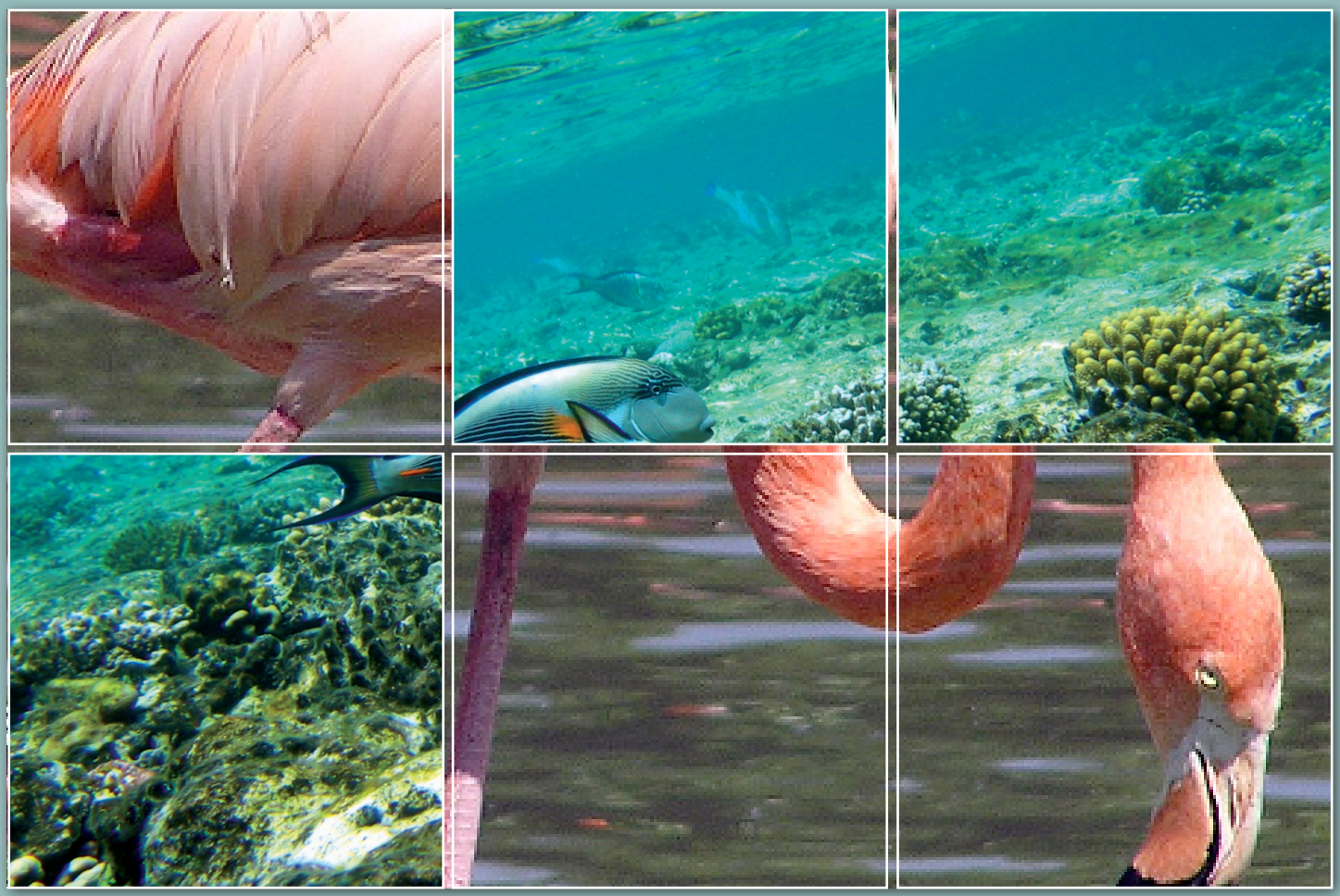
Kingdom of Bahrain

Public Commission for the Protection of

Marine Resources, Environment and Wildlife

State of the Environment in the Kingdom of Bahrain



Prepared by:

Directorate of Enviromental Assessment and Planning - 2009

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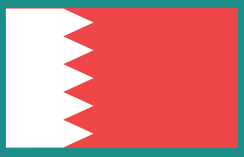
2009

Bahrain Fact Sheet



Capital	Manama
Governorates	Five (5): Asamah, Janubiyah, Muharraq, Shamaliyah, Wasat
Total Area	Land: 750 km^2 (9.2%) Territorial Waters: 7,478 km^2 (90.8%)
Coastline	350 km
Climate	Summer: July-September, very hot and humid (Avg. 36°C). Winter: December to February, cool or mild with occasional rain (10°C - 20°C). Remaining months: March to May and October to November, warm with occasional pleasant breezes (20°C - 30°C).
Official Language	Arabic
Political System	Constitutional monarchy, presided by H.H. King Sheikh Hamad Bin Isa Al Khalifa; Prime Minister, H.H. Prince Khalifa Bin Salman Al Khalifa; Crown Prince, H. H. Prince Salman Bin Hamad Al Khalifa
Population	1,048,418 (2007 Statistics) broken down as follows: 529,638 Bahrainis and 517,446 non-Bahrainis
Currency	Bahraini Dinar (BD)
Gross Domestic Product (GDP):	4.1 Billion BHD (2006 statistics), broken down as follows: Oil & Gas: 13.1%; Financial Services:24.2%; Commerce: 12.4%; Industry: 12.4%; Tourism: 3.0%; Real estate, construction and business activities: 13.4%; Agriculture: <1%; Public administration: 10.8%
Causeways	Saudi Arabia to Bahrain – completed in 1986 Bahrain to Qatar – expected to be completed in 2013
Major Industries	Bahrain Petroleum Company (BAPCO), established in 1929 Aluminum Bahrain (ALBA), 1968 Arab Ship Repairing Industries Corporation (ASRI), 1977 Gulf Petrochemicals Industries Company (GPIC), 1979
Major Ports	Port of Mina Salman (Oldest and main port in Bahrain) Port of Mina Khalifa (completed 2008)

Energy Consumption	About 8,000 GW per year (for 2007)
Water Consumption	About 172.7 million m^3, as follows: - 132.3 million m^3 from desalination (2007) - 40.4 million m^3 from underground water (2007)
Number of Arrivals	7,833,610 tourists per year (63.3% from GCC countries)
Large Scale Sea Reclamation Projects	Diyar Al Muharraq residential project (underway); Darari residential project (underway); Salam Beach Resort; The North Bahrain New Town Project, residential project implemented by the government; Bahrain Bay, commercial, residential and retail project; Duratt Al Bahrain, residential, commercial and retail project; Amwaj Islands, residential, commercial and retail project

Foreword

"The State shall take the necessary measures for the protection of the environment and the conservation of wildlife"

Article 9 (h) of Bahrain's Constitution

Over the past decades, and in an effort to respond to rapid social and economic changes across all sectors of Bahraini society, the Kingdom of Bahrain has promulgated several laws, royal decrees, and ministerial decisions to regulate the use of natural resources and protect the environment. Article 5 of Chapter 3 of the National Action Charter stressed the need to take appropriate legal measures and implement procedures to reduce pollution from various sources. The Public Commission for the Protection of Marine Resources, Environment and Wildlife has endeavored to issue the report on the state of the environment for 2008, in a major step reflecting the environmental commitment of the government of Bahrain.

This report is issued according to the provisions of Decree-Law No.(21) of 1996 on the environment which mandated to the Public Commission the responsibility of examining, identifying and addressing environmental problems by conducting appropriate research and studies in collaboration with other relevant authorities. The Public Commission has already issued a number of reports on the state of the environment in Bahrain according to the previous mechanism and methodology of the United Nations Environment Program (UNEP) for the years 1988, 1990 and 1992. This report however was consolidated based on the integrated environmental assessment methodology developed by UNEP to prepare periodic reports on the state of our planet, better known as the Global Environment Outlook (GEO). The GEO aims at identifying the current state of the environment and environmental trends based on recent data and indicators. It analyzes linkages and the impacts of human activities (namely driving forces and associated environmental pressures) on ecosystems and human wellbeing. Furthermore, the GEO identifies the societal response to environmental problems and formulates mitigation measures using the DPSIR framework (Driving Forces, Pressure, State, Impact and Response). Additionally, it analyzes current environmental policies and their implications on the environment, predicts future environmental trends and their impact on development plans and programs using scenario analysis.

This report consists of nine (9) chapters including Marine and Coastal Environment, Land Use, Air, and Water. The report also addresses climate change, energy, and waste as cross-cutting issues impacting the environment. To the extent possible, every chapter on the state of the environment was prepared consistent with the DPISR methodology. The reader will notice that all chapters are interlinked to reflect the importance of having a comprehensive environmental assessment of the state of the environment. In line with current efforts to formulate the Kingdoms' vision over the horizon 2030, a special chapter on future scenarios was prepared for this report, focusing on the human element, good governance and regional cooperation as a foundation for sustainability. This chapter presents three storylines (Markets First, Policy First and Sustainability First) to describe how alternative approaches, policies and societal choices will influence and affect the Kingdom of Bahrain, by 2030. Moreover, it illustrates how current social, economic and environmental trends will evolve and respond to future development paths and what this could mean for the environment, development and human wellbeing.

Since its establishment, the Public Commission for the Protection of Marine Resources, Environment and Wildlife has followed a holistic approach to achieve environmental equilibrium by balancing the requirements of economic growth, sustainable development, and the use of natural resources. In an effort to promote real participation across all classes of Bahraini society, the Public Commission continues to prioritize partnership building and cooperation between all relevant institutions in the Kingdom. Despite tremendous challenges and obstacles facing the Kingdom over the past three decades, we are still determined to move forward, enhance our programs and train our human resources so that we may improve our capacity to preserve the environment and protect the safety and health of our citizens and all those who live on our esteemed land, Bahrain. Only by doing this will we be able to protect our right and that of future generations to a safe environment and sustainable resources.

We hope that this report helps clarify the current state of the environment in Bahrain.

Dr. Adel Al Zayani
Director General

Introduction

Institutional Background

The Public Commission for the Protection of Marine Resources, Environment & Wildlife (henceforth "Public Commission") was established in 2002 (decree no. 41 and 50) to consolidate all agencies dealing with the environment under one umbrella organization. The principal mandate of the Public Commission is to promote sustainable development in the Kingdom of Bahrain. It has articulated an overall strategy around the following objectives: safeguarding the environment from polluting activities and substances; formulating policies and action plans to protect public health; restoring the integrity of terrestrial and marine ecosystems; and promoting the wise management of natural resources to sustain the needs of present and future generations. The Public Commission is working towards achieving these objectives using three guiding principles: (1) pollution prevention, (2) polluters pay, and (3) partnerships and environmental cooperation. It is the lead government agency responsible for setting environmental standards and monitoring compliance, and for recommending and drafting new environmental legislation.

Objectives of Environmental Reporting

Environmental reporting is today a fundamental requirement for sustainable development. Understanding the state of the environment, and trends, is a necessary precursor to environmental forecasting and policy setting. Because anthropogenic activities continue to affect and alter the environment in more ways than we can possibly appreciate, countries across the globe are developing and improving their capacities to collect, consolidate, and interpret raw data to understand the state of our environment and keep the global environment under review. The United Nations Environment Program (UNEP) published in 2007 the Global Environment Outlook 4 (as known as GEO4), which is the most comprehensive report on the global environment to date. It was designed to ensure synergy between science and policy, while maintaining its scientific credibility and making it responsive to policy needs and objectives. The Kingdom of Bahrain, Region of Western Asia (ROWA), participated in the formulation and review of the GEO4 assessment.

Target Audience

This report has something for everyone! Educators will find a wealth of data and information to support and inspire course work and further research. Policy makers will appreciate some of the environmental linkages affecting our lives and alternatives to current trends. Specialized institutions and non-governmental organizations can also benefit from the report as they will be able to zoom in on key issues of interest to them and implement targeted actions to improve the state of the environment, locally.

Reporting Methodology and Scope

Environmental reporting is today a very well defined process. In a bid to help member countries report on the state of their environment at the local and regional levels, UNEP has developed guidelines for integrated environmental assessment, which is the identification, analysis and appraisal of all relevant natural and human processes and their interactions which determine both the current and future state of environmental quality, and resources, on appropriate spatial and temporal scales, thus facilitating the framing and implementation of policies and strategies. The Bahrain Environment Outlook, the third such report in the Kingdom, was prepared by the Public Commission for the Protection of Marine Resources, Environment & Wildlife (henceforth "Public Commission") using, for the first time, the integrated environmental assessment process. The assessment was carried out by nine chapter experts. The report is available in both Arabic and English and can be downloaded from the website of the Public Commission.

Introduction

Report Structure

The Bahrain Environment Outlook report is organized into nine (9) chapters:

Chapter 1 Marine and Coastal Environment
Chapter 2 Air Quality
Chapter 3 Water Quality
Chapter 4 Land Use
Chapter 5 Biodiversity and Nature Reserves
Chapter 6 Waste Management
Chapter 7 Environmental Linkages
Chapter 8 The Future Today? Bahrain Environmental Scenarios
Chapter 9 Environmental Priorities and Policy Options

Chapters 1 through 6 provide an accurate assessment of the current state of the environment, and the driving forces affecting environmental trends. Chapter 7 on environmental linkages explains the interconnectedness between our actions and the environment using three examples (trade and environment, energy and climate change, environment and health). Chapter 8 presents three scenarios to the year 2030, using a narrative storyline to explore different policy approaches and societal choices made by the Kingdom of Bahrain (market first, policy first, sustainability first). Finally, Chapter 9 summarizes environmental priorities and outlines policy options for improving the environment in the Kingdom and reversing current trends.

Summary of Driving Forces

The Kingdom of Bahrain has witnessed significant transformations in the last century, many of which are irreversible and will affect the quality of life for the local population. The most significant drivers include:

(1) Population growth and urbanization. The resident population has increased from 672,124 in 2002 to 1,048,000 in 2007. The majority (about 90%) live in or near the coast. Nationwide, this translates into a population density of about 1,400 inhabitants per km^2. The oil boom has further accelerated the rate of urbanization with the resulting repercussions on transport, waste, and quality of living.

(2) Large scale construction in the coastal zone. The Kingdom has witnessed unprecedented projects to reclaim the sea to accommodate large-scale real estate developments such as Bahrain Financial Harbor, Bahrain Bay, Durrat Al Bahrain Resort, and Amwaj Islands Resort. These projects have not only changed the coastline of Bahrain, but also affected marine currents, life and activities such as fishing and pearl hunting.

(3) Desalination to meet freshwater demand. Despite a serious water deficit, the Kingdom has been able to provide freshwater to meet domestic needs as well as water needs for industry and agriculture by desalinating the sea. Water desalination is not only extremely energy demanding; it also provokes significant impacts on the environment in the form of salt rejects and carbon emissions.

(4) Power plants to cope with the rapid economic expansion. The growing demand for electricity during the last decade came not only from the domestic sector but also from the industrial, service and tourism sectors. Growth in these sectors has prompted the Government to build new or upgrade existing power plants. Power production has a negative impact on the environment and is one of the principal sources of greenhouse gas emissions, in a region that is just starting to gear itself towards carbon reduction.

Collectively, these drivers are impacting every aspect of Bahrain's environment. Those impacts, including long-term repercussions, are outlined in this report.

Executive summary

The Kingdom of Bahrain is considered one of the island regions with unique rich ecosystems and wide biodiversity range. Despite its location in an arid dry region, Bahrain has been blessed by plenty of fresh underground waters, natural springs and valuable marine resources. All of which, lead to this country to be the land where ancient civilizations flourished for thousands and thousands of years. Bahrain was, after all, known as the land of immortality and the land of the million palm trees.

Nevertheless, the kingdom of Bahrain, and the rest of the world, has experienced the aspects of urbanization, economic development, rapid population growth and what comes along with all that like the huge demand on natural (limited) resources. With the changes in the modern life, there has been an increasing pressure on the fragile ecosystems, increasing waste production and accelerating pollution of resources. With the global weight of climate change, the situation has been an alarming threat to the human welfare. The situation seriously needs interferences and policies that balance between protecting the environment and developing the economy.

The following report presents an evaluation of the status of the environment and its futuristic directions using integrated environmental evaluation methodologies. The report will go through the causes (or reasons) for the environmental alteration, weather direct or indirect. The report will also define the current situation of the environment and its effects on the flow of ecosystems and human welfare. Moreover, the report will go through the mitigation measures to remedy deteriorated areas of concern. Finally, the report explores the issues related to the environment, future scenarios, environmental priorities and suggestions for sustainability in order to assist policy makers to take good decisions with comprehensible environmental vision.

The marine environment represents an economic and environmental wealth once managed in a sustainable manner. The marine regions take up to %92 of the total area of Bahrain, where %90 of the population resides on its coasts and where water desalination plants are located. The sea of Bahrain allows a self-sufficient fish production (%98 annual consumption), and it's enriched by a wide biodiversity of species. However, the sea is bombarded by marine and terrestrial pressures mainly by domestic and industrial projects, its infrastructure and liquid wastes. The sea is also negatively affected by water desalination plants, waste water treatment plants, reclamation and dredging activities on the shores, pollution due to dumping residues of sand washing plants, etc. All of the above have lead to the deterioration of marine habitats especially sea grass, coral reefs and mangroves. In addition, reclamation activities have wiped out around %20 of fish landings and caused reduction in fish availability which in turn had adverse social and economic effects that influenced the wellbeing of an important class of the population.

It is expected that these harmful effects would increase and the shortage of fish stock would worsen with the endurance of land reclamations for the projects adopted in the National Economic Strategy for Bahrain 2030 and with the launch of the Bahrain-Qatar causeway. And perhaps the reoccurrence of the fish kill phenomenon on the shores of Bahrain (especially Tubli bay) is clear evidence that the pressure on the environment has reached a critical condition that requires setting a strategic plan for comprehensive management of the coastal regions. It is also required to take strict measures to protect, conserve and rehabilitate the marine ecosystems for it to face growing environmental stressing factors that are amplified with the effects of climate change, the possibility of rising sea levels and the deterioration of sensitive environments and living species.

As for Air Quality, studies done by the Public Commission show that %49 of air pollutants come from transportation methods which have an annual increase rate of %9. Some of the top factors that reduce the quality of air and affect health are energy production and conversion processes and the emissions of the petroleum and industrial sectors. The Public Commission has redeveloped the monitoring network stations and has set many rules and regulations regarding air quality measures, Environmental Impact Assessment (EIA) enforcement, remedy of old factories and commitment to clean production in modern factories. The Public Commission succeeded in directing the use of natural gas as a source of energy, improving the quality of fuel and monitoring car exhaust. However, there are a handful of issues still pending and yet harming the quality of air like the inconsistency of the policies regarding transportation to limit the numbers of cars, the issues of old factories and the issue of overlapping between industrial areas and some residential areas. With the relatively small area of Bahrain, there is a huge need to establish an efficient public transportation system (Dubai Metro as an example), establish an early air pollution alarm system, build the capacities and improve studies regarding air pollutions and its health impacts in the kingdom.

Bahrain is considered one of the top water stressor regions in the world, and it is a concern that this could be a future restrain to social and economical development of the country. The greatest challenges lie in the water demand for the agriculture sector (%67) and the accelerating demand on drinking water (%30) due to the constant demographic growth, the expansion of tourism and industry sectors and the high consumption manners that does not go along with the scarcity of water resources in Bahrain. As a result, underground water levels have declined and salinized. This has also lead to a growing economical burden on the government to support production and distribution of desalinated drinking water and treatment of increasing levels of waste water, not to mention the global water stress facing the whole world because of climate change.

Some of the priorities for conserving water resources are enforcing the role of The Water Resources Bureau and adoption of comprehensive management strategies for water resources that relies on the triangle of Economic Efficiency, Social Justice and Ecological Sustainability. More priorities focus on managing the demand side of the equation by reducing water consumption, while others focus on amending and empowering concerned associations and modifying water policies and regulations.

Two main factors lead to the elimination of agricultural lands from the circle of investment; the deterioration of underground water (quantitatively and qualitatively) and the rising demand on available lands for the housing and investment sectors. The cultivated area is declining and the numbers of palm trees are diminishing and the quality of what is left of them is poor. Many habitats and ecosystems have been lost and the biodiversity has been decaying. Therefore, the need has risen for setting strategies to protect the size and diversity of the agricultural sector, using modern farming methodologies and adopting sustainable farming practices based on agricultural research and development programs to enhance food production. Also to improve the situation there is an urging call for rehabilitation of waste water treatment plants to be used in the agricultural sector and homogenization and integration of the agricultural and water policies. Furthermore, it is it is very necessary to work on merging water demand issues and water, land and biological resource management with the climate change adaptation measures. There should also be a secure balance between international environmental agreements like desertification agreements, loss of biodiversity and climate change.

Despite Bahrain's relatively low contribution in emitting green house gases (%0.1 of global emissions) and its relatively low population on a global scale (%0.0147 of 6.789 billion people in the world based on 2008 statistics), yet it is expected that climate change will severely affect the country's water resources. It is also expected that the crop production will be affected in cases of drought and excess water consumption, let alone floods of the low coastal lands by rising sea levels. To limit such disastrous consequences, there must be an evaluation of the ecosystems susceptibility to be affected by climate change. It is a crucial matter to set a national strategy to cope with climate change due to the close link between climate change and human wellbeing.

The limit in land area in Bahrain and the population growth create a real challenge for urban development. In spite the continuous efforts to expand roads and build bridges, the roads are still incapable to take up the large amount of cars. In addition, some health problems like respiratory diseases and premature births have gone worse due to the following, the expansion of cities and their overlapping with some industrial areas, the emergence of mixed use areas (domestic/industrial) and the reduction in green spaces.

The presumed age for Askar land fill has lowered significantly due to the increase in sold wastes produced and the absence of modern recycling technologies and proper treatment methods. There should be solid support for sustainable consumption and encouragement of the private sector to get involved in recycling projects. There should also be more awareness and education in such environmental issues, and finally there should be proper planning and management of urban cities.

In issues related to the environment, it is expected that liberalization of trade would improve the efficiency of specializing resources in Bahrain, opening the market for clean technologies, facilitating the exchange of environmentally friendly products and the concern with measures and specifications like ISO certifications. This requires reconsideration in support issues especially energy support, the importance of including the true prices of products and services, offer clean technology loans, pursue incentives for environmental reports and ISO certificates and other environmental management tools. The report presented three environmental scenarios for Bahrain based on the main forces to identify the developments of the current environmental, economic and social directions with the future development directions and their effects of humans and the environment. It is clearly stated that the investment in development of human resources, improving the environmental management and establishing regional cooperation are some of the main issues that Bahrain should achieve to reach sustainability.

Finally, sustainable development and environmental protection are closely related and connected since the environment and natural resources are the base of countries wealth, and what is happening in climate change and conflicts in ecosystems can certainly affect the human health and his/her financial need and social well being and security, which means lower levels of human wellbeing or poverty as described in the millennium environmental evaluation. To convert to sustainable development policies and to maintain what the kingdom of Bahrain has reached in terms of human development, there should be effective demographic policies that lead to slower or steady population growth, involve environmental economies issues and the economic costs of resources and deterioration in the environmental policy. There should also be more regional cooperation with both GCC countries and the rest of the Arab nations. There must be more attention given to education and public awareness on environmental issues, adoption of cooperative and consulting manner in formulation the environmental policy, empower the role of Associations of the society and involve them in amending environmental issues and manage them through campaigns and general awareness and educational programs.

List of Participants from Arabian Gulf University

Dr. Waleed Khalil Zubari

Dr. Asma Ali AbaHussain

List of Participants from the Public Commission for the protection of Marine Resources, Enviroment & Wildlife

Eng. Zahwa Mohammed Alkuwari

Eng. Suzan Mohammed Alajjawi

Mr. Ebrahim abd Ali Bu Hussain

Eng. Maryam Mohammed Alansari

Mr. Ali Mansoor Abbas

Mr. Abdul Karim Hassan Rashid

Eng. Hassan Abdullah Marzooq

Mr. Ali Jassim Alhesabi

Mrs. Haya Salman Al Doseri

Chapter One

Marine and Coastal Environment

1. Introduction

The Kingdom of Bahrain is an archipelago located in the Arab Gulf, halfway between the mouth of Shatt al Arab and the Hermes Strait east of Saudi Arabia. Bahrain consists of 40 islands scattered over a marine area of 8,269 km2. The combined land area is approximately 760 km2.

The marine and coastal environment covers 7,510 km2, about 92% of the kingdom's total area. Ninety percent of the population is concentrated in the coastal zone where most water desalination plants are located. Bahrain has very diverse ecosystems including coral reefs and sea grass that constitute a major source of feed and a natural habitat for many species of fish, particularly during reproduction period. Another asset is the algae ecosystem, mudflats, rockflats and sandflats, as well as mangrove trees and endemic plants. These ecosystems are also an important resting place for resident and migratory birds. Bahrain's regional waters are also home to many rare and threatened species.

Exhibit 1 - Land and Territorial Waters of the Kingdom of Bahrain

Bahrain's diverse ecosystems and habitats give rise to a wealth of marine resources such as fishes, crustaceans, and mollusks; all of which live, reproduce and feed in Bahrain's territorial waters. This makes Bahrain self-sufficient in terms of local fish whereby 98% of annual consumption is provided locally.

2. Main Issues of the Marine and Coastal Environment

Many factors have resulted in environmental problems that are deteriorating Bahrain's marine environment.

2.1 Large-Scale Construction in the Coastal Zone

The Kingdom of Bahrain is witnessing a dramatic rise in the number and scale of development projects that are affecting marine life either directly or indirectly. Major projects include:

2.1.1 Bahrain Financial Harbor (area 0.38km2)

The harbor is located at the center of Manama's northern coast, where the old port used to be. It consists of towers, offices, banks, international and local businesses, world class restaurants, luxurious hotels, chalets, an opera house, health clubs, and television and radio stations. The development of the harbor is expected to be completed by early 2010.

2.1.2 Bahrain Bay (BB) (area 0.765 km2)

This is a massive construction project located on a reclaimed island facing the diplomatic area and Al Bissayteen. It comprises many buildings, trade towers, offices, global banks, 6-star hotel chains, luxurious restaurants, and fishermen ports. Construction works are slated for completion in 2010.

2.1.3 Durrat Al Bahrain Resort (area 20 km2)

The resort consists of several man-made islands with beautiful shores located southeast of the main island of Bahrain. The crescent-shaped island is the beating heart of the resort and is located at the center of the cluster of islands. The project is a waterfront city resort consisting of many chalets, hotels, and public utilities servicing tourists and residents alike of Durrat Al Bahrain. The utilities include mosques, retail stores, shopping malls, restaurants, to name but a few. Adjacent islands are connected to one another via water bridges.

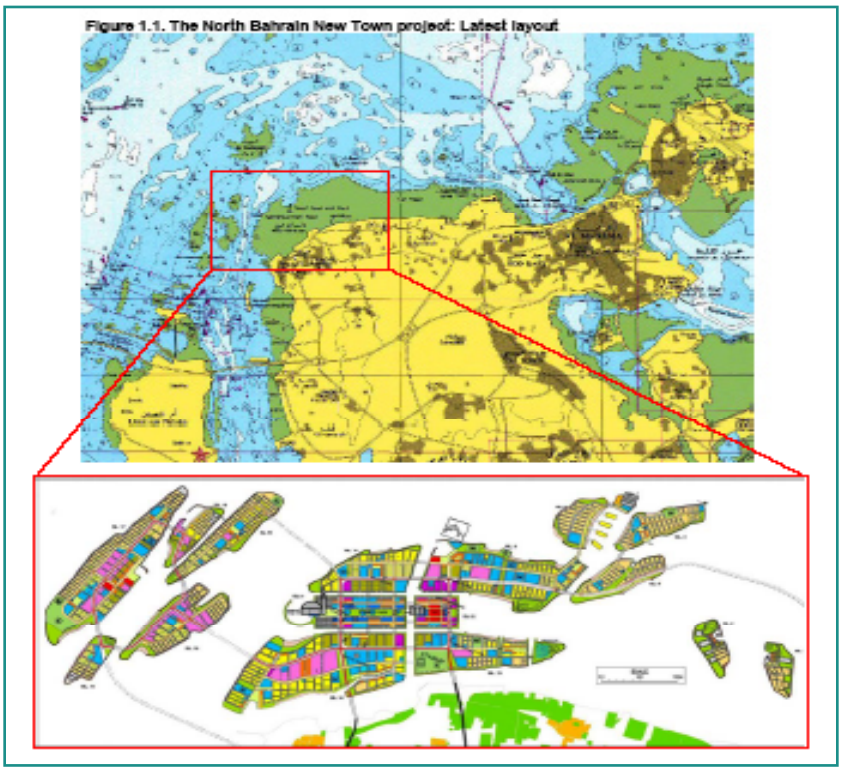
2.1.4 Amwaj Islands Resort (area 2.8 km2)

The resort consists of a group of clustered islands, chalets, hotels, and other tourism utilities. It is located off the northeast coast of Al Muharraq Island.

2.2 Sea Reclamation to Meet Demand for Residential Housing

Over the past few years, Bahrain has witnessed a shortage of lands for residential development. As a result of the demographic explosion, Bahrain has resorted to reclaiming sea areas to accommodate new residential cities and thereby resolve the housing problem. Most important among them is the Northern City Project which will initially serve as a residential city with an area of 6.9km2 northwest of the city of Al Badih. Exhibit 2 illustrates the project consisting of two central islands around which will appear a series of other islands, interconnected by bridges and roads. This project will be executed in several stages.

Exhibit 2 – Overview of Northern City Project



Desalination and Wastewater Treatment Plants

Bahrain's demographic explosion has also accelerated urbanization. As a result, demand for desalinated water and wastewater treatment has increased proportionally. To cater for these needs, several water desalination plants and wastewater treatment plants were built in recent years.

3. Pressures and Threats to the Marine Environment

In addition to harboring seaport infrastructure, Bahrain's coastal zone is also the center of many industrial, tourism and cultural development activities. Such activities on Bahrain's eastern coast are diverse and differ from those on the northern and western coasts. Industrial activities such as oil refineries, petrochemical complexes, water desalination plants and power generation stations are concentrated on the eastern coast. The western and northern coasts are a hub for tourism, urban development and business activities. The divergence in activities between on the one hand the eastern coast and, on the other hand, the western and northern coasts has resulted in different physiological and biological characteristics including sea surface temperature, salinity, and hydrogen ion concentration.

A review of the threats affecting the quality of the marine and coastal environment in Bahrain reveals the following:

3.1 Land-Based Sources

Tertiary-level wastewater treatment plants along the eastern coast of Bahrain represent a

major land-based source of pollution. These plants discharge considerable quantities of treated wastewater into the marine environment; a primary source of coastal pollution in Bahrain. Water discharged into the sea often has high levels of Biological Oxygen Demand and Chemical Oxygen Demand. The water also carry's high concentrations of Ammonia and heavy metals. Ninety percent of Bahrain's households are directly connected to the main sewage network, while wastewater generated by remaining households is hauled to the Tubli treatment plant, by trucks. This plant receives over 190,000 m3 per day of domestic wastewater from all over Bahrain. An additional 15,000 m3 per day reach the plant from other, smaller, wastewater plants across the kingdom. Treated wastewater discharged into the sea reaches approximately 130,000 m3 per day

Bahrain currently has 11 wastewater plants that provide tertiary treatment; all of these plants discharge treated effluent into the marine environment and only Bahrain UPlant reuses the water for irrigation. Table 1 summarizes discharges from each wastewater treatment plant.

Table 1 – Wastewater Discharge from Secondary Plants into the Marine Environment

WWT Plant*	Drainage Rate (m3/d)
1. South Alba Plant	1,340
2. Jau Plant	308
3. Al Jasra Plant	1,078
4. Sitra Plant	8,220
5. Askar Plant	410
6. Jidda Plant	269
7. Bahrain University Plant	No discharge into the sea
8. Al Hamala Plant	153
9. Al Dur Plant	55

** Tubli Plant (primary station) not included, Source: Compilation of midyear plant reports*

The industrial activities on the coast are carried out in specific areas of Bahrain such as the industrial area of Al Hadd, Sitra, Tubli Bay, and Ras Zueid. These activities produce pollutants that affect the marine environment. Table 2 presents discharges rates for five leading industrial establishments.

Table 2 – Selection of Industrial Wastewater Discharge into the Marine Environment

#	Company	Discharge Rate (m3/d)	Main Substances
1	The Bahrain Petroleum Company (BAPCO)	693,974	Ammonia, Chlorine, Fluor, Hydrocarbons, Organic carbon
2	The Gulf Company for Petrochemicals	1,030,525	Ammonia, Nitrate, Chlorine, Mercury
3	Water Purification Company	395	Chlorine, Calcium, Sodium, Magnesium, Potassium


4	Middle East Company for Ice and Freshwater	30	Chemical oxygen demand, Lead, Organic Carbon, Fluoric Petrol
5	Bahrain Aluminum Extrusion Company	20	Ammonia. Fluor, Chlorine, Zinc

Source: Compilation of midyear plant reports

Other land-based sources of marine pollution include the water desalination plants scattered along Bahrain's eastern coast. Some of these plants use Reverse Osmosis (RO) techniques, such as the plants of Al Dur and Rass Abou Jarjoor. Other plants use multi-stage flash (MSF) techniques, such as the plants of Al Hidd and Al Azel and some operate on multi-effect distillation as is the case with the third stage of Al -Hidd plant. The overall production capacity of these plants is about 113,650 m3 of desalinated water per day. Desalination plants discharge large quantities of highly saline water into coastal waters as a byproduct of the desalination process. Chlorine poses an additional threat as it releases heat in the receiving waters affecting the marine environment. The discharged waters also contain micro-organisms such as bacteria, protozoa and viruses.

Moreover, temperature affects the auto-purification phenomenon of water organisms. A rise in temperature will accelerate the decomposition of organic compounds in water and sediments, which in turn increases demand for dissolved oxygen. Higher temperatures therefore will accelerate oxygen depletion and the decay of organic material.

Chlorine is a poisonous, yellow-green gas that dissolves quickly in water and reacts with many organic and non-organic compounds. Free chlorine reacts with nitrogen compounds to create chloramines, which are toxic to fish, but to a lesser degree than free chlorine. Chlorine also reacts with fish gills, causing lacerations that impair oxygen transport by red blood cells, leading to suffocation and fish kill.

3.2 Coastal and Land-Based Sources of Pollution

Bahrain's rapid growth and economic expansion in the coastal zone have increased pressure on the marine environment and habitats, particularly coral reefs which are on the verge of extinction. Bahrain's coasts have also witnessed intensive sand dredging and coastal zone reclamation. These activities gained momentum in the 1970's due to the increasing pressure from industrial and residential projects. The reclamation of large coastal zones was needed to accommodate industrial complexes, and for building the King Fahd Causeway connecting Bahrain to the Saudi Arabia. In total, reclamation projects have increased Bahrain's area from 661.87 km2 in 1963 to 760 km2 in 2007 – i.e., 99 km2 of reclaimed land in 45 years. Furthermore, urban sprawl continues to encroach on Bahrain's coastal areas.

3.3 Sea-Based Sources

Incoming oil tankers from around the world represent an additional source of pressure on the marine environment. Considerable quantities of oil derivatives are exported and transported by the Bahrain Petroleum Company (BAPCO) in the area of Sitra. Many resulting oil spills have inflicted serious damage to the marine environment. Moreover, oil is also released into the sea during routine drainage of ballast water, which is contaminated by oil from the tankers. Ships

also generate used oil from engine rooms and during the washing of ship engines. Although such waste quantities are insignificant, they are high in oil content. Ships also produce sewage and other human waste (produced by the crew and the passengers, such as food residues and garbage). Proper waste disposal from ships requires appropriate port reception facilities for waste and ballast water.

Bahrain does offer reception facilities for handling ship waste. For example, BAPCO receives and treats ship waste produced from washing oil storage tanks (As knows as slop oil), typically a mixture of oil products and cleaning water. The Arab Shipbuilding and Repair Yard (ASRY) receives and treats oil sludge that usually accumulates at the bottom of the ship reservoirs. Waste contractors licensed by the Public Commission for the Protection of the Environment collect solid waste from ships and haul them to designated locations in the area of Askar for treatment.

In Bahrain's marine and coastal environment, there are several pipelines that carry crude oil from Saudi Arabia to Bahrain, and oil products to export ports. These pipelines are rarely installed underground due to high construction cost.

Dredging operations remove significant volumes of sand and clay from several coastal zones. Sands are dredged to prevent the build-up of alluvial sediments and fine sands in seaports and waterways. Sand dredging is also used to implement construction and architectural projects in sub-tidal waters, as part of large-scale reclamation ventures.

Sand dredging and sand washing plants are concentrated in Bahrain's eastern coast. These plants discharge water generated during dredging into the surrounding coastal environment. Oftentimes, the silt contained in the discharged water exceeds permissible levels. The dispersion of silt in marine waters creates turbidity, which reduces the rate of photosynthesis needed for the growth of marine organisms. Table3 summarizes the pressures and threats to the marine and coastal environments described in the previous sections.

Table3 - Pressures and Threats to the Marine and Coastal Environment

Land-Based Sources	Coast-Based Sources	Sea-Based Sources
- Wastewater treatment plants - Water desalination plants - Industrial activities	- Sand dredging - Coastal zone reclamation - Tourism and leisure complexes	- Oil tankers - Offshore oil pipelines - Marine dredging

4. Current Situation

4.1 Main Marine Habitats

Bahrain's main marine habitats can be divided as follows:

4.1.1 Seagrass Ecosystems

Seagrass are considered one of the best habitats for many types of marine organisms of commercial significance. Seagrass are present in small patches scattered along the coasts of Bahrain. They flourish extremely well but do generally not extend more than 8 meters below sea level.

Seagrass occur mostly on sandy substrates. Three species of seagrass are very common in Bahrain: Halodule uninervis (Forsskal) Ascherson, Halophila ovalis (R. Brown) Hooker, and Halophila stipulacea (Forsskal) Ascherson.

Bahrain's seagrass beds cover a large area of the sea bottom and provide a habitat for many important marine species. The majority of seagrass habitats in Bahrain's territorial waters are located in the eastern sub-tidal waters. The second largest seagrass beds are found in the western sub-tidal areas.

4.1.2 Algae

Algae-dominated habitats occur in the eastern intertidal and sub-tidal areas of the Bahrain main island and around Hawar islands. Field surveys identified four main types of algae: green, red, brown, and coralline algae. These types are very difficult to subdivide further using remote sensing.

4.1.3 Coral Reefs

Despite the common belief that coral reefs do not survive in extreme climate environments such as areas located above and below the 23.5° parallel north and south of the equator, the presence of coral reefs in the Gulf region is perceived as a unique example of adaptation by marine organisms. Reefs abound in Bahrain's northern coast.

About 30 marine species and 19 genera of corals are found in Bahrain's territorial waters which cover less than 5% of the reef areas in Fasht Al Adhm, Fasht Al Jarim and Khor Fasht. The healthiest and most diverse coral reefs in Bahraini waters are located in Fasht Abu-Thama, about 75 km north of the main island. Coral reefs are therefore not abundant near the shoreline of Bahrain.

4.1.4 Mangroves

Mangrove ecosystems comprise more than 60 species of trees that collectively provide a vital habitat for more than 2,000 species of fish, invertebrates, and plants around the globe. Mangrove tree Avicennia marina is only found in Tubli Bay but currently faces extinction due to intensive sea reclamation. Other species of mangroves are found in Dohat Arad where Bahrain's Fisheries Department transplanted Mangrove seedlings in the mid 1990s to create an artificial habitat.

4.2 Living Marine Resources

4.2.1 Crustaceans

- Shrimps

The Tubli Bay and the shallow water areas south of Fasht Al Adhm are known for the abundance of the Penaied family of shrimps that include seven species. Commercial fishing relies on one species only: Penaeus semisulcatus. The other species represent 5% of the quantities of shrimps caught annually.

Only two species grow into large size: Penaus latisulactus and Matapenaeus kutchensis. The remaining four species: M. stebbingi, Trachypenaeus cuvirostris, Metapenaeopsis stridulandns and M. mogiensis are known for their small size, and are usually dumped (or returned to sea) after capture. The quantity of small shrimps caught at the end of the fishing season (February and March) exceeds large shrimp landings. Trawlers that scour the seabed are the primary cause of the decline of the main shrimp specie, P. semisulcate. This was confirmed by reduced landings of the specie and other small-size shrimps during a survey conducted by GCC countries. Nevertheless, fishing boats that use dragnets have a limited impact on the eggs of this shrimp specie.

- Lobsters

Out of four families of lobster, two are found in the Arabian Gulf area: spiny or rock lobster (Palinuridae) and slipper lobsters (Scyllaridae). Some of the spiny lobster species are exploited for commercial use, such as round spiny lobster (scalopped) and spiny lobster.

In Bahrain, the shovelnose lobster (Thenus oientalis which belongs to the family Scyllaridae) is extensively caught as a by-catch during shrimp fishing. Around 200 tonnes of this species of lobster are fished annually.

- Fishes

In general, there has been a substantive decline of fish species in the Arabian Gulf area in general due to widespread drought and subtropical climate conditions. However, some species do persist in large numbers. The Arabian Gulf area harbors more than 500 species of fish, most of which live in oceanic habitats or fine-particle seabed habitats. Coral reefs alone are home to at least 125 species; Bahrain boasts 71 species.

A report by the Public Commission showed a decrease in fish production by 68% in the last ten years. In addition, the report shows the reduction in types of fish landings to 18 types only while before they were 33 types.

Fish landings in Bahrain did not increase significantly since 1996 despite the rising number of fishing boats and fishermen. Table 4 shows the reduction in fish production from 1998 till 2008, it also includes other species in the counts.

Table (4): The reduction if Fish Production and other species (1998-2008) Metric Ton's

Fish Groups	Years										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fish	1386	1648.5	1082.6	1073.2		1158	607	517	944	426	520
Crustaceans	261	77	670	252	36.9	192	83.6	53.3	14.9	9.8	23.4
Molluscs	749	0	30.6	23.7	65.3	60.4	17.3	20.8	5.5	13.8	11.7
Total	1722	1725	1783	1349		1413	708	591	964	450	556

4.3 Characteristics of Marine Life

4.3.1 Water Temperature

Most studies related to seawater temperature in Bahrain's coasts were limited in space (few

locations) and time.The studies focused on the northern and northeastern areas of the Kingdom. In general, temperatures vary between 14 and 35°C (see monthly and seasonal temperature ranges in Table 5). Average seasonal temperatures range from 18.4°C in winter to 31.4°C in summer.

A study conducted in June in 25 locations on and off the coast, in northern and northeast Bahrain, showed that further from the coast, temperatures decrease slightly. For instance, the highest temperature was recorded in the coastal zones east of Bahrain, more specifically in the area of Jau with 31.5°C. The lowest temperature, 29.2°C, was observed north of Fasht Al Jarem in northern Bahrain. Overall, these results indicate that coastal seawater temperature in shallow waters (near the coast) is higher than in deep waters (far from the coast).

Table 5 - Temperature Fluctuations in a Coastal Location Northeast of Bahrain

Season	Average Temperature
Winter (December to February)	18.4
Spring (March to May)	22.6
Summer (June to September)	31.4
Fall (October to November)	27.5

4.3.2 Salinity

A study was conducted in four different coastal locations, from the south of Sitra to the village of Askar, in the period between February and December (see Table 6 below). Despite the limitations of the study, it is noted that salinity did not change and was not affected by season or location. This can be attributed to the fact that all locations are situated east and southeast of the Bahrain main island, i.e. in very close locations. However, a separate national study covering most of Bahrain's coastline revealed salinity variations based on the location and time of year (see Table 7 and 8 respectively).

Table 6 - Monthly Variations of Water Characteristics in Four Different Locations

Month	Salinity (‰)	pH	Dissolved Oxygen (mg/l)
February	43.3 – 43.8	8.32 – 8.81	-
March	43.2 – 43.5	8.41 – 8.47	8.0 – 8.84
April	43.5 – 44.5	7.81 – 8.83	6.50 – 8.66
May	40.4 – 42.0	7.79 – 7.86	6.21 – 8.27
June	42.0 – 44.4	7.7 – 7.99	5.88 – 8.10
July	41.9 – 42.5	7.54 – 7.61	5.30 – 7.10
August	41.9 – 42.5	7.54 – 7.61	5.30 – 7.10
September	41.1 – 41.3	7.81 – 7.82	4.48 – 6.44
October	44.0 – 44.4	8.99 – 9.05	5.44 – 8.00
November	41.5 – 42.1	7.03 – 7.95	5.22 – 6.75
December	42.3 – 44.3	7.63 – 7.84	6.61 – 7.09
Annual Average	40.4 – 44.5	7.03 – 9.05	3.40 – 8.66

Table 7 - Monthly Variations in Water Salinity (in ‰ or ppt)

Location/Month	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Al Jazaer Beach	55	55	53	54	54	55	55	54	54	55	54	52	54
Al Zallaq	55	55	53	53	55	55	53	54	55	55	55	54	54
Al Badih	48	47	46	46	50	46	46	47	50	47	46	50	47
Northern Al Muharraq	43	43	43	43	44	47	43	44	45	42	41	42	43
Al Hadd	42	42	42	42	43	42	42	41	47	42	42	43	42
Salman Port	42	42	42	42	42	42	42	40	42	42	42	42	42
Al Nabeeh Saleh	42	41	40	42	42	43	41	41	42	42	41	42	41
Sitra	42	41	41	43	45	45	41	42	42	42	42	42	42
Askar	42	43	43	45	43	45	43	42	45	45	45	44	43
Mean	44	45	44	45	45	46	45	42	45	45	44	44	

Table 8 - Monthly Salinity Fluctuations on the Coasts of Bahrain (in ‰ or ppt)

Location	Winter	Spring	Summer	Fall
Al Jazaer Beach	54.1	54.2	54.6	54.5
Al Zallaq	55.0	54.1	54.5	55.0
Al Badih	48.6	47.6	47.3	46.5
Northern Al Muharraq	43.1	43.9	45.1	41.7
Al Hadd	42.5	42.7	43.1	42.0
Salman Port	42.3	42.2	41.7	42.2
Al Nabih Saleh	41.9	41.8	42.0	41.7
Sitra	42.0	43.4	42.6	41.7
Askar	43.0	44.1	43.8	44.0
Average	45.8	46.0	46.1	45.5

4.3.3 Dissolved Oxygen

According to a June 2001 study covering 25 sea locations, dissolved oxygen (DO) levels in seawater varied between 5.1 and 6.2 mg/l, indicating that there are no tangible differences in DO levels on and off the coast.

Table 6 indicates that the pH level of seawater is moderately alkaline but those levels do not vary considerably in time and space (pH range was 7.83 and 8.26). Dissolved oxygen data however show that DO levels is inversely proportional to water temperature; i.e., DO levels go up in winter and down in summer.

5. Efforts Exerted to Fight Marine Environment Pollution

In fulfillment of its obligations under several international and regional commitments to protect the marine environment, the Public Commission for the Protection of Marine Resources, the Environment and Wildlife carried out several activities aiming at protecting the marine resources. A national commission that brings together all relevant authorities including national NGOs was established to protect the marine environment. The main functions of the commission are to:

(1) Formulate general principles for the protection of coastal zones;

(2) Prepare an action plan for marine resources protection at local / int'l levels;

(3) Study the impact of rising sea level (global warming) on coastal zones; and

(4) Develop a plan to promote research on the marine environment.

The Public Commission for the Protection of Marine Resources, the Environment and Wildlife has already launched a monitoring program to begin to manage the discharge of liquid wastes into the marine environment. Through this program, the Public Commission was able to establish a database, identify sources of pressure on the marine environment, set national standards for the discharge of liquid waste into the sea, and implement periodic monitoring and assessment activities. The final results of these activities show a considerable reduction in the discharge of untreated waste into the sea following serious efforts to upgrade the capacity of treatment units, and the installation of large treatment utilities inside industrial plants, as well as the promotion of self-monitoring policies for liquid waste generated by large industries. Furthermore, environmental impact assessment is now compulsory for newly established projects.

5.1 At the international level

The Kingdom of Bahrain ratified the Ramsar Convention in 1998. Several coastal areas were identified as natural reserves including the mangroves in the Tubli Bay, as well as the Hawar Islands and the surrounding marine resources. Bahrain also signed in 1982 the UN Convention on the Law of the Sea and in 1985 the International Convention for the Prevention of Marine Pollution from Ships (as known as MARPOL).

5.2 At the regional level

As a member of the Regional Organization for the Protection of the Marine Environment, Bahrain signed and ratified the following conventions:

(1) Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution

(2) Protocol Concerning Cooperation in Cases of Emergency in Combating Pollution by Oil and other Harmful Substances

(3) Protocol for the Protection of the Marine Environment from Land-Based Sources

(4) Protocol Concerning Marine Pollution Resulting from Exploration and Exploitation of the Continental Shelf

A number of legislations have been promulgated for the protection of marine and coastal environments. However, these legislations need to be revised to focus on the sustainable use of marine and coastal resources. The Public Commission for the Protection of Marine Resources, the Environment and Wildlife intends to develop a strategic plan for the integrated management of coastal zones and marine resources. There is an urgent need for agencies and institutions working in the field of marine resources to participate actively in the sustainable development of the resource, as well as in formulating and implementing policies that affect development and tourism.

5.3 Emergency Plan to Combat Oil Spills in Bahrain

In the early 1990s, the Kingdom of Bahrain put in place an emergency plan to respond to oil spills. Since then, practical training on how to implement the plan was only provided once. Many government authorities are engaged in the implementation of this plan, including ministries such as the Ministry of Municipalities, the Ministry of Internal Affairs (Coast Guards, Traffic Department, General Security), the Ministry of Finance and National Economy, and the Ministry of Health. The Public Commission for the Protection of Marine Resources, the Environment and Wildlife plays a supervisory and coordination role in combating oil spills. Because many ministries have undergone drastic changes since the early 1990s, it is necessary to update and modernize the emergency plan by adapting it to the current ministerial situation. The Public Commission is currently working with these relevant authorities to update the national plan.

The Public Commission owns basic oil containment and cleanup equipment. These are currently stored in temporary warehouses (located on the eastern coast) but will be relocated to permanent warehouses when such warehouses are acquired by the Commission.

Table 9 - Oil Spill Equipment Owned by the Commission

No	Equipment	EA	MEMAC	BAPCO
1	Desmi Power pack	4	-	2
2	Desmi Skimmer	3	-	2
3	Desmi Skimmer floatation units	3	-	1
4	Desmi Hydraulic Hose Reels	3	-	2
5	Generator Airman battery	1	-	-
6	German Power pack	1	-	-
7	German Skimmer	2	-	-
8	Boom (25 m)	82	-	-
9	Boom (20 m)	111	-	-
10	Boom (15 m)	115	-	-
11	Shovels	270	-	-
12	Rakes	123	-	-
13	Rope	-	-	-
14	Oil Catchers – super attack (50x50x0.4cm)	-	-	-
15	Oil Catchers – neo attack ace (50x50)	81	-	-
16	Oil Catchers – mitsui (65x65x0.4cm)	96	-	-
17	Anchors – large	22	-	-
18	Anchors – medium	8	-	-
19	Anchors – small	21	-	-
20	Spare discharge hose	1	-	-
21	Lockers	30	-	-
22	Floaters – small	20	-	-
23	Floaters – large	8	-	-
24	Suck hose	5	-	-
25	Rubber	90	-	-
26	GT-185 skimmer	-	1	-

Abbreviations: MEMAC = Marine Emergency Mutual Aid Center, BAPCO = Bahrain Petroleum Company

5.4 Resolved Oil Spill Incidents

Bahrain's most severe oil spill occurred on March 15, 2003 when the Ministry of Interior's Aviation Department detected an oil slick, about 20 miles north of Bahrain's northern coast. The slick moved closer to Bahrain until reaching the northern coasts on March 17. Three days

later, the spill had affected the eastern and western coasts of the island of Al Muharraq. The slick also extended to the Salman Port and to a nearby fishing harbor, causing considerable damages to fishing boats. The oil slick also blocked the water intakes of two power and one desalination plants.

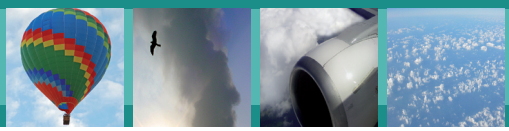
In total, the slick had contaminated 18 kilometers of Bahrain's coastline with about 100 tonnes of crude oil. Contamination was also detected on the Saudi coasts off the King Fahd Causeway which connects Bahrain to Saudi Arabia.

Bahrain's Coast Guards participated in the oil spill clean up which was launched by the Public Commission of the Marine Resources, the Environment and Wildlife except for the period from March 15 to March 24, 2003.

Exhibit 3 – Oil Spill Photos

Charter Two

Air Quality



1. Major issues related to air quality

Air quality in the Kingdom of Bahrain can be characterized as follows:

First: Deteriorating quality of air caused by emissions from energy generation and transmission, car exhausts, and industrial emissions.

Second: Intrusion of industries into residential areas (and vice versa) raises the risk of exposure to air pollutants by residents.

Third: Increased inhalation of minute particles due to quarrying activities, precast and blocks factories, construction and building sites, limited green areas, desertification, and regional sand storms.

Fourth: Lack of an early warning system for air pollution.

Fifth: Limited data on some emissions and the limited number of air quality monitoring stations.

Sixth: Insufficient human resources (technical cadres) specialized in air pollution.

Seventh: Scarcity of research on the impacts of air pollution on public health, as well as research related to cleaner production and renewable energy.

2. Factors Affecting AIR Quality

Pollutants emitted by point sources into ambient air can undergo physical and chemical changes. If present in large volumes and for long periods, they can inflict harm on people, wildlife, animal and plant life, and can reduce the quality of wellbeing.

2.1. Transportation

Air pollution monitoring stations in the Kingdom show rising levels of air pollutants, a result of emissions from car exhausts. Vehicles consequently represent the largest source of pollution in Bahrain, especially given the difficulty of controlling this source of pollution in light of the accelerated and massive increase in the number of cars, estimated at 9% annually, within a limited area.

Gas emissions from the transportation sector, especially non-methane hydrocarbons (NMHCs), nitrogen oxides (NOx), carbon monoxide (CO), particulate matter PM10, and carbon dioxide (CO2) emissions, are a major source of concern to relevant local, regional and international parties. These emissions result from the combustion of fossil fuels by the transportation sector and represent a growing share of total emissions generated by human activities, globally.

According to a study conducted in 1997 by the Environmental Affairs of Bahrain to estimate air pollutants emitted by various sources, vehicles accounted for approximately 49% of total emissions, with 1,686 thousand tonnes. The study also found that almost 39.91% of carbon monoxide emissions were attributed to vehicles. Vehicles were also determined to be the primary source of hydrocarbon emissions as they contribute to 98.85% of all hydrocarbons, estimated at over 102,000 tonnes annually. The contribution of vehicles to particulate matter, nitrogen oxides and sulfur was estimated at 35.6%, 29.8%, and 4.2% respectively (see Table 1).

Table 1 - Air Pollutant Emissions from the Transportation Sector (Vehicles)

Element	Symbol/Abbreviation	Annual Quantity Emitted	
		Tonne/year	%
Carbon Monoxide	CO	672,841.6	39.9
Sulfur Oxide	SO	1,682.1	4.2
Nitrogen Oxide	NO	46,257.8	29.8
Particulate Matter	PM	5,046.3	35.6
Hydrocarbons	HCs	100,926.3	98.8
Total		826,754.1	49.0

Source: Department of Environment Affairs, Ministry of Housing & Municipalities, 1997

2.2. Industry

Gases emitted from factories in the Kingdom rank second in terms of air pollution, oil refining, aluminum manufacturing, and power plants are among the primary sources of air pollution. The Public Commission for the Protection of Marine Resources, Environment and Wildlife has since the 1980s released several environmental restrictions and conditions that compel existing factories to implement corrective measures to protect the environment. The Commission would then monitor the implementation of those measures by routinely following-up with the factories and the committees charged with environmental compliance.

Air quality in the Kingdom of Bahrain is influenced by the following sources:

Fixed Sources		Mobile Sources	
Source	Units	Source	Units
Oil Production and Refineries	1	Car exhausts	345,350 (Yr2007)
Natural Gas Production	1	Trans-boundary pollutants	NA
Power Generation	4		
Petrochemicals	1		
Al production & manufacturing	7		
Manufacturing industries	NA		
Quarries	1		
Landfills	2		

Figure 1 - Images of a Few Sources of Air Pollutants in the Kingdom of Bahrain

Aluminum Production-ALBA

Askar Quarries

Gulf Petrochemicals-GPIC

Riffa Power Station

Vehicles emissions

Oil Tanks Farm

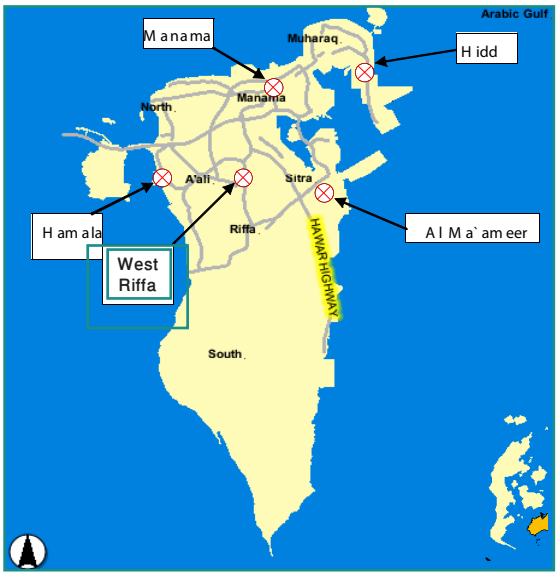
3. State of ambient Air Quality in the Kingdom of Bahrain

The air quality monitoring program in the Kingdom of Bahrain started in 1986 with the introduction of one semi-mobile station. Three other fixed stations were added in 1993, and in 2006, all stations were replaced by five modern mobile stations that were distributed in the five provinces of Bahrain (Muharraq, Manama, Shamaliyah, Central, and Southern). The five stations are linked to two central computers for storing the data, located at the headquarters of the Public Commission for the Protection of Marine Resources, Environment and Wildlife in Salmabad. The two computers are equipped with a communication system that can automatically retrieve and store air quality monitoring data at the rate of one reading per minute or on demand.

These stations monitor air quality round-the-clock to identify the most significant air concentrations, including carbon monoxide, sulfur dioxide, nitrogen dioxide, hydrogen sulfide, ammonia gas, ozone gas, hydrogen fluoride, non-methane hydrocarbons, methane gas, volatile organic compounds (benzene, toluene, and xylene) and inhaled particles less than 2.5 and 10 microns. Additionally, the stations collect meteorological data such as wind speed and direction, temperature, relative humidity, and solar radiation due to their importance and relevance to the concentration of various compounds. The stations can also detect the direction of pollutant sources.

Exhibit 1 - Mobile Air Quality Monitoring Station in Bahrain

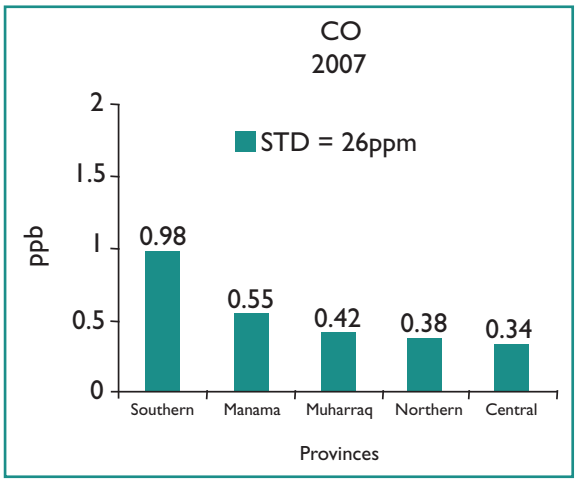
Exhibit 2 - Map of the Locations of Air Quality Monitoring In Bahrain



4. Measured Pollutants & Air Quality in the Kingdom

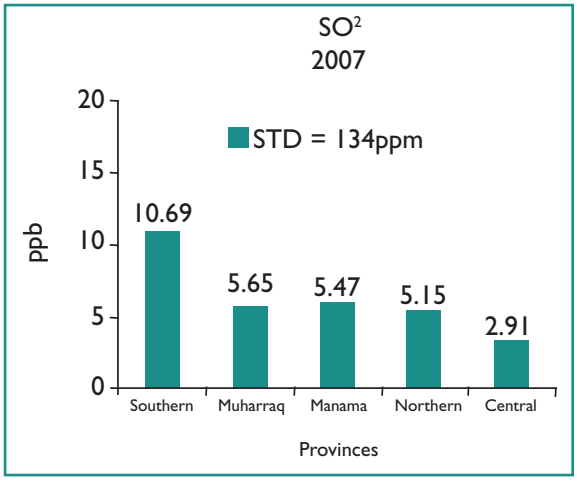
4.1. Carbon Monoxide (CO)

A highly toxic colorless and odorless gas capable of reacting rapidly with hemoglobin in blood, leading to a reduction in the blood oxygen level, and hence to suffocation if present in sufficient amount. It is one of the most common air pollutants, especially in urban centers; CO levels increase as a result of the incomplete combustion of carbon fuels. The transportation sector accounts for over 70% of total CO emission.



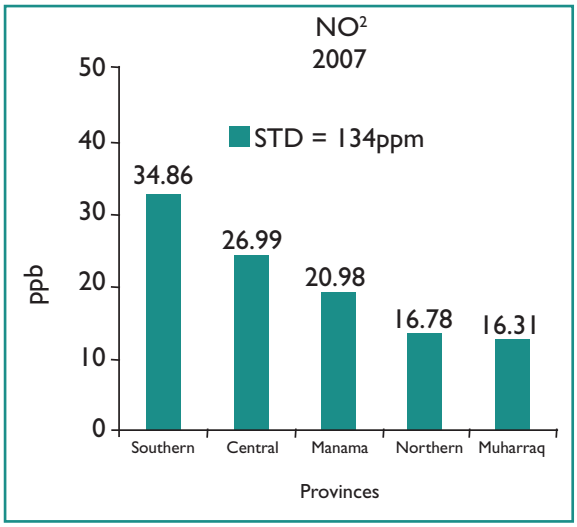
4.2. Sulfur Dioxide (SO^2)

Sulfur dioxide is a colorless gas with a pungent odor that irritates the respiratory system. It oxidizes in the atmosphere to turn into sulfur trioxide which rapidly dissolves in water vapor to form sulfuric acid and drop as rain or as acidic spray in the event of high relative humidity. This gas is emitted during the combustion of sulfur-containing fossil fuels (coal and oil), the extraction, production and refining of oil, production of sulfuric acid, emissions from diesel car exhausts, and power plants. Exposure to large amounts of this gas, even short durations, can cause severe impact on the upper channels of the respiratory system, pulmonary and bronchial infections as well as pulmonary swelling.



4.3. Nitrogen Dioxide (NO^2)

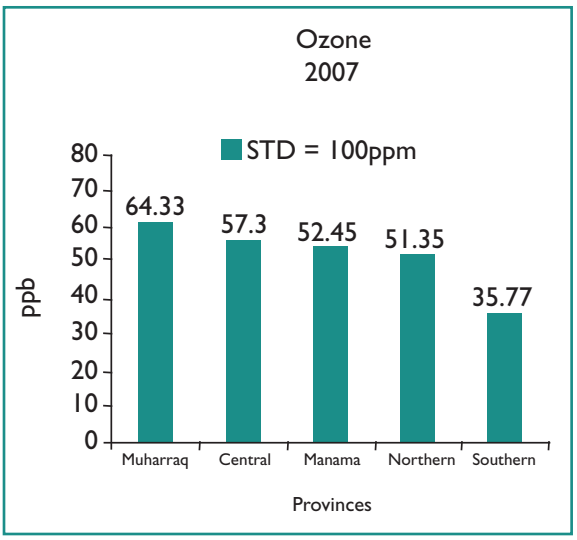
Both nitrogen monoxide (NO) and nitrogen dioxide (NO2) are among the most common gases with respect to air pollution. These oxides are emitted during the combustion of fossil fuels, the oxidization of nitrogen compounds, from car exhausts and high temperature combustion stations, and from the production of nitric acid. Additionally, different nitrogen oxides are formed in the air as a result of the interaction of carbon monoxide (NO) which plays a fundamental role in photochemical reactions, since it oxidizes and transforms into nitrogen dioxide (NO2) which may then interact with hydrocarbons in the presence of sunlight to form photochemical fogs



such as ozone gas (O3). It may also interact with hydroxyl (OH) to form nitric acid and cause acid rain. The focused interest in nitrogen dioxide is attributed to its impacts on environment and health, and it is currently subject to environmental standards. It is a reddish-brownish gas with a pungent odor. Human exposure to NO2 can damage the respiratory system and the human heart as well as impair vision, not to mention other impacts on vegetation.

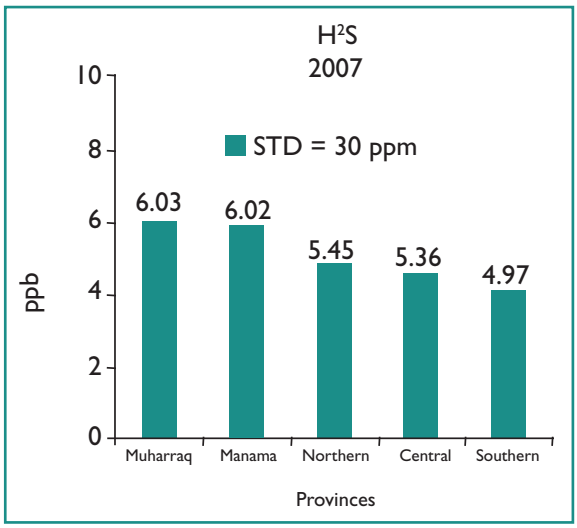
4.4. Ozone Gas (O^3)

Ozone gas is a gas with a pungent odor and a bluish color. It is generated at the surface of the earth as a result of photochemical interaction of nitrogen oxides with hydrocarbon vapors, carbon monoxide and water vapor in the presence of sunlight, and as a result of the impact of oxygen oxidization during lightning, welding operations, and in case of using high energy electric currents such as electric ovens used to weld iron and aluminum. Ozone gas can damage pulmonary tissues; it is poisonous to animal and plant life and has environmental effects on the atmospheric layer.



4.5. Hydrogen Sulfide (H2S)

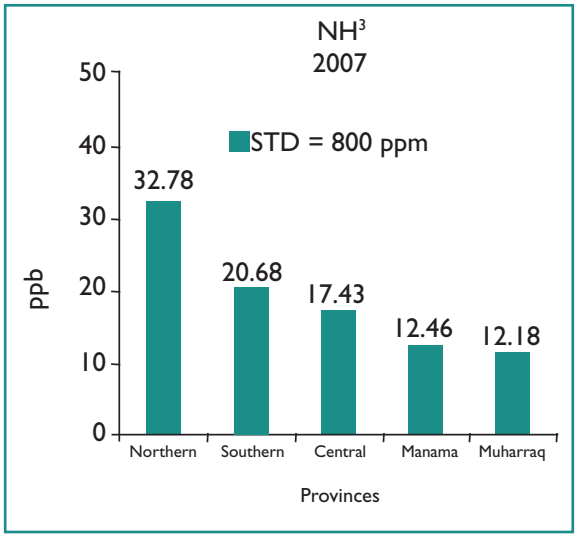
Hydrogen Sulfide is a colorless gas with a nasty odor similar to rotten eggs. It is naturally present in nature and may be emitted by garbage. Sewage, garbage, cattle feces, the remains of garbage trucks, and chemical residues may all emit hydrogen sulfide. It may also be present in underground water, especially in wells close to oil fields or wells that penetrate sand rocks. Hydrogen sulfide is also present in oil fumes and natural gas. Natural gas constitutes up to 28% of hydrogen sulfide, and hence may cause air pollution in areas of natural gas production as well as in areas where oil is refined. This gas may also be emitted by industries that use sulfur compounds.



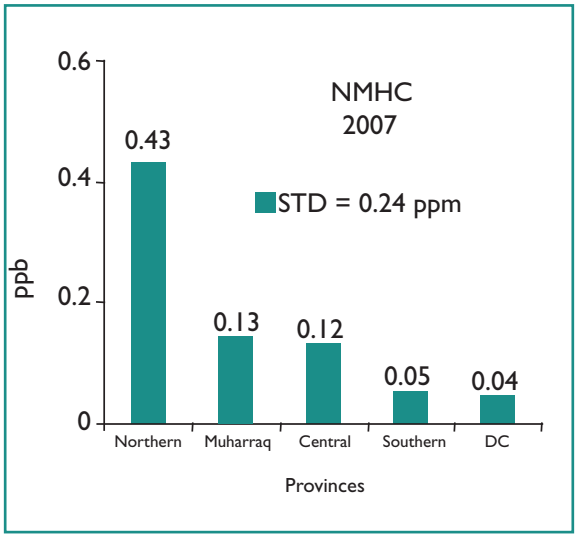
Exposure to hydrogen sulfide with its recognizable odor (the smell or rotten eggs) can irritate respiratory channels and cause the temporary loss of the olfactory sense. When exposed to concentrations greater than 550 parts per million, air exits the lungs rapidly leading to suffocation. Exposure to hydrogen sulfide can also lead to nausea, coughing, headache, dizziness, severe eye infection and bronchial infections. The combustion of hydrogen sulfide can result in explosions and cause the emission of intoxicating gases such as sulfur dioxide, nitric acid and other sulfuric compounds. Liquid sulfur releases toxic fumes when poured.

4.6. Ammonia (NH3)

Ammonia is a colorless gas that dissolves in water up to 34%. It is a corrosive substance with a pungent odor. It is considered the primary source of nitrogen in various nitrogen fertilizers as well as in ammonium phosphate fertilizers.



Anhydrous ammonia causes infections and irritations in the skin, eye, nose, throat, and the upper part of the respiratory system. Since ammonia is the primary source of nitrogen needed for the growth of marine plants, it can possibly contribute to the eutrophication of stagnant or slow-flowing water surfaces, especially those with limited amounts of nitrogen. Moreover, ammonia is moderately toxic for marine life. So far, it has not been scientifically proven that ammonia is a carcinogen.



Environmental problems associated with ammonia are attributed to the fact that it dissolves in water and diffuses in gas state. Ammonia can cause serious harm to wildlife, and when absorbed by water currents, it can also harm fish including cold water fish. In the air, ammonia combines with sulfur ions and dissolves in rain water, rapidly returning to the soil and water surfaces. Ammonia is considered a primary compound in the nitrogen cycle; it converts into nitrates in lakes, rivers, and natural water flows.

4.7. Non-Methane Hydrocarbons (NMHC's)

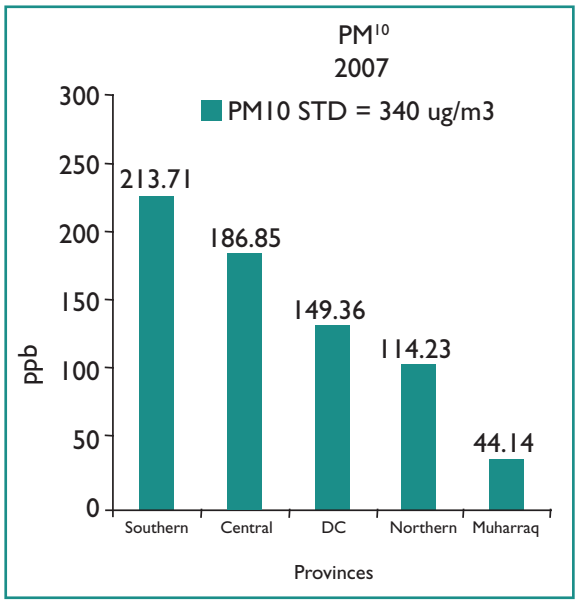
Non-Methane Hydrocarbons are a group of organic compounds that form through the association of hydrogen and carbon. They are emitted as a result of the incomplete combustion of fuel in car exhausts, oil and petrochemical industries, and the biological decomposition of organic matter and swamps. They also include volatile organic compounds such as benzene, toluene, xylene and other multi-ring organic compounds such as vinyl chloride, naphthalene, and formalene. All these compounds have hazardous effects on human health in general, and some are potentially carcinogenic.

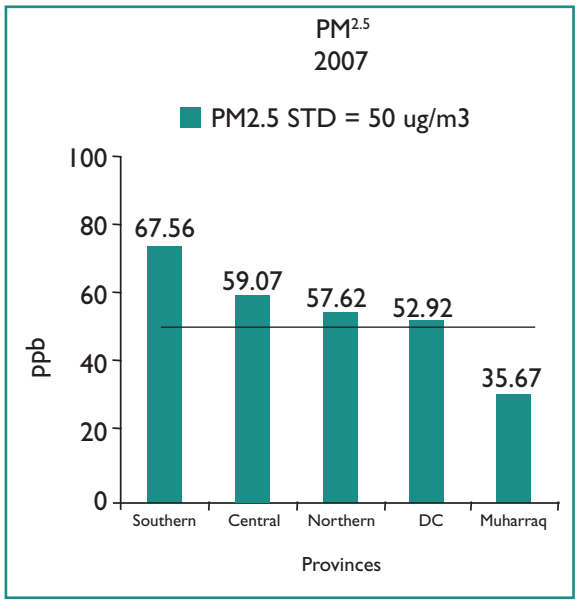
4.8. Volatile Organic Compounds (VOC's)

VOC's are found in nature in various forms. They possess an odor similar to that released by pine trees. They are released during fuel combustion in vehicles, power plants and factories. These chemicals then mix with the remnants of fuel such as carbon and oxygen left in the air to produce a volatile organic compound. Solvents, dyes, glues, and chemicals used in dry cleaning are among the primary sources of these compounds. Moreover, they contribute to the formation of low-lying ozone near the earth surface. Some of these gases may be toxic while others may be carcinogens or hazardous to plants. Examples include benzene, toluene, and xylene.

4.9. Inhaled Particulate Matter less than 10 microns and 2.5 microns (PM_{10} – $PM_{2.5}$)

These are fine solid or liquid particles whose sizes vary from 0.1 to 100 microns, which allows them to stick in the air for long periods of time and to spread far from the source. Their physical and chemical structure depends on the nature of the emission source. They are emitted from natural sources including volcanoes, seas, and soil. They are also emitted by cement and block industries, quarries, oil drilling, minerals and oil extraction, the exhausts of various transport vehicles, and the erosion of tires as well as by complete combustion processes which release ash. They are also released when crops are burned. The chemical structure of these compounds and their concentration in atmospheric air play an important role in determining their impact on the environment and human health. The size of these particles also plays an important role in determining their impact on public health in case of exposure; the impact intensifies when the particles are smaller in size as this makes it easier for them to penetrate and precipitate in the lower parts of the respiratory system. This explains the interest in particulate matter of 10 microns or less since they can easily infiltrate the respiratory system and can inflict multiple health effects. Consequently, the World Health Organization (WHO) recently started recommending member states to pay more attention to particulate matter of 2.5 microns. The spread of particulate matter in the air can impair vision as well as cause direct toxicity due to the presence of heavy metals and hazardous compounds such as lead, mercury and vanadium. Their presence can also complicate cases of asthma, allergies and other respiratory illnesses. Finally, particular matter can impair photosynthesis and harm plants and animals.





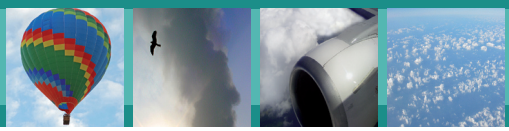


Table 2 - Pollutant Levels and their Effects (2007 data)

Pollutant	Symbol	Min / Max Levels*	Unit	Major Effects
Carbon Monoxide	CO	0.35/1.16	ppm	• Toxic gas that causes suffocation
Sulfur Dioxide	SO_2	2.53/11.77	ppb	• Irritates respiratory system • Pulmonary bronchial infection and pulmonary swelling
Nitrogen Dioxide	NO_2	10.18/26.56	ppb	• Affects respiratory system • Impaired vision • Impact on vegetation
Ozone	O_3	19.82/54.84	ppb	• Destroys pulmonary tissues • Toxic for plant and animal life
Hydrogen Sulfide	H_2S	1.15/6.37	ppb	• Irritates respiratory channels and temporary loss of olfactory sense • Nausea, coughing, headache, and acute eye infection
Ammonia	NH_3	6.92/13.54	ppb	• Irritation and infection of eye, nose, throat, and upper respiratory tract
Non-Methane Hydrocarbons	N-CH_4HCs	0.01/0.09	ppm	• Toxic and carcinogenic
Benzene	C_6H_6	0.6/0.92	ppb	• Carcinogen • Destroys plant life
Toluene	$C_6H_5CH_3$	0.40/0.97		• Carcinogen • Destroys plant life
Xylene	$C_6H_4C_2H_6$	0.15/0.53	ppb	• Carcinogen • Destroys plant life
Particulate Matter less than 2.5 microns	$PM_{2.5}$	35.71/68.84	µg/m3	• Asthma, allergy and respiratory illnesses • Precipitates in the lower respiratory system
Particulate Matter less than 10 microns	PM_{10}	74.69/207.03	µg/m3	• Asthma, allergy and respiratory illnesses • Impairment of photosynthesis

* *calculated based on monthly averages.*

5. Efforts by the Kingdom to Control Air Pollution

5.1. Air Quality Standards

Bahrain has issued a number of ministerial decrees related to air quality standards. Decree No. 10 (of 1999) sets air quality standards for carbon dioxide gas, nitrogen dioxide gas, and particulate matter (less than 10 microns). It also includes emission standards for air pollutants by source for the following industries: combustion units (all fuel combustion processes), oil refining, aluminum welding, the welding and manufacturing of non-iron metals, iron industry, fertilizers, cement industry, petrochemicals and ammonia production, textiles, and coal calcinations (see major industries in Section 2.2).

5.2. Cleaner Fuel

Based on its policies and commitment to ministerial decrees including decree number 21 for the year 1999, and according to environmental law of 1996, Bahrain Petroleum Company (BAPCO) started to produce unleaded gas in 2000. It also reduced sulfur in diesel from 6500 to 500 parts per million for domestic use, and to less than 10 parts per million in exported diesel.

5.3. Vehicle Exhaust Monitoring Program

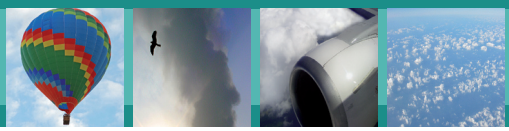
This program is considered to be one of the important attempts at improving the quality of air in the kingdom since it aims at monitoring vehicle emissions based on ministerial decree number (8) for 2002 which sets the standards of pollutants and emissions from vehicles and their exhausts, and calls for inspecting gasoline-powered vehicles manufactured in 2004 to ensure that they are equipped with excitation transformers. The decree also stipulates that carbon monoxide emissions by gasoline-powered vehicles do not exceed 45 parts per million and hydrocarbons 1.2 parts per million.

5.4. Modernizing the Detection Network & Adding New Standards

As mentioned earlier, the air quality detection monitor was modernized in 2006 such that the old fixed stations were replaced by new mobile stations. The number of stations also went up from three to five, in addition the increase in the number of measured pollutants from six to twelve.

5.5. International Conventions for the Protection of the Atmosphere

Convention	Content of Conventions	Accomplished to Date
UN Framework Convention on Climate Change Date of Signature: Jun 1992- Date of Ratification/Adherence: Dec-1994	Limiting concentrations-of greenhouse emissions -Limiting influential h - man activities	Issued the First National Communications Report (2005); the second Report is in process
Vienna Treaty and Montreal Protocol on substances that deplete the ozone layer Date of Signature: Sep 1989- Date of Ratification/Adherence: Apr-1990, Jul 1990	Limiting the depletion of ozone layer	Prepared and implemented several programs to gradually eliminate ODS

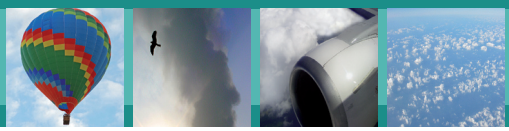


Geneva Work Environment Convention (Air Pollution, Noise & Vibration) Date of Signature: 1977- Date of Ratification: not ratified yet-		

Table 3 - Air Emission Measures from Various Sources

Sector/ Industry	Source	Pollutants	Unit	Measure
	All processes of fuel combustion	Particulate Matter (3)	mg/m3	0 for units 50 megawatts power input 100 for units with power input less than 50 Megawatts (for units operating by oil fuel)
		Hydrogen sulfide in fuel	per million	600 – gas fuel (4)
		Sulfur dioxide	mg/m3	500 – oil fuel
		Nitrogen oxides	mg/m3	100 – gas fuel
		Nitrogen oxides	mg/m3	150 – oil fuel
		Carbon monoxide	mg/m3	100
Petrol Refining	All Processes	Hydrogen sulfide	mg/m3	150
		Particulate matter	mg/m3	50
		Carbon monoxide	mg/m3	100
		VOCs	% retrieved	95 – 100%
	Sulfur Extracting Units	Carbon monoxide	mg/m3	150
	Other Combustion Units	Carbon dioxide	mg/m3	500
	Fluid catalytic cracking unit (FCCU)	Carbon monoxide	Per million	500

Sector/ Industry	Source	Pollutants	Unit	Measure
Aluminum Welding	Reduction Cells	Particulate Matter	mg/m3	30 (total emission should not exceed 3kg/ton of aluminum)
		Hydrogen fluoride	mg/m3	1
		Fluorides	mg/m3	2 (total emission should not exceed 1.25 kg/ton of aluminum)
		Sulfur dioxide	kg/ton	32
		Organic compounds	mg/m3	20
	Heating Processes for Positive Anode Equipped Units	Particulate Matter	mg/m3	30
		Sulfur dioxide	mg/m3	500
		Nitrogen oxides	mg/m3	400
		Fluorides	Kg/ton of aluminum	0.05
		VOCs	mg/m3	20
		Phosphoric Compounds	mg/m3	10
		Copper & Cooper compounds	mg/m3	5
		Chrome	mg/m3	2
		Lead	mg/m3	5
		Hydrogen Chloride	mg/m3	50
		Fluorides	mg/m3	10
		Chlorine	mg/m3	30
		Cadmium	mg/m3	1



Sector/ Industry	Source	Pollutants	Unit	Measure
Iron Industry	Sintering	Sulfur dioxide	mg/m3	500
		Nitrogen oxides	mg/m3	750
	Pelletizing	Sulfur dioxide	mg/m3	500
		Nitrogen oxides	mg/m3	250
	All processes including ovens	Fluorides	mg/m3	5
		Particulate Matter	mg/m3	50
		Lead	mg/m3	1
		Chrome	mg/m3	2
		Nickel	mg/m3	1
	Arched Electric Ovens	Particulate Matter	mg/m3	10
Fertilizer Industry	All Processes	VOCs	% retrieved	99%
		Particulate Matter	mg/m3	30
		Ammonia	mg/m3	50
Cement	Ovens, coolers, grinding units and other processes	Sulfur dioxide	mg/m3	400
		Particulate Matter	mg/m3	50
		Nitrogen oxides	mg/m3	600
Petro-chemicals and Ammonia Production	All Processes	Ammonia	mg/m3	15 (Petrochemicals) 30 Ammonia
		Aromatic Benzene	mg/m3	5
		Carbon monoxide	mg/m3	100
		Hydrogen Chloride	mg/m3	10
		Vinyl chloride	mg/m3	5
		Dichloroethane (1,2)	mg/m3	5
		Sulfur dioxide	mg/m3	500
		Nitrogen oxides	mg/m3	300
		Particulate Matter	mg/m3	20
		VOCs	mg/m3	20

Sector/ Industry	Source	Pollutants	Unit	Measure
Textiles	Processes of fabric forming, drying and applying solvents	VOCs	mg/m3	20 (emissions not to exceed 1kg/ton of produce)
Calcination of Petro Coal	Ovens	Particulate Matter	mg/m3	50
		Sulfur dioxide	mg/m3	500

(1) Emission standards for SO2 and NOx are applicable to all incineration units in all factories. Emission standards for SO2 and NOx from different sources other than combustion have been determined.

(2) Combustion gases must be dry at a temperature of 273 Kelvin and a pressure of 101.3 kilopascal, with an oxygen content modified to 15% (oxygen volume / total volume)

(3) Particulate matter (PM) standards for other applications are 50 mg/m3

(4) If the hydrogen sulfide H2S content is higher than this rate, a system for eliminating sulfur dioxide SO2 must be used to reduce it to this level

(5) For units that do not use natural gas as fuel and use other gas fuels

Chapter Three

Water

1. Driving Forces and Pressures Affecting Water Quality

Due to very limited rainfall, limited surface area and its geographic position on our planet, the Kingdom of Bahrain does not have surface water resources. The Kingdom therefore has to resort to traditional and non-traditional water sources to meet its needs. Until recently, groundwater resources represented the principle source of water to satisfy the water demand of different sectors. However, demographic growth since the 1970s and increased development linked to the oil boom have caused water demand to surge and exceed groundwater supplies. Consequently, there was an urgent need to resort to non-traditional sources to meet water demand and reduce pressure on groundwater resources. The main water issues are:

- Persistent deterioration of groundwater quality due to over-pumping and salinity build-up, as well as surface contamination from anthropogenic sources;
- Reduction of groundwater areas that are suitable for immediate use.
- Surging demand on water desalination plants to meet the water needs of development projects, which puts a burden on plant productivity.
- Contamination of seawater used in desalination by hydrocarbons and chemicals and the potential seepage of contaminants to potable water.
- Absence of a single administration that manages all water resources.

Average Annual Rainfall

Bahrain's climate has the characteristics of the world's dry areas whereby evaporation rates exceed by far rainfall. Annual evaporation in Bahrain is estimated at 1,850 mm. Evaporation rates increase considerably in summer to reach 33 mm/day (During winter the evaporation is around 9 mm/day). Rainfall occurs only in winter. It is scarce and irregular with an average of 80 mm/year.

Source: Al Nuaimi, 1999

Traditional and Non-Traditional Water

Natural water resources (as known as traditional water resources) are sources of water that form without direct intervention from man. These resources assume many shapes and forms such as river basins, lakes and valleys, springs and groundwater. Groundwater is the only source of natural water in the Kingdom of Bahrain.

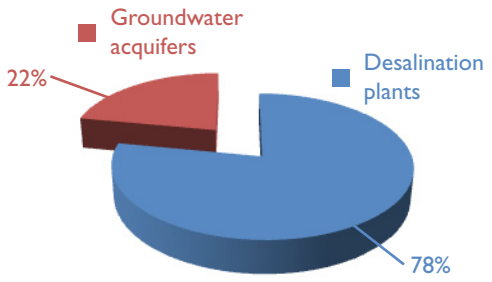
The limited natural recharge of groundwater in Bahrain, compared with high consumption levels, is one of the major challenges facing the sustainability of groundwater resources. The overuse of these resources over the past 50 years has led to the increase of salt concentration in groundwater and to the deterioration of water quality. Furthermore, groundwater resources were not sufficient to cater for human demand particularly with the accelerated demographic growth. The competent authorities had to resort to another source to cater for water needs. Since the 1970s, water desalination has been adopted as an alternative technique, and desalinated water is now considered a non-traditional water resource. By the end of the 1980s, treated wastewater was also listed among the non-traditional water resources, and it is mainly used for irrigation in the agricultural sector.

2. State of Water

2.1. Underground Water

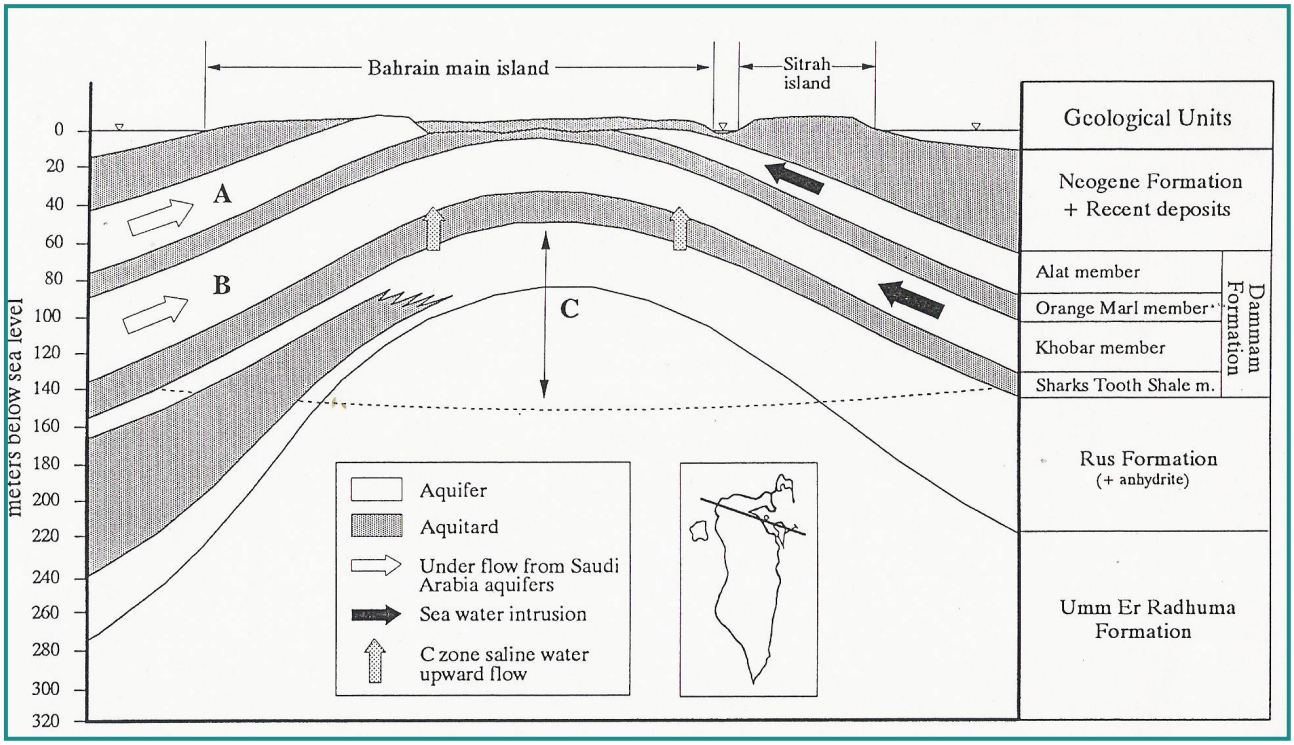
Groundwater supplies 72% of the Kingdom's water needs for the municipal, agricultural and industrial sectors. Groundwater comes from three major formations: Dammam, Rus Umm Er Radhuma and the Negoene Formation. The Dammam Formation, the main aquifer, supplies most of Bahrain's annual groundwater supply. The rate of groundwater pumping exceeds by far the rate of renewal (the annual recharge rate for the Dammam Formation is estimated at 100 million m3 while the annual rate of water extraction is 200 million m3, which results in a deficit of 100 million m3 annually). The current situation compromises the availability and quality of groundwater for future generations.

Water desalination plants currently produce 28% of Bahrain's water sector needs. The remaining 72% are extracted from two major aquifers (Dammam and Umm Er Radhuma)



Source: Water Transportation and Distribution Directorate, 2007

Exhibit 1 - Drainage, Extraction and Water Strata Systems in Bahrain



The agricultural sector consumes the largest share of extracted groundwater (67%) followed by the municipal (at 30%) and industrial sectors (3%). Overexploitation of groundwater resources over the past 50 years has caused a drop in the water table and seawater intrusion. Furthermore, groundwater salinity which ranges from 2,000 to 10,000 ppm is much higher than international levels (usually less than 500 ppm). This makes it unsuitable for drinking in some areas, and puts more economic pressure on the government with regards to water desalination. There is also the risk of groundwater contamination by septic tanks and oil well borings in some areas.

2.2. Desalinated Water

Bahrain established the first seawater desalination plant in 1975 with an initial capacity of 0.0189 million m3/day. This was the Sitrah plant for power generation and water desalination. Later, several other plants were established, thus increasing the volume of desalinated water from 0.95 million m3/year in the mid 1970s to 62.75 million m3/year in 1999. In 2000, a major accomplishment was the completion of the first stage of Al Hadd Plant which added another 0.15 million m3/day. The ALBA Plant delivers approximately 16.6 million m3 of excess water per year directly into the government water pipelines. Bahrain currently has five desalination plants and total production capacity reached 119 million m3 in 2006 and 132.3 million m3 in 2007. Table 1 lists those plants by location, technology and capacity.

Table 1 - Daily Production Capacity of Desalination Plants for 2007

Plant Name - Year of Operation	Mixing with Groundwater	Method Used	Source of Water and Area	Daily Production*
1. Sitra Power Generation and Water Production, 1975	√	MSF	Seawater / Sitra	0.100
2. Ras Abou Jarjoor Water Desalination, 1984	-	RO	Groundwater /Al Rass and Um Al Radma	0.057
3. Al Dur for Water Desalination, 1990	-	RO	Seawater/ Askar and Jau	0.022
4. Al Hadd for Water Desalination, 1999	√	MSF	Seawater/Al Muharraq	0.170
5. Alba Plant, 2002	√	MSF	Seawater/Askar and Jau	0.032

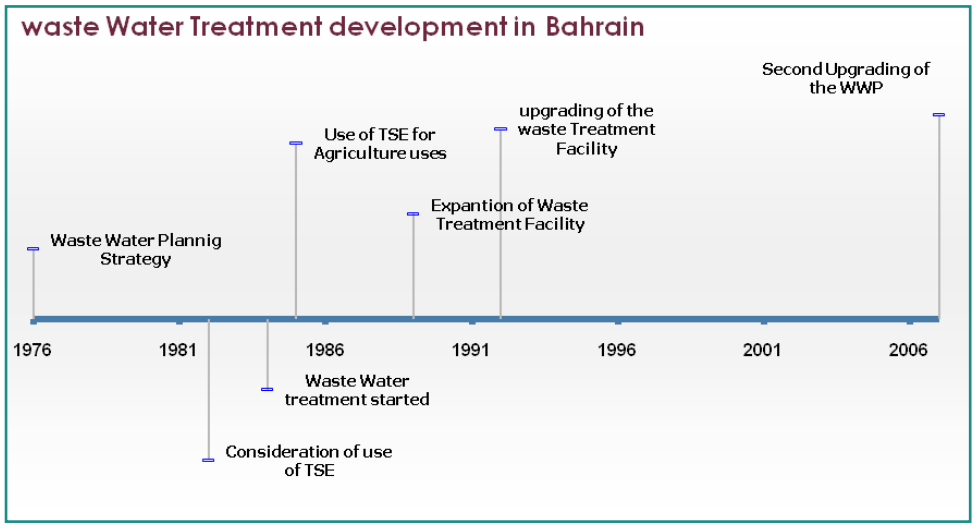
** In Million Cubic Meter (MCM), Multi-Stage Flush (MSF), Reverse Osmosis (RO)*

Source: Annual Report of the Ministry of Electricity and Water

2.3. Treated Wastewater

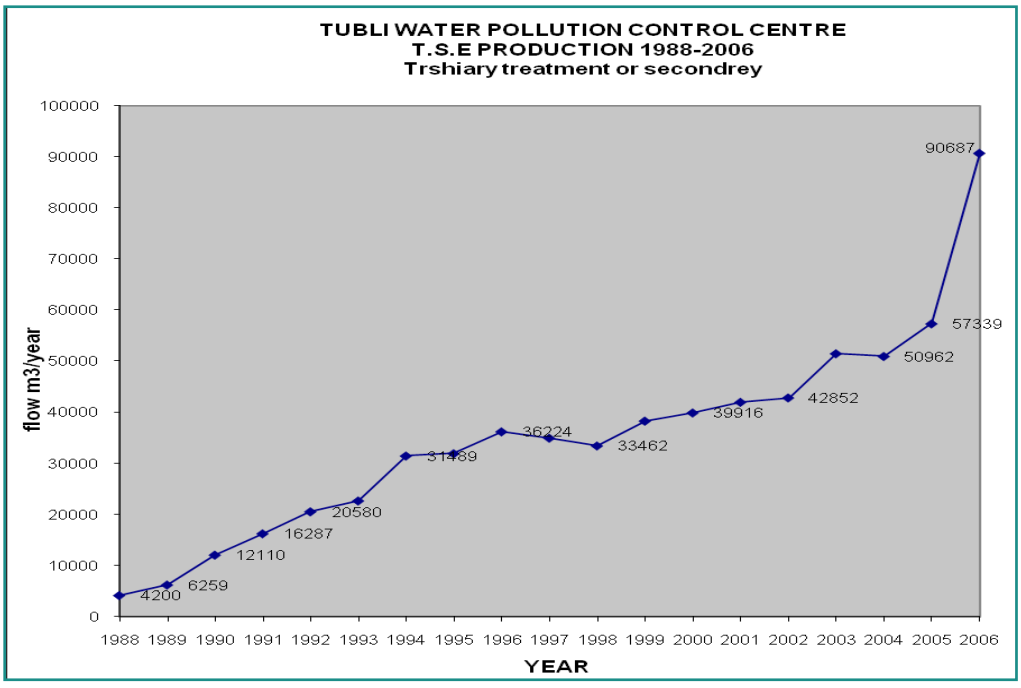
With the implementation of the wastewater master plan in 1976 and the accelerated demographic growth, Bahrain began in 1982 to consider the use of treated wastewater as an alternative source of non-traditional water to be used for irrigation. In 1984, Bahrain effectively began treating wastewater and, in 1985, treated wastewater was being used in the agricultural sector. In 1989, the wastewater treatment plan was expanded (see history in Exhibit 2).

Exhibit 2 – Evolution of Wastewater Treatment in Bahrain



Bahrain's sewage network currently collects 88% of the total wastewater produced in the Kingdom. The Tubli Plant, Bahrain's largest wastewater treatment plant, received in 2006 an estimated 170,000 m3/day, broken down as follows: (1) 79,000 m3/day were treated to the secondary level prior to discharge into the sea; and (2) 90,680 m3/day were treated to the tertiary level. Eighty percent of tertiary treated water was reused for irrigation (farms, fodder, trees, and green areas) and the remaining 20 percent was discharged into the sea. These plants produce 15-20 tonnes of sludge per day, of which 30% is used by farmers as soil conditioners. The rest is disposed off at the Askar municipal landfill. Exhibit 3 illustrates the quantity of treated wastewater from 1988 to 2006.

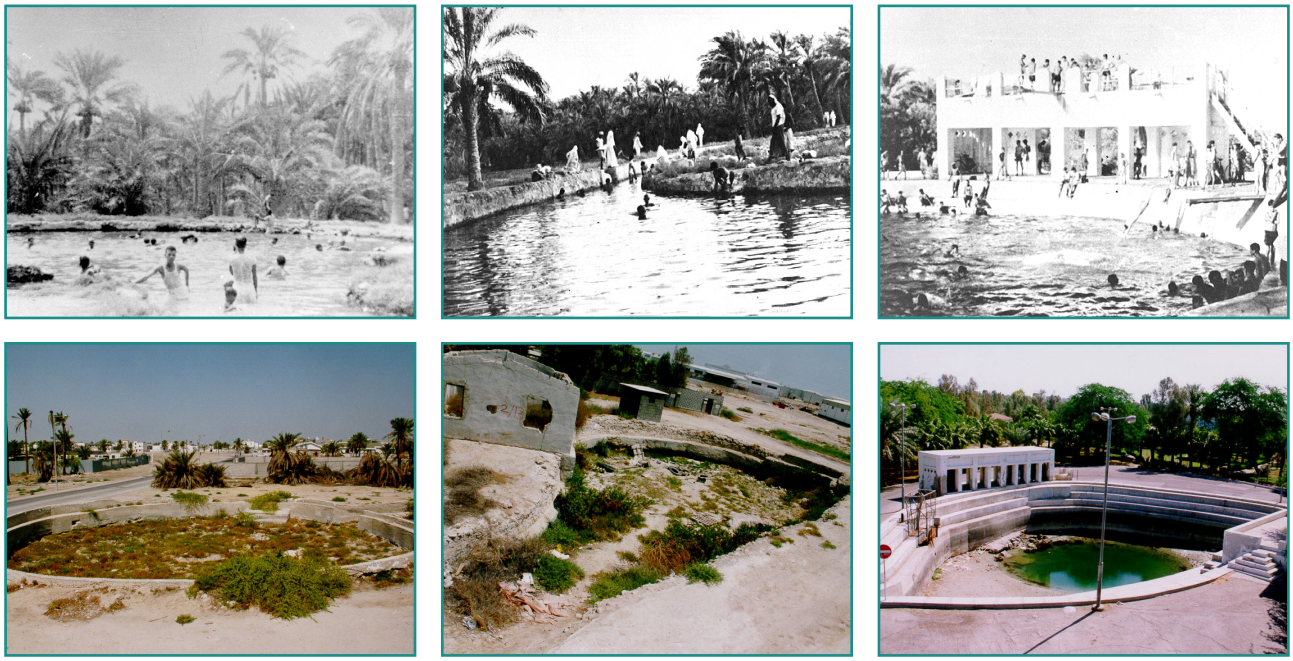
Exhibit 3 - Treated Wastewater from 1988 to 2006



3. Impacts of Water Quality Deterioration

The overexploitation of groundwater over the past 50 years has depleted groundwater reserves and caused seawater intrusion. Consequently, salinity levels have increased rendering it not suitable for drinking in some areas. This was followed by the gradual decline in the flow of natural springs, eventually leading to the complete drying out of such water bodies. In turn, this resulted in the deterioration of ecosystems and wildlife habitats, plants and animals, and the loss of the biological diversity of such habitats, in addition to the loss of several habitats for migratory bird. Exhibit 4 show several examples of the drop in the water levels and the complete desiccation of several springs in Bahrain (period from 1950's to 1990's).

Exhibit 4 – The Loss of Natural Springs in the Kingdom of Bahrain



Note: (from left to right) Ain Athari, Al Raha, Al Safahiya in the early 1950's and the late 1990's

Source: Al Kussaibi, 1997

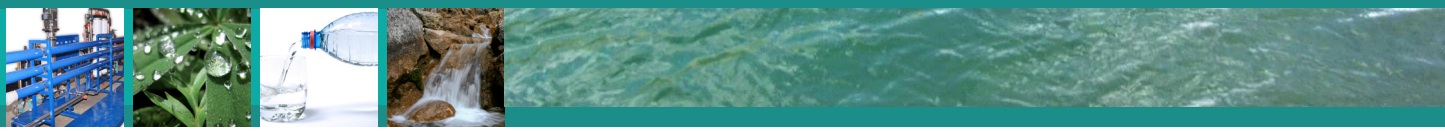
Until the 1930's, agriculture ranked second in terms of national income, right after the pearling industry. The cultivated areas accounted for a large percentage of the overall area of Bahrain (farmed lands declined from 0.036 ha per capita in 1924 to 0.009 ha per capita in 2003). Currently, agricultural activities are concentrated along a narrow coastline north of the main island and in the northern, central and eastern parts of the country. The economic and social value of agricultural occupations has gradually declined, as currently reflected in the deterioration of agricultural infrastructure since the 1960's (see photos in Exhibit 5). The combination of groundwater quality deterioration (the man source of irrigation water) and increased salinity have driven many agricultural lands out of production leading to desertification; these lands are gradually being consumed by residential developments which is more profitable than traditional farming.

Exhibit 5 - Deterioration and Loss of Agricultural Lands

The rapid increase in groundwater abstraction and the increased output of desalination and wastewater treatment plants have so far been able to cover the water deficit in Bahrain. However, this has also resulted in pollution. Non-traditional water resources are considered one of the major sources of environmental pollution in Bahrain. Water desalination has indeed contributed to meeting rising water demand across different sectors, however not without severe environmental repercussions. This includes stack emissions (clearly evident in the form of yellow plumes fumes that form above major water desalination plants such as Al Rifaa and Al Hidd plants) and liquid waste that is discharged into the marine environment, threatening several marine habitats that have both cultural and economic value.

If well managed, the impact of wastewater treatment plants should remain minimal. However, the main problem remains the disposal of raw sewage when the Tubli Plant is operating above load capacity; this contaminates the sea and destroys sensitive ecosystems that also have cultural and economic importance. Furthermore, water treatment produces large quantities of sludge every day. Sludge disposal has also become a burden at the Askar municipal landfill which is now close to shutting down its operations. The social impact of dealing with wastewater is an important challenge in societies that lack awareness of wastewater treatment concepts and that resist efforts to reuse treated wastewater for reasons pertaining to religion and cultural beliefs. These challenges are compounded by the fact that natural resources are becoming scarcer and water production costs are exorbitantly high.

The large demographic growth over the past 50 years was coupled with an increase in urban growth levels. The oil boom threw the door open for a development frenzy and urban redistribution in many of the Kingdom's towns and cities. As a result, consumption patterns changed, particularly with regards to the wellbeing of local citizens and residents in terms of water. Per capita water consumption in the municipal sector in Bahrain (about 511 liters/capita/day) now exceeds consumption levels in Europe and Japan (only 320 liters/capita/day). In 1996, water consumption in Bahrain was only 250 liters/capita/day.



4. response to Limit Water Quality Deterioration

Several authorities share responsibility for the management of water resources. The Ministry of Municipalities and Agriculture is in charge of compiling statistics on groundwater supply from different sources, as well as statistics on groundwater demand by sector. The Electricity and Water Authority oversees water production at desalination plants and the extent to which such water is being mixed with groundwater. The Authority also controls water distribution through the networks, and sets water tariffs. The Ministry of Public Works' main area of competence is the Tubli wastewater treatment plant which provides tertiary treatment to wastewater after which the treated water is piped to where it is needed. Most of the wastewater that is treated to the secondary level is discharged into the sea. A team comprising the Ministry of Health, the Ministry of Municipalities and Agriculture, and the Electricity and Water Authority was established to follow up on wastewater treatment operations, quality and usages. The Bahrain Center for Studies and Research conducts scientific research related to wastewater.

In mid-June 2007, Bahrain's Cabinet submitted to the Parliament a decree to amend the mandate of the Water Resources Council. The Council was established in 1982 to formulate water policies that would prevent resource depletion and quality deterioration, but it was unsuccessful.

Over the past few years, Bahrain's relevant authorities sought to adopt several policies and regulations that would put an end to the overexploitation of water resources. Many laws and resolutions were promulgated (see selection in Table 2) to regulate the use of water, set tariffs, and limit the deterioration of water resources.

In particular, the government of Bahrain was able to:

- Supply safe water to meet population requirements, in addition to sanitation. In this respect, the government assumed the largest share of costs related to production, distribution and treatment.
- Exert more efforts to protect public health and the environment. Bahrain adopted measures to guarantee water safety and provide sanitation services that comply with internationally-recognized standards.
- Reduce unaccounted-for water losses in the distribution system to less than 20% of the total flow (currently estimated at 18%). This was achieved by installing new pipelines of international standards. Furthermore, a leakage detection program was put in place at all sub-networks.
- Set in 1986 a sliding-scale tariff system for municipal water, by sector (see tariffs in Table 3). This tariff system has helped reduce per capita municipal water consumption. Moreover, a water rationing program was put in place for all subscribers. This program locates areas that show a sudden rise in water consumption, and then provides users in these locations with guidelines on how to install water saving devices; the program also examines the feasibility of such devices and distributes the devices to households.

Exhibit 5 - Deterioration and Loss of Agricultural Lands

Resolution / Decree	Discription
Decree on Law #2, 1971	On the regulation and monitoring of water controls
Decree on Law #12, 1980	On the regulation of water use
Resolution #23, 1980	Prohibits water abstraction the Ulat and Khobar strata
Decree on Law#7, 1982	Establishes the Water Resources Council
Resolution #10, 1982	Compels well owners to install water meters
Resolution #4, 1983	Extends the implementation of Resolution #23 of 1980 prohibiting the abstraction of groundwater from the strata of Al Ulat and Al Khobar, and issues licenses for cleaning up old or neglected water springs and wells
Decree on Law #12, 1997	Amends some provisions of Decree on Law #12, 1980
Resolution #6, 1997	Imposes a tariff on groundwater abstraction from the Al Khobar strata
Resolution #5, 1997	Registers artesian wells and swimming pools
Resolution #4, 1997	On the installation of water meters and the recirculation of water in wells and swimming pools
Resolution #2, 1998	Mandates the employees of the Water Resources Authority to enter farms and fine wrongdoers
Decree on Law #9, 1999	Amends the provisions of Decree-Law#12 of 1980 regarding the regulation of groundwater use
Resolution #5, 2000	Amends Article 1 of Resolution #6 of 1997 regarding tariffs on groundwater abstraction from the Al Dammam formation

Table 3 – Municipal Water Tariffs (Domestic/Industrial/Commercial

Desalinated Water Tariff for Domestic Use	
(m3)	Cents per m3
1 to 60	25
61 to 100	80
More than 100	200
Desalinated Water Tariff for Industrial and Commercial Use	
(m3)	Cents per m3
1 to 450	300
More than 450	400
Groundwater Tariff for Industrial and Commercial Use	
(m3)	Cents per m3
1 to 60	20
61 to 100	25
More than 100	85

- The Kingdom of Bahrain has issued several licenses for companies to desalinate seawater to produce bottled water for domestic consumption, despite the fact that municipal water complies with both GCC and international quality standards for drinking water.

Because there is no central authority responsible for all water-related issues and requirements, the intersection and overlapping of organizational mandates have limited the effectiveness of Bahrain's water response. The water sector still suffers from several problems due to the absence of a water policy that is capable of preserving traditional as well as non-traditional water resources in Bahrain.

Chapter Four

Land Use


1. Driving Forces and pressures

The accelerated growth in population size, coupled with economic and social development has increased demand on land to cater for urgent housing and investment needs. This has propelled local authorities to resort to the reclamation of shallow water coastal zones and the transformation of agricultural areas into areas for residential developments and other forms of investment. As a result, Bahrain's area grew from 660 km2 in 1963 to almost 760 km2 in 2007 - an average increase of 2.0 to 2.2 km2 per year (see Table 1).

Table 1 – Evolution of Bahrain's Overall Land Area

Period	Area in sqm
1963	661.03
1977	681.0058
1982	682.4615
1989	702.5579
1997	711.1578
2004	726.8345
2006	736.9535
2007	758.9399

Source: Geographical Information System, Public Commission, 2008

2. Current Situation

Dredging and reclamation operations continue to expand Bahrain's coastal zones to accommodate new:

(1) Residential areas

(2) Artificial and leisure islands (Durrat Al Bahrain, As Salam Beach, etc.)

(3) Seaports and bridges

(4) Power generation and water desalination plants

These plants are located near the coast to facilitate access to seawater for water desalination, cooling and manufacturing. Proximity to the coast also allows the discharge of process water directly into the sea. However, these activities often target ecologically-sensitive and vulnerable areas, and areas that are rich in biodiversity. Exhibit 1 shows the locations of the areas that were reclaimed over the course of time. Moreover, and due to the limited availability of continental sand needed for the construction sector, marine sand is often used to meet construction demand, and to carry out coastal zone reclamation projects in shallow waters. On average, 2.5 million tonnes of sand are dredged from the sea every year.

Table 2 - Industrial Areas in the Kingdom of Bahrain

Number	Industrial Zone	Year of Launch	Number of Projects	Overall Area/ m^2
1	Salman Port	1960	76	730,000
2	Al Maameer	1975	100	850,000
3	North of the refinery	1976	60	360,000
4	Dawar Sitra	1976	20	120,000
5	North of BAPCO	1976	-	1,740,000
6	Hafeera	1984	15	2,850,000
7	South of ALBA	1978	141	4,316,111
8	North of Sitra	1978	148	1.770.000
9	Aarad	1981	95	100,000
10	Al Hadd*	1978	50	8,880,000
11	Bahrain International Investment Park	2004	58	2,470,000
Total			763	24,186,11

Source: Department of Industrial Zones – 2008 Statistics, Ministry of Industry and Commerce

** Includes current projects such as ASRI, GIIC, Bahrain Business Incubator Center (BBIC)*

The overall area of industrial zones in Bahrain is estimated at over 24,186,111 sqm, which amounts to 3.5% of the Kingdom's total area. Exhibit 1 shows the distribution of industrial zones across the Kingdom's provinces. Because many are obsolete and/or did not undergo environment impact assessment studies when they were established, many industries contribute today substantially to air pollution. This applies to the power generation plant in Al Rifaa (see Chapter 2 on Air) and the adjacent marine environment. Furthermore, sand washing plants discharge their waste into the marine environment. Very often, this waste contains a high concentration of alluvium, which increases water turbidity in the Tubli Bay, formerly one of the richest marine environments in the kingdom (see Chapter 1 on Marine and Coastal Environment).

The lack of well-defined areas for service activities (light industries) away from residential areas, and the absence of sound planning when licensing the construction of industrial plants, have resulted in so called mixed zones whereby residential and industrial areas coexist. One example is the Maameer industrial zone adjacent to a village whose residents are routinely complaining about the emissions generated by nearby industries, and the continuous violation of their privacy either (i) due to the continuous movement of vehicles loaded with raw materials, or (ii) as a result of the settlement of immigrant workers, which is altering the social structure of the area.

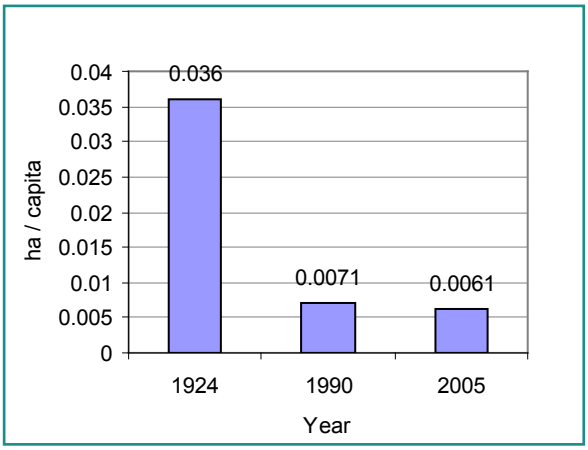
The solid waste resulting from heavy and light industries in Bahrain is generally non-hazardous. Except for the waste generated by aluminum manufacturing (ALBA) and related industries, and that of BAPCO, which is discharged at the Hafeera dump for hazardous and semi-hazardous solid waste, most of the industrial waste stream is non-hazardous and consequently disposed of at the municipal dump of Askar.

The economic development of Bahrain has also affected agricultural lands. Land uses have changed and many areas were driven out of agricultural production. Arable lands in Bahrain are estimated at 11,000 hectares (11% of the country's total area) of which 4,200 hectares are cultivated (6%), and irrigated. Of the cultivated area, 3,400 hectares are used for sustainable crops such as palm

Exhibit 2 - Distribution of Industrial Zones across Provinces

and fodder, and the remaining area (800ha) is planted with seasonal crops. Statistics show that the per capita area available for agriculture dropped from 0.036 hectares in 1924 to 0.006 in 2005 (see Exhibit 2). Pressures on Bahrain's agricultural sector include limited arable land, deterioration of agricultural lands, and real estate (shifting agricultural lands to real estate is more profitable in the short-term). Figure 4 illustrates the current status of agricultural lands in Bahrain following years of deterioration despite the fact that Bahrain used to have more than a million palm trees and used to attract visitors from neighboring countries during summer thanks to its green spaces and water.

Exhibit 3 - Agricultural Land per Capita



As a result of the accelerated demographic growth and economic prosperity that began with the oil boom, the number of vehicles in Bahrain increased rapidly, leading to a visible traffic problem in most cities. Traffic is now a normal occurrence in the capital, Manama, and has altered land uses in many parts of Bahrain.

The government bought off agricultural lands and residential areas, and resorted to sea reclamation to build bridges, tunnels and roads. This was part of an ambitious plan to upgrade and expand the road network, and build bridges to cater for the booming urban activities. Despite these efforts, streets and roads are still congested and unable to absorb the large number of cars and vehicles (estimated in 2007 at 345,350 vehicles). In addition, ongoing road construction projects are damaging important agricultural zones (such as the road leading to the new northern city) as well as vulnerable marine ecosystems (such as the road leading to the Amwaj Islands and Manama's North Bridge).

Exhibit 4 - Deterioration of Agricultural Lands

3. Impact

Bahrain's lifestyle has radically changed over the past 25 years, introducing radical changes in land use, particularly as a result of urban sprawl which occurred at the expense of rural and coastal zones. The impact of changing land uses can be summarized as follows:

(1) Threats to public health
(2) Sand storms and particulate matters
(3) Decline of the agricultural sector and the loss of important ecosystems
(4) Negative social repercussions attributed to a growing foreign labor force

3.1. Threats to Public Health

The overlapping of industrial and residential areas are causing several social and health problems. For a start, residents are exposed to many chemical pollutants because they live near industrial zones, particularly in Al Maameer, Al Nouaydrat and south of ALBA (Askar and Jau).

Over the past 10 years, residential areas have crawled rapidly and cities are now closer than ever to the peripheries of industrial zones. The rapidly expanding Hafira industrial zone will soon infringe

on nearby residential areas which are also expanding at an accelerated pace, especially in Askar and Jau. This transformation will be even more strongly manifested when the Friendship Causeway is completed in 2012 linking Qatar to Bahrain. Emissions from these industries differ as a function of the activity. Some residents south of ALBA and in Al Maameer complain about emissions from oil refining and aluminum extrusion. Residents in Al Rifaa complain about emissions from Al Rifaa power generation plant (established in 1978 and one of the oldest in Bahrain). There, residents can see the yellow clouds that settle over the plant all year round. The industrial area of Al Hadd is also an industrial pollution hot spot as it harbors several old industries and is witnessing the expansion of residential projects and other investments nearby.

The Directorate of Environmental Assessment and Planning conducted in 2007 a study on the impact of air pollution on public health (nitrogen oxides, sulfur oxides, carbon dioxide, particulate matters PM10) in the Kingdom of Bahrain. The study showed that there is an irrefutable link between increasing concentrations of PM10 and the surge in the cases of asthma, allergy and respiratory problems. The concentration of different pollutants in the air could also result in premature births and weight deficiency in newborns.

3.2. Sand Storms and Particulate Matter

A separate study also carried out by Directorate of Environmental Assessment and Planning showed that PM10 level in Bahrain increased from 1997 to 2004. The study further indicated that sand storms in the region occur primarily in summer, but could also occur during fall and spring. This is due to seasonal changes in atmospheric pressure, possibly attributed to climate change and its related impacts. Yet, many other factors may contribute to storm intensity, such as the concentration of residential complexes coupled with the dwindling green spaces in old and new cities (see photo). Moreover, the dispersion of sand dredged from the sea for reclamation or construction purposes is further aggravating air quality when sand storms occur.

3.3. Decline of Agricultural Sector and Loss of Important Ecosystems

The decline in agriculture and the degradation of the vegetative cover, such as the removal of trees and palms in the northern parts of the kingdom (they play a crucial during sand storms by intercepting particles), are the root causes behind the intensification of sand storms.

The decline of the agricultural sector has also accelerated the extinction of several ecosystems unique to Bahrain. As a result, many local products that used to distinguish Bahrain have simply disappeared. After a long history of self-sufficiency, Bahrain is now a net importer of palm products. The demise of local agriculture resulted in the extinction of several local products that had significant economic and cultural value, such as aromatic plants that are used in the manufacturing of locally produced medicines. Furthermore, there is a social impact stemming from the loss of many artisanal professions, which creates a burden for a segment of society who were actively engaged in the artisanal industry since many years and for many generations. There is also an economic dimension to this problem resulting from the need for the government to properly re-qualify these citizens into other economic sectors.

3.4. Social Repercussions Attributed to a Growing Foreign Labor Force

The rapid economic boom was coupled with the arrival of large numbers of foreign laborers (foreign laborers in Bahrain represent 40% of the total population, most of them being low-income laborers). This has created additional strains on the government's resources and services, particularly housing and healthcare. More importantly, these large communities of foreign laborers living near local residential areas are introducing new social values and behaviors that depart from their host (Bahraini) community. This is defying the specificity of Bahrain's society by injecting new moral standards that conflict with the culture of local residents.

4. Response

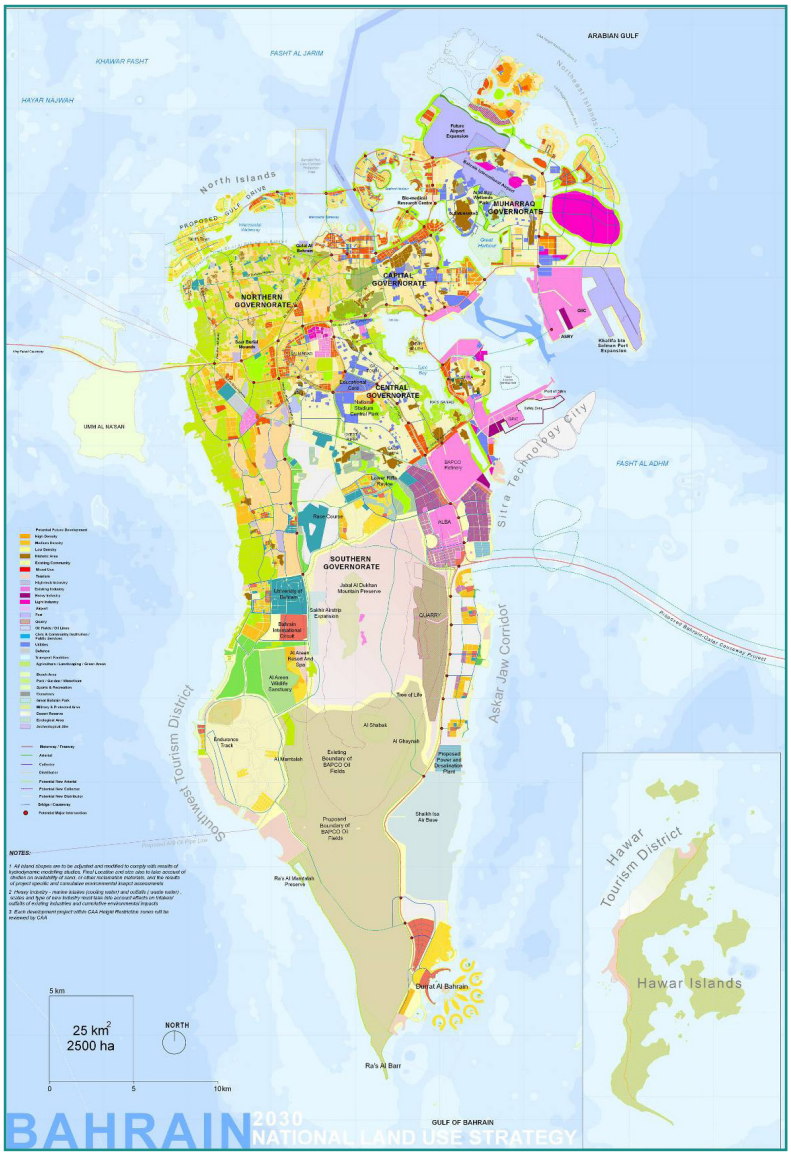
Many legislations and decisions were promulgated in an effort to regulate the occurrence of industrial zones near residential areas. For example, Decision No. 3 of 2005 on the required standards for service sites helped alleviate the problem of zones for light industries. Decision No. 1 of 1998 addresses the environmental assessment of projects and the need to subject the older ones to such an assessment in compliance with this decision. Finally, Decision No. 10 of 1999 and its amendments related to environmental standards encouraged many industries to modernize their processes and resort to clean technologies to reduce environmental pollution.

The 2007 National Structural Strategic Plan presented a long-term vision for the Kingdom of Bahrain over the 2030 horizon. The Plan emphasized the need to incorporate environmental considerations in the planning of all major projects (see overview in Exhibit 5) and also identified marine and land

areas that are vulnerable and/or important. The Plan reflects the desire of relevant authorities to balance between economic, social and environmental sustainability in an effort to achieve sustainable development.

Despite the existence of such plans and the promulgation of new land use legislations, the Kingdom of Bahrain still needs to take a closer look at the social, economic and environmental losses incurred (see Chapter 1 on Marine and Coastal Zone) due to large-scale residential and recreational projects. It is also our common duty to prevent the loss of precious, non-renewable, resources to large concrete cities that by no means reflect our social values.

Exhibit 5 – Bahrain 2030 National Land Use Strategy



Chapter Five

Biodiverstiy and Nature Reserves

Biodiversity is the infrastructure from which we proceed to a better understanding and preservation of the environment and its components. Biodiversity represents a cultural heritage for every civilization, which explains the particular attention given by the Kingdom of Bahrain to this matter, particularly with respect to the marine environment which gave Bahrain its very name. The Kingdom of Bahrain is conscious that by protecting biodiversity it is preserving culture, civilization and sustainable development. The sustainable protection of biodiversity helps society meet the present human needs by sharing these natural resources namely in the fields of public health and nutrition. Protecting biodiversity today will definitely help us meet our future needs. tomorrow.

What is biodiversity?

Biodiversity is defined as the different living organisms within a given ecosystem. The term «biodiversity» calls for a particular attention to «species». Therefore, «species» is the key element for understanding the dimensions of biodiversity.

The basic value of biodiversity lies in preserving the natural balance between all components of the ecosystem, and also in preserving the environmental, social, economic, educational and recreational values in a way that ensures the continuity and sustainability of life. Despite its small area, the Kingdom of Bahrain is characterized by remarkable biodiversity in terms of ecosystems and species.

Why should we care about biodiversity?
- It is the basis for understanding and protecting the environment
- It represents a cultural heritage for every civilization
- It meets the human needs in the present and future
- It preserves the balance between the different components of the ecosystem
- It durably preserves environmental, social, economic, educational and recreational values

1. KEY ISSUES

The state of biodiversity is affected by the following key issues:

1. The small geographical area of the Kingdom of Bahrain has indirectly contributed to the deterioration of biodiversity as a result of urban sprawl at the expense of various ecosystems on land and in sea.
2. The scarcity of rainfall has increased soil salinity and altered soil fertility. Scarce groundwater resources have also caused drought conditions affecting many agricultural areas.
3. The rapid demographic growth has increased pressure on environmental resources including fauna and flora. Both marine and terrestrial biodiversity are declining.
4. Temperature change linked to climate change has clearly contributed to the bleaching of coral reefs (observed in 1998).

2. STATE OF BIODIVERSITY IN THE KINGDOM OF BAHRAIN

The general status of biodiversity in Bahrain is not different from what it is globally in terms of habitat degradation and species decline. This is evident in the shrinking areas of these habitats and the loss and scarcity of some species.

2.1. At the Species Level

According to the (incomplete) preliminary statistics, the number of species in the Kingdom of Bahrain amounts to 1,361 (see summary distribution in Table 1).

Table 1 - Distribution of Species in the Kingdom of Bahrain by Group

Group	No of Species
Algae	34
Vascular Plants	357
Corals	24
Annelids	27
Sea Shells (Gastropods and Bivalves)	184
Crustaceans	64
Echinoderms	13
Insects	39
Arachnids	6
Fishes	239
Amphibians	1
Reptiles	20
Birds	331
Mammals	22
Total Number of Species	1,361

The number of vascular plants (wild and cultivated) amounts to 357 species, knowing that desert plants vary between annual and perennial.

Bahrain's environment is one of the most important environments in the Middle East. It is home to many types of birds and forms a major stop for the annual bird migration. The preliminary statistics indicate that the number of birds amounts to 331 species, 26 of which breed on the islands of Bahrain. The most important of these bird species is the Phalacrocorax nigrogularis, whereby Bahrain harbors the largest colony in the world (about 20% at the global population). Moreover, Hawar Islands are also home to the largest colony of breeding Egretta gularis in the Middle East.

Bahrain also harbors the second largest population of dugongs (Dugong dugon) in the world, a mammalian species, after Australia. Nearly 600 dugongs have been spotted south of the island of Bahrain. Despite the fact that there is no national list of threatened species, observations have showed the presence of some threatened species including the Arabian Toad Bufo arabicus, the Caspian Turtle Clemmys caspica, as well as the dugong Dugong dugon which is listed on the IUCN Red List of Threatened Species alongside green turtles. On a different note, there are some invasive species such as the crow and the Conocarpus tree that create a burden to Bahrain's biodiversity.

2.2. At the Ecosystem Level

The desert covers most of the land areas in Bahrain, with the exception of the green belt in the northern and western coastal regions and some central regions. Green spaces consisting of palm and date trees, as well as clover plants have covered the coastal area for thousands of years.

Palm fields are considered one of the most important and varied terrestrial ecosystems, and they consist of domestic as well as imported species. This ecosystem harbors many species of vascular plants, algae, stagnant water fishes, insects, amphibians and arachnids, along with several resident and migratory birds for which the ecosystem is their shelter.

These fields get their water supply from freshwater springs, many of which are drying up or have already disappeared. Fields became dependent on water wells operated using pumps. These wells have also experienced salinity buildup and their numbers are ever declining as a result of excessive water pumping. Consequently, date palm fields have begun shrinking in size, not only due to water scarcity and salinity, but also as a result of the considerable impact of urban sprawl.

The desert environment is usually rich in flora in spring and after rainfalls. Many species of wild drought-resistant plants cover large areas of southern Bahrain. As a result of rapid urban growth, this region will soon experience drastic changes and will certainly be affected in terms of area, resources and diversity.

The marine environment is no less harsh than its terrestrial counterpart; high water temperatures reaching 45°C and high salinity (as much as 60 ppt in some regions, especially in the south) exert tremendous pressure on marine life. Despite these harsh conditions, the marine environment boasts significant diversity:

Coastal Environments	Underwater Environments
Mangrove	Sea Grasses
Mud Flat	Coral Reefs
Sand Beaches	Algae
Rocky Beaches	Oyster Bed

2.2.1 Coastal Environments

Despite its small geographical area, Bahrain is characterized by an interesting diversity of coastal environments. These environments have their own physical and biological characteristics and their importance is manifested by pisciculture and the thriving of diverse marine organisms. The following are the most important of these environments:

2.2.1 Coastal Environments

Mangrove Ecosystem

Mangroves have a particular importance that stems from the richness and diversity of their living organisms. Mangroves form a habitat for sea birds, fishes, crustaceans and several marine organisms. The only species of mangrove present is the Grey Mangrove Avicennia marina. In terms of geographical distribution, mangroves are concentrated in three main regions in Bahrain:

Tubli Bay	Mangroves are found in several locations in Tubli Bay, whereas the largest (in terms of number, size and density) are located in the area of Ras Sanad. Very rich in biodiversity and able to outlive many other species, the mangroves cover an area of about 0.5 km^2. As a result, this area has been classified a Type A Protected Area. There are also some mangrove bushes north of Tubli Bay near the sewage outfall. They are considered the second largest population of mangroves. Other smaller populations are scattered in the gulf (regions of Aker, Nouwaydarat and Nabih Saleh)
Arad Bay	Mangroves have been successfully cultivated in Arad Bay Reserve since the 1990's and are still standing to this day, thus enhancing biodiversity in the region.
Ras Hayyan	It is located in the eastern part of the island of Bahrain, near the National Center for Fish Farming. These mangrove trees have also been cultivated successfully.

Mudflats Ecosystem

Mudflats are found on many islands of Bahrain, but the largest are the mudflats located on the east coast of the mother island particularly in Tubli Bay, Ras Hayan, Al Mamtala and Hawar Islands. The importance of these mudflats lies in their biodiversity that results from phytoplankton that decompose soil organic matter. Therefore, this ecosystem constitutes a major rest area for migratory seabirds particularly the Greater Flamingos Phoenicopterus ruber. According to one study, more than 45 bird species are attracted by mudflats.

Sand Beaches Ecosystems

This ecosystem can be divided into two subcategories: natural sand beaches and artificial sand beaches. The most important regions of this ecosystem are Umm Jalid Island, Qlaiyah Island, Umm al-Na'san Island, Noun Island, and some of the Hawar Islands. The artificial beaches result from sea reclamation at a specific inclination and are usually used for recreational development. They are mostly common in some areas of the north such as Sanabis.

The most important characteristic of these beaches is that they are home to the ghost crab, Ocypode saratan. Moreover, this region is known for the abundance of crustaceans of the isopods type, gastropods and bivalves which attract birds that feed on them.

Rocky Beaches Ecosystem

Rocky beaches are located in some islands such as Nabih Saleh Island, Al Yasouf Island and some of Hawar Islands. They are characterized by the clear distribution and concentration of the living organisms that thrive on these coasts. They also consist of small water pools that house some organisms that rely on the movement of ebb and flow for their survival. Most importantly, these rocky beaches are home to marine barnacles and some phytoplankton that have a distinctive color, in addition to some species of shellfish and marine crabs.

2.2.2 Underwater Ecosystems

Located in the water at different depths, these ecosystems include:

Sea Grass Ecosystem

The sea grass ecosystem is scattered across different areas of the island of Bahrain, the densest of which is in the southeastern waters. It is one of the most important marine ecosystems since it forms a nutritional source of primary productivity and has a high concentration of biodiversity. Therefore, this ecosystem is a breeding ground for dugongs Dugong dugon and the green turtle Chelonia mydas, which are both threatened species.

The economic importance of this ecosystem resides in the fact that it is a nutritional source for commercial fishes especially Siganus canaliculatus, a habitat for Penaeus semisulcatus shrimps, and a refuge for Pinctada radiata. There are three different species of sea grass: Halodule uninervis, Halophila ovalis and Halophila stipulacea.

Coral Reefs Ecosystem

Coral reefs are located in the north and east of Bahrain, the largest of which is Fisht Al Azem east of Sitrah Island, with a total area of 85 km2, followed by Fisht Al Jarim. Some coral reefs are scattered around the island of Bahrain; however the richest, best and most diverse coral reefs area is Hair Abu Luthama in the far north of Bahrain.

The importance of coral reefs lies in the fact that they promote biological balance in the marine environment. Coral reefs are considered one of the richest productive environments on earth. According to some studies, there are 31 coral species in Bahrain. Coral reefs suffer from natural pressures such as high salinity and temperature. In 1998, widespread coral bleaching occurred due to rising sea temperatures resulting in the loss of 90% of all coral reefs in Bahrain.

Algae Ecosystem

There are more than 34 species of marine algae that were classified and accurately catalogued. Algae are common throughout Bahrain. They often coexist with other ecosystems. For example, during summer, mudflats are covered with green algae in Tubli Bay region. In other cases, they thrive independently in deep water creating separate groups. However, phytoplankton does not create a stable environment; they move with water currents and many marine organisms feed on them.

Oyster Bed Ecosystem

The bottom of this ecosystem is usually rocky allowing oysters better anchorage. These ecosystems are usually common in the far north, east and south of the island of Bahrain. Among Bahrain's eight species of oyster, as determined in a specialized study, the Atlantic pearl-oyster Pinctada radiata is the predominant species.

3. PRESSURES AND RESULTING EFFECTS

Pressures on biodiversity can be summarized as follows (see photos in Exhibit 1):

1. Population growth and urban sprawl
2. Sea reclamation and dredging in marine and coastal environments
3. Depletion of groundwater resources
4. Soil degradation and soil salinity build-up
5. Overfishing and overhunting of some species of fish and birds

Exhibit 1 - Pressures and Threats to Biodiversity

Depletion of underground water resources

Sea reclamation and excavations in the coastal and underwater marine environments

Urban growth and construction expansion on land

Soil degradation and high soil salinity

Overfishing and overhunting

The impact of biodiversity changes can be divided into two parts: (1) the impact of species loss and the (2) impact of alien species.

3.1. Impact of Species Loss

(1) The decline of biodiversity has led to the loss of Bahrain's cultural identity in terms of flora such as palm and desert plants. Bahrain is also losing some species of endemic fishes, sea turtles, freshwater turtles and others.

(2) The loss or scarcity of genetic material that have economic, social, environmental and/or health value has also had a negative impact as is the case with some wild medicinal plants.

(3) Endemic fauna and flora have a tourism/recreational value. Their loss or scarcity therefore has resulted in a direct impact on the tourism sector, which may in the future affect the local economy if it is not addressed. An example in this regard is the scarcity of some freshwater turtle species.

(4) The landscape value of ecosystems and species has been declining (i.e., the area of some ecosystems is shrinking and the occurrence of some species is declining). For example, the mangrove ecosystem in the Tubli Bay is shrinking and so are some desert ecosystems including their fauna and flora.

3.2. Impact of Alien Species

(1) Alien species contribute to the loss of naturally occurring biodiversity by competing with endemic species and plant communities, leading to reductions in numbers. An example of this is the farming of Conocarpus sp. tree, which not only competes with local plants, but also affects agricultural production by depleting soil and water nutrients.

(2) Some alien species feed on local wildlife species, which may result in population decline. An example of this is the crows that arrive to Bahrain on vessels from overseas.

4. RESPONSE TO MITIGATE BIODIVERSITY DEGRADATION

In an attempt to preserve Bahrain's biodiversity, which is quite significant despite its small area, there have been many efforts resulting in notable responses, on more than one level.

4.1. Environmental Legislation

There are about 17 local legislations and laws directly related to biodiversity and about 7 others that have an indirect impact on biodiversity.

At the regional and international levels, Bahrain has signed several conventions related to biodiversity, summarized in Table 2 below.

Table 2 – Conventions Related to Biodiversity

Regionally	Internationally
(1) Kuwait Regional Convention on the Protection of Marine Environment (1978) and the Protocol on Biological Diversity (2) Convention on the Establishment of a Regional Commission for Fishing Grounds (2002) (3) Convention on the Conservation of Wildlife and Natural Habitats in the Countries of the Gulf Cooperation Council in 2002	(1) Convention on Biological Diversity (1996), (2) Ramsar Convention on Wetlands (1997), (3) United Nations Framework Convention on Climate Change (1994), (4) Convention on the Protection of the World Cultural and Natural Heritage (1991)

These conventions and their resulting obligations have helped the Kingdom of Bahrain assess the state of the environment and conduct specialized studies, which have resulted in the promulgation of local decisions to protect biodiversity. Furthermore, these conventions play a positive role in preserving biodiversity and natural ecosystems. For instance, the signing of the Convention on the Protection of the World Cultural and Natural Heritage and the subsequent designation of the Bahrain Fort (Qal'at al-Bahrain) a world heritage site has contributed to protecting the coastal environment near the fort from construction.

Table 3 - Legislation Affecting Biodiversity either Directly or Indirectly

Legislation Having an Direct Effect on Biodiversity	Year
1- Animal Welfare Act Promulgated in 1920, Article (25) of this Act prohibits hunting of all kinds of birds and their selling on the market.	1920
2 - Government Declaration on the Prevention of Mud Removal Issued in May 24, 1941, it prevents the removal of mud and mangroves from the sea in the area between Maktaa Tubli and Radem Al Kori.	1941
3 - Resolution No. (26) of 1980 on Shrimp Fishing Article (1) states that (shrimp fishing is prohibited within the fishing limits in Bahrain during the period from March 1 through June 30). This resolution is reissued almost every year.	1980
4 - Law on the Protection of Palm This Royal Decree No. (21) on the protection of palm trees was issued in 1983 to ban cutting down palm trees or the obstruction of their growth in any way. It also stipulates taking care of them to ensure their survival, in an effort to preserve this heritage and natural renewable resource, and protect it from deterioration and extinction.	1983
5 - Resolution No. (4) of 1986 banning dugong fishing	1986
6 - Resolution No. (6) of 1986 specifying the sizes of fishing nets	1986
7 - Resolution No. (8) of 1986 preventing the fishing of baby rabbit fish	1986
8 - Royal Decree No. (2) of 1995 on Wildlife Protection It aims to protect various species of wild terrestrial and marine organisms, including rare and threatened species of animals, plants or birds.	1995

9 - Decision of the Council of Ministers on the prevention of sea reclamation and construction in Tubli Bay The decision of the Council of Ministers in its session No. (1341) held on April 16, 1995 was issued to prevent sea reclamation and construction in Tubli Bay, which is one of the most important natural ecosystems at the economic, environmental, social, cultural and landscape levels.	1995
10 - Decision Designating Hawar Islands a Protected Area For the protection of the unique natural heritage of Hawar Islands, the Decision of the Council of Ministers No. (16) of 1996 was issued to declare Hawar Islands and the adjacent waters a protected area	1996
11 - Decree No. (21) of 1996 on the Environmental Law It aims at protecting the environment from sources of pollution, and halting the environmental degradation by formulating and implementing necessary plans and policies to protect the environment from activities that damage public health, agricultural crops, marine and terrestrial wildlife, climate and other natural resources. This is the second such legislation after Law No. (2) of 1995.	1996
12 - Decree Law No. (20) of 2002 on regulating fishing and the exploitation and protection of marine resources This law aims at the protecting fisheries and marine resources in general.	2002
13 - Ministerial Decision (1) of 2002 on declaring Jazirat Mashtan and the surrounding waters a protected area	2002
14 – Resolution No. (4) of 2003 for the prevention of the fishing of dugongs, sea turtles and several dolphin species	2003
15 – Resolution No. (5) of 2003 on declaring the region of Arad Bay a nature marine reserve	2003
16 - Law No. (5) of 2003 on approving agricultural quarantine in the GCC countries. This law (regulation) aims at preventing the spread of agricultural pests, protecting the environment and plant resources, and easing trade.	2003
17 - Law No. (8) on approving the veterinary quarantine system in the GCC countries, which regulates the import and export of all species of animals, animal products, derivatives, waste and fodder of animal contents, animal biological products and tools from and to the member states.	2003
Legislation Having an Indirect Effect on Biodiversity	**Year**
18 - Ministerial Decision No.10 of 1998 on the adoption of taxes related to permits and other services provided by the Environmental Commission	1998
19 - Ministerial Decision No.10 of 1998 on controlling ozone-depleting substances (ODS)	1998
20 - Ministerial Decision No.10 of 1998 on the upkeep of buildings and equipment containing asbestos	1998
21 - Ministerial Decision No.3 of 2000 on environmental control	2000
22 - Ministerial Decision No.3 of 2000 on the registration of consulting agencies for conducting environmental impact assessment of studies	2000
23 - Ministerial Decision No.1 of 2000 on medical waste management	2000
24 - Ministerial Decision No.7 of 2002 on the control of banned chemicals and chemicals of specific use	2002

4.2. Nature Reserves

Bahrain started the establishment of a number of reserves for the conservation of biodiversity. Al Areen Wildlife Park & Reserve was the first nature reserve, followed by Ras Sanad and Tubli Bay Reserve, Hawar Islands Reserve and adjacent waters, the island of Jazirat Mashtan Reserve and adjacent waters and finally the Arad Bay Reserve. The following sections describe each reserve in some detail.

(1) Name: Al Areen Wildlife Park & Reserve

Reserve location: Central west of the island of Bahrain	Reserve classification: A reserve and a recreational park for the protection of Arab species.
Reserve total area: 5.6 km^2	
Year reserve was declared: 1976	
Most important plant and animal species: Perennial plants (31 species), annual halophytes (22 species), as well as three animal groups: mammals (35 species), birds (54 species) and reptiles (11 species).	

Most important characteristics:

The reserve consists of two parts:

(1) The Reserve is dedicated to the conservation of desert in the Kingdom of Bahrain. This nature reserve is only open for scientific research and specialists; it aims to protect all desert species including animals and plants, most importantly the Arabian Oryx (Gazella arabica), Bahrain's Goitered gazelle (Gazella subgutturosa) and Decne plants (Leptadenia pyrotechnica).

(2) The Park deals with the preservation and breeding of Arab species of animals and birds in particular, it is open to groups and individuals provided that they are accompanied by qualified guides. In addition, the park has specific educational objectives aiming at raising public awareness on the importance of preserving wildlife and biodiversity, especially among students.

Description of the geography and geology of the region

There are two types of soil depending on the physiographic area. The soil in the western part of Al Areen is sandy, calcareous, salty and often with a high gypsum content and a shallow groundwater. In this part, the main vegetative cover is Decne plants (Leptadenia pyrotechnica), after which the area was named. In the eastern part, the sandy soil is varied and contains a lot of small stones and gravel, in addition to soft sediments and sand dunes due to the prevailing winds. In this region, vegetation is very scarce and limited to some shrubs that were planted to provide shelter for animals. In general, about 70% of the reserve area contains porous sandy red soil, about 10 feet deep, while the rest is clayey, stony and calcareous.

(2) Name: Ras Sanad and Tubli Bay Reserve

Reserve location: Northeast of Bahrain	Reserve classification: A Category II Natural Reserve (Nature Park)
Reserve total area: 13.5 km^2	
Year reserve was declared: 1988, 1995, Ramsar Convention 1997, 2006	
Description of the geography and geology of the region: The most important plant and animal species in the area: mangroves, 19 species of fishes and shrimps, migratory birds, summer and winter birds (plover, dunlin, sea gull and lark).	

Most important characteristics of the reserve

The environmental importance of Tubli Bay has two facets: the diversity of (1) the natural ecosystems and (2) plant and animal wildlife. Ecosystems in the bay include the mangroves, sea grasses and mudflats that are characteristic of Tubli Bay. Ras Sanad was also declared a Ramsar Site, pursuant to the Ramsar Convention which was ratified by the Kingdom of Bahrain in 1997.

Reserve location: Hawar	Reserve classification:
Reserve total area: 51.4 km^2	A Category II Natural Reserve
Year reserve was declared: 1996	(Nature Park)
Most important plant and animal species Salt marshes, marine algae, coastal vegetation and inland plants. The most important birds species are Socotra cormorant, white-cheeked tern and greater flamingo, reptiles, amphibians and land and sea mammals, most importantly dugongs.	

Most important characteristics of the reserve: N/A

Description of the geography and geology of the area:

The islands consist of limestone, the result of the accumulation of marine sediments over a very long period, reaching up to 19 meters. There are several rocky islands that are characterized by rocky shores. The eastern part is jagged and is composed of stagnant lakes with mud sediments.

Reserve location: Al Muharraq City (north of the island of Bahrain)	Reserve classification: Natural Marine Reserve
Reserve total area: about 0.5 km2	
Year reserve was declared: Resolution No. (4) of 2003 Director of the Public Commission for the Protection of Marine Resources, Environment and Wildlife	
Most important plant and animal species: Farmed mangroves and birds	

Most important characteristics of the reserve:

The Arad Bay is considered one of the rare marine environments in the Kingdom of Bahrain and an important rest area of resident, passing and migratory water birds searching for food and shelter. Because it is calm, the small lake attracts small fishes and larvae of other marine organisms. Moreover, mangrove trees provide such microorganisms with the appropriate protection and organic materials that form the very basis of the food chain. The lake also harbors algae species which usually grow in the summer and help sustain the breeding of some fish such as the white-spotted rabbit fish (Siganus canaliculatus). Therefore, many fishermen come here to collect these algae and use them in fishing.

Description of the geography and geology of the region:

It is a tidal environment where water recedes in full. At the same time, it is a semi-closed, calm and quiet marine area.

(5) Name: Mashtan Island

Reserve location: southeast the island of Bahrain and north of Hawar Islands, with an area of 2.8 km^2	Reserve classification: N/A
Reserve total area: 2.8 km^2	
Year reserve was declared: Resolution No. (1) of 2000, President of the Public Commission for the Protection of Wildlife	
Most important plant and animal species:	

Most important characteristics in the reserve:

The area around Mashtan Island is an important nutritional source for fishes. It is inhabited by the Sargassum seaweed which is known for its length. In the northern part of Mashtan, the sea grass Halodule uninervis was observed at 1-meter depths.

Description of the geography and geology:

The coasts of Mashtan Island offer excellent sandy beaches. On the Arab coast of Mashtan, there is a rocky seabed (no reefs) covered with a thin layer of sand.

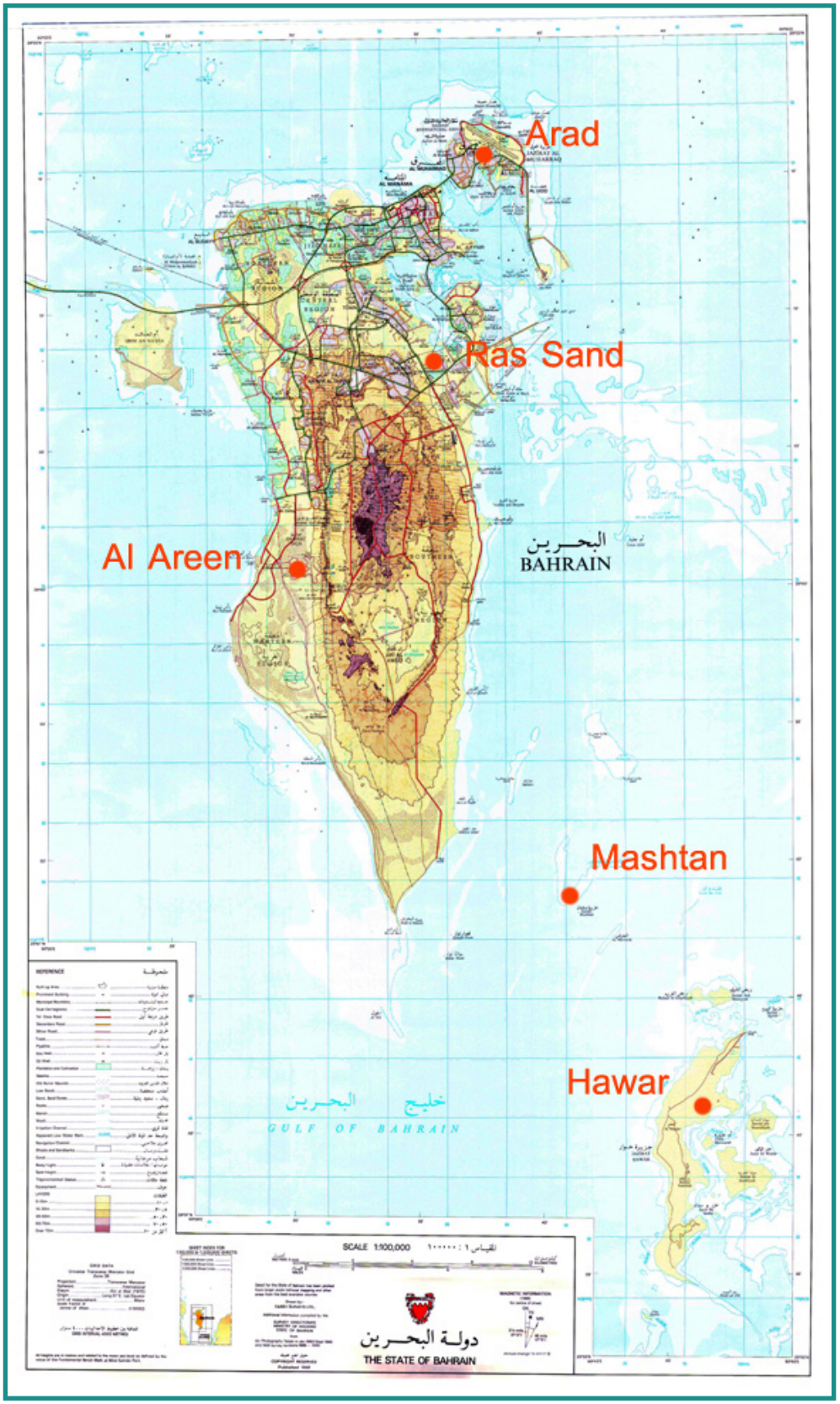
Most important plant and animal species:

The island is home to many of Bahrain's salt tolerant plants and it is also well known for some characteristic birds such as the Socotra Cormorant. The waters surrounding the Kingdom are home to many important marine plants and organisms with direct economic benefits, such as lobsters, shrimp, stingray, halfbeak, needlefish, rabbit, groupers, angel fish, and threadfin breams.

In the north and northeast, the region is characterized by the prevailing species of grasses Halodule uninervis, and another species such as Halophila stipulacea. It is the largest source of primary production and is found in high concentrations extending far to the north. Sometimes they occur in patches and harbor the threatened dugong (Dugong dugon); reportedly the second largest population of dugongs in the world. The surrounding waters host two species of sponges (the red sponge and the blue haliclona) and several species of tunicates.

There are also some unclassified reserves in the military area south of Bahrain.

Exhibit 2 – Location of Nature Reserves in the Kingdom of Bahrain



4.3. Breeding of Species

This initiative aims to increase the population of those organisms that began to decline rapidly or are on the verge of extinction. Trials have so far produced good results. In fact, these species are bred and re-integrated in their natural habitats. There are five methods for breeding, either direct or indirect, as summarized next.

First: Breeding living organisms in designated areas (ex-situ) and reintegrating them into their natural habitat

One such example was carried out by the National Center for Fish Farming which succeeded in farming several fish species that had started to show declining populations, including the Java Rabbit fish (Siganus javus) and the grouper (Epinephelus multinotatus).

Moreover, Al Areen Wildlife Park & Reserve plays an equally important role in captive breeding, particularly the Oryx and the antelope, which are later released into the protected southern regions or in Hawar Islands. Al Areen Wildlife Park & Reserve also contributes to the breeding of frogs and freshwater turtles, which began to decline in recent years due to urban sprawl and population growth. These trials were also successful.

Second: Creating artificial environments similar to the natural environments

For example, concrete blocks are placed on the seafloor to help reestablish, after some time, a rich and diverse ecosystem whereby algae grows on the surface of the concrete and becomes a haven for fishes and many other marine organisms, allowing natural reproduction (a.k.a., artificial reefs). The process of placing concrete blocs in the water to serve as artificial reefs has proven successful.

Third: Regulating fishing

Fish regulation aims to prevent fishing at certain periods of the year in order to provide opportunities for the reproduction of living organisms. One clear example is the banning of shrimp fishing from March to July of every year. Moreover, the hunting ban on the Bahraini nightingale contributed to the active breeding and reproduction of this bird in its natural habitats.

Fourth: Fishing Ban

A ban on fishing primarily targets threatened species - although there is no established list – such as dugongs, dolphins, sooty falcon, ospreys and turtles. The fishing ban stipulated by domestic laws help living organisms reproduce in their natural habitats and increase population size to fend off the threat of extinction. In this regard, the Environment Commission has taken a decisive step by banning the hunting of the nightingales following their sharp decline a few years ago. As a result, nightingale populations have been restored despite the shrinking area of their natural habitats.

Fifth: Plant tissue culture

This method aims at preserving the beneficial species selected according to specific criteria, by multiplying them in a way that guaranties their survival. Bahrain is currently employing tissue culture techniques on date palms and tangible results have already been achieved.

4.4. Environmental Information and Education

Information plays an important role in shaping the public perception of different concepts. Biodiversity is one of the issues that have received significant media coverage in the Kingdom of Bahrain. Many publications, studies, books and documentaries have been issued both in Arabic and English.

Environmental education and awareness have also been promoted through seminars and conferences

organized by public agencies, NGOs and the private sector, all aiming at explaining the concept of biodiversity and conservation tools. The National Museum is also playing a leading educational role in shedding light on Bahrain's civilization and cultural heritage. The Natural History Hall and the Diving Museum showcase a selection of wildlife species that help anchor a sense of environmental belonging. Soon, an official website highlighting Bahrain's biodiversity will be launched to boost environmental education further. This website will respond to Article 17 on facilitating the exchange of information.

4.5. Ecotourism

Ecotourism aims at exploring wildlife sites for the purpose of studying, appreciating and enjoying them. Bahrain possesses some ecotourism assets such as the nature reserves listed in Section 4.2, especially in relation to bird-watching. Additionally, there is a small site in the northwest of Bahrain that harbors thousands of Grey Hypocolius (Hypocolius ampelinus) migrating from Iran and Iraq. This site has a global importance and is also a favored destination for eco-tourists. Moreover, traditional fishing sites that use set nets are scattered around the coasts of Bahrain. This fishing technique, rather uncommon around the world, has become an important attraction for tourists.

Freshwater springs (terrestrial and marine), which were once a major source of attraction for ecotourism, have now all disappeared. These unique ecosystems harbored significant biodiversity but have gradually dried out due to environment pressures on groundwater. Bahrain is supporting the private sector in the field of ecotourism by facilitating the issuance of licenses for practicing ecotourism.

4.6. Building national capacities and promoting scientific research

The Kingdom of Bahrain strives to build national capacity and develop available resources to support scientific research. This is where the role of the Bahrain Center for Studies and Research and several other research centers at public and private universities comes to the forefront. Through government and private sector support, the Kingdom of Bahrain has introduced several awards for recognizing outstanding research in environment and/or biodiversity. One example is the Crown Prince Award for Scientific Research and Environmental Studies.

4.7. Environmental Monitoring

Environmental monitoring targets ecosystems and sensitive habitats (of significant environmental importance) as well as species (especially those that are threatened and or endangered). The Monitoring Department has produced a preliminary inventory of fauna and flora indicating the number of species, particularly those that are abundant such as vascular plants, algae, birds, mammals, reptiles, amphibians and fishes. However, there are still some weaknesses in the inventory pertaining to microorganisms such as phytoplankton and zooplankton, fungi, insects and bacteria.

The monitoring system also evaluates environmental components and wildlife as well as the impact of human activities upon them. Therefore, the monitoring system examines the quality of the ambient environment and emission levels, and produces environmental forecasts. It performs high-level scientific and technical tasks in planning and implementing environmental monitoring strategies and verifying scientific findings, in addition to providing the data and the information to support environmental decision-making.

With regards to genetic diversity, there is no monitoring program in place.

4.8. Environmental Impact Assessment

Projects that potentially affect biodiversity must undergo an Environment Impact Assessment (EIA) process, to be followed by mitigation measures to reduce or avoid adverse impacts.

4.9. Integrating the concepts and elements of biodiversity in education

Environmental education aims at directing behaviors towards the environment and biodiversity. In addition to the scientific concepts taught to students as part of the academic syllabus, there is also an educational process that aims to instill among students a sense of environmental belonging, and to direct their behavior towards biodiversity preservation. There are currently 14 textbooks currently used by high-school students (in addition to manuals and booklets from earlier school years); some make direct reference to biodiversity while others address biodiversity indirectly through, for example, photos. The following is a list of some of these books:

- Book on Living Organisms and the Environment (Volumes 1 and 2)
- Book on Microorganisms
- Trees and Shrubs of Bahrain
- Medicinal Plants
- Birds
- Book on Metabolism and Balance (Volumes 1 and 2)
- Book on Cell Biology and Genetics
- Book on Basic Marine Sciences
- Book on Living Organisms
- Foundations of Scientific Agricultural Fields (Volumes 1 and 2)
- Principles of Agriculture for the Primary School

On a different level, environmental committees and clubs in schools and universities also help integrate biodiversity in the educational process, and thereby have a positive impact on student behavior. The project "Friends of the Environment Schools" sponsored by the Department of Public Relations and Information is playing a leading role by introducing students to environmental practices and lessons. Therefore, it is safe to say that the educational sector in Bahrain complements other efforts in environmental protection and biodiversity conservation.

Chapter Six

Waste


Waste management is currently considered one of Bahrain's most important challenges as it poses intricate and complex problems for modern urbanizations. Waste management has become one of the strategic pillars of sustainable development. Bahrain is currently struggling to manage wastes from multiple sources including household (domestic), industrial, agricultural, and healthcare. Bahrain's waste management crisis is exacerbated by the accelerated increase in waste volume, limited geographical area, scarcity of safe waste-disposal sites, in addition to the lack of environmentally appropriate technologies for waste handling and treatment. Inappropriate waste handling and disposal causes soil, water and air pollution. Solid Waste Management (SWM) has therefore become a global necessity for protecting public health and the environment.

Addressing this important ecological problem in a manner that is socially, environmentally and economically sound is now a top priority. The Kingdom of Bahrain is approaching SWM by strengthening, enforcing and enhancing the role of the Public Commission for the Protection of Marine Resources, Environment and Wildlife. Hence, the Public Commission can then formulate policy instruments and implement long-term solutions.

Compelling reasons for resolving the solid waste problem:

(1) Waste generation is increasing rapidly due to growing consumption, which is directly attributed to economic and demographic growth;

(2 Waste is tarnishing Bahrain's civil image;

(3) Waste is impacting and constantly harming the environment and public health; and

(4) Waste can serve as raw or secondary material to support environmentally-friendly industries

1. The Current Situation

1.1. Municipal Waste

Several studies on the municipal waste stream showed that waste volumes have been increasing steadily to reach more than 3,000 tons/day in 2006. Municipal waste increased by 173% during the period 2000-2006, as illustrated in Exhibit 1.

1. The Current Situation (continued)

1.1. Municipal Waste (continued)

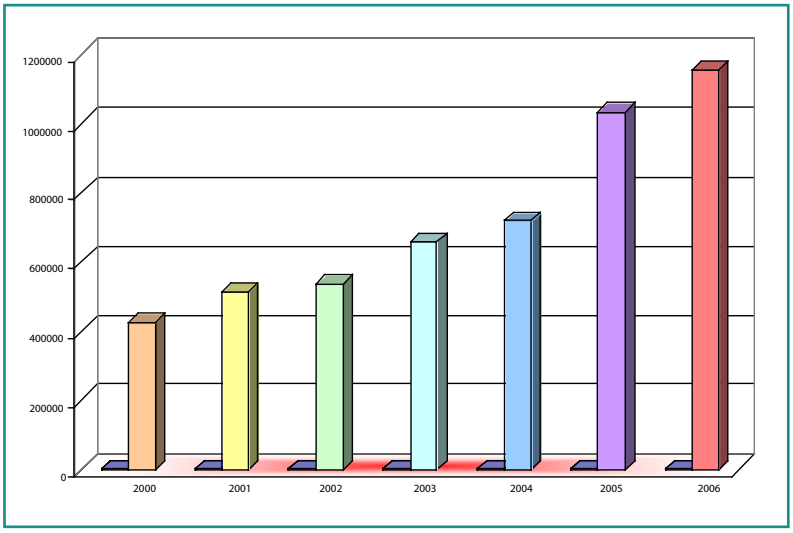


Exhibit 1 - Municipal Solid Waste Generated (2000 to 2006) in ton/year

Ministerial Order #3 of 2006 related to hazardous waste management defined municipal solid waste (MSW) as litter, food residues, fruit and vegetable waste, office waste and other types of non-hazardous waste that originate from residential, commercial, and industrial areas, as well as recreational centers, educational and health facilities, and from social activities. Exhibit 2 shows the composition of MSW in the Kingdom of Bahrain.

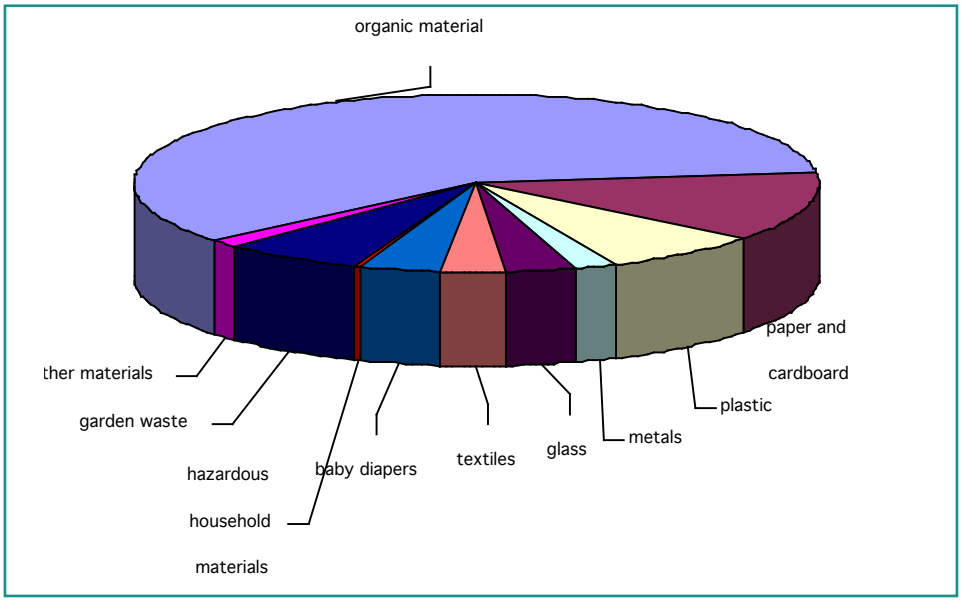


Exhibit 2 – Composition of Municipal Solid Waste in the Kingdom of Bahrain


1.2. Industrial Waste

The volume and composition of industrial waste in Bahrain vary according to the type and size of the industry which can be large, medium or small in size. Statistics from the year 2000 showed that industries generate on average about 384 tons/day, equivalent to 140,000 tons/year.

1.3. Used Oil

Used oil (a.k.a. waste oil) is a serious source of concern in the Kingdom. Of the total volume of oil used, engine oil represent about 80% of the total demand, followed by electric generator oil (at 15%) and brake gearbox oil (only 5%).[3]

1.4. Medical Waste

According to Ministerial Order #1 of 2001 on Hazardous Medical Waste Management, hazardous medical waste is generated from healthcare activities such as nursing, therapeutic and diagnostic healthcare, including the activities of laboratories, research centers, dental treatment, veterinary treatment, drugs and medications produced by pharmaceutical plants and warehouses. This definition complements earlier definitions provided by Ministerial Orders from the Ministry of Health in coordination with the Ministry of Municipal Affairs and the Environment.

Bahrain's hospitals, healthcare centers and clinics generate an estimated 3 tons of clinical/medical waste per day. Total generation increased from 514 tons in 2002 to 1,200 tons in 2006.

1.5. Liquid Waste

In the absence of alternative treatment methods, non-hazardous liquid waste is currently discharged at the Aaskar municipal landfill (located in a quarry area, 25 km south of Manama and 3 km northwest of the village of Aaskar). This landfill is owned and operated by the Ministry of Municipal and Agricultural Affairs. Nearly 2 million gallons of non-hazardous liquid waste from industries have been landfilled at this site to date.

2. Impact of Waste on the Environment and Public Health

For years now, Bahrain has been disposing unsorted municipal waste in Aaskar landfill; this practice releases several greenhouse gases that contribute to climate change. Methane, a main greenhouse gas, is emitted by the decomposition of organic waste materials in landfills. The daily accumulation of solid waste represents a major challenge to municipal affairs. The current delay in the privatization of solid waste collection and treatment services can lead to the spread of diseases.

There is only one secure landfill for hazardous and semi-hazardous industrial waste. Industrial waste generation is rising steadily, creating more pressure on land use. Treatment facilities for industrial waste, particularly liquid waste, are currently non-existent. Table 1 presents daily waste generation by source (municipal, industrial and medical), including waste characteristics and disposal methods.

Table 1 - Waste Generation, Characteristics and Disposal Methods

Source	Quantity (ton/day)	Characteristics	Disposal Method
Municipal	3,000	Mixed waste	Aaskar Landfill
Industrial	384	Hazardous, semi-hazardous, non-hazardous	Aaskar/ Hafira Landfill
Medical	3	Hazardous	Medical waste incinerator

3. Waste Management Efforts

3.1. Industrial waste

The Hafira Landfill for hazardous and semi-hazardous industrial waste was established in 2001 as one component of integrated waste management that provides a safe disposal of industrial waste with no harm to the environment and public health. Ministerial Order #3 of 2006 on hazardous waste management was issued to support and legalize waste management. The Ministerial Order also determined the legal and administrative tools to control waste and prevent the spread of harmful pollutants that degrade the environment, wildlife and public health. During the period from 2001 to 2006, the Hafira Landfill received an estimated 70,000 m^3 of industrial waste (see photo).

Liquid Waste Evaporation Basin at Hafira Industrial Landfill


Given the absence of industrial waste treatment plants, the Waste Management Department began to authorize the export of industrial waste pursuant to the Basel Convention. Despite difficulties related to licensing ships that transport industrial waste, Bahrain exported 3,762 tons of mixed industrial waste in 2006 for treatment and final disposal in other countries. The Department is also implementing a waste exchange program between industrial plants to transform waste products from one facility into raw material for other facilities. This program focus mainly on chemical waste since there is no treatment facility in Bahrain for such waste.

3.2. Used Oil

Used oil is currently recycled by some industries. Asphalt (bitumen) plants collect used oil from car mechanics and reuse it in bitumen production. The largest share of used oil, however, is exported to other countries for processing and recycling. In 2006, Bahrain exported 13,530 tons of used oil. The total quantity of treated (filtered) oil in Bahrain dropped from 1,997 tons in 2005 to 583 tons in 2006, primarily because of higher export volumes, which is regulated by Ministerial Order pursuant to the Basel Convention.

Modern Medical Waste Incinerator

3.3. Medical Waste

Ninety eight percent of Bahrain's medical waste stream is currently treated by one specialized company (Bahrain Waste Processing Company) using an environmentally-friendly incinerator that satisfies emissions standards. The handling and treatment of medical waste is regulated by Ministerial Order #1 of 2001, according to which Bahrain must setup a system for monitoring and controlling the storage, transport, treatment and disposal of medical waste in an environmentally-friendly manner.

Chapter Seven

Environmental Linkages

1. PART I - Repercussions of Trade Liberalization on Bahrain's Environment

1.1 Introduction

Many Arab countries, including Bahrain, have adhered to and ratified some international conventions and protocols with commercial dimensions such as the Montreal Protocol, the Basel Convention, and the Framework Convention on Climate Change. Furthermore, many of these countries have joined the World Trade Organization, which resulted in more economic and social obligations, repercussions and challenges that require serious and objective action.

There is an increasing consensus at the international, regional and local levels that the current trends in the industrialized countries to link trade to a number of environmental systems and procedures form a sort of trade protectionism that largely affects the competitiveness of these countries and their ability to export and penetrate new markets. These procedures took different shapes that went from mandatory health and environmental standards for some products (such as fertilizer and chemical residues in food products), to performance criteria with regards to power consumption. This is in addition to environmentally-friendly practices for some products such as the requirement that wood furniture be made of wood that is harvested from sustainably-managed forests. There are also environmental specifications such as eco-labeling which relies on the analysis of a product's Life Cycle, and the implementation of ISO 14000 Environmental Management Standards.

These are some of the most relevant environmental procedures that industrialized countries intend to adopt and that will affect the movement of products from developing countries into their markets. Additionally, if we also consider the recommendation of the World Trade Organization on the need to remove all forms of subsidies and protection measures on products, goods and services, we will begin to appreciate the challenges and obstacles that the Arab economies will face, particularly in relation to their export sector. This problem is compounded by the fact that the economies of Arab countries rely primarily on raw materials (agricultural produce, oil and petrochemicals products).

In the industrial sector, plans for the diversification of income sources and the incentives offered to employ national labor have resulted in many forms of subsidies and protection in support of that sector. Sustaining these subsidies and protection measures will invariably contradict the orientations of the World Trade Organization and the recommendations of the Commission for Trade and Environment (CTE).

1.2 Expected Repercussions of trade Liberalization

1.2.1 Impact on Quantity and Scale

The liberalization of trade services in the tourism and health sectors is expected to result in a considerable economic growth that will in turn increase production and consumption to cater for the growing demand on such services. It will also have an adverse impact on the environment such as higher rates of waste generation of all sorts, surging pressure on marine ecosystems in coastal zones and the deterioration of air quality as a result of pollutant emissions from associated sectors (industry, transport). For example, many global tourism corporations have already established hotel facilities and services in the Kingdom of Bahrain and therefore represent new sources of environmental pressure.

1.2.2 Structural Impacts

Trade liberalization is expected to improve the efficiency of resource allocation in Bahrain by eliminating all restrictions on the market forces such as subsidies, dumping and protectionism. The Government of Bahrain has already begun privatizing many service sectors such as transportation. It is also opening up the telecommunication sector for foreign competition, and the postal sector will soon be privatized and operated by international companies.

1.2.3 Impact on Technology

In principle, trade liberalization will open up the market for clean technologies which will in turn help reduce environmental degradation (from so called dirty industries). However, this depends on the extent to which the industrialized countries will honor the many engagements they made in several conferences with regards to the transfer of technology to developing countries. This also depends on the extent to which the developed countries will use loopholes in several other agreements, including TRIPS (Trade Related Aspects of Intellectual Property Rights), to avoid honoring their engagement for technology transfer.

The Kingdom of Bahrain has enacted the required regulations and legal procedures that industrialized countries had presented as a pre-condition for the transfer of technology. For example, Bahrain has taken active steps to protect property rights. In fact, the Kingdom promulgated a law on individual property rights which has already facilitated the transfer of appropriate technology in some sectors such as oil and petrochemicals. The Kingdom has and continues to use best available technologies in other projects (past and on-going) including the Urea project, the low-sulfur diesel projectand the industrial wastewater treatment unit at the Bahrain Refinery.

1.2.4 Impact on Product Quality

Trade liberalization is expected to play a positive role in facilitating the exchange of environmentally-friendly products and increasing the use of recycled materials in the production of goods. Recently, there has been a rise in the number of companies that practice recycling in Bahrain. There has also been a surge in the recycling of paper, scrap metal and used oils. The recycled products are primarily exported to India and Pakistan.

1.2.5 Regulatory and Policy Impacts

Trade liberalization will also have an impact on the international regulations and policies such as the developments that followed the Uruguay Round which diverted increased attention to the specifications and standards of service sectors, individual property, and the role of international organizations including the International Standards Organization (ISO).

1.3 Required Procedures to Adapt to Trade Liberalization

The following procedures would help the Kingdom of Bahrain adapt to recent developments and transformations linked to trade liberalization:

- Reconsidering the forms of subsidies offered to the production and services sectors, and adding the real costs of goods and services to the actual price, including the externalities, taking

into account the ensuing social impacts and costs. For instance, the continued subsidies for the energy sector have resulted in the waste of many non-renewable resources such as oil and gas, and led to price distortion of many goods and services.

- Financial institutions (industrial and agricultural development banks and commercial banks) should play a major role in allowing productive and services sector to embrace clean technologies by providing soft loans. Some banks such as the Bahrain Development Bank and others have started to play this role.

- Export-oriented production sectors should adapt to the new market requirements in industrialized countries, such as: acquiring ISO 14000 certification, abiding by environmental standards, and developing eco-labeling systems that rely on the analysis of the product life cycle. Many industries have come to realize the importance of such requirements and have therefore started applying for ISO 14000 certification. Some of these companies include Aluminum Bahrain (ALBA), the Gulf Petrochemicals Industries Company (GPIC), the Gulf Industrial Investment Company (GIIC) and Bahrain Petroleum Company (BAPCO).

- Promoting intra-trade in Arab countries to reduce reliance on international markets.

1.4 Suggestions to Mitigate the Environmental Impacts of Trade Liberalization

The following suggestions would help the Kingdom of Bahrain mitigate the impacts of trade liberalization on the environment.

- Set national and regional policies to curb the negative impacts of trade liberalization, such as the increased economic growth and production, and the consumption of goods and services, and turn these threats into positive economic advantages. For example, attention should be given to the recycling sector and the re-use of resources. Investments should be promoted using appropriate economic tools that would help overcome the problem of increased waste generation, and contribute to alleviating unemployment from which many Arab countries suffer. Promoting investments may also help reduce production costs for products manufactured using recycled materials, rendering these products more appealing internationally because they are environmentally friendly.

- Remedy contradictions and inconsistencies between national environmental regulations and the requirements of foreign markets related to exporting sectors. These requirements often increase production costs because manufacturing industries must comply with national regulations as well as international norms at the same time.

- Identify effective economic alternatives to current subsidies and protectionist measures. Such alternatives would help Arab countries overcome the obstacles restricting the flow of their goods and services to international markets. Eliminating subsidies on resources (water, energy, fertilizers, etc.) and making use of these allocations to increase subsidies on social development (housing, health, education, training programs), infrastructure development (telecommunication, roads) and raise the wages of the working class who are affected by the removal of subsidies. This would pave the way for a more efficient economic system that benefits all sectors far beyond subsidies can do.

1. PART 1 - Repercussions of Trade Liberalization on Bahrain's Environment (continued)

1.4 Suggestions to Mitigate the Environmental Impacts of Trade Liberalization (continued)

- Encourage transnational corporations to invest in polluting industries that require significant financing and advanced technologies, because these corporations can more readily access funding and clean technologies. For instance, investments by transnational corporations in Malaysia's electronic sector are estimated at 80 to 85% of the total sector. These corporations have maintained a good track record with regards to environmental performance and compliance and have demonstrated their ability to respond to foreign market requirements.

- Take immediate measures to raise the awareness of export-destined sectors in the Arab world so that they meet market requirements.

2. PART 2 – Health and Environment

Over the past few decades, the Kingdom of Bahrain has witnessed significant transformations and an economic boom across all sectors including industry, transport and tourism. This development has resulted in the diversification and intensification of pollution sources, thereby affecting a range of environments. Because human health and well-being is the main concern of the Public Commission for the Environment and Wildlife, as stipulated in decree-law 21 of 1996, the Public Commission is formulating environmental policies to improve and protect public health. To that end, the Public Commission has implemented several plans and programs to assess the impact of pollution on public health and identify protection measures. For example:

1. A preliminary study was conducted to link the results of the air quality monitoring program – launched in the late 1980s – to the impact of air quality on public health. Based on statistical data, the study demonstrated the correlation between air pollutants and many diseases. This correlation is most significant in the case of particulate matters (PM10), congenital malformations, pregnancy and post natal diseases (see initial assessment of air pollution impact on public health in Bahrain in Exhibit 1).

Exhibit 1 - Initial Assessment of Air Pollution Impact on Public Health in Bahrain

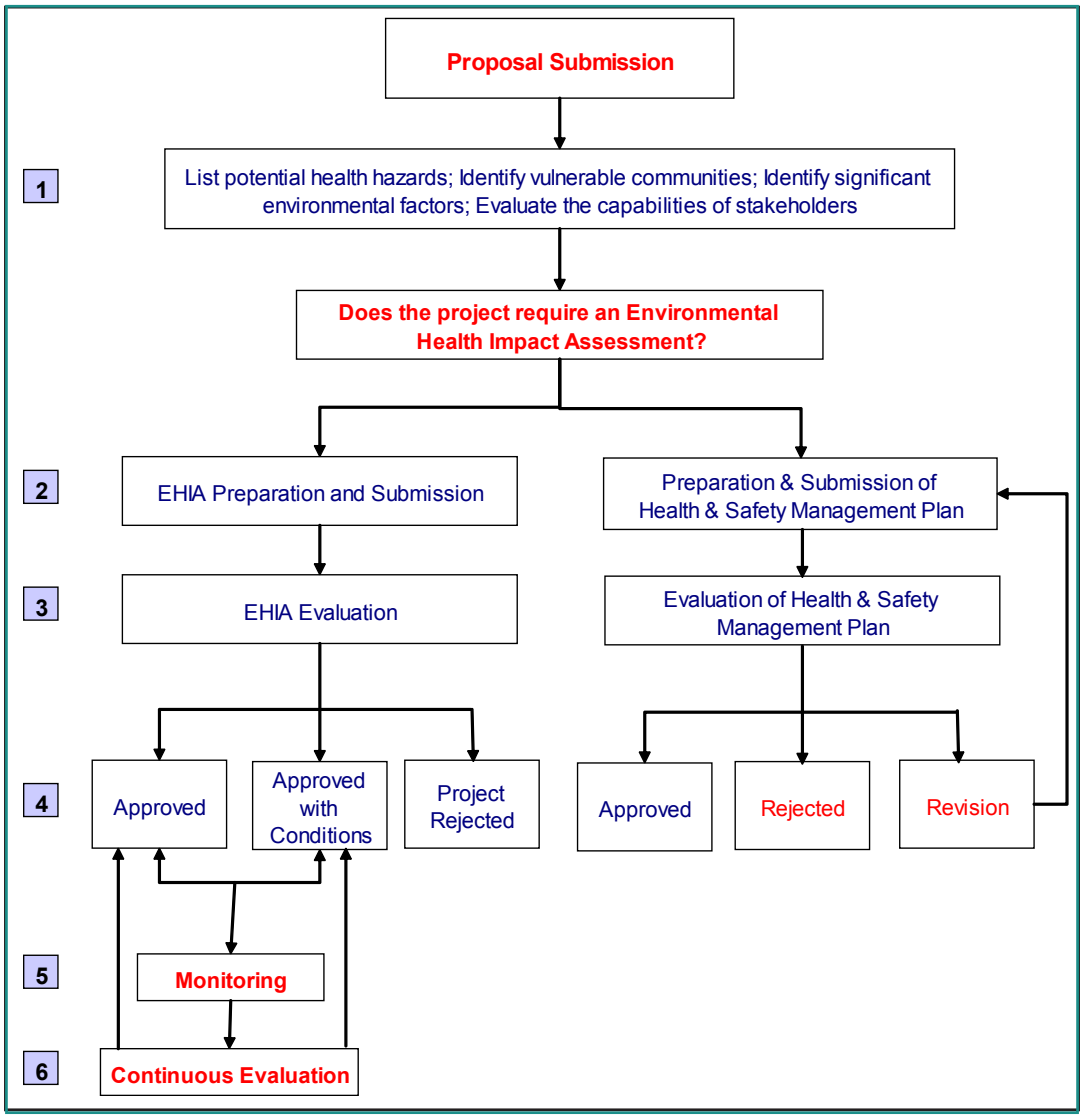
Initial Assessment of Air Pollution Impact on Public Health in Bahrain

Summary of Regression Findings for Daily Bahrain Non-Cancer Hospital Admission Counts and Daily Mean Air Toxics Concentrations from August 1993 through December 2003

Analyte (by location)	Regression Findings			Regression Findings by Disease Category						
	positive	negative	none	Neoplasms	Blood Diseases	Cardio-vascular	Respiratory	Pregnancy Diseases	Congenital Anomalies	Total Diseases
ASKAR										
SO2	0	2	5	B	B					
O3	0	3	4			B		B		B
CO	0	5	2	B		B	B	B		B
PM10	2	2	3		B	A	B	A		
NMth	1	3	3	B	B		B	A		
NO2	3	1	3	A	B			A		A
total positive correlations	6		27	1	0	1	0	3	0	1
total negative correlations		16		3	4	2	3	2	0	2
total no correlations			27	3	3	4	4	2	7	4
MANAMA										
SO2	3	2	2	A	A		B	A	B	
O3	0	4	3			B	B	B		B
CO	2	1	4	A	B			A		
PM10	1	5	1	B		B	B	B	A	B
NMth	1	2	4	B			B			A
NO2	3	1	3		A		A	B	A	
total positive correlations	10			2	2	0	1	2	2	1
total negative correlations		15		2	1	2	4	3	1	2
total no correlations			24	3	4	5	2	2	4	4

2. A project was implemented to include health considerations in the Environment Impact Assessment process of development projects. As a result, Bahrain now has an improved mechanism for incorporating environmental health issues in project design (see Exhibit 2 overleaf).

Exhibit 2 – Environmental Health Impact Assessment Process



1 = Screening and Scoping

2 = EHIA Preparation

3 = EHIA Review

4 = Implementation

5 = Monitoring

6 = Evaluation

3. PART 3 – Energy and Climate Change

The oil industry (including oil refineries and petroleum-based manufacturing industries) has over the past seven decades exerted increased pressure on the environment. This is especially true in the case of air quality and the discharge of industrial waste into the marine environment. Despite the existence of some environmental rules and regulations since 1998, several ecosystems now need many years to recover from environmental degradation, particularly marine ecosystems.

Despite the relatively low contribution of Bahrain's emissions of green house gases (%0.1 of global emissions),the energy sector is still viewed as the principal source of pollution in Bahrain. It is also the largest source of greenhouse gas emissions which contribute to global warming.

3.1 Overview of Electricity Production Capacity

Power generation in Bahrain is one of the main activities of the energy sector; electricity production increased 6.5% between 2003 and 2004, from 7,768 Giga Watt (GW) to 8,267 GW. The growing population, real estate growth and rising GDP are increasing energy demand by 5-6% annually, over the medium term. The government of Bahrain is currently in the process of determining future requirements of the electricity and water infrastructure. Following the 23rd of August 2004 when Bahrain experienced a total blackout, the Ministry of Electricity and Water requested BDH700 million (approximately $1.9 billion) for expanding Bahrain's power production capacity.

Bahrain's power generation capacity originates from six plants, four of which are owned by the State and two others were recently privatized. In 2004, the daily production of these plants was estimated at 1,849 MW. These plants consume more than 3 billion m3 of gas annually to produce around 83% of Bahrain's total electricity output. The remaining 17% of Bahrain's electricity is purchased from ALBA which produces 1,527 MW per day. Future expansion will raise ALBA's production capacity to 3,613 MW per day (see table below).

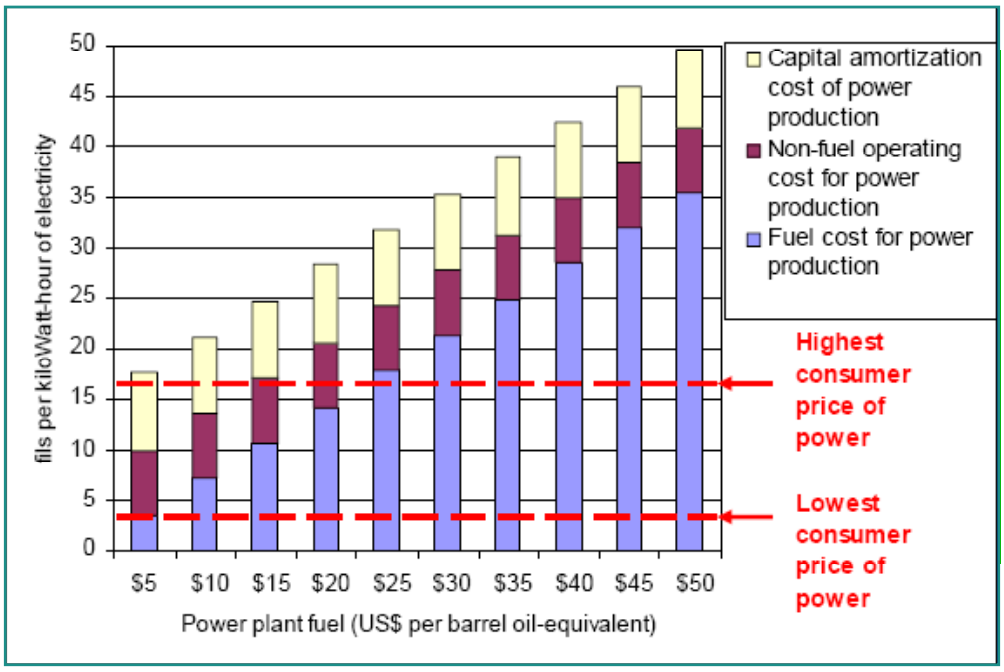
Table 1 – Summary of Bahrain's Power Generation Capacity in 2007

Plant	Location	Ownership Status	Year in Operation	Production Capacity (MW/Day)
Sitra Plant	Sitra	Public	1975	125
Al Rifaa Plant	Al Rifaa	Public	1983-1984	700
Al Hadd Plant	Al Hadd	Private	1998	810
Al Aazel	Al Hadd	Private	2005	1000
BAPCO Plant	Sitra	Semi-private*	1973	70
ALBA Plant	Raas Zuwaid	Semi-private*	1992	1527
Al Muharraq Plant	Manama	Public	1950	32
Total	7	-	-	4,389 MW/Day

*Whereby the Government is the largest shareholder

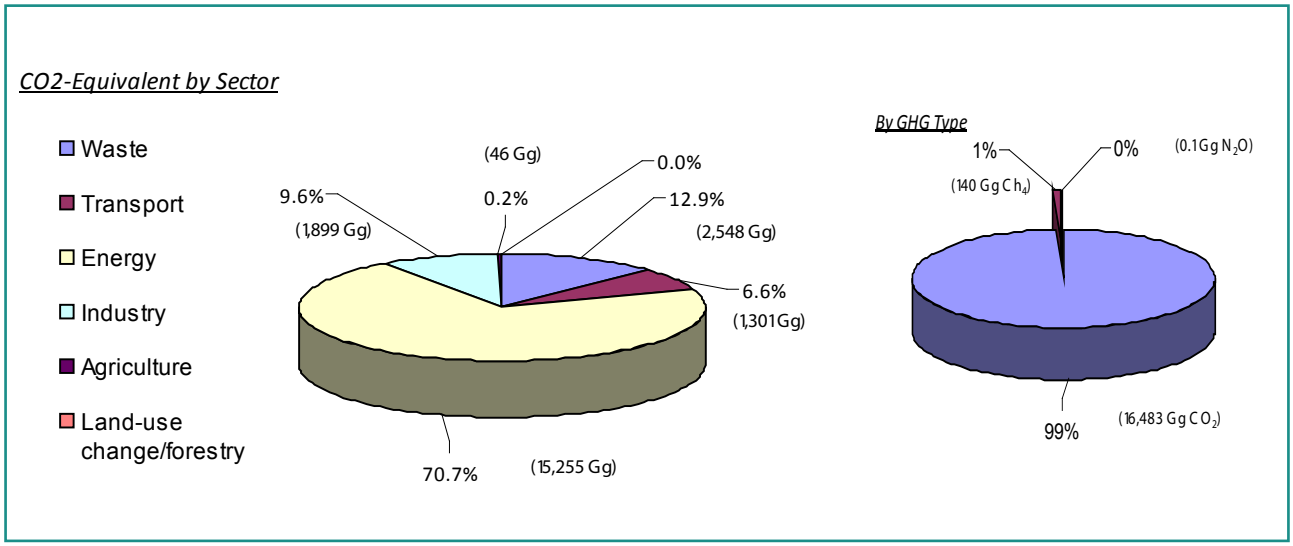
Bahrain's electricity tariffs are heavily subsidized, a factor that hinders production efficiency and competency. Rectifying electricity tariffs is of paramount importance if Bahrain aspires to increase production efficiency. The current tariffs are much lower than the capital and operational costs of electricity production and transmission (see Exhibit 3).

Exhibit 3 - The Real Cost of Power Generation Compared to Actual Tariffs



Bahrain's gas reserves are estimated at 3.25 trillion cubic feet. Power generation and industrial plants consume most of the gas production. ALBA is considered the largest industrial consumer of natural gas. Despite its large gas reserves, Bahrain is expected to become a net gas importer by 2020 (see GHG emissions by type and by sector in Exhibit 4).

Exhibit 4 - Total GHG Emissions by GHG Type and Sector, 1994 (Gg)



3.2 Energy, Environment and Climate

All power plants in Bahrain operate on gas. Gas burning generates carbon dioxide (CO2), particulate matters (PM10), nitrogen oxides (NOx), sulfur oxides (SOx), as well as lesser quantities of non-methane volatile organic compounds (NMVOC). These pollutants are a source of concern to public health and, by extension, authorities.

Locally extracted gas contains high levels of sulfur estimated at 6% of its total volume. This problem is exacerbated by the fact that several power plants in Bahrain lack the appropriate environmental technology such as filters and/or other equipment for the removal of nitrogen and sulfur (as known as desulfurization). This is why energy-related environmental problems are particularly complex, especially in relation to power generation.

Currently, three out of seven of Bahrain's power generation plants (ALBA, BAPCO and Al Rifaa) emit nitrogen levels that exceed the corresponding limit values both nationally and internationally. In 1999, German company LAHMER evaluated the environmental performance of these plants by measuring emissions. The study showed that the concentration of nitrogen oxides in the two turbines at Al Rifaa Plant ranged from 255 to 313 ppm, and between 264 and 313 ppm at the ALBA plant. These values exceed Bahrain's emission standards as well as the standards set by the Saudi Presidency of Meteorology and Environment (PME), the World Bank and Germany which range between 39 and 49 ppm.

Based on this study and on Resolution No. 10 of 1998 on water and air quality standards, the Public Commission for the Environment requested that these plants comply with applicable environmental standards. Pursuant to this request, ALBA submitted a compliance plan according to which it will finalize the installation of appropriate technological modifications (retrofitting the gas turbines) by the end of 2008. The Ministry of Electricity and Water has launched the modernization process of Al Rifaa Plant early this year which should be completed by the end of 2010.

3.3 National Laws and Regulations and International Cooperation

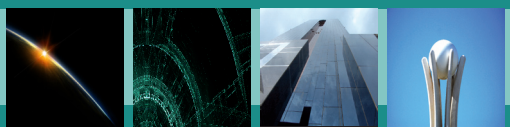
It is widely recognized that the best way to prevent pollution resulting from the energy sector is to limit the use of fossil fuel. However, this short-term solution is not practicable and politically not feasible. National and international efforts are focusing instead on finding ways to reduce emissions of hazardous pollutants.

Bahrain's environmental assessment mechanism is the most important legal tool governing the emission of pollutants. The environment law No.21 of 1996 and the resolution on environmental compliance require all industries and businesses to obtain an environmental permit for industrial activities. The Environmental Assessment and Planning Directorate uses specific requirements for permits issued for energy activities. Furthermore, oil refineries and oil production companies are requested to submit to the Directorate on a regular basis emission readings from the environmental monitoring program. The Directorate is also implementing a plan for the gradual phase-out of substances harmful to the environment. Also, the Kingdom of Bahrain recently set acceptable limit values for emissions from the oil industries.

At the international level, Bahrain is participating in global efforts to limit the negative impacts of the energy sector on the environment. The most important of these efforts is Bahrain's membership in the Regional Organization for the Protection of the Marine Environment (ROPME), the ratification of the Kyoto Protocol on GHGs and the implementation of a national plan for emission reduction.

Chapter Eight

The Future Today: Bahrain Environmental Scenarios




This chapter builds on previous environmental sectors chapters by exploring how current social, economic and environmental trends may unfold along the divergent development paths in the future and what might this mean for the environment, development and human wellbeing. It presents three scenarios to the year 2030, using narrative storyline to explore different policy approaches and societal choices made by the Kingdom of Bahrain. The main messages of the Scenarios – Markets First, Policy First, and Sustainability First – are:

The most important policy lesson of the scenarios is that investment in human resources development, governance improvement, and regional cooperation/integration are key issues in the long, intricate path to sustainability for Bahrain. Relying on the Market alone is unlikely to achieve key environmental and human well-being goals. Although it stimulates needed improvements in resources utilization efficiency and developments of some new technologies, the extreme emphasis on markets and economic growth in the "Markets First" results in significant increases in environmental pressures and only slow down advances in achieving social targets and increases socio-economic disparity. It is envisaged that the resulting socio-economic disparity under this scenario might lead to the impediment of economic growth, and subsequently the rise of authoritarian solutions and responses.

Alternatively, the increased levels of investments in human resources development, improvement in governance along with increased integration among the GCC countries in "Policy First" and "Sustainability First" make for significantly faster progress without sacrificing economic development. In "Sustainability First", the improvement of governance resulting from advanced democratic transformation, and a sustained link between social, economic, and environmental policies provides a solution to the sustainability challenge in Bahrain.

1. Introduction

An increasingly common approach in environmental assessments for exploring the future has been the use of scenarios, serving as useful tools for evaluating future environmental problems and assessing policies to resolve them, and for synthesizing and communicating complex and extensive information to decision makers and the public. The value added for scenarios to the traditional SOEs is in their capabilities in handling and assimilating enormous amounts of information and insights, and providing an effective format for bringing these information together. Moreover, as scenarios are written in the form of stories, the results of an assessment can be communicated to a large and diverse audience, both technical and non-technical. Finally, probably, the most important function of both scenarios and environmental assessments is that they act as a crucial bridge between environmental science and policy. They influence policymaking by summarizing and synthesizing scientific knowledge in a form that can be used by policymakers to develop policies. They help policymakers to visualize the different aspects and connections of an environmental problem, as well as its large time scale.

This chapter builds on the previous chapters in this report by exploring how current social, economic, political, technological and environmental trends may unfold along the different development paths in the future, and what this might mean for the environment and human well-being in Bahrain. It explores Bahrain's future through the lens of "environment and development", and concentrates on the end results of these various choices that might be taken through the use of scenarios thinking.

Three scenarios exploring different policy approaches and societal choices are presented using a narrative storyline. These are termed Markets First, Policy First, and Sustainability First. The framework of these three scenarios is based mainly on UNEP's Global Environmental Outlook process, namely GEO-4 (see Box 1), with a shorter time frame of 25 yearsand are customized to Bahrain local setting and environment. It should be noted that these developed scenarios are not predictions, nor should they be taken as the most likely of possible futures. At most, they portray pictures of limited number of plausible futures based upon a certain set of assumptions about driving forces, critical uncertainties, and system relationships.

These include governance, demography, human development, economic development, science and technology, culture, and regional integration. Their rationale is not to indicate what will, but rather what might, happen if certain choices are made. Their purpose is to assist in thinking more carefully about how it might be possible to encourage or counteract particular events and trends.

The fundamental assumptions defining the scenarios focus on who is making the key decisions, i.e. the dominant actors; how these decisions are made, i.e. the dominant approaches to governance; and why certain decisions are made, i.e. the dominant priorities. The assumptions about these in each of the scenarios for Bahrain are summarized in brief in Annex A.

1.1. Bahrain Environmental Scenarios

What lies ahead for the natural environment and human well-beinga in Bahrain? What are the main driving forces that will shape this future? Which of the current social, economic, and environmental trends will continue and which will see a dramatic shift? What are the impacts of these changes on the environment and human well-being? And finally, what role can we play in shaping this future?

All these questions need to be addressed if Bahrain wants to have a role in determining its destiny/future, by taking policies and actions that will take it from its current state to the future that it hopes for and that for its next generations, or at least, to enable it to adapt and adjust itself to future external developments and avoid/alleviate their negative impacts. Better still, to be able to identify future opportunities and benefit from them in building a healthy and environmentally flourishing future for the country.

In order to achieve that, it is necessary first to identify the main driving forces in the society, which could be social, technological, economical, environmental, and political policies (STEEP), whether they are internal (that we take) or external (that are imposed on us), and know their past trends and their various impacts on humans and environment (Annex A). Then, try to forecast/predict what might happen if these driving forces continue or discontinue on the long-term, and imagine the future that might be reached if these driving forces/policies/choices continue, and examine whether these policies are adequate to take us to the hoped future socially, economically, and environmentally.

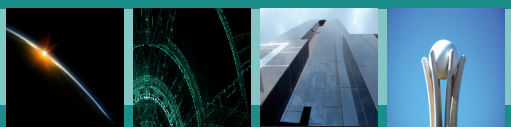
1.2. Scenarios Key Questions

The scenarios presented here are designed to try to answer the following main question: Over the next 25 years, could Bahrain achieve sustainable development, where socio-economic development and environmental protection are balanced; If yes, how? and if not, why?

Other key more specific questions these scenarios are trying to address and explore are: Under the current socio-economic development policies, what are the impacts on human wellbeing and environmental consequences? Under these conditions, is it possible to avoid environmental negative impacts or mitigate them? What are the compromises/tradeoffs involved? Can environmental and natural resources continue to be exploited to increase economic development and human welfare without victimizing these resources? And, finally, what are the environmental, economic, and social costs that would result from this exploitation on the long term?

1.3. Key Environmental Challenges and focal Issues

Bahrain key environmental challenges and focal issues can be summarized in:




- Inadequate Water Resources Management (increasing water scarcity, groundwater depletion and quality deterioration; escalating demands and demand management; high cost of desalination and water treatment; agricultural lands salinization and desertification; loss of natural springs and their surrounding habitats; …).
- Deterioration of Marine and Coastal Environment (resources depletion and habitat loss and fragmentation by reclamation and dredging; biodiversity and species losses; pollution and environmental degradation by industrial effluents, desalination plants, oil-related activities/oil spills, and untreated or partially treated municipal wastewater discharge; over-fishing and fish stock depletion; introduction of invasive species (ship ballast water); …).
- Waste & Pollution Sources Management (increasing solid and liquid wastes from municipal, industrial, commercial, agricultural activities, and medical hazardous wastes; air emissions and pollution; desalination discharges and emissions, industrial waste management, oil spills and their impact on desalination plants operation, …)
- Management of the Urban Environment (air pollution, solid and liquid waste management…)
- Agricultural lands desertification and loss, Ecosystems and Habitats loss & degradation, overall Biodiversity loss

2. The Scenarios Narrative

The following three scenarios narrative storyline attempts to explore the level of impacts of the different policy approaches and choices that could be made by Bahrain on the current and future environmental challenges and issues its facing. While they show the impacts of the various STEEP drivers on the future paths of the country, they also show how acting reactively or proactively would affect and determine these paths. The scenarios narrative storyline is supported by quantitative modeling of some socio-economic and environmental indicators (Figures 1-9) using International Futures (IFs) Modeling Program. The purpose of these quantitative indicators is for illustration and comparisons between the scenarios, and they should not be taken in their absolute values.

2.1. Markets First Scenario

Under this scenario, development in Bahrain is dominated by market forces and market mechanisms (demand and supply for goods and services); the slogan of "economic growthb at any cost!" dominates. Exploitation of natural resources, provision of imported inexpensive labor, mass production and manufacturing efficiency are seen as the formula for lowering prices and competition in the regional and global markets. Economic development through better technology and management is prioritized, while social problems and environmental stresses are ignored and are left to the self-correcting logic of competitive markets. In the field of human development, the assumption that economic growth will naturally lead to improvement in social conditions prevails, meaning that investment in education and health must compete against other possibilities that might offer more immediate returns. Bahrain society adopts and gradually converges to the values and expectations prevailing today in industrialized societies (materialism, individualism, and consumerism).

Private sector investment and marketing initiatives play the main role in moving the wheel of the economy, while government officials and legislators are increasingly put under pressure to minimize intervening in free market mechanism and so facilitate self-regulation (e.g., oil, power, services & tourism sectors self-regulation). The economic base will be expanded with less dependence on oil revenues and diversification in industrialization and services sector. While Bahrain witnesses positive socio-economic trends, natural and

environmental resources depletion, environmental degradation, and health risks increase.

Bahrain has undergone economic policy reforms and restructuring with fast transformation of the state role from a service provider to service enabler and regulator. Privatization was perceived as the main way to lower government economic burden, attract investments, increase services efficiency, and enhance cost recovery. Privatization accelerated and included vital sectors such as water (i.e., desalination & wastewater) and energy sectors. On the other hand, democratic transformation system was not fully established, and the decision-making process continued to be made using a top-down approach. One side-effect of this climate was that environmental legislation and regulations were relaxed in order to attract outside investments. State support of training, capacity development and education was very weak and left mostly to the private sector. Market forces led to greater technical and economic efficiency and better performance of services. Nevertheless, social disparity and environmental problems increased.

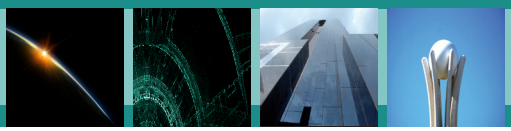
Population continued to increase mainly due to investment policies and failure of government substitution programs to control foreign labour force to meet rapid economic growth requirements. The population of Bahrain reaches about 1.3 million (Figure 1). Growth in the absence of strategic human development continued to constitute a core development problem, leading to increased levels of unemployment and poverty especially among the poorer social groups, with an overall negative impact on the environment, natural resources, and the economy.

Social disparity, resulting from increased levels of poverty and unemployment, lead to frequent social unrest and increased crime rates, endangering the stability and security of Bahrain. This in turn discourage foreign investments and result in a trend of migration out of Bahrain to more secure and stable investment climate in the Gulf, and eventually leading to the impediment of the sought-after economic growth targets. Under these conditions, authoritarian solutions and responses became common, which only serve to fuel this vicious cycle, returning the country to the conditions (i.e., emergency laws) that existed before the political reforms in 2002.

Water stress in Bahrain continued to increase due to the rapid population growth rates and the limitation of renewable water resources and non-conventional water resources. Per capita available water share (from conventional and non-conventional water sources) continued to decrease and remained under the absolute water scarcity line of 500 cubic meters per year, as water demand rates will by far exceed the anticipated water resources development rates (desalination and reuse of treated wastewater). Water demands, particularly by the agricultural sector, continued to exceed available groundwater replenishment rates. Prolonged groundwater over-exploitation led to the increase in the salinization of groundwater quality, exacerbating the water scarcity issue in Bahrain, increasing land degradation, reducing food production (Figure 2) and increasing water-related health problems, with the latter caused by the intensive use of agrochemicals. Sectoral competition, mainly between the agricultural and domestic/industrial (due to rapid urbanization and industrialization) sectors increased (with more water diverted to the latter sectors) further exacerbated the situation.

As water scarcity worsened, water became more expensive, leading to increased usage of desalination and reuse of treated wastewater to meet escalating demands. In the case of the latter, reuse is made without strict adherence to wastewater reuse standards and guidelines due to the large generated municipal wastewater volumes in comparison to the available treatment capacity which could not cope with these generated volumes, and due to the high agricultural water demands. Outbreaks of water-related diseases occur frequently. Furthermore, Bahrain, like the rest of the GCC countries, had to import desalination and treatment technologies because investments in research and development (R&D) were relatively low; GCC countries efforts to coordinate research in desalination has failed.

Desalination facilities were powered almost exclusively by fossil fuels, thereby increasing the emissions of greenhouse gases and other air pollutants. The use of clean renewable energies, such as solar and wind, abundant in the region, continued to be very limited and their share in the region energy sector continued to be marginal (Figure 3). The volume of reject water discharged from the desalination facilities into the




marine environment becomes so large that marine ecosystems in the vicinity of these facilities are significantly disturbed. However, many steps have been taken to control pollution from these plants to alleviate air pollution (e.g., NOx burners) and to reduce thermal, brine, and chemical pollution to the coastal and marine environment.

Privatization of the water sector, along with other sectors, intensified, leading to an increase in water use efficiency; however, it was accompanied by removal of water subsidies leading to less accessibility to the poor. In general, water resource management authorities ignored issues of social equity and environmental sustainability.

Urbanization continued to increase at a relatively large growth rates (Figure 4), a natural consequence of rapid population and economic growth, and had many negative environmental and health consequences that are associated with rapidly growing population centers and cities, in terms of air and noise pollution, large increased, locally-concentrated waste production (liquid & solid), encroachment on and loss of limited agricultural, recreational, and coastal and marine areas. Furthermore, infrastructure and resources are over-stretched to satisfy increasing demands, and infrastructure deteriorates rapidly as most resources are directed towards extending and constructing new infrastructure without providing the necessary maintenance to the existing one. The transportation problem in Bahrain cities becomes very acute, with the bill being paid for by more air pollution, higher energy consumption rates, and losses to the economy.

Intensified development of coastal zones and marine areas for various development activities (urbanization, industrialization, recreational and tourist facilities, etc.), associated with poor management and regulations, lead to marine ecosystem and habitat degradation and loss of biodiversity. As oil continue to dominate the world, as well as the region energy sector, exports of oil from the region increased; higher risks of oil spills from offshore extraction and transportation, hydrocarbon concentrations in the Arabian Gulf water in general and Bahrain surrounding seawater in particular, and spread of invasive species from ships ballast waters also increased.

Furthermore, industrialization (e.g. petrochemicals, refinery, desalination plants, and other industries located mainly on the coastal areas) expanded on the coastal zone leading to an increase in land-based activities contamination to the coastal and marine environments. In addition, wastewater treatment capacities limitations in comparison of the municipal water consumption lead to frequent discharges of raw or partially treated wastewater to the coastal and marine environment. Under all these conditions, there will be a general deterioration of the coastal and marine ecosystem, habitats and losses of biodiversity, and more incidents of fish mortality, leading to an overall decrease in marine food production and economic losses to the fishery industry.

The situation exacerbated as food demand increased in Bahrain with little cooperation between the riparian countries in the management and regulation of the marine environment of the Arabian Gulf, leading to the over-exploitation of marine resources and fish stocks. As a consequence, aquaculture and mariculture industries thrived, driven mainly by the private sector, to meet escalating food demands (a naturally great business opportunity). However, there was minimum concern of environmental consequences and damages of these industries to the local marine environment (e.g., mangrove destruction, concentrated wastes, disease outbreaks, threat to native species).

Agricultural lands continued to be lost in Bahrain (land transfer to other sectors either due to the absence of effective agricultural lands protection polices or their existence but non-enforcement) due to urbanization expansion and growth of other economic and services sectors. As food demand increased due to population growth as well as change in consumption patterns, it leads to further groundwater resources over-exploitation and salinization and land over-cultivation. Over-cultivation under the conditions of deteriorating irrigation water quality and soil salinization lead to land degradation and productivity loss, and eventually more

desertification. As a consequence, there will be an intensive use of agrochemicals (fertilizers, pesticides, etc.) as well as over-irrigation (to wash soils from salts) to increase productivity, leading to more groundwater over-exploitation and quality deterioration and water logging and soil salinization (farmers vicious cycle). Trends of desertification and agricultural lands loss observed in the last century in Bahrain continued to the extent that agricultural lands in the country became meager.

Under these conditions, Market forces lead to the gradual expansion of non-traditional agriculture (e.g., protected and soil-less agriculture) and the importation of genetically modified crops (drought and salt tolerant crops), which increased agricultural productivity. However, the introduction of GMOs is made with little concern for minimizing potential health and environmental impacts and side-effects. Furthermore, as food demand increased, and as Bahrain has exploited most of its arable land with absence of "regional" strategic food production and management, food security became a major issue in Bahrain, increasing significantly agricultural food imports (Figure 5) impacting its economy, and making it more vulnerable to frequent global food crises and prices increase.

Deterioration of habitats and ecosystems continued, as a direct result of the increase of human pressures exerted on Bahrain's limited and fragile biological and natural resources (croplands, coastal areas, and fishing grounds). The area and number of protected lands in Bahrain decreased with time and was transferred to other sectors. The deterioration of the ecosystems led to a decline in species population, increase in the number of threatened species, and the overall continuous loss of biodiversity

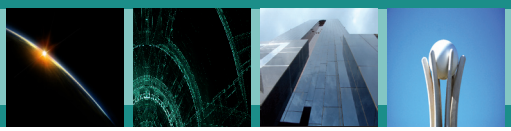
On the other hand, international environmental polices exerted strong pressures on the private sector to abide by environmental regulations related to exports. In response, environmental aspects are considered by industries and manufacturers (e.g., ISO14000 series of standard on environmental management systems, de-sulphurized diesel, etc.) to ensure adequate access to the international market. Although this allowed better management and control of various emissions and less stress on natural resources, it was not able to lead to rapid rehabilitation of the deteriorated environment and the restoration of damaged ecosystems and habitats.

In general, under the "Markets First Scenario" pollution loads will increase significantly, and will have negative impacts on human health and the environment. This is mainly due to the concentration on economic development while giving little attention to the environmental aspects, where investment policies over-ride environmental policies (weak environmental governance and institutions, particularly weak enabling environment: institutions, policies, and legislation/enforcement).

2.2. The Policy First Scenario

Under this scenario, strong actions are undertaken by the Government of Bahrain in an attempt to reach specific social and environmental goals. The Government places strong policy constraints on market forces in order to minimize their undesirable effects on human and environment. Environmental and social costs are factored into policy measures, regulatory frameworks and planning processes. Required laws and legislation for the protection of the human health and the environment, and the enhancement of resources sustainability are formulated, implemented, and enforced. The private sector is brought on board to contribute in investment and economic development by public-private-partnership (PPP) schemes and a set of incentives, and with strong regulatory body and regulations, however.

This scenario envisages that democratic transformation, i.e. constitutional democratization, public representation, auditing and transparency, etc., are further advanced in Bahrain. Civil society empowerment will gradually advance and pubic participation will have some impact upon major decision making. Health and environmental issues gradually became one of the main concerns of the civil society, enhancing and strengthening the role of environmental authorities/institutions in the decision making process at the national level (i.e., an alliance is gradually formed between environmental authorities and environmental NGOs, and other related associations). At the regional




level, there will be greater regional harmony and cooperation at the level of ministerial forums and organizations (e.g. GCC, CAMRE, ROPME). Furthermore, Bahrain will have more integration in the GCC block (in infrastructures of transportation, energy, water, and human resources, etc.). This will result in the emergence of a strong diversified economic block that takes into account each member country comparative advantage.

The government of Bahrain decided to integrate social and environmental issues into economic and fiscal policies to mitigate rising environmental, social, and cultural costs of the free market economics. More attention was given to environmental policy and this led to a decrease in the rate of environmental degradation. Population growth is slowed down (less than the market forces scenario, but still high). This occurred due to many factors, but mainly due to effective national population policies that aim at controlling and reducing foreign migration and their planned substitution by nationals made possible by heavy investment in nationals training and capacity building programs, and by the increase of women entry to the work market.

The reduction of the population growth rate (Figure 1), in addition to the adoption of strategic water resources management to increase water use efficiency and resources protection further alleviated the water stress in the country. Water moves gradually to the top of the national agenda priority list, and Bahrain reformed its water management institutions. This was followed by a major policy shift from supply augmentation towards demand management, conservation, and protection. Different instruments and programs that include water pricing with targeted subsidies, awareness and education campaigns, legislation enforcement, management of marginal water, and efficient water resources allocations among the competing economic sectors are implemented.

However, still water demands continued to exceed available water resources, and depletion and degradation of groundwater quality continue (but at lesser rates than the Markets First scenario), with its negative impacts on land degradation and food production. But the treatment of wastewater becomes common such that the total volume of untreated wastewater decreases significantly. This was achieved by the adoption of a decentralized wastewater treatment system, where domestic wastewater is treated and reused near the source. The need for non-conventional water resources continued to increase; the production of desalinated water and the reuse of treated wastewater increased significantly, with more cooperation between the GCC countries on these technologies. The hope is that this coordinated regional research will eventually make major breakthrough in freshwater production, increase freshwater resources, and significantly modify per capita freshwater share in the domestic sector in the region. Use of clean renewable energies, particularly solar, increased in the region and in many sectors; their share continued to be marginal in the energy and water sector, however (Figure 3). Thus, there are concerns that this achievement will continue to be associated with environmental problems such as air and marine pollution, as fossil fuel will continue to be the dominant form of energy.

Private sector participation in water services and production was encouraged by the government to increase efficiency and lower economic burdens, but with careful consideration to the poor strata of the society with appropriate subsidies ensuring their accessibility, and strong environmental regulations. Furthermore, economic integration and regional cooperation helped in modifying agricultural policies in the region and in reducing agricultural water consumption.

Urbanization trends in Bahrain continued to increase, but they were at lesser rates than the Market Firsts scenario due to the relative reduction in population growth rate and the adoption of integrated urban planning methodologies (Figure 4). Environmental policies, including transportation, energy, water, and waste management sectors are implemented to reduce environmental and health problems associated with the rapid urbanization experienced in the last century (escalating demands on water and energy, waste management problems, and deterioration of air quality). Furthermore, there was more protection of the limited coastal and agricultural lands and enforced land use zoning, as well as policies that encourage vertical expansion. Through proper land use zoning, industries located within urban areas are either moved out of urban areas,

or forced to control their gas emissions and waste, in order to minimize their impact on human health and the environment.

The implementation of land use planning to protect land resources slowed down arable lands loss and enhanced their conservation. The effectiveness of these policies is strengthened by the abatement of urbanization expansion. Food demand increased at slower rates than in the market forces scenario, and Bahrain adopts strategic food demand management that takes into account the available resources capacity and their sustainability. Food demand management addressed increases in food needs taking into account water and land use and eliminating over-exploitation of resources. In addition, heavy national/regional investments in research and development in improved farming practices and soil management are made, leading to significant increase in agricultural production (Figure 2). These efforts helped reduce or stabilize environmental degradation, increase the levels of food security/self-sufficiency, and in reducing food imports (Figure 5).

Import of genetically modified crops continued as in Market First scenario, but with better consideration of the potential negative impacts, and the effective implementation of "Cartgena Protocol of Biosafety". Furthermore, economic integration and regional cooperation among the GCC countries as well as between the Arab countries help modify agricultural policies of maximum food production/food security in the Kingdom and reduce water consumption by the agriculture sector.

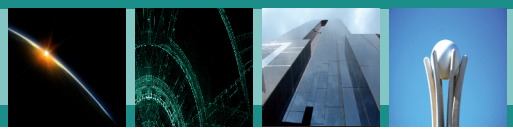
The rate of destruction of habitats and ecosystems has been greatly reduced by the implementation of appropriate land-use management plans which help reduce human pressures on natural ecosystems, adoption of effective laws to protect biodiversity and species populations, and regulating the introduction of foreign and genetically modified species. Bahrain increases protected areas to reach international target and requirements (reflecting habitat variation) and significantly stopping the depletion of biological resources. Furthermore, through regional cooperation, trans-boundary reserves are established between the countries of the region. Public awareness has been increased through the establishment of botanical gardens, herbaria, and natural history museums.

The development of coastal zones and marine areas is slowed down by coastal and marine resources protection strategies: Coastal zone management plans are implemented, well-planned national and regional marine bio-reserves and protected areas increased, and marine resources are rationally managed. Marine ecosystem and habitat degradation and biodiversity loss is slowed down, and fish stocks are maintained. This is advanced by a regional cooperation between the riparian states of the Arabian Gulf and implementation of relevant Multi-lateral Environmental Agreements (MEAs). Aquaculture and mariculture industries continued to increase to meet increasing food demands in the Bahrain; however, potential environmental consequences and damages of these industries are well-researched and mitigated through precautionary plans.

As the region share of oil exports and its petrochemical and other coastal industries increased with time, risks of oil spills, spread of invasive species, and land-based contamination to the marine environment continued to increase. In response and to minimize these risks and contamination, Bahrain imposes stringent and strict regulations to protect the marine environment (e.g., ballast water discharge (receiving facilities), land-based activities discharges (treatment before discharge), decreasing thermal and chemical pollution of desalination plants, etc.). The overall impact of these policies and strategies is in the slowing down of the degradation of coastal and marine resources and in some cases their rehabilitation.

This scenario envisions an improvement of human well-being and decrease of environmental degradation due to assigning higher priority to human resources development, health and environment protection than the Market First scenario. However, great pressures will continue to be exerted on the environment by investment and economic development policies. Furthermore, the governance approach in this scenario, in addition to its top-down approach, suffers from being a reactive rather than proactive and is slow to respond to change.

2.3. The Sustainability First Scenario




This scenario pictures an emergence of a new development paradigm in response to the challenges of sustainability, supported by new, more equitable values and institutions. The notion of human development, rather than material acquisition, is advanced as a form of cultural and social evolution (i.e., investment in human capital). A more visionary state of affairs prevails, where proactive solutions to the challenges of sustainability are provided (sustained link between social, economic and environmental policies). This is achieved by the adoption of long-term integrated strategic planning, with the objective of achieving higher quality of life, and longer life expectancy and healthy environment (Figure 6), and accomplished in the long-term by strong emphasis and heavy investment on human development through educational, training and capacity building programs (Figure 7). The aim is to create a productive knowledge-based society that will fulfill the needs of the Kingdom's economic development (Figure 8). Environmental sustainability is pursued through changing the education system and human behavior and attitude towards his surrounding environment for long-term viability and success.

Furthermore, Scientific R&D to solve the society's social, economical and environmental problems is encouraged greatly with significant funds allocations in the Kingdom national budget drawn from both the private sector and the government. Universities and research institutes are capable of carrying out competitive research projects in the key fields of societal concerns. Bahrain society is gradually transformed into a scientific, knowledge-based society. In this scenario, environmental policies aiming at protecting the environment and the sustainable use of resources will decide investment policies, leading eventually to massive use of green technologies. Eco-taxes and polluter pay charges proliferate.

Bahrain society will adopt the positive features of cultural globalization and industrial societies. Materialism and consumerism, associated with western life style/industrial societies, will be rejected, while professionalism, productivity, awareness, public participation, and commitment towards the environment (environmental citizenship) will infiltrate society to replace some of the existing widespread negative cultural habits and attitudes (e.g., non-compliance, petition system, corruption, and wastage). National/regional identity and positive indigenous societal values, such as family/society unity and spiritual/moral values will be maintained and enhanced. Furthermore, women empowerment reaches high levels in Bahrain (Figure 9), which increase the production and innovation of Bahrain society, and help in the reduction of the population growth rate.

Under this scenario, democratic transformation and civil society empowerment in Bahrain has reached its highest levels, leading to active public participation with major participation in the decision making process (balanced relationship and power between government, private sector, and civil society). This transition has a positive impact on the decision-making process, development, and public involvement and participation. Health and environmental issues will become the main concern of the civil society. As a result, government environmental authorities will have a strong impact on the decision-making process, leading to favoring environmental policies on economic policies in cases of their conflict.

On the regional level, integration between the GCC countries reaches its highest levels, leading to one (Con)-Federal State (replacing the Gulf Cooperation Council), has the required elements for survival and facing external challenges and threats. This marks the emergence of a strong diversified economic block in the region, with strong economic ties with the Arab world at large.

The regional ministerial forums/organizations will be enhanced and strengthened by this development. Regional environmental policies will be formulated at the regional level by these organizations with full cooperation of the member states and implementation at the national level. The region will be an active partner in setting the global environmental policies.

Under these developments, water stress in Bahrain has been significantly reduced by the implementation of the effective population policies leading to a slowing down/stabilization of population growth, achieving high

level of environmental awareness at all level of society, and enhanced by the adoption of IWRM strategies (economic efficiency, social equity, and environmental sustainability), with strong emphasize on demand management and conservation. This was made by establishing an enabling environment for water resource management through institutional, policy, and legislation reforms. Water now is a national priority.

Whether this scenario becomes a reality in Bahrain or not, Bahrain is expected to be very short in some resources, the most vital of which is water. Being aware of this reality, the water scarcity problem absorbs the full attention and consideration of the government and it embark on taking sufficient measures to ease the problem. Water was given a prominent place on national and regional agendas. This was made possible by institutional, policy and legislative reforms and the placement of water high on the national and regional agendas. The adoption of IWRM strategies, with strong emphasis on demand management and conservation, aided by slowing population growth rates and environmental awareness, significantly reduced water stress.

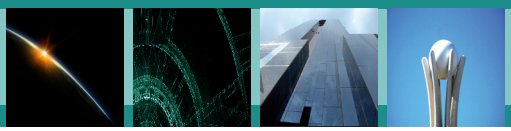
Strong cooperation between the GCC member countries in non-conventional water technologies is made, where these countries decided to own and localize water desalination and treatment technologies in a specific period of time (say, 15 years), and allocate considerable funds to achieve this goal. These major investments in R&D in these technologies are paralleled with the same in alternative cleaner renewable energies (solar and wind) leading to major breakthrough in desalination and treatment technology without major environmental problems (Figure 3). This is made despite the abundance of fossil energy in the region, and its continued dominant share in the world energy market, in fact this will lead to prolonging the life of the fossil fuel reserves in the region, while making a considerable income for the countries of the region.

The unit cost of desalination was not reduced significantly (as in the Market First scenario), but environmental pollution by desalination plants (represented by air, coastal and marine pollution) is reduced considerably. More importantly, the localizing of desalination and treatment technologies increased the added-value to the GCC countries economies.

Water stress has also been substantially reduced by high investment in non-traditional hi-tech agriculture (e.g., soilless culture) to overcome the problem of water and land scarcity, resulting in significant reduction in agricultural water demands, while increasing agricultural production (Figure 2) and significant reduction in food imports (Figure 5). As a result, degradation in the quality of available groundwater resources has been significantly lowered. Furthermore, there will be limited and rational application of biotechnology in the field of food production, with careful and safe handling of genetically modified crops. These efforts, aided by population growth rates slowing down/stabilization, will lead to a significant modification in water stress, and per capita water share of available water resources is stabilized.

Green cities will be widely spread in Bahrain, and negative environmental and health impacts associated with urbanization (problems of air, noise, waste, sanitation, etc.) are mitigated through better integrated planning and management. Expansion of cities in Bahrain will be at slower rates and will be well-planned (Figure 4), while encroachment on agricultural and coastal lands will be minimized. Integrated land management strategies taking into consideration MEAs (e.g., desertification control CCD) are implemented, resulting in ecological balance and well-planned arable and coastal land transfer to other sectors, sustainable conservation of land, coastal and marine resources, and rehabilitation of degraded ones, all enhanced by environmental awareness of the population.

There will be a wide implementation of integrated coastal zone management (ICZM) in Bahrain. The unplanned/random development of coastal and marine areas is stopped by coastal and marine resources protection strategies. On the other hand, extensive efforts are made in the restoration of the degraded marine and coastal ecosystems; marine resources are rationally managed and preserved with strict regulations on fishing and development, with well-planned marine bio-reserves and protected areas reaching world standards. Bahrain, with other GCC countries jointly implement relevant MEAs, particularly MARPOL73/78 protocol, establish oil wastes reception facilities, and declare the ROPME Sea Area as a Special Area,




resulting in significant reduction of marine oil pollution. The global program of action for the protection of the marine environment from land-based activities is also strictly implemented to control sewage releases into the marine environment (polluters pay), significantly reducing sewage releases into the marine environment. This will lead to a considerable reduction of hydrocarbon and other industrial pollution into the marine environment.

Under this scenario, a balance will be struck between natural and human managed ecosystems in the long-term. These practices will lead to conservation and efficient use of natural resources and sound management of the environment, providing ideal conditions for human well being. Although economic growth will be moderate and less than the market forces and policy reforms scenarios (trade-off), there will be a considerable improvement in health and environmental welfare, and the cost of pollution on the Bahrain's GDP is reduced considerably.

3. Conclusions and Policy Lessons

Markets First is an environmentally depressing scenario for the Kingdom of Bahrain; although the market stimulates needed improvements in resource use efficiency and developments of some new technologies, Bahrain faces considerable problems on various levels due to the almost exclusive emphasis on economic growth. Problems of social and environmental stress are left to the self-correcting logic of competitive markets, which only partly solves these problems. In fact, the increased socio-economic disparity might lead to the impediment of economic growth. In Policy First, strong and coordinated government interventions and actions to achieve greater social equity and environmental protection leads to a decrease in environmental degradation and improvement in human well-being; however, pressures from investment policies continue to be high. In Sustainability First, the improvement of governance and a sustained link between social, economic, and environmental policies provides a solution to the sustainability challenge in Bahrain. Probably, the most important policy lesson that these scenarios offer, in addition to the above, is that investment in human resources development, governance improvement, and regional cooperation and integration with the GCC countries are key issues in the long, intricate path to sustainability.

3.1. Key Scenarios Messages and Strategic Recommendations

The above three scenarios have investigated the implications of different choices, premises, approaches, and priorities on the natural environment and human well-being. This section attempts to summarize the key messages concluded from the scenarios. Although they have many uncertainties involved in their derivation and are based mainly on qualitative analysis, these scenarios can provide valuable insights for the boarder process of policymaking, and could help decision makers to give special thought to how they might direct their actions to creating the best possible future hoped for Bahrain. The followings are the main messages and strategic recommendations to policymakers and decision-makers:

3.2. Main Messages to Policymakers

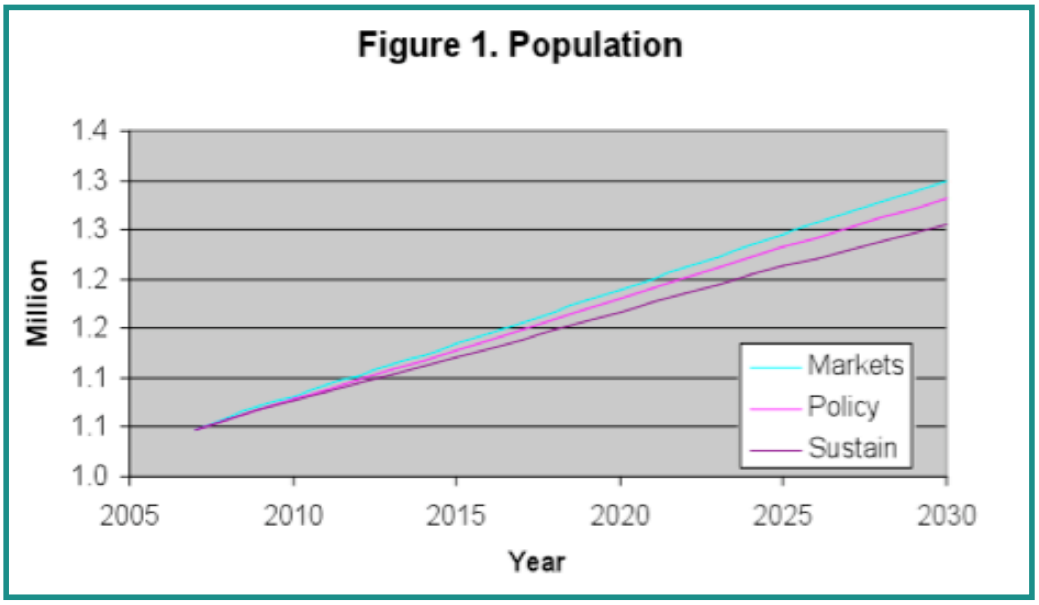
- The most important choices affecting the environment in the future are not necessarily environmental choices; achieving environmental sustainability relies on a multitude of potential interventions and developments, such as changing governance approach, the education system, the implementation of technological innovations, and changing the behavior of people.
- The environment is not compartmentalized and nor should environmental policies be, and they should be integrated and mainstreamed into the national socio-economic development plans; sound sustainable policies should have human and environment central to planning.

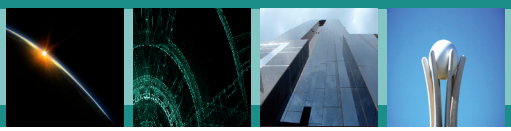
- The path to sustainable development is a long one, and achieving long-term goals requires long-term thinking; long-term thinking is vital for guiding near-term actions towards a sustainable future.
- The trend towards less environmental regulation and self-regulation (Market First scenario), i.e., letting markets decide, can lead to the complication of many environmental problems and consequently may lead to social problems.

3.3. Strategic Recommendations to Decision Makers

For Bahrain, the major strategies that need to be made can be summarized in the following:

- Investment in human resources development in the fields of education, training, and capacity building with the ultimate objective of establishing a knowledge-based society, accompanied by effective, well-planned substitution programs is a key issue in the long path to sustainability.
- Investment in R&D to solve societal problems and meet its needs is a key issue in the development and progress of Bahrain.
- Due to its limited natural and financial resources, regional integration and cooperation with the GCC countries, and the Arab countries at large is vital for the future of Bahrain. the main areas of cooperation and integration are in the fields of food production, R&D in desalination and water treatment technology, trans-boundary bio-reserves and protected areas, GMOs handling and management, and the protection of the Arabian Gulf marine environment.





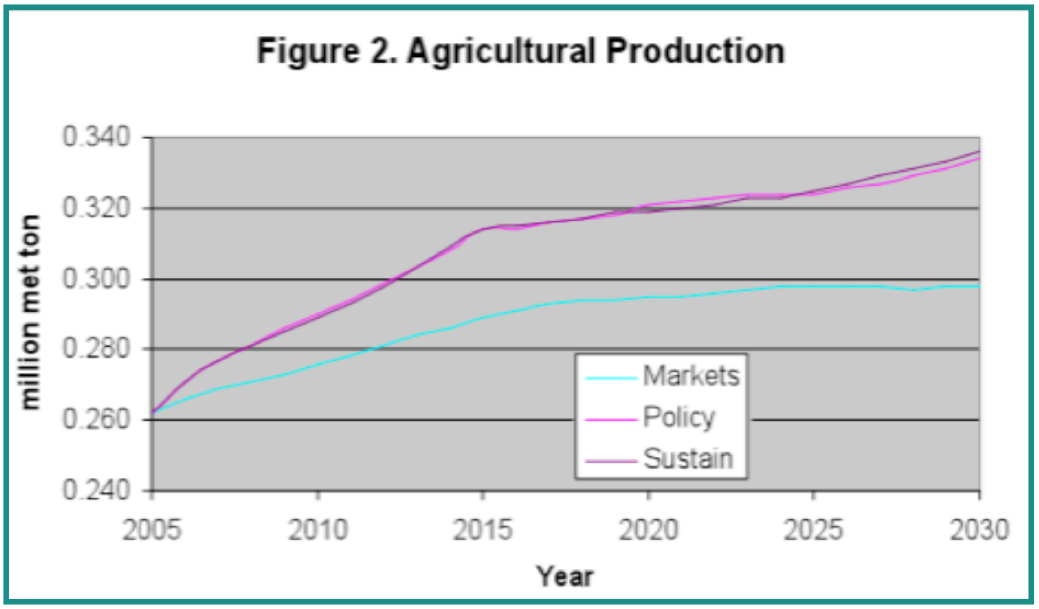



Figure 2. Agricultural Production
million met ton
0.340
0.320
0.300
0.280
0.260
0.240
2005
2010
2015
2020
2025
2030
Year
Markets
Policy
Sustain

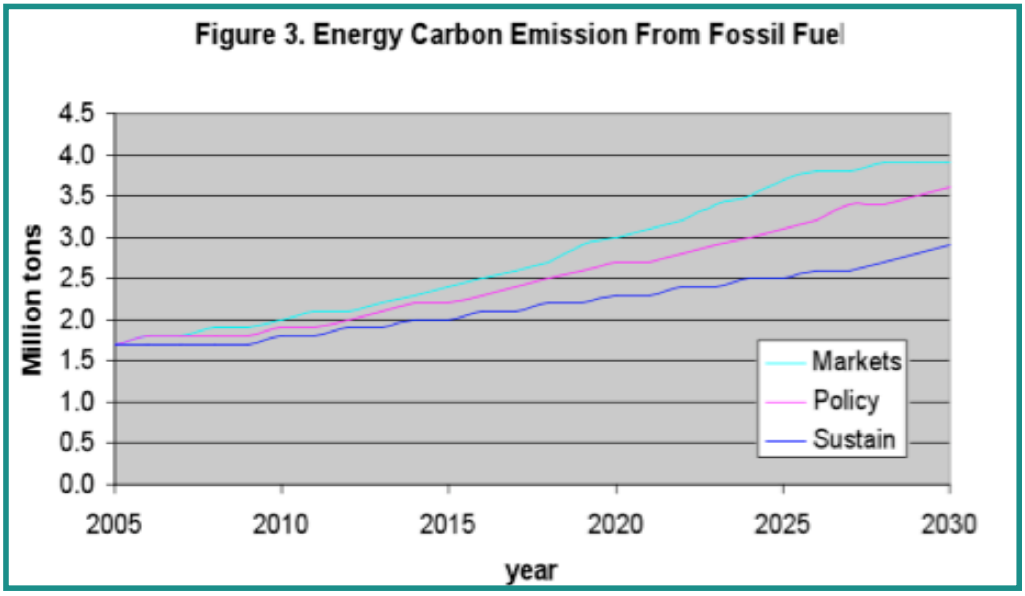


Figure 3. Energy Carbon Emission From Fossil Fuel
Million tons
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2005
2010
2015
2020
2025
2030
year
Markets
Policy
Sustain

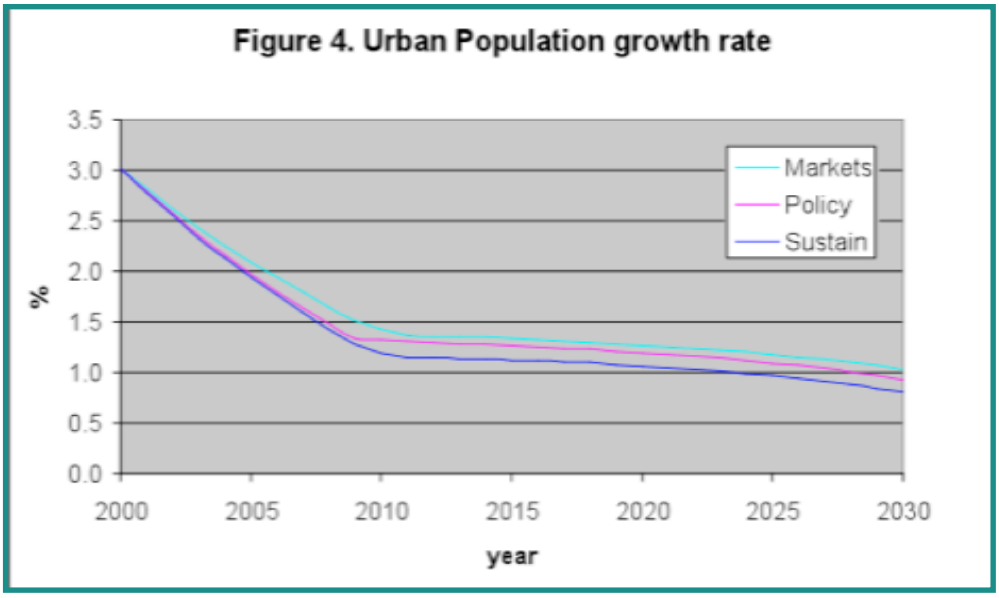


Figure 4. Urban Population growth rate
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
%
2000
2005
2010
2015
2020
2025
2030
year
Markets
Policy
Sustain

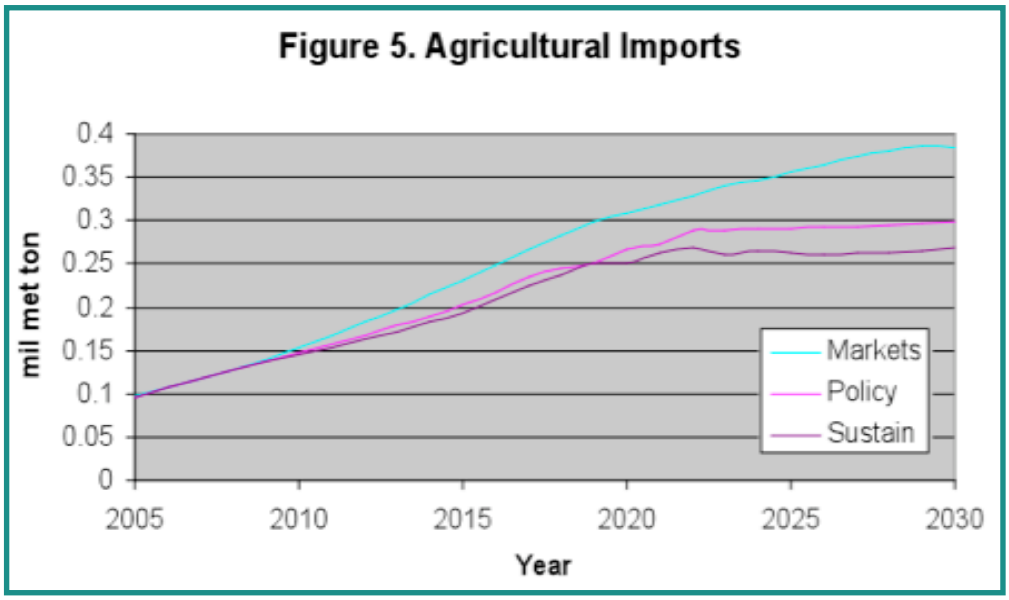


Figure 5. Agricultural Imports
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
mil met ton
2005
2010
2015
2020
2025
2030
Year
Markets
Policy
Sustain

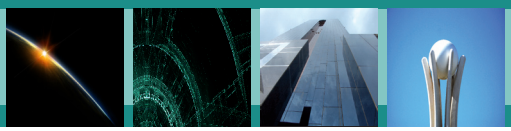



Figure 6. Life Expectancy

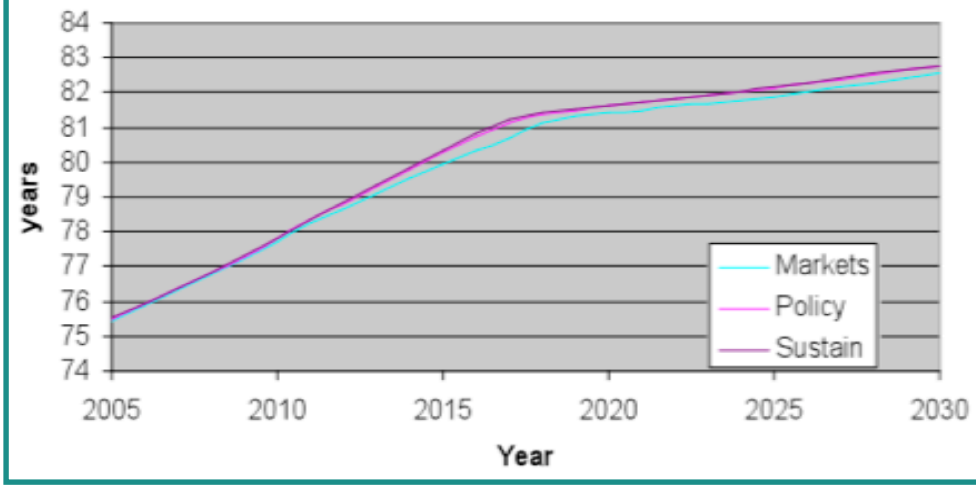
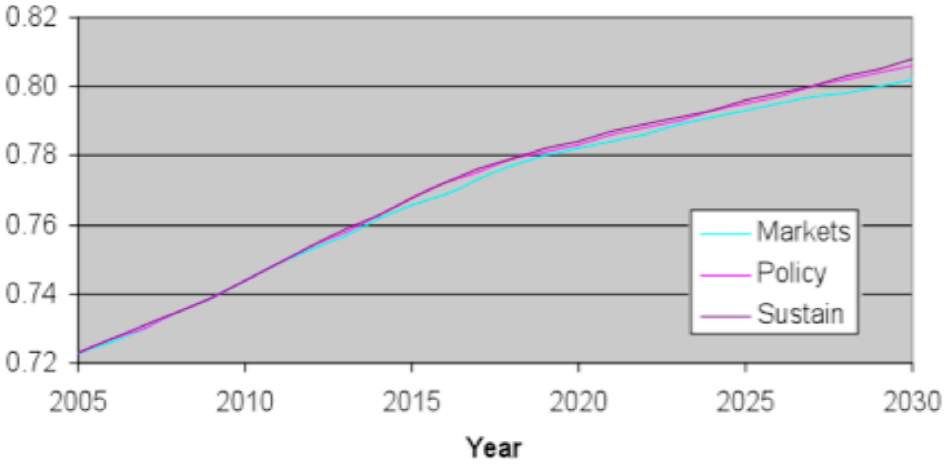


Figure 7. Human Development Index



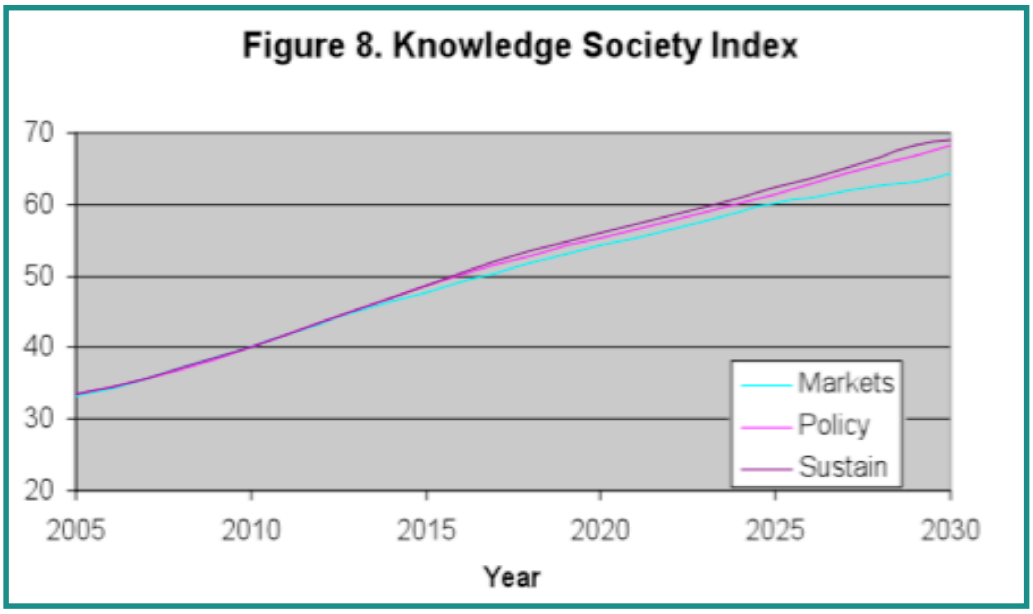


Figure 8. Knowledge Society Index
70
60
50
40
30
20
2005
2010
2015
2020
2025
2030
Year
Markets
Policy
Sustain

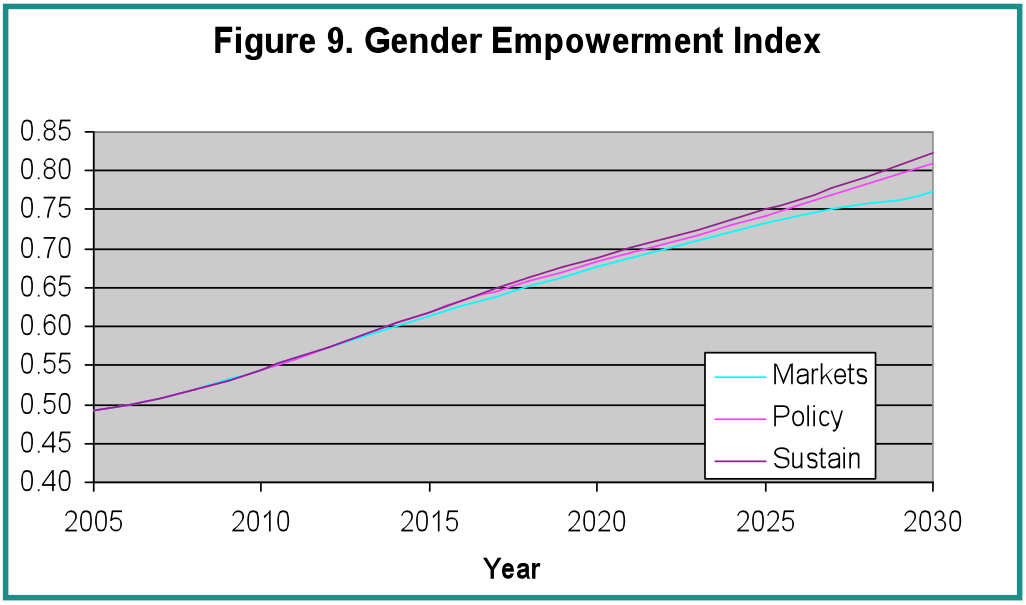


Figure 9. Gender Empowerment Index
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
2005
2010
2015
2020
2025
2030
Year
Markets
Policy
Sustain

Chapter Nine

Environmental Priorities and Policy Options

The previous chapter presented Bahrain's environmental scenarios through the year 2030 as per the strategic national vision of the Kingdom, and described the expected outcomes for each of the three scenarios: Markets First, Policies First and Sustainability First. The previous chapter also presented some recommendations to assist policy and decision makers to take the necessary measures to put Bahrain on the path of sustainable development.

Bahrain's National Environmental Strategy published in 2006 specifically outlined the priorities for environmental action, and suggested solutions that complement the government's drive towards sustainable development. In its recommendations, the strategy stressed the need to enhance the capacities of Bahrain's institutional and legislative environment framework so that the Public Commission for the Protection of Marine Resources, Wildlife and the Environment may spread its vision, which in turn would prompt the government to take the environmental considerations into account when planning and implementing development projects. Exhibit 1 below summarizes the main environmental priorities and corresponding policy options some of which are being implemented while others are presented here for consideration by decision makers.

Exhibit 1 – Summary of Environmental Priorities and Policy Options

Environmental Priority	Policy Options & Actions
Water desalination: Bahrain's five desalination plants produce about 132 million m3 of freshwater per year. These plants discharge highly saline effluents into the environment causing serious damage to coastal and marine ecosystems.	Bahrain's desalination industry must find alternative disposal methods to prevent further degradation of the marine (receiving) environment. One option would be to discharge the saline effluent through long sea outfalls to ensure maximum dilution in deep waters.
Wastewater treatment: Bahrain's largest wastewater treatment plant (Tubli) receives approximately 170,000 m3/day of which 40% are treated to the secondary level and 60% to the tertiary level. A sizeable fraction of the treated wastewater is discharged into the sea.	Bahrain's water authorities must reuse a higher percentage of its treated wastewater (currently, at least 20% of tertiary treated wastewater is discharged into the sea). Wastewater reuse is based on treatment level. Policies are needed to educate farmers on safe water reuse practices.
Water consumption. Per capita water consumption continues to rise unabated (from 250 liters/day in 1996 to 510 liters/day today). About 72% of total water consumption (domestic, agricultural and industry) comes from three major formations. Groundwater abstraction exceeds natural recharge rates by about 100 million m3 per year.	Bahrain must embrace the principles of integrated water resources management (economic viability, social equity, and ecological sustainability) and must urgently develop policies to curb consumption. The media and NGO's must play a more active role in promoting water awareness and educating end-users (for example, launch jointly awareness campaigns during summer, celebrate World Environment Day, Water Day, organize environmental competitions and award scheme, etc.). The Water Resources Council must be revived (resolution with Parliament) and allocated resources to fulfill its mandate.
Springs. Bahrain's natural springs are fast disappearing. These springs used to constitute unique recreational areas where Bahrainis would converge to spend quality time.	Restore some of Bahrain's water springs and their associated ecosystems. This requires a strict control of nearby urban development and groundwater abstraction.

Environmental Priority	Policy Options & Actions
Coastal development and sea reclamation projects. Dredging and reclamation have consumed an estimated 90 km2 of marine area since 1932. Important and unique coastal habitats have disappeared or have been irreversibly damaged.	Enforce EIA regulations for large-scale urban development projects in the coastal zone, and monitor compliance with environmental monitoring plans to minimize environmental disturbance. Control/ban the use of marine sand for construction (and find alternative sources). Survey and protect remaining ecologically-sensitive coastal zones from any new construction and reclamation.
Industrial zones. Bahrain's 11 industrial zones occupy a total area of 24 km2. Many of these zones are old and were setup prior to the promulgation of EIA procedures. Additionally, Bahrain's light industry has spread outside formal industrial zones (in so called mixed zones), resulting in public nuisance and social tension due to the settlement of immigrant workers.	Freeze all licensing of new light industries inside mixed zones and review zoning regulations. Review existing regulation and/or promulgate new environmental limit values for existing light industries in mixed zones. Invest in capacity building and vocational training to create skills locally and reduce dependence on foreign workers.
Biodiversity. Approximately 1,361 species have been recorded in Bahrain. Many of these species are under threat and/or face extinction.	Review and start implementing Bahrain's National Biodiversity Action Plan, pursuant to the Convention on Biological Diversity; and mobilize resources for protecting Bahrain's natural species. Develop and update a national list of threatened species (it would include the Arabian Toad, the Caspian Turtle and the dugong) and formulate clear actions to protect those species.
Ecosystems. Bahrain's coastal (mangrove, mud flats, sandy beaches, rocky beaches) and underwater environments (sea grasses, coral reefs, algae, oyster bed) are unique but under significant pressure. Bahrain's six nature reserves (Al Areen Wildlife Park & Reserve, Ras Sanad and Tubli Bay Reserve, Hawar Islands Reserve, Jazirat Mashtan Reserve, Arad Bay Reserve, Heer Abulthama) do not cover all the ecosystems in the Kingdom.	Increase funding to support the management of Bahrain's nature reserves. Establish new reserves to ensure full representation of the Kingdom's ecosystems. Ensure adequate resources to sustain the Kingdom's breeding programs (ex-situ breeding followed by integration into their natural habitat, artificial reefs, fishing regulations, no catch zones/season, plant tissue culture). Additionally, the planned Friendship Causeway that will link Bahrain to Qatar must undergo a very serious and transparent EIA process to minimize environmental damage.
Education and outreach. The Kingdom lacks a national strategy for environmental education and outreach. A future strategy would need to build on existing initiatives; for example, the Department of Public Relations and Information is sponsoring a national project "Friends of the Environment Schools" to introduce students to sound environmental practices. Coverage of biodiversity issues and concepts in relevant high-school textbooks (about 14) remains inadequate despite previous efforts to revamp the curriculum.	Design and sustain public awareness programs to educate and sensitive the local population (Bahrainis and foreign workers) on the importance of biodiversity. These programs will help induce a behavioral change across Bahraini society. Review and infuse concepts related to biodiversity into the school curriculum Setup a revolving grant and/or government fund to support innovative research in biodiversity conservation and management.

Environmental Priority	Policy Options & Actions
Waste management. Bahrain produces daily 3,000 tonnes of municipal solid waste (up 173% since 2000), about 384 tonnes of industrial waste (2000 data), and an estimated 3 tonnes of health care waste.	Formulate a National Waste Management Strategy. The strategy would determine the most suitable course of action based on a review of available options (minimization, source separation and recycling, landfilling, composting, incineration, etc.). The strategy would need to: (1) Improve the current exchange program for industrial waste (waste from one industry becomes raw material for another); and (2) initiate waste minimization programs at all levels (household, commercial, and industrial).
Shrinking arable land area. Statistics show that the area available for agriculture dropped from 0.036 ha per capita in 1924 to 0.006 ha per capita in 2005	Hinder further loss of limited agricultural land to urban sprawl. While Bahrain can never achieve autonomy in food production, it must protect the remaining arable land to ensure some level and agricultural output, maintain farming jobs, and conserve soil and biodiversity.
Emissions and air quality. Control emissions from primary sources of air pollution including oil refineries, aluminum manufacturing and power plants.	Declare a national commitment to harness and promote the use of renewable energy. Establish the Bahrain Green Building Council to promote and regulate the design and construction of water and energy efficient buildings Provide incentives for the retail industry to supply energy efficient equipment and appliances (for public and private use) Monitor compliance with relevant regulations (decree #21, 1999 on fuel quality) and emission standards (decree #8, 2002) Meet other obligations under the UNFCCC (on climate change, ratified in 1994) and the Montreal Protocol (on ODS, ratified in 1990)
Air quality monitoring system. Bahrain's air quality monitoring capabilities are limited (coverage is incomplete; readings are not sufficiently used to inform the population, etc.).	Expand and sustain the national air quality monitoring program to inform commuters of actual pollution levels, on a real time basis (SMS broadcast, highway billboards, radio spots, etc.).
Green cover. Bahrain's dwindling green cover is under severe threat from urban sprawl. Reduced cover is also changing the frequency and intensity of sand storms affecting road visibility and public health.	Protect the dwindling green cover by restoring some of the (traditional and characteristic) palm plantations to improve the landscape and help combat desertification and reduce the intensity of sand storms
Electricity production. Bahrain's power production (about 8,300 GW in 2004, of which 83% is generated from natural gas) is highly subsidized. Electricity tariffs are much lower than actual costs (about one third; 17 fills per KWH compared to 50 fills, assuming $50 per barrel of oil-equivalent).	Bahrain must review its tariff system and gradually lift the subsidy on electricity (consumers must pay the full production cost). The current sliding tariff scale (from 4 to 17 fills per KWH) impedes production efficiency.

To achieve sustainable development, Bahrain must adopt additional policies and measures not listed in Exhibit 1. Collectively, these policies will help the Kingdom move forward from the current state of the environmental affairs and adapt to future changes and emerging socio-economic needs. Most importantly, Bahrain needs to invest in developing its human capital through education, training and capacity-building. Regional integration and cooperation with the GCC countries and the rest of the Arab world is equally important and will provide much needed support as Bahrain embarks on the long path towards sustainable development.