

EFFECTS OF LAND RECLAMATION ON MARINE LIFE ON DOHA COASTAL REGION, STATE OF QATAR

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Abstract: Gaining land from water bodies, sea, coastal or shores wetlands is called Land reclamation. Due to the need of dry land for agricultural purposes, industrial use, urban development or port expansions some countries use this method of land fill to achieve its requirements. Land reclamation could have significant adverse impact upon marine environment. Such activities normally take place along the coastline and primarily affect coastal and marine habitats close to the shore, for example, coral reefs, estuaries, marshes and saline habitats, as well as species that occur in these habitats, e.g. planktons, fish, shrimps and turtles. The aim of the study is to evaluate using literature review, qualitative and quantitative methods, the effects of land reclamation on marine environment in Doha and to develop a Doha Marine environment benchmark, among six key stakeholder groups, to mitigate the impacts of land reclamation. The current work has demonstrated that land reclamation has had a great effect upon the marine environment in general and specifically on marine life and this impact has been noticed clearly in the stakeholder's reviews. There was a general feeling among participants that although land reclamation has economic benefits it has on the other hand disadvantages on the marine environment.

Keywords: Doha, Land Reclamation, Marine Environment, Marine Habitat, Qatar, Sediment.

I. INTRODUCTION

Gaining land from bodies of water, the ocean and coastal wetlands and shores is referred to as land reclamation [1]-[2]. Due to the need for dry land for agriculture, industry, urbanization and the expansion of ports, some countries use landfill to meet their requirements. This process of reclamation has continued into the 21st century in Qatar, beginning in the 1970s, with the formation of new land in water becoming the basis for large-scale reclamation projects in urban development, airport construction, industrial expansion, etc. [3].

However, it should not be ignored that land reclamation can have a significant adverse impact upon marine environments. Such activities normally take place along the coastline and primarily affect coastal and marine habitats close to the shore; for example, coral reefs, estuaries, marshes and saline habitats, as well as impacting on the various species found in these habitats, such as plankton, fish, shrimps and turtles. In fact, marine habitats are permanently lost where land is reclaimed from the sea and the effects also include increased turbidity, with changes to seabed habitats and sedimentary structures [4], [2]. Notwithstanding the negative implications, however, land reclamation is one of the most widespread human activities threatening coastal territories worldwide, mainly in Asia and Europe [3]. According to [5], there are different techniques involved in land reclamation processes, especially when planning large-scale projects. These methods include underwater explosion for the removal of sediment, rock-dumping techniques and silt dredging. All these methods can lead to various types of undesirable impact upon marine habitats; the effects of which will depend on the reclamation techniques used [5]. [3] reviewed the impact of land reclamation

on marine environments and cite the main causes as changing the evolution and hydrology of the shoreline; the degradation of water and soil quality; the alteration of microbial communities; the progress of vegetation and benthic species; fisheries, and impaired functioning of ecosystems. It must also be noted here that the policy-makers in most countries involved in gaining land from the sea, such as Qatar, are aware of the considerable number of studies that have thoroughly investigated the environmental impact of land reclamation.

There are examples of negative impacts, from land reclamation, upon environments in the Netherlands, North America [4], Bahrain [6], Singapore [7], Malaysia [8] and Hong Kong [9].

What is worthy of attention in this research project is the knowledge that land reclamation in Qatar can compromise the need to preserve nature and protect its shores, in exchange for more urban space. It is undeniable that hi-tech dredging equipment could wreak havoc in Qatar's marine environment. However, government authorities in the majority of countries convinced of the need for land reclamation to fulfil industrial and residential purposes have been seduced by the fact that it appears less expensive than harnessing existing land.

To all intents and purposes, the studies and literature reviewed for the current research project are therefore derived from empirically-based scientific papers, which can delineate the physical and social repercussions of land reclamation. [10] claims that drastic man-made alterations to coastal areas can lead to irreparable ecological damage. The cumulative impact of reclamation is known to be associated with the dredging of ecologically important marine environments. Thus, the current inquiry on land

reclamation seeks to identify the ecological consequences for Qatar in particular.

Large-scale reclamation is viewed as having a huge potential impact on all facets of Qatar's coastline. [11] stress that the estimated cost of destroying the marine ecosystem is significantly greater than the internal cost of reclamation activities. Awareness of the ecological damage associated with land reclamation could therefore lead to greater foresight and better informed strategies for stakeholders and decision-makers, thus promoting the notion of the sustainable use of marine resources. The context of the problem can thus be specified as the ecological impact of land reclamation, with the precise study objectives being related to a logically structured inquiry, aimed at responding to the causes of environmental degradation, the deleterious effects on biodiversity in a marine habitat, and governmental policies on coastal preservation and conservation. Indeed, the detrimental effects of land reclamation on marine ecology may be assumed.

In this inquiry on Doha's land reclamation activities in coastal areas, the researcher believes that it is necessary to explore and describe the phenomena surrounding land reclamation. The apparent lack of theory or previous academic research on Doha's coastal land reclamation could lead to inaccurate, incorrect, or biased findings. This being the case, it is imperative to determine how the present study relates to other investigations conducted along Doha's coastline. The truth of the matter is that only a relative handful of inquiries (such as the Environmental Studies Centre: 2014, Qatar University and Texas A&M University) have investigated the environmental issues associated with the present topic. Despite the scarcity of information in the domain of land reclamation in Doha's coastal areas, this study seeks to delve into the direct impact of reclamation on the environment. In truth, other GCC countries, like Saudi Arabia, the UAE and Bahrain are also caught in never-ending land reclamation incentives. These countries, like Qatar, claim that billions of dollars have been invested in modern infrastructural projects, but the respective policy-makers are not mindful of ecological considerations.

Clearly, without thorough knowledge of the impact of reclamation on marine and terrestrial environments, there was no hesitation displayed as regards engaging in land reclamation.

The aim of the study is to evaluate using literature review, qualitative and quantitative methods, the effects of land reclamation on marine environment in Doha and to develop a Doha Marine environment benchmark, among six key stakeholder groups, to mitigate the impacts of land reclamation. The work reported in this paper is the first phase of the study.

II. LAND RECLAMATION

2.1. In the Gulf

The Gulf Cooperation Council (GCC) was established in 1981, comprising the countries located in the Arabian Gulf or the 'Gulf' (previously, the Persian Gulf). These consist of Qatar, Bahrain, Oman, Saudi Arabia, the United Arab Emirates (UAE) and Kuwait. **Figure 1.**



Figure 1. Arabian Gulf Countries

Throughout the past two decades, the Gulf region has witnessed extensive dredging and land reclamation activities in coastal and marine areas. However, there is currently insufficient data concerning the impact of dredging and reclamation on the Gulf's marine ecosystems. Nevertheless, approximately 40% of the coastline in some Gulf countries is in the course of development, thus jeopardizing the wildlife and biodiversity of habitats.

Below are listed some of the mega-land reclamation projects in GCC countries:

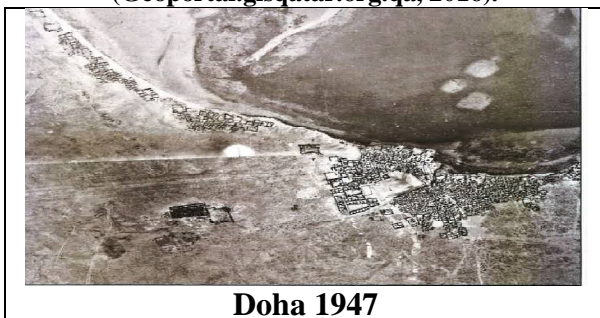
1. For the Palm Jumeirah in Dubai (the UAE), 10 million cubic metres of rock and 186.5 million cubic metres of sand were used to build these US\$12 billion artificial islands, [12].
2. Bahrain has been a pioneer of land reclamation among the GCC countries. An estimated 80% of its coastline has been exposed in the process, [13].
3. In Kuwait, there are no official published reports on massive land reclamation projects. However, the Al Zour Refinery Project, launched in 2014 and forecast for completion in 2019 is considered to be the largest land reclamation project so far. 65 million cubic metres of sand and major top soil improvement covering an area of 1,320 ha have been anticipated for this oil-refining plant. The Al Zour Refinery Project will be one of the largest oil refinery projects in the region, [14].
4. In Saudi Arabia, most of the land reclamation or landfill takes place on Saudi's eastern coast, especially the area from Tarut Island to Dammam, where almost 6832 ha of landfill reclaimed from the sea were recorded between the years, 1982 and 2015. Some of this extended to around 8 km into the Arabian Gulf waters, [15]. According to [16], Tarut Island, considered as the largest Saudi island in the Arabian Gulf 50 years ago, is no longer an island, due to the incessant land reclamation process connecting the island to the mainland.

2.2. Land reclamation In Qatar

The State of Qatar is a country in the Middle East in West Asia. Since 1947 till the present, aerial photos of Doha’s metropolitan area shown in Figure 3, illustrate how it has extended in all directions, especially into the sea. In the early 1970s, projects to reclaim land from the sea were initiated to meet the need for urban expansion. The coastline of Qatar extends for about 900 kilometers. The Arabian Gulf seawater surrounds the northern, eastern and western sides of the Qatari Peninsula. The east coast is mostly sand, while the western and northern coasts are mostly rocky. Qatar holds the world’s third largest natural gas reserves. Currently there is a massive development in Qatar to achieve the National Vision 2030, with which it aims to obtain an advanced, sustainable and diversified economy. In order to do that, Qatar has invested billions USD into improving the infrastructure. Most of the economic development projects are focused on the coastal areas, especially on the eastern coast, where there are development projects such as water desalination stations, ports and urban and industrial cities. In 1971 Qatar declared its independence from Britain and The City of Doha become the capital of the emerging state. The first recorded land reclamation was during the 70’s to develop and extend the city center to meet the needs of the new state. Evidently, the aerial pictures shows there has been a massive land reclamation along Doha’s coastline. In the



Figure 2. Map of Doha city (Geoportal.gisqatar.org.qa, 2016).



Doha 1947

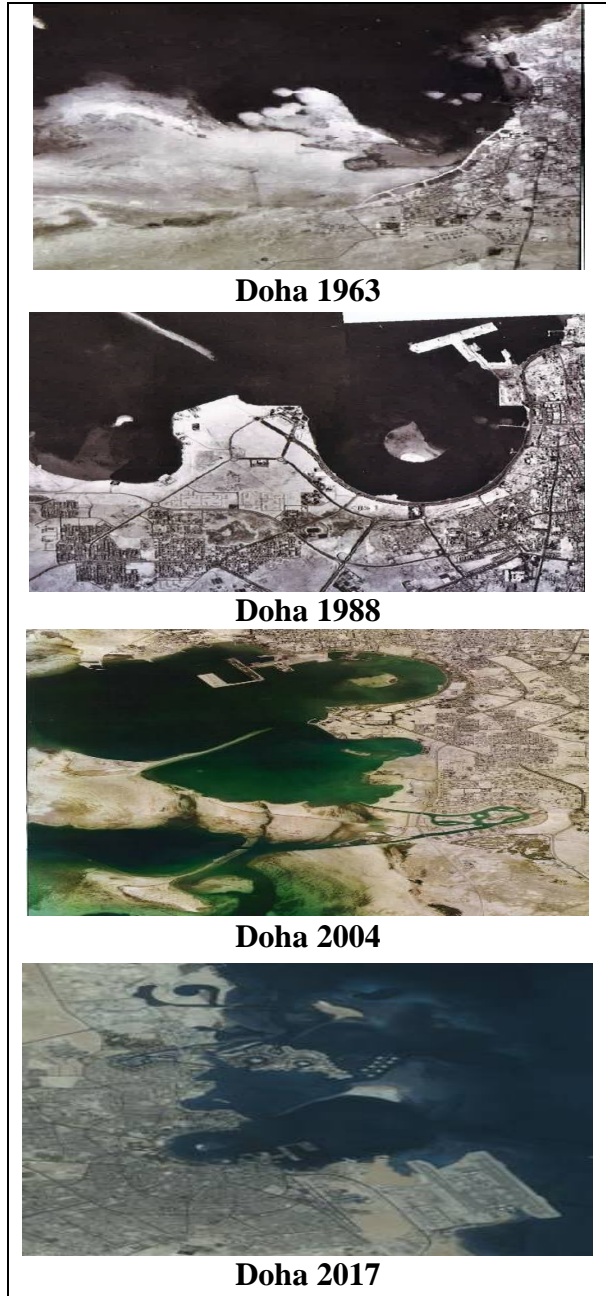


Figure 3. Doha city 70 years Aerial photos.

Northern side of Doha city there is the Pearl Project, which is about 400 hectares of new land reclaimed from the sea. The second major project is the Lusail City, which is still under development, covering approx. 35 km² north of Doha. In the southern side there is Hamad International Airport, 60% land of which (approx. 22 km²) was reclaimed. This involved moving and desalinating 6.5 Mm³ of waste material for landfill.

Qatari’s love the sea since ancient times and they consider seafood as their main nutrition. Back in the 70’s and 80’s most of fishing lovers would find a number of fishing locations around the Doha coast. Moreover, the quantity and the variety of the fish species caught were massive. Approaching the end of the 80’s and forward, especially in the last 10 years

the situation has changed. There is a noticeably high level of sediment and fewer fish species near the Doha coast.

III. METHODOLOGY

The work plan for this inquiry begins with data collection (this include, document analysis, a questionnaire, focus group meetings with experienced stakeholders, natural observation, and structured interview questions

As a naval officer serving for more than 30 years, cruising around the Qatari coastal area, the lead researcher has witnessed the fast-paced development on the Doha coast during the last three decades and observed a number of marine environmental issues emerging to reveal the influence of this development on the coast.

The literature review indicated that gathering information to identify current and future risks related to land reclamation is best achieved by conducting interviews, questionnaire and focus groups with experienced stake holders.

From reviewed literature the following six groups of stakeholders were involved in the project due to their direct connection to the marine environment:

- (i)Active fishermen. These people who work in the profession of fishing mainly, as well as have a number of fishing boats.
- (ii)Non-active fishermen. These people who have a hobby of fishing constantly for 20-year or more.
- (iii)Re-creational staff. These people who work in places on the coast or the nature of their work had to direct contact with the coast.
- (iv)Government officials linked to marine environment.
- (v)Coast guards.
- (vi)Naval officers.

Because of the need of having people who observed the change during the period from the 80' until present day, these groups were selected on the following criteria:

- (i)Having experience of more than 20 years in the sea environment.
- (ii)Being interested in marine environmental issues.
- (iii)Agreeing to participate in the project.

In order to arrange for this methodology to be executed an ethical approval was granted by Cardiff Metropolitan University and the organization which would accept to host the meetings. As the lead researcher is a former member of the Qatar Scientific Club board (QSC), the present board of members in the club accepted to cooperate and support the research by hosting all required meetings or interviews.

3.1. Field work

At the early stage of the research a field observation method was planned to evaluate the current situation of the Doha coast. Two boat trips around Doha coastal areas were conducted, one trip in winter and

another in summer. The preparation of the boat trips started by contacting several marine expert by meeting them and explain the objectives of the research to get their support by knowledge of the coastal area and equipment. The Field work was prepared in three stages:

1. Pre-fieldwork stage. The boat was selected to be able to get as close as possible to the beach and sail over shallow depths, the boat was equipped with all the safety equipment for the journey such as life jackets, telecommunication radio, distress device and radar navigation, in addition to fuel and water needed for the trip. The crew of the boat formed of boat captain, technician and seaman in addition to the researcher. A registration to the Coast Guard chick point before all sailing was mandatory.

2. During fieldwork journey. The journey started with coasting of from the boats marina sailing from the south to the north close to the coast of Doha as shown in Figure 4. This course route had been stored in the boat navigation radar to be used as reference for the next trip. All notes during the fieldwork trip were documented manually in a small notebook. The researcher was not able to acquire many pictures at this stage because most parts of the coast are privately owned so a written permission is required before the process of taking picture.

3. Post-fieldwork. All notes or remarks had been taken regarding any visual pollution on or near the shore line of Doha coastal area was typed in laptop in MS word format with time and date.



Figure 4. Field work

3.2 INTERVIEWS

The interview is a very important tool to collect as much indigenous knowledge from stakeholders as possible. The interviews were divided into two sections: governmental interviews and individuals' interviews.

(i) Governmental interviews.

The aim of the governmental interview was to evaluate point of view of the decision makers on the impact of land reclamation on the marine

environment as part of the collection of information for the research.

A letter of recommendation from the military attaché of Qatar Embassy requesting to facilitate the interview was a great help to overcome difficulties such as underestimating the importance of the research by officials and hesitating to talk freely. However, even with the support of the recommendation letter there was some routine procedure which led to delay in processing the letter and determine the date of the meeting which required a daily follow-up. All the governmental meetings took place in their main building and the following was organized in advance:

- a. Date, time and duration of the interview.
- b. Research aim and objectives.
- c. Briefing about the ethical concept of the research.
- d. Issues to discuss.

All the interviews were in the Arabic language, which is the native language of all the participants, and this helped to facilitate the communication during the interviews.

Two documentation methods were used to collect information: note-taking during the interview and written feedback from the participants.

The government official secretary sent his overview and opinion later after reviewing it. All interviewees' opinions and thoughts were typed in separate sheets for each participant in Microsoft Word format. Data has been stored in a password protected computer and the following is a list of the governmental Department where some of the officials interviewed:

- a. Department of Fisheries, MME.
- b. Environmental Assessment Department, MME.
- c. Environmental Studies Centre, Qatar University.
- d. Geographic Information Systems Department, MME.
- e. Exxon Mobil Centre for Environmental Research, Qatar branch.
- f. Public Works Authority.

(ii) Individuals' interviews.

A list of potential participants was made according to the research criteria, each participant was contacted initially by a personal phone call, the concept and the objectives of the research were clearly explained to the participant during the phone call to have his verbal agree to participate by his opinion and thoughts in the research. Before the interview the university's ethical approval and the introduction letter from Qatar Embassy in the UK was shown to the interviewee to assured him that it's an formal scientific research and to be more comfortable during the interview. Additionally, a participant consent form was signed by the participant. A list of open ended questions was prepared in advance to introduce to the participant and the date, time and duration of the interview were set. Most of the participants preferred to have the interview in their Majlis, the Arabic name for the guest room in the house or in a public area like a traditional coffee shop where they

feel more comfortable. The conversation was documented in writing during the interview and then typed in a separate sheet for each participant. All interviewees' opinions and thoughts were typed in separate sheet for each participant in Microsoft Word format. Data has been stored in a password protected computer.

The following is a list of the interviewees:

- a. Anonymous marine environment expert.
- b. Anonymous residents of areas adjacent to the coast.
- c. Active Fisherman with experience of 30 years.
- d. Non-active fishermen.
- E. Re-creational staff.

3.3. FOCUS GROUP MEETINGS

The meeting was established firstly by personal calls with the potential participant. After participant agreed to participate in the research the concept and the objectives of the research was clearly explained supported by the university ethical approval and a letter of introduction from Qatar embassy in UK. Participant consent form was presented and approved by the participant. A list of open ended question was prepared in advance to introduce to the participant. Date, time and duration of the interview were set. Each participant at a focus group signed a confidentiality declaration that responses will remain completely anonymous and that no reference to the names of participants will be kept on any records, and also that any audio recording of the interview will be destroyed once an anonymous transcript has been prepared. The focus group meetings took place in the QSC.

The conversation documented in writing during the interview and then typed separate sheet for each focus group meetings and all interviewee's opinion and thought were typed in separate sheet for each participant in Microsoft Word format and data has been stored in a password protected computer.

The following is a list of the interviewees:

- (i) Naval officers.
- (ii) Non-active fishermen.

RESULTS AND DISCUSSION

The most important observations noted in the field work sailing phases were as follows:

1. There are more than four large water outlets along the Doha Corniche, which are discharged directly into the sea. Three of these outlets discharge clear water and one discharges slightly muddy water **Figure 5**. According to the boat captain, these outlets are used to discharge surface water emerging from below ground during the digging and construction phase of infrastructural and neighbouring projects.



Figure 5. Doha Corniche large water outlets.

2. It was noted that in the boat marina, turbidity was too high, especially under the boat jetties. There were also oil spills floating on the surface of the sea. There was a high level of turbidity, sediment and a faint bad smell in the areas shown on the map in **Figure 6**. These areas are mainly recreational beaches. .

3. Generally speaking, the inner side of the coast from the boat marina in the south as far as Katar Beach in the north is clear of any solid material pollution. However, some pollution by solid materials can be seen on Al Safliya Island, located around 5 NM east of the coast at Doha. The strength of the sea current around the south of the Pearl Project is less marked in terms of both speed and force.

All interviews with government officials and other individuals were concentrated on their opinions and suggestions concerning four main issues, as follows:



Figure 6. High level of turbidity, sediment

(i) The causes and level of pollution in the marine environment. The majority (approx. 78%) of the participants agreed that the level of pollution had increased over the past two decades and almost half of them believed that urban projects on the coast were the main causes of marine pollution. Other factors mentioned by some of the participants were surface water dumping, harbours, human activities (such as beach camping), and sea water desalination plants. It must be clarified here that most of the urban projects on Doha's coast are constructed on land reclaimed from the sea, such as the Pearl Project, Lusail City, Al-Dafna and Hamad International Airport.

(ii) With more specific reference to the relationship between land reclamation and marine pollution, there was almost unanimous agreement amongst the interview participants that the levels of sediment in reclaimed areas near the coast had increased since the

1990s. Furthermore, some of the interviewees linked the decrease in the number of fish in this area to the effects of sediment upon sea grass, the main food source for fish.

(iii) Regarding the quantity and quality of fish over a 10-year span, just one interviewee thought that these had remained constant, while all the other participants were of the opinion that they had decreased; some even declaring that fish quality and quantity had declined dramatically.

(iv) The interviewees went on to make recommendations for mitigating or controlling marine pollution. Their opinions differed over the most appropriate solutions to the problem, with some stating that urban projects on the coast should no longer be carried out. Others, however, believed that the government should increase the number of protected marine zones along the Qatari coast. Moreover, some participants sought the formulation and implementation of tougher legislation against damage to the marine environment by visitors to the area..

CONCLUSIONS

In conclusion, the current work has demonstrated that land reclamation has had a great effect upon the marine environment in general and specifically on marine life, this impact has been noticed clearly in the stakeholder's reviews. The participant have started to realize the importance of this study and they were supporting the idea of increasing the awareness of relevant stakeholders at the time of this research finish. Furthermore, there is a general feeling among participants that although land reclamation has economic benefits it has on the other hand disadvantages on the marine environment.

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