9% and the total population of these three coastal cities increased by 1.8 times during this period [36-37]. On the other hand, the built-up area increased by 2.6 times [27,48]. The overall residential density sharply dropped during this period. Further, urban areas expanded by 2487 ha at the cost of both agricultural and seashore lands. The negative attitude for primary sector (i.e., agriculture and fishing industries) continued to increase over time. According to the workforce data provided by the Central Department of Statistics and Information [37], the workforce in agriculture and fishing industries accounted for less than 3.2% of the total workforce in these three coastal cities. Government services accounted for the majority of workforce with 43%, followed by trade and related activities (32.8%) and oil and related industries (21%). The three coastal cities of the Qatif Oasis have today merged into one contiguous linear coastal city, extending farther into the south and merging with Dammam, Dhahran, and Khobar cities and to the north, partially merging with Safwa and Ras Tanura cities [27]. This area is now known as Greater Dammam and is the third largest metropolitan area in the Kingdom of Saudi Arabia and the main urban mass in the Eastern Province.

Table 1. Urban area size and population of coastal cities of Qatif Oasis [27-30,36-38]

Year	Urban area (hectares)	Population	Density ratio (person/hectare)
1955	33	12,000	363.6
1965	71	28,200	397.2
1975	90	46,600	517.8
1985	844	98,425	116.6
1995	1,535	174,280	113.5
2005	2,023	247,420	122.3
2015	4,022	310,820	77.3
2040*	6,916	712,280	103.0

\*Projected data based on the technical report provided by the Ministry of Municipal and Rural Affairs [27]

**Table 2.** Loss of agricultural areas and seashore land infill (hectares) [28,34,42-43,46,49]

	1975-85	1985-95	1995-2015	2015-2040*
Loss of agricultural land	308	710	972	1200
Seashore land infill	660	1090	1515	608
Total	968	1800	2487	1808

\*Projected data based on the technical report provided by the Ministry of Municipal and Rural Affairs [49]

### 3. RAPID TRANSFORMATION AND ENVIRONMENTAL IMPACTS

The historical rapid pace of urban growth and development over the last 60 years helped these three coastal cities in the Qatif Oasis transition from a group of small fishing and agricultural towns to a large urban center. Within the last 60 years, these coastal towns transformed from agriculture- and fishing-based areas that used renewable resources to industry-based cities based on manufacturing, trade, and commerce industries that mostly used non-renewable resources. On the one hand, this rapid transformation provided the residents of these coastal cities with a better economic status, in terms of higher income and job security, as well as a higher standard of living, in terms of housing, modern amenities, health, education, and other social facilities. On the other hand, a web of serious environmental problems has been associated with this rapid urbanization. The rapid loss of agricultural areas and the devastation of marine life along the shores of these three cities (because of landfilling activities along the western shore of the Arabian Gulf) are the most severe environmental problems facing these coastal cities.

#### 3.1 Urban Expansion on Agricultural Lands

Agricultural areas are valuable and sustainable assets especially in nations like Saudi Arabia that heavily rely on their oil resource, which although provides a lot of wealth, may not do so forever and may only last for two or three generations [18,22]. Adding to their historical value is the fact that these agricultural areas, along with the gulf waters and the extended desert background, offer a unique pleasing landscape and a natural combination rare to find elsewhere in Saudi Arabia [18,39]. Therefore, protection of these agricultural lands must be an unquestionable objective. Despite this unique characteristic value of agricultural areas, the master plan for the Qatif region prepared by CH2M Hill International and CEG in 1982 [31] permitted the approval of urban subdivision plans on agricultural areas on the condition of getting an approval from the Ministry of Agriculture [31,39]. Urban expansion on agricultural areas has ever since sharply increased. Since the early 1980s, mega-development projects, such as housing, infrastructure, industrial and commercial estate projects, and several Aramco gated housing projects, have consumed excessive agricultural land. Moreover, land speculation has led to excessive property investment, putting more pressure on agricultural areas in these three coastal cities. Consequently, urban land use consumed roughly 1680 ha of highly productive agricultural lands in these three cities during the 1985-2015 period.

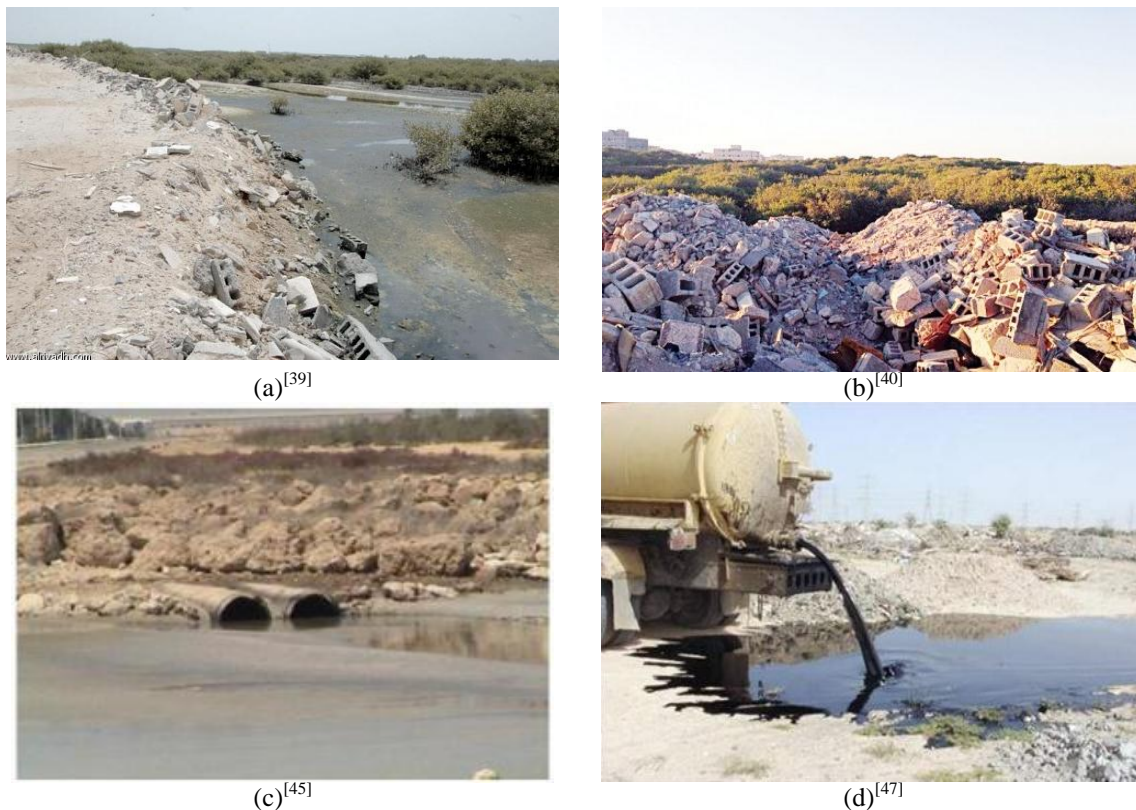
The population of the three coastal cities being studied increased by about 26 times in the last 60 years. The total population is expected to increase by about 401,460 people in the next 25 years [49]. The built-up areas increased by more than 121 times over the last 60 years. The urban area is expected to increase by 2890 ha in the next 25 years, which in turn indicates that more and more agricultural lands will vanish in the near future under the process of urban expansion and development [38,49].



### 3.2 Urban Expansion on Seashore Lands

One of the most harmful human activities to coastal and marine ecosystem resources is the reclamation of seashore land [14,21,25-26]. Experts have anticipated that the future growth of these coastal cities would depend on both coastal land and bay water. Poor land use regulation and in particular the premium prices of seafront properties are considered among the key driving factors behind the landfilling activities in these three coastal cities [39]. Large offshore areas have been subjected to landfill in the last 60 years. It was estimated that more than 3200 ha of seashore land have been already reclaimed and about 608 ha of land will be reclaimed by landfill in the near future [38,45].

Additionally, large mangrove forests surrounding the coastal cities have been cut down and replaced by landfill. It was estimated that currently only 10% of the mangroves remain, the rest have been destroyed by the ongoing bulldozing and landfill operations [50]. Moreover, negative and careless attitude toward the environment has been another major problem. About 65% of the urban area of Anak, 57% of the urban area of Saihat, and 30% of the urban area of Qatif, a total area of about 904 ha, were not covered by sewage network and depended on septic tanks in 2006 [48]. This vast urban area produces huge amounts of wastewater that needs to be discharged. This has been aggravated by the fact that contractors, and in some cases some industrial establishments, usually discharge wastewater directly into coastal creeks. Furthermore, the reclamation activities along the seashore of these cities harshly influenced the oasis fishing market, which is estimated to have experienced about 65% decline over the past 20 years [50]. Landfill activities along with the destruction of mangrove forests and wastewater being discharged directly into coastal creeks are likely to have an adverse impact on the long-term ecological viability of the area (Figure 3). Waste management, air quality, pollution, traffic congestion, and land contamination are also among the major threats to the environmental viability of these coastal cities.



*Fig. 3. Mangrove forest destruction and wastewater discharge into coastal creeks*

The unsustainable development practices affecting the marine environment and ecosystem viability triggered several environmental protection campaigns in the Qatif Oasis during the last 10 years. Among them are the following: saving the mangroves campaign; agriculture protection campaign; protect the environment campaign; and school environmental protection campaign. Environmental activists stated that these campaigns have enabled efforts to eliminate much of the plastic waste that is harmful to wildlife and causes the death of dozens of birds and fish and the destruction of marine life habitats (Figure 4). They added that more volunteers were needed to clean up the thousands of tons of waste that is polluting the mangrove forests and other marine habitats [51-53].



Fig. 4. Activities of environmental protection campaigns in Qatif Oasis

### 3.3 Causes of Urban Expansion on Agricultural and Seashore Lands

Much of the increasing severity of agricultural and environmental problems in these coastal cities is driven by the demographic situation, socio-economic status, transportation sector, infrastructure-related development, and institutional and legal frameworks. Demographic trends (i.e., population growth rate and high residential density levels) have significantly contributed to shaping the agricultural and environmental problems in these cities. The population of these three coastal cities is currently exceeding 310 million with an annual growth rate of about 2.9%, and nearly half of the population is below 16 years of age, yielding a population doubling time of 20-30 years. At this rate of growth, the population of these cities will exceed 700 million by 2040 [50]. It is a well-documented fact that high population growth rates and high residential densities strongly correlate with rates of deforestation, the depletion of highly fertile agricultural lands, and the destruction of marine ecosystems due to increasing pollution levels and the discharging of wastewater and solid waste disposal directly into coastal creeks [4-5,7-16].

The transportation sector and mega infrastructure-related development projects (including ARAMCO construction projects) have become key accelerating factors for economic growth as well as environmental degradation in these three coastal cities. A relatively heavy concentration of road networks and vehicles in these small coastal cities has resulted in high levels of pollution, poor air quality, and high traffic congestion. Moreover, infrastructure-related development projects along the coastal shore of these cities have resulted in the degradation of coastal ecosystems, including the destruction of mangrove forests, fisheries, and coral reefs. Institutional and legal frameworks have also played a key role in accelerating problems of agricultural land and marine environment. According to Abou-Korin [39], most of the environmental institutions in the Eastern Province in general and the Qatif Oasis in particular are relatively small and far from satisfactory in terms of staffing and financial resources. Inadequate availability of professional and administrative expertise and resources in the field of environmental impact assessment process, coupled with lack of trained personnel and comprehensive environmental databases, are the main challenges facing the adaptation of environmental legislation in Saudi Arabia in general and the coastal cities in particular.

## 4. RESULTS AND DISCUSSION

This study examined the environmental impacts associated with the urban expansion and rapid transformation of coastal cities in the Qatif Oasis located in the Eastern Province of Saudi Arabia over the past 60 years. The three coastal cities experienced rapid transformation throughout history as they transitioned from a group of small fishing and agricultural towns to one large contiguous



city. This rapid urbanization is associated with some serious unsustainable development practices that are linked to the rapid loss and destruction of highly productive agricultural areas, marine environment, and ecosystem along the western shores of the Arabian Gulf. Several root causes of urban expansion on agricultural and seashore lands have been discussed throughout this paper. The demographic situation, transportation sector, infrastructure-related development, and institutional and legal frameworks are some of the causes. These factors have played a significant role in accelerating the agricultural and environmental degradation in the three coastal cities of the Qatif Oasis.

These three coastal cities of the Qatif Oasis need to be treated differently from other cities and communities in the region in respect of land use management and development. The management approach toward these coastal cities and their environment should reflect adjustments to these unsustainable development practices. Therefore, coastal residents, planners, and policymakers need to adopt a new urban growth paradigm for promoting coastal sustainability and sustainable development practices. This paradigm should focus on three main issues: (1) protection of existing and potential agricultural areas and the marine environment; (2) preservation of urban lands for future uses; and (3) promotion of the overall urban environment quality.

To achieve sustainability and sustainable development practices in the coastal cities of the Qatif Oasis, legal regulations and environmental protection legislation toward preserving agricultural lands and protecting the marine environment need to be revised, improved, and adopted. A new land use policy should be urgently established to control the urban sprawl, and to redirect urban growth toward the desert hinterlands. Public participation through community awareness programs and voluntary work toward protecting agricultural areas and the marine environment needs to be encouraged and maintained. Finally, adequate professional and administrative expertise in the field of environmental studies (of urban and regional planners, engineers, and economists) is urgently needed to create more effective environmental assessment procedures for sustainable development in the Qatif Oasis. Future research should conduct further in-depth comprehensive environmental assessment studies to assess the environmental consequences associated with rapid urban growth in the different coastal areas of Saudi Arabia.

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