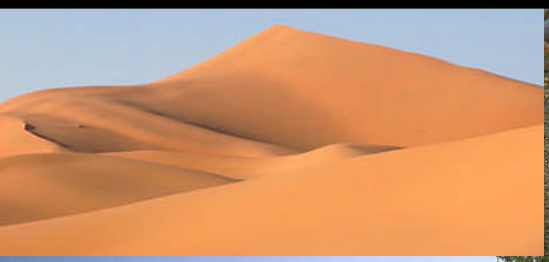
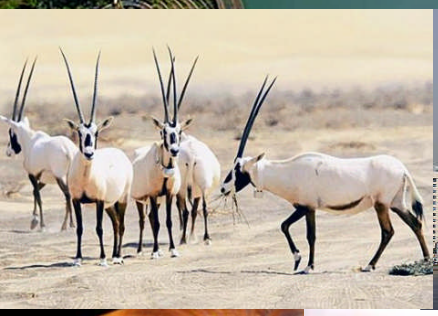
The United Arab Emirates

Second National Communications to the Conference of the Parties of United Nations Framework Convention on Climate Change










Ministry of Energy

January 2010

Foreword

On behalf of the government of the United Arab Emirates, it is my pleasure to present our "Second National Communication" to the Conference of the Parties through the UNFCCC Secretariat in fulfillment of obligations under the United Nations Framework Convention on Climate Change.

The UAE acceded to the United Nations Framework Convention on Climate Change in December 1995 and became an official party in March 1996 with a mandate, as a Non-Annex 1 Party to the Convention, to submit National Communications. The National Communication has been prepared by a team of scientists and experts specializing in different disciplines and has been coordinated by the Ministry of Energy.

The UAE, a country that is highly vulnerable to the impacts of climate change, believes that that the challenges posed by climate change demand urgent and decisive action. Indeed, we find ourselves in agreement that the world - and all its member states – can no longer afford to delay regarding innovative and coordinated action to confront climate change. We consider this a moral obligation to our children and their progeny. As an oil-exporting country, we have already begun our journey towards sustainable development by introducing new thinking, new frameworks, and new partnerships for reducing our carbon footprint.

The Second National Communication has been prepared in accordance with the methodologies provided by the Intergovernmental Panel on Climate Change (IPCC) and the guidelines by the Conference of Parties. The information contained in this submission reflects the best available at the time of writing this report.

I would like to seize this opportunity to thank H.H Sheikh Hamdan Bin Zayed Al Nahyan, Ruler`s Representative in the Western Region and chairman of the Abu Dhabi Environmental Agency for his support. I would also like to thank all the parties and individuals who participated in the preparation of this report, and in particular, the Abu Dhabi Environmental Agency for their role in the compilation and preparation of this report.

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List of Acronyms

°C	degrees Centigrade
ADICO	Abu Dhabi Chamber of Commerce
ADNOC	Abu Dhabi National Oil Company
ADUPC	Abu Dhabi Urban Planning Council
ADWEC	Abu Dhabi Water and Electricity Company
AGEDI	Abu Dhabi Global Environmental Data Initiative
btu	British thermal unit
CCCMA CGCM 3.1	Canadian Center for Climate Modeling and Analysis
CDM	Clean Development Mechanism
CERT	Centre of Excellence for Applied Research and Training
CFL	Compact florescent light bulbs
CH_4	methane
CHP	Combined heat and power
CNG	Compressed natural gas
CNRM CM3	Meteo-France, Centre National de Recherches Meteorologiques
CO	carbon monoxide
CO_2	carbon dioxide
COP	Conference of the Parties
CSIRO mk3.5	CSIRO Atmospheric Research, Australia
EAD	Environment Agency Abu Dhabi
ESCO	Energy service company
EWS	Emirates Wildlife Society
GCC	Gulf Cooperation Council
GCM	Global Circulation Model
GDP	gross domestic product
GFDL CM 2.0	NOAA Geophysical Fluid Dynamics Laboratory
Gg	Gigagrams (i.e., one billion grams)
GHG	Greenhouse gas
GISS ER	NASA Goddard Institute for Space Studies
GWh	gigawatt-hour (billion watt-hours)
IAA	International Advertising Association
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPSL CM4	IPSL/LM/LSCE, France
Km	kilometers
Kt	kilotonnes (thousand metric tonnes)
kWh	thousand watt-hours
MAGICC	*M*odel for *A*ssessment of *G*reenhouse-gas *I*nduced *C*limate *C*hange)
MIUB ECHO-G	ECHO-G, Germany/Korea
MPI ECHAM 5	Max Planck Institute for Meteorology, Germany
MRI CGCM 2.3.2	MRI-CGCM 2.3.2, Japan
MW	million watts
N_2O	nitrous oxide
NCAR	National Center for Atmospheric Research (USA)
NCEP	National Centers for Environmental Prediction (USA)

NGCC	natural gas combined cycle power station
NGO	Nongovernmental organization
NMVOC	non-methane volatile organic compounds
NO_x	nitrogen oxides
PCMDI	Program for Climate Model Diagnosis and Intercomparison
PDF	probability distribution function
ppmv	parts per million by volume
RO	Reverse osmosis
RPS	Renewable portfolio standard
SCENGEN	*SCEN*ario *GEN*erator
SLR	Sea level rise
SNC	Second National Communication
SO_2	sulfur dioxide
SOMD	Self Organizing Maps Downscaling
TSE	Treated sewage effluent
UAE	United Arab Emirates
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VMT	vehicle miles travelled

Executive Summary

Located in Southwest Asia towards the south-eastern area of the Arabian Peninsula, the United Arab Emirates (UAE) is a federation of seven Emirates – Abu Dhabi, Dubai, Sharjah, Umm al-Quwain, Ajman, Ras Al Khaimah and Fujairah - that span approximately 83,600 square kilometers. The UAE's coastlines form the south and south-eastern shores of the Arabian Gulf and part of the western shores of the Gulf of Oman. The UAE shares borders with Qatar to the west, Saudi Arabia to the south and west, and Oman to the east and south, and occupies a strategic location along southern approaches to the Straits of Hormuz.

National Circumstances

The climate is hot and arid and is subject to ocean effects due to its proximity to the Arabian Gulf and the Gulf of Oman. There are two main seasons, winter and summer. Winter, between November and March, averages a temperature of about 26˚C during the daytime and 15˚C during the nighttime, with temperatures seldom dropping below 6˚C. Summers are very hot, stretching from April through the month of September, and temperatures can rise to about 48˚C in coastal cities – with humidity levels reaching as high as 90%. In the southern desert regions temperatures can climb to 50°C with low humidity.

The UAE's population is increasing rapidly. Population has grown nearly ten-fold since 1975, qualifying the UAE as having one of the highest population growth rates in the world over the period 1975-2005. However, much of this population increase is associated with non-nationals coming to the country on temporary work assignments. With a low ratio of nationals to non-nationals remains low, the national population is increasing at an average annual rate of 2.9%, while the corresponding figure for expatriates is about 6.9%.

The UAE's government is a constitutionally-based federal system. Under the leadership of Sheikh Zayed bin Sultan Al Nahyan, six Emirates became a federation in 1971, with Ras al-Khaimah joining in 1972. Now Under the leadership of Sheikh Khalifa bin Zayed bin Sultan Al Nahyan, the political system comprises several intricately connected governing bodies that include the Supreme Council, the Council of Ministers, the Federal National Council and the Federal Judiciary.

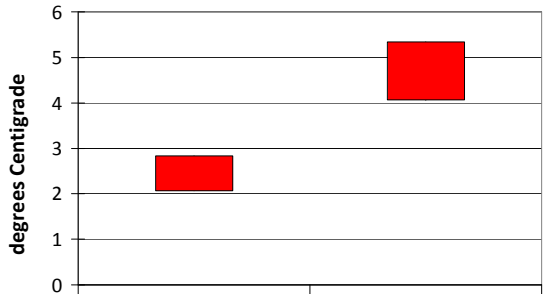
The UAE's economy is well diversified and has experienced robust growth in recent years. Despite being a major oil-exporter possessing the sixth largest proven oil reserves and the fifth largest proven natural gas reserves in the world, oil and gas activities accounted for only about 38% of national GDP in 2007. Overall GDP has been growing at an average real annual rate of 11.2% for the past dozen years. The UAE is also a large international trading partner with trade in 2007 totaling nearly US$0.3 trillion, accounting for approximately 22% of the total Arab commercial exchange despite the fact that the population of the UAE is under 2% of the population in the Arab bloc.

Natural resources have always been recognized in the UAE as precious and fragile assets to be preserved. Several long-term environmental sustainability strategies have been launched to protect urban air quality, impose tighter regulatory regimes on industrial and other development activities, establish conservation areas for biodiversity and endangered wildlife habitats, and sustainably manage scarce water resources.

The UAE has invested heavily in providing medical and health services for its citizens and has nurtured the growth of related industries in the country, from new local pharmaceutical

product manufacturing to the procurement of state-of-the-art medical equipment, to overall wellness resorts and private hospitals. Child mortality and life expectancy rates are comparable to most developing countries, while endemic diseases have been eradicated. Preventive medicine campaigns, a priority area for public health policy, have had a major impact on life expectancy and constitute a key element of health care strategy.

Figure ES-1: Projected annual average temperature change; 2050, 2100



	2050	2100
Minimum	2.1	4.1
Maximum	2.8	5.3

The UAE offers a comprehensive education to male and female students from kindergarten to university, with education for the country's citizens being provided free at all levels. There is also an extensive private education sector at primary, secondary and tertiary levels, while several thousand students pursue courses of higher education abroad at government expense. There are approximately 60 government and private universities. Over half of school enrollments are female and the national literacy rate is around 93%.

The UAE maintains a strong focus on maintaining an efficient transportation system. Ports and airports, shipping companies and airlines, together with efficient road networks, have underpinned plans to develop the country into a major transport hub.

Greenhouse Gas Emission Inventory

The UAE compiled an update to its inventory of greenhouse gas emissions for the year 2000 (see Table ES-1). Total GHG emissions in 2000 were 129,550 Gg CO2-equivalent, which includes 116,114 Gg from energy; 6,466 Gg from industrial processes; 4,348 Gg from agriculture, and 2,622 Gg from waste. CO_2 sequestration by the forestry and land use sector in 2000 amounted to 9,665 Gg. Net GHG emissions are estimated at 119,885 Gg CO2-equivalent. Emissions from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6) in the UAE are negligible as the products containing these gases are not produced in the country. On a net CO_2equivalent basis, emissions in the UAE increased by nearly 61% over the period 1994 to 2000, or by about 8.3% per year.

Table ES-1: Total GHG emissions in the UAE, 2000 (Gg)

GHG Sources & Sinks	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1 Energy	116,114	96,240	796	10	247	362	19	8,085
2 Industrial Processes	6,466	6,466	0	0	1	151	21	6
3 Solvent & Other Product Use	0	0	0	0	0	0	0	0
4 Agriculture	4,348	0	80	9	0	0	0	0
5 Land-Use Change & Forestry	-9,665	-9,665	0	0	0	0	0	0
6 Waste	2,622	0	120	0	0	0	0	0
Total National Emissions	129,550	102,706	997	19	248	513	41	8,091
Net National Emissions	**119,885**	**93,041**	**997**	**19**	**248**	**513**	**41**	**8,091**

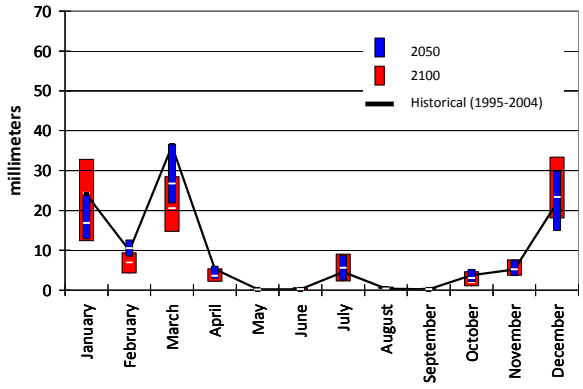
Vulnerability and Adaptation

Since the submission of its Initial National Communication, the UAE has undertaken regional climatic modeling analysis, as well as vulnerability and adaptation studies for coastal zones,

water resources, and dryland ecosystems. A study was also undertaken regarding the economic vulnerability of the UAE relative to response measures undertaken by Annex 1 countries in compliance with Kyoto Protocol targets.

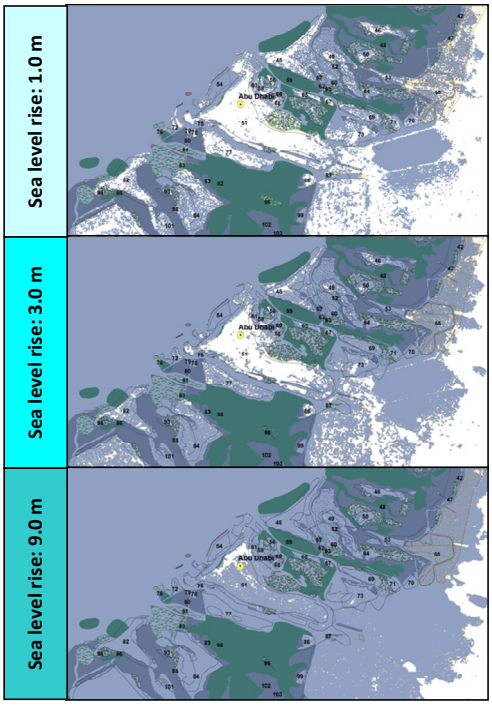
Climatic downscaling was carried out using the Self Organizing Maps downscaling (SOMD) methodology, and nine global circulation models applied to the SRES2A GHG emission scenario. Figure ES-1 shows projected annual average minimum and maximum temperature change for 2050 and 2100 relative to the 20th century observed values in UAE. Temperatures in 2050 are expected to increase between 2.1°C and 2.8°C over the historical average; and between 4.1°C and 5.3°C over the historical average by 2100. Figure ES-2 shows the range in projected monthly mean precipitation for 2050 and 2100 relative to average 20th century observed values for the UAE. While the large envelopes suggest high uncertainty, the downscaling predicts a drier future climate, particularly during winter months when rainfall levels have been historically high (i.e., January, February, and March).

Figure ES-2: Average monthly precipitation relative to observed levels; 2050, 2100



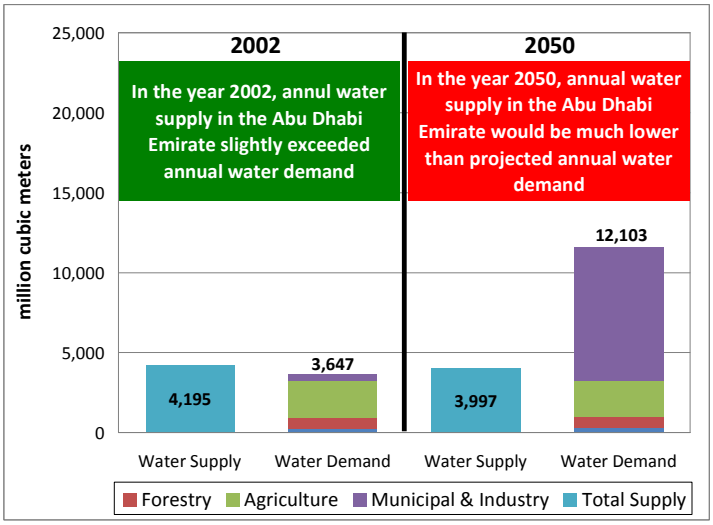
A key finding of the coastal vulnerability study is that coastal areas are projected to be extensively inundated due to sea level rise as current shorelines migrate inland substantially. Indeed, all coastal cities in the UAE are projected to experience progressively increasing inundation, depending on the scenario analyzed. Taking Abu Dhabi as an example, even the smallest sea level rise scenario shows that by 2050 significant areas of the built environmental in coastal regions may be inundated (see blue-shaded areas in the topmost map in Figure ES-3). With the highest sea level rise scenario in 2100, corresponding to accelerated deglaciation assumptions, the inundated area is quite extensive in comparison and leads to the shoreline migrating southward by about between 25 and 30 kilometres (see blue-shaded areas in bottommost map in Figure ES-3).

Figure ES-3: Impact of projected sea level rise on Abu Dhabi



A key finding of the water resource vulnerability study is that the combination of future population growth, irrigation requirements, and economic activity and business-as-usual water resource management will lead to future water demand far in excess of current supplies. Even with desalinated water supplies, water demand in 2050 would be roughly 3 times more than current supplies as shown in Figure ES-4, emphasizing the need to either increase desalinated capacity or reduce water demand, or both. To address the major findings above, the study recommends exploring strategies to narrow the growing gap between

Figure ES-4: Water supply and demand balance, 2002 and 2050



available water supplies and projected water demand. The central recommendation is to develop a strategy to reduce per capita water consumption by about 50% from current levels by the year 2012, with resulting level of per capita water consumption maintained through the year 2050. To achieve this target, key recommendations include implementing a public awareness programme for water conservation, increase the penetration of high efficiency water use devices, strategies, and measures, incentivize additional water reductions, and develop a comprehensive integrated water management and planning system.

A key conclusion of the dryland ecosystem vulnerability study is that climate change is expected to cause shifts in the basic ecological characteristics upon which dryland ecosystems rely. There is a significant risk that highly interdependent biota will lose synchrony, impacting both local and migratory species. Coping with future climate change will require planned adaptation in dryland areas involving strengthen biodiversity conservation, develop an ecosystem threshold modeling capability, and strengthen dryland ecosystem research capacity.

Finally, the economic vulnerability study concluded that through 2025, there are not expected to be any available substitutes for petroleum-based transportation fuels, as biofuels will not be produced in sufficient quantity to impact global oil markets. The world demand for oil in 2025 for each of the policy scenarios and economic growth tracks is summarized in Table ES-2 showing that there is little change in projected global oil consumption at tax rates below $90 per barrel. However, even in the most extreme scenario in which a $180/barrel tax is added to the price of oil, global demand for oil in 2025 is still projected to be just over 80% of the demand level associated with no carbon tax for both economic performance tracks.

Table ES-2: Projected global oil demand in 2025 relative to CO2 tax ranging from $0/tC to $180/tC

Scenario	Carbon tax ($/barrel)	Global oil consumption in 2025 (million barrels/day)	
		Stagnant growth	High growth
Baseline	0	89.1	110.4
1	4	89.0	1104
2	9	88.9	110.3
3	18	88.8	110.1
4	45	88.2	109.7
5	90	86.1	107.9
6	180	73.5	91.2

Greenhouse Gas Mitigation

Greenhouse gas mitigation activities have taken on increasing prominence in the UAE over the past few years. Among the most notable is the MASDAR initiative, a $15 billion programme linking climate change, economic opportunity, and clean energy. Funding is targeted for new infrastructure, manufacturing, and renewable energy projects such as solar power, hydrogen, wind power, and carbon

reduction and management technologies. The goal is to raise more than $200 billion dedicated to research and development of renewable energy technologies, making the UAE is the first major hydrocarbon-producing nation to take such a major step in the development of clean sources of alternative energy.

As part of the initiative, the world's first carbon-neutral, zero-waste city is built in the deserts of Abu Dhabi. MASDAR City will be 100 percent powered by renewable energy to sustain a population of 50,000 and 1,500 companies. The city will span about 6 square kilometers and will feature compact high density development, a photovoltaic power plant, and will exemplify how energy and water conservation can be achieved while enhancing quality of life. MASDAR City will show how growth with a high living quality can be sustained while simultaneously avoiding greenhouse gas emissions. For this vision, MASDAR City has been designated as an official "One Planet Living Community" by the World Wide Fund for Nature.

In addition to the MASDAR initiative, there has been an ongoing governmental process to identify appropriate strategies to reduce GHG emissions in the UAE. Given its important role in the GHG inventory, energy supply and demand has been the primary focus of policy-level discussions regarding potential GHG mitigation options. Investments in modern energy infrastructure, including the progressive deployment of energy efficient and renewable technologies are projected, over the longer term, contribute to substantial reductions in GHG emissions. Moreover, enhanced oil recovery schemes using carbon captured from industrial flue gases and transported/injected into onshore oil fields is being actively explored through a joint ADNOC and MASDAR collaboration.

Major GHG mitigation strategies either under consideration or already underway include sustainable (green) building codes, ecological footprint assessment, low-carbon electricity supply using renewables, peaceful nuclear energy, high efficiency natural gas plants, sustainable transport initiatives in aviation, public transport and alternative fuels, and variety of climate change awareness raising campaigns targeted at the general public, media, and businesses. Over the period of their implementation, the above measures are projected to yield reductions of about 1.1 billion tones of CO_2-equivalent cumulatively through 2030.

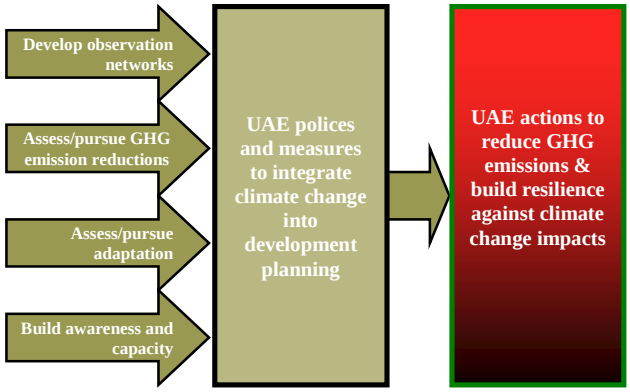
Steps to Implement the Convention

The discussion in the previous chapters makes clear that through its environmental vision, fulfillment of its international commitments, improved understanding of vulnerability to climate change, and proactive steps in promoting alternative energy investments, the UAE has already taken important steps in the implementation of the Framework Convention on Climate Change since the submission of its Initial National Communication. The key priorities are outlined in the bullets below; the overall process is illustrated in Figure ES-5.

- *Develop observation networks:* this refers to monitoring and GHG emission tracking systems to strengthen the UAE's quantitative understanding of how climate change is impacting key vulnerable sectors, how local climate patterns are changing, and how productive activities are contributing to GHG emissions;
- *Assess and pursue greenhouse gas emission reduction strategies:* this refers to the assessment of policies, strategies and measures for reducing GHG emissions throughout the economy leading to concrete GHG emission reductions in certain priority sectors;

- Assess and pursue climate change adaptation options: this refers to actions to reduce the vulnerability of key ecosystems, structures, and communities to the adverse impacts of climate change through near-term actions in coastal zones, water resources, dryland ecosystems, food security, and public health; and

Figure ES-5: Process for implementing the Climate Change Convention



- *Build awareness and capacity:* this refers to enhancing the individual, institutional and public/private capacity to address the challenges of climate change in order to promote a better informed general public as well as strengthened capacity in key institutions to undertake the needed analyses and studies that contribute to better decision-making.

This process is already well underway in the Abu Dhabi emirate, and consultations are ongoing for appropriate ways to extend the process throughout the other six Emirates. While much remains to be done to establish implementation and coordination arrangements across national institutions, agencies, and stakeholders, the process enjoys increasing support and is intended to be further refined over the months and years ahead.

Chapter 1

National Circumstances

1.1. Introduction

This chapter provides a description of the United Arab Emirates' national and regional development priorities, objectives and circumstances, on the basis of which, it will address climate change and its adverse impacts. This chapter also includes information on features of UAE geography, demography, climate and economy to provide a sense of the overall national context in which climate change mitigation and adaptation challenges are being addressed.

1.2. Geography

Located in Southwest Asia towards the south-eastern area of the Arabian Peninsula between latitudes 22.0° and 26.5° N and between 51° and 56.5° E, the United Arab Emirates (UAE) is a roughly triangular landmass whose coastlines form the south and south-eastern shores of the Arabian Gulf and part of the western shores of the Gulf of Oman. The UAE shares a maritime border with Qatar to the west, and land borders with Saudi Arabia to the south and west and the Sultanate of Oman to the east and south. The UAE thus occupies a strategic location along southern approaches to the Straits of Hormuz.

Figure 1-1: UAE's regional context (source: Google Maps)

The UAE is a federation of seven Emirates – Abu Dhabi, Dubai, Sharjah, Umm al-Quwain, Ajman, Ras Al Khaimah and Fujairah - that span approximately 83,600 square kilometers. This area includes an archipelago that extends over the Arabian Gulf for about 5,900 square kilometers. Abu Dhabi counts for roughly 87% of the UAE's total area. The city of Abu Dhabi is also the capital and second largest city in the country.

Prior to construction of the 'Dubai Palms' islands and other construction schemes along the coast, the shoreline of the UAE was approximately 1,318 kilometers along both the Gulf of Oman and the Arabian Gulf. Ongoing land reclamation projects are extending this figure and the new coastline length is yet to be determined.

The UAE can be characterized by its three main types of terrain: low-lying coastal plains, rolling sand dunes of the Rub al-Khali desert, and rugged mountains along the border with Oman. Arable land constitutes around 6.5% of the UAE's total land surface (UAE 2nd Report to UNCCD, 2002). Most of the cultivated land lies in four areas: a strip of land along the east coast, Al Ain, the oasis of Dhaid, and the gravel plains in Ras Al Khaimah (UAE INC, 2006).

1.3. Climate

The United Arab Emirates has an arid climate that is subject to ocean effects due to its proximity to the Arabian Gulf and the Gulf of Oman. There are two main seasons, winter and summer. Winter, between November and March, averages a temperature of about 26˚C during the daytime and 15˚C during the nighttime. Temperatures seldom drop below 6˚C. Although generally warm and dry in the winter, weather in the proximity of the Al Hajar

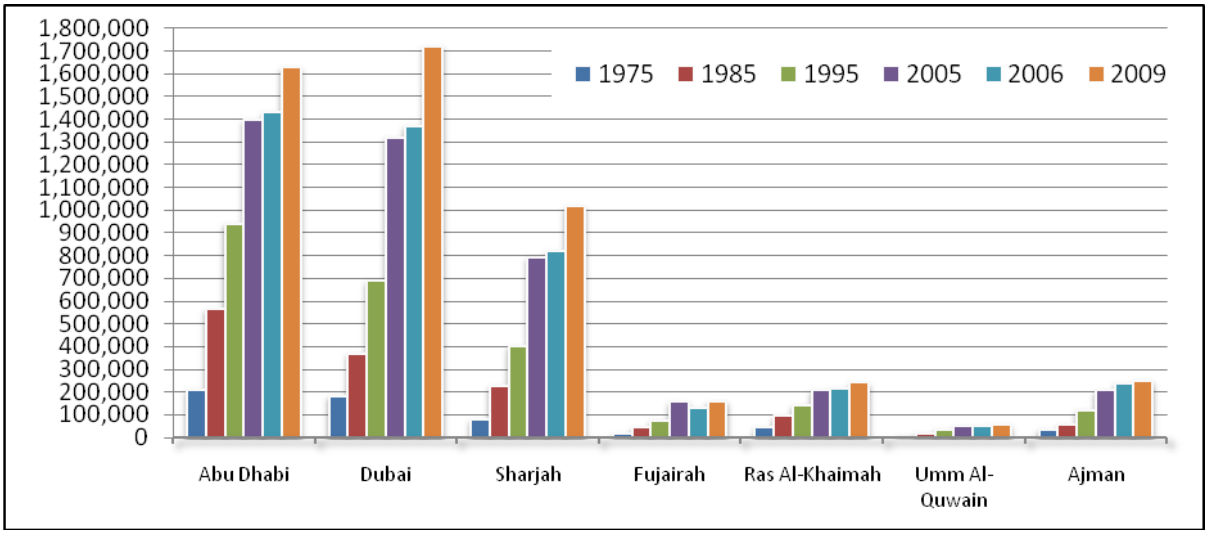
al Gharbi Mountains lead to generally cooler weather conditions. Average minimum temperatures in the winter months of January and February are between 10°C and 14°C. Summers are very hot, stretching from April through the month of September, and temperatures can rise to about 48˚C in coastal cities – with humidity levels reaching as high as 90%. In the southern desert regions temperatures can climb to 50°C with low humidity.

A combination of atmospheric depressions and northwesterly winds from the Mediterranean produce most of the rainfall in winter months; February and March being the wettest months of the year. While summer rainfall levels are very low in the coastal areas, they are higher in the mountainous and southeastern regions, where annual average rainfall ranges between 140 and 200 mm/year precipitation patterns. In some years, however, there is no rain at all, and in others, rain occurs on only a few days in the year can total more than three times the long term annual average (ADEA, 2002).

1.4. Demography

The UAE's population increased by about 75% between 1995 and 2005, the year when the last census was conducted. Population has grown nearly ten-fold since 1975 when the population was just 557,887, qualifying the UAE as having one of the highest population growth rates in the world over the period 1975-2005. Moreover, the population is expected to increase to 5.06 million by the end of 2009. The overwhelming majority of population growth is associated with non-nationals coming to the country on temporary work assignments. Total population figures are disaggregated by Emirate in the following chart.

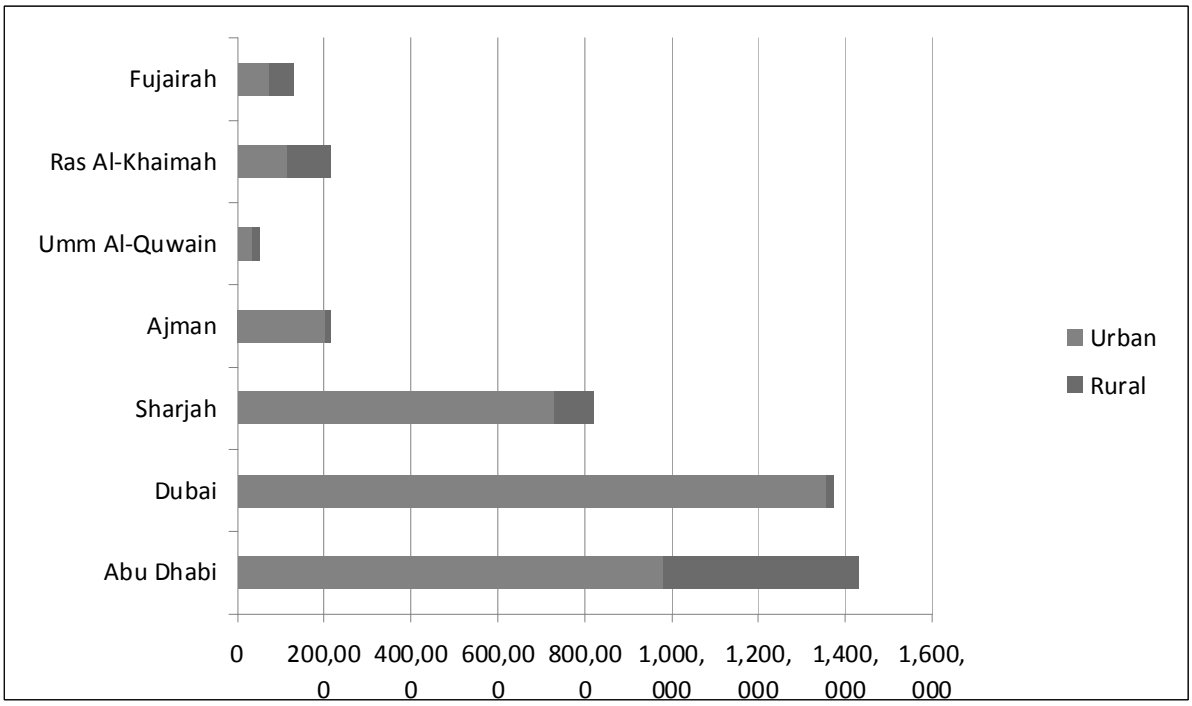
Figure 1-2: Emirate population changes over time from 1975- 2006 (source: Vine, 2009)



The ratio of nationals to non-nationals remains low. A breakdown for 2007 indicates 864,000 UAE nationals and 3.62 million expatriates. The national population is increasing at an average annual rate of 2.9%, while the corresponding figure for expatriates is about 6.9%. National and non-national population annual growth rates are forecasted to be similar for the near future.

The UAE's population is also heavily urban-based. In 2006, the estimated urban population the UAE was about 83% of the total population. This urban population level varies considerably at the emirate level, ranging from about 50% in Fujairah to 99% in Dubai, as illustrated in the following chart:

Figure 1-3: Emirate-level rural urban population, 2006 (source: Vine, 2009b)



1.5. Governance

The UAE's government is a constitutionally-based federal system under the leadership of Sheikh Khalifa bin Zayed. The political system comprises several intricately connected governing bodies that include the Supreme Council, the Council of Ministers, the Federal National Council and the Federal Judiciary.

The Supreme Council, which is made up of the rulers of each constituent emirate, is the top policy-making body in the nation. The Council of Ministers or Cabinet, headed by the Prime Minister, is the executive authority for the federation. The Federal National Council has both a legislative and supervisory role, its 40 seats allocated to the individual emirates on the basis of population and size. Since 2005, members of the Federal National Council are indirectly elected through local electoral colleges. The Federal Judiciary, whose independence is guaranteed by the Constitution, includes the Supreme Court and the Courts of First Instance.

The relationship between the federal and emirate governments is established in the Constitution, which allows for a degree of flexibility in the distribution of authority. Each of the seven emirates has its own local government, the complexity of which differs according to their size, population and resources. Over the past several years, major steps have been taken, both at a federal and at a local level, to reform the structure of government to enhance responsiveness to the citizenship and emerging challenges of sustainable development.

An important recent development was the development of a national Government Strategy. Launched in 2007 by HH Sheikh Mohammed bin Rashid, Ruler of Dubai and Vice president and prime minister of the UAE, it aims to establish foundations for a new era of public administration. Implementation of the strategy has continued to make progress resulting in the enhancement of collaboration between the federal and emirate-level authorities. The

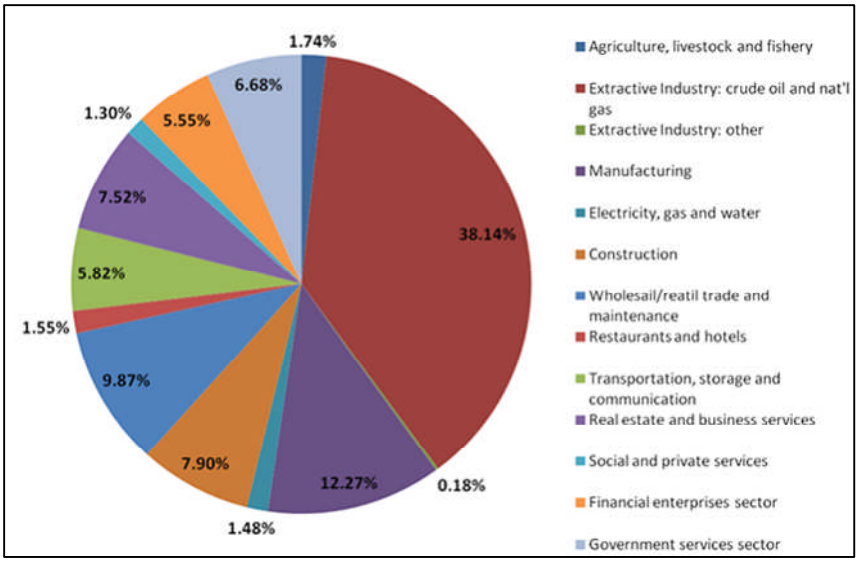
national policy agenda has been followed by several notable local initiatives including: Plan Abu Dhabi 2030, Al Ain Plan 2030, and in late 2008 a new Plan 2030 for the Western Region of Abu Dhabi, now officially called Al Gharbia, in an effort to ensure that this large area receives its full share of economic and social development.

1.6. Economy

In 2007, the UAE's GDP reached nearly 730 billion dirhams (about US$ 200 billion), up from almost 242 billion dirhams in 2000 and 157 billion dirhams in 1995. The national economy is well diversified (see Figure 1-5) and has experienced robust growth in recent years, with GDP growing at an average real annual rate of 11.2% for the past dozen years. In 2008, however, the global financial crisis led the federal government to take strong action to ensure sufficient liquidity in the banking system. A range of economic performance indicators in 2009 confirms that the federal government continues to weather the economic disruption.

Despite the global financial crisis, the country remains a fast-growing economy. Notably, this is not solely due to the oil and gas sectors which accounted for less than 40% of the economy in 2007. According to Central Bank statistics, the highest economic growth has taken place in the construction, industrial, real estate, finance, transportation & communications, and tourism sectors. Indeed, tourism has become an important part of the economy with nearly 9 million arrivals in 2007, roughly 8% more than the year before.

Figure 1-4: Composition of UAE economy, 2007 (source: 2009 UAE Yearbook)



Overseas investment is a critical component of the UAE's economic development strategy. For decades, there has been a concerted effort to diversify where and how it invests its financial assets. Such an investment strategy serves as a security net for future generations who will one day face a depletion of the country's energy resources. Investment within the UAE by public institutions and private entities is another driver of economic growth and employment creation. Almost Dh150 billion (about US$ 41 billion) of fixed investment was made in 2007, mostly in hydrocarbons, manufacturing, transport and communications, and real estate. This represented an increase of about 23% over 2006 levels. Private sector investment accounted for about 57% of the total.

The UAE was the second largest trading nation in the Arab world in 2007. Trade for the year totaled Dh1 trillion (about US$275 billion) in 2007, accounting for approximately 22% of the total Arab commercial exchange despite the fact that the population of the UAE is under 2% of the population in the Arab bloc. This is due to a variety of factors, including higher non-oil exports by free zones and other areas, a sharp rise in imports as a result of strong domestic

demand, a steady increase in re-exporting, and an increase in crude oil and gas exports. The balance of trade in 2007 was a surplus of about Dh236 billion (about $US 65 billion), nearly 12% more that in 2006.

Economic planning helps explain the strong performance of the UAE economy. For example, the Abu Dhabi Council for Economic Development recently developed its strategic plan for 2008–2012 which calls for more liberal economic policies, boosting industrial infrastructure, and supporting small/medium scale businesses through leveraging the emirate's strong hydrocarbon sector. In contrast, Dubai's economic plan downplays the importance of oil revenues and aims to sustain real economic growth at a rate of 11% per year by promoting tourism, transport, trade, construction and financial services.

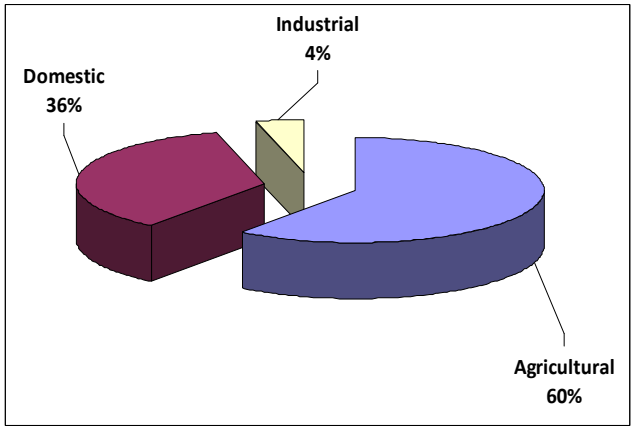
1.7. Water supply and demand

Water resources are a critical natural resource for the UAE and a focus of policy scrutiny. The country has a hyper-arid climate with less than 100 mm/yr of rainfall outside of mountainous areas, very high evaporation rate (2-3m/yr), very low groundwater recharge rates (<4% of total annual water used) and no reliable, perennial surface water resources. Although there are substantial groundwater reserves, these were recharged some 6,000 to 9,000 years ago are essentially non-renewable resources (Wood and Imes, 1995). Surface waters that are present are prone to flash flooding and more often damage planted areas rather than benefit them.

Paralleling this scarcity of renewable freshwater is the Emirates' explosive population and economic growth. Prior to the 1950s, most of the population of the region was supported by groundwater from shallow wells and the traditional falaj system of groundwater collection systems and hand dug tunnels. Most of these systems have since dried up, and in their place is an extensive system of boreholes that mine the region's fossil groundwater supplies. The most recent estimates indicate that groundwater in the UAE is being extracted at over 13 times the annual recharge rate (Murad *et al*, 2007). Reversing this pattern is widely acknowledged throughout the UAE as essential for the sustainable use of limited water supplies. National strategies are under development to reduce consumption, increase information about aquifers, and promote water conservation.

Water consumption trends show sharp difference across the seven Emirates. Differences in consumption are due to differences in economic development, Emirate size, population growth, and land use strategies. In Abu Dhabi, for example, the bulk of limited freshwater supplies is consumed by the agricultural, forestry, and plantation sectors, with some estimates that these demands are more than 80% of the total annual water use of 3.4 billion cubic meters. Amenity planting, forestry, and agriculture farms are expanding the irrigated areas as there have been few constraints on water use until recently. In Sharjah, while water demand is a tiny fraction of Abu Dhabi's demand, it has been growing just as rapidly, roughly 7%/year. For the UAE as a whole, an FAO study estimates that agricultural and domestic activities will continue to consume the largest share of water resources up through 2010 (see Figure 1-6).

Figure 1-5: projected water demand (million m_3) in the UAE, 2010 (source FAO, 2000)



At present, water for domestic and industrial uses is largely derived from desalination of seawater or brackish groundwater, an option that the UAE has increasingly pursued over the past two decades. Desalinated water produced in UAE currently accounts for about 22% of the total desalinated water produced in the Gulf States. Currently, there are 35 desalination plants in the UAE with a total capacity of 700 million cubic meters per year (Murad *et al*, 2007); the largest single desalination plant in operation in the world is the 456,000 m^3/d plant in the Fujairah Emirate.

1.8. Environment

Since the submission of the UAE's initial national communication to the UNFCCC, long-term environmental sustainability strategies have been launched and plans have drawn up for a wider network of protected areas. One focus has been on the implementation of a tighter regulatory regime on industrial and other development activities that have an impact not only on the environment and wildlife but also on the country's human population. Conservation of endangered species of wildlife continues to be a major focus of the UAE's environmental policy.

In October 2008, the UAE announced the formation of a new Mohammed bin Zayed Species Conservation Fund, which was initially endowed with Dh125 million or roughly USD 470 million. The purpose of the fund is to provide targeted grants to individual species conservation initiatives, recognize leaders in the field of species conservation; and elevate the importance of species protection in the broader conservation debate. Other notable developments include the following:

- *Tighter controls over the country's quarrying industry*: new regulations introduced by the Ministry of Environment and Water cover air quality guidelines, noise, health and safety practices and the impact on the environment of areas adjacent to quarry sites and their associated rock crushers;
- *Abu Dhabi Environment Strategy 2008–2012*: establishes the environmental policy agenda for the next five years. Two and five year targets have been identified for ten priority areas, including environmental sustainability, water resource management, air quality, hazardous materials and waste management, biodiversity management, environmental awareness, an environmental health and safety management system, and management of emergencies; and
- *More protected areas:* for example, areas of the Hajar Mountains are being prepared for designation as protected areas, the mountains are home to much of the UAE's endangered wildlife and provide key habitats.

In addition to national legislation that targets environmental issues, the UAE is a party to several regional and international Conventions and Protocols, as summarized in Table 1-1, with the ratification of the Kyoto Protocol taking place in 2005.

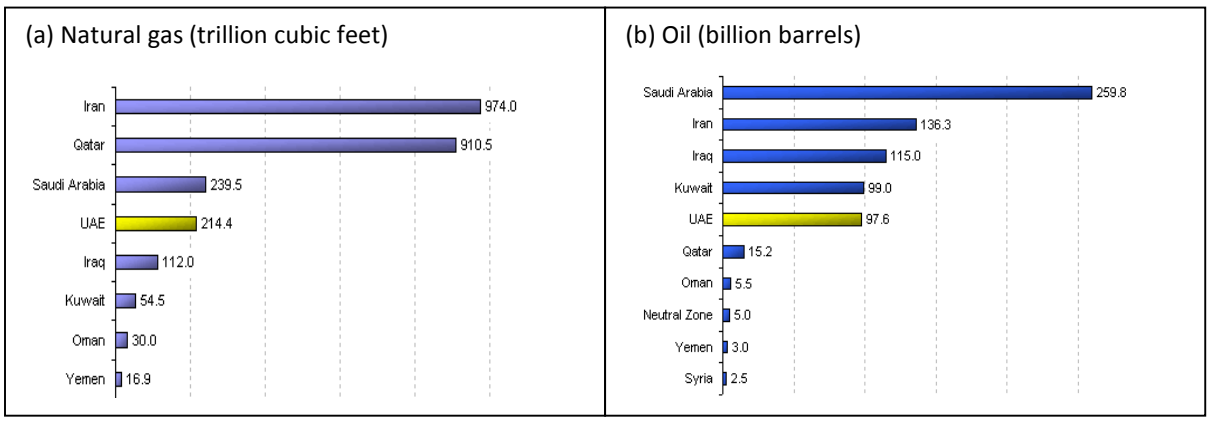
Table 1-1: UAE formal commitments to regional and International agreements

Ratification/ Accession	International and regional Convention/Protocol
1979	Kuwait Convention for cooperation on protection of the marine environment from pollution
1989	Vienna Convention for the Protection of the Ozone Layer of 1985 and Montreal Protocol on Substances that Deplete the Ozone Layer
1990	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
1990	Basel Convention on Control of Transboundary Movements of Hazardous Wastes & disposal
1995	United Nations Framework Convention on Climate Change
1998	United Nations Convention to Combat Desertification
1990	Protocol for Marine Pollution resulting from Exploration/Exploitation of Continental Shelf
1999	Convention on Biological Diversity
2002	Convention on Persistent Organic Pollutants (POPS)
2002	Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC Convention)
2003	Convention on Conservation of Wildlife and its Natural Habitats in the GCC countries
2005	Montreal Amendments (London 1990, Copenhagen 1992, Montreal 1997, Beijing 1999)
2005	Koyoto Protocol, 1997
2005	Protocol on the Control of Marine Transboundary Movements and Disposal of Hazardous Wastes and Other Wastes
2007	Ramsar Convention

1.9. Energy

The UAE has the sixth largest proven oil reserves and the fifth largest proven natural gas reserves in the world. As of January 2007, proven oil reserves were about 98 billion barrels and proven natural gas reserves were 214 trillion cubic feet. Relative to other countries in the Middle East region, the UAE holds the fifth largest proven oil reserves and the fourth largest proven natural gas reserves (see Figure 1-6). Foreign Minister Sheikh Abdullah bin Zayed al-Nahyan announced in April 2007 that the UAE plans to increase oil production capacity to 5 million barrels per day by 2014, further increasing the UAE's energy profile in the Middle East region.

Figure 1-6 (a) & (b): Proven fossil fuel reserves by country in Middle East (source: Oil and Gas Journal, 2007



Regarding oil production, UAE oil reserves represent about 8.5% of total world oil reserves, most of which are located in the emirate of Abu Dhabi which controls about 92.2 billion

barrels located in onshore/offshore reservoirs within its territory. Dubai controls about 4 billion barrels, followed by Sharjah with 1.5 billion barrels, and Ras al Khaimah with 500 million barrels. World oil markets value crude oil streams from the UAE more highly than from other Middle Eastern producers due to their light and sweet properties. The UAE has committed itself to infrastructure development and enhanced oil recovery techniques in mature fields, potentially making the UAE a 'swing' producer that can strengthen its role and influence in the region. (EIA, 2009).

Regarding natural gas, UAE natural gas reserves represent about 3.9% of total world natural gas reserves. Rising prices for natural gas on world markets have spurred development of the UAE's large natural gas reserves even though high extraction costs and sulfur content pose difficulties for the industry (EIA, 2009). These difficulties, in part, led to the development of the Dolphin Project, an agreement to import natural gas from Qatar's North Field to Abu Dhabi and then Dubai via a subsea pipeline to meet local increasing demand in the power generation and petrochemical industries. Gas production began in July of 2007 and the project represents the first transboundary natural gas line in the Gulf Arab region. Since 1977, the UAE has been exporting liquefied natural gas from its LNG plant on Das Island to Asian markets, mostly to Japan. Plans are underway to build extensive natural gas distribution pipelines to meet growing industrial and residential energy needs.

The Supreme Petroleum Council sets energy policy in the UAE. The largest state owned company is the Abu Dhabi National Oil Company (ADNOC), which operates 17 subsidiary companies in the oil and natural gas sectors. ADNOC maintains up to 60% stake in new major oil projects. Hydrocarbon production is handled on a production sharing basis between state-owned companies and foreign investors. Natural gas exports are managed by an ADNOC subsidiary, Abu Dhabi Gas Liquefaction Co. (ADGAS). The National Gas Shipping Company (NGSCO) handles shipments from the LNG plant, and operates the LNG carriers.

In an effort to promote sustainable energy development by stimulating economic growth, nurturing social development, and promoting environmental protection, the UAE is also seeking to play an active role in developing new technologies for meeting future energy solutions. Recently, the Abu Dhabi emirate has made significant investments in alternative energy through the MASDAR Initiative that has attracted worldwide interest. The initiative is a multi-billion dollar commitment to invest in alternative and renewable energy sources; sustainable development; education; manufacturing and carbon management with the aim that alternative energy becomes a cornerstone of the country's future economic stability (see Chapter 4).

1.10. Public Health

Since its inception the UAE has seen remarkable progress in health care. Over the past 28 years government health strategies have paid special attention to the welfare of UAE citizens. The UAE has a comprehensive, government-funded health service and a developing private health sector. Substantial government investment has enabled the UAE to make major progress in health care.

In pursuit of government strategy to coordinate and implement a coherent healthcare policy throughout the Emirates, a national Health Council was established in July 2008. The new council is entrusted with the task of coordinating efforts by federal and local healthcare authorities, as well as the public and private healthcare delivery sector, to ensure an

integrated service and improve the standards of health care in the country. The council will also coordinate with the Ministry of Higher Education and Scientific Research on the drawing up of educational policies for the study of medicine and health sciences in the UAE and abroad.

This progress is clearly reflected in the positive changes in health statistics which indicate that the UAE has taken its place among the developed nations of the world. Child mortality rates are 9 per 1000, comparable to most developing countries, while preventive medicine campaigns have had a major impact on life expectancy, now 76 years for women and 74 years for men. Endemic diseases have been eradicated. Preventive medicine campaigns, which have been launched to combat and control more than 36 infectious diseases in the UAE, have had a major impact on life expectancy and constitute a key element of health care strategy.

The UAE has invested heavily in providing medical and health services for its citizens and has nurtured the growth of related industries in the country, from new local pharmaceutical product manufacturing to the procurement of state-of-the-art medical equipment, to overall wellness resorts and private hospitals. For example, in August 2008 Tatweer announced an investment of Dh3.68 billion (about US$ 1 billion) in a NewWellness Resort to be based in phase two of Dubai Healthcare City (DHCC), also a member of Tatweer.

The focus of a network of Government primary health care centers is maternal and child welfare, school health and health education. The public hospitals offer specialized services, including telemedicine links with major hospitals abroad and state-of-the art surgery. The health care infrastructure is upgraded regularly, with a central data base project being prepared. There are plans to double bed capacity in public hospitals over the next ten years. The Government finances 81% of the cost of health care, but several initiatives towards privatization have been launched recently (Ministry of Health- MoH).

In February 2008, the MoH unveiled a five-year health strategy for the public health sector in the northern emirates, which fall under its purview and which, unlike Abu Dhabi and Dubai, do not have separate healthcare authorities. The strategy focuses on unifying healthcare policy and improving access to healthcare services at reasonable cost, at the same time reducing dependence on overseas treatment.

To this end, comprehensive health programmes have been adopted to meet the needs of UAE society, compatible with the ideal of achieving health for all. Indeed, mandatory health insurance in Abu Dhabi for expatriates and their dependents was introduced in 2007 and has been a major driver for reform of healthcare policy. Abu Dhabi nationals were brought under the scheme from 1 June 2008 and Dubai followed suit for its government employees. Eventually, under federal law, every Emirati and expatriate in the country will be covered by compulsory health insurance under a unified mandatory scheme.

1.11. Education

At present, the UAE offers a comprehensive education to male and female students from kindergarten to university, with education for the country's citizens being provided free at all levels. School enrolment in the 2007-2008 academic year was 648,000 students in 1,259 public and private schools, of which over half the students are female. There is also an extensive private education sector at primary, secondary and tertiary levels, while several thousand students pursue courses of higher education abroad at government expense. There are approximately 60 government and private universities.

The UAE is also committed to increasing the age for compulsory education to 18 years. The UAE has pledged to eradicate alphabetical illiteracy in seven years, thus becoming the first Arab country to attain full literacy. Currently, the national literacy rate is quite high, around 93%.

Government bodies, educational consultants, policy advisors and education specialists are all working to meet the challenges of transforming a centralized bureaucratic system into a student-centered learning environment, whilst bringing international best practice into play. Curricula revision, teaching standards and student performance are areas that are receiving critical attention. The goal is to produce graduates that are able to compete not only in a regional knowledge-based economy but will also be competitive within global labor markets.

1.12. Agriculture

Although highly arid, the United Arab Emirates has been able to develop a thriving agricultural industry. Despite rapid population growth, it is now self-sufficient in some vegetable crops throughout the year (Ministry of Environment and Water, 2009). Small-scale farming based upon exploitation of underground water resources began in desert oases and mountain valleys at least 5000 years ago, but the lack of rainfall makes large scale agriculture impossible.

Modern irrigation techniques and water from deep artesian aquifers and from desalination plants have made it possible for large areas to be cultivated. There are currently more than 100,000 hectares of cultivated land, producing a range of crops, including vegetables, potatoes, fruit and fodder. In traditional mountain farms, production of tropical fruits like guava and citrus as well as tobacco continues. The Government supports agriculture through preparation of land for farms which are distributed free to citizens, and follows this up with a free agricultural extension service. Farmers are also offered a guaranteed price for produce and subsidized machinery and fertilizers. The most recently available agricultural production statistics are summarized in Table 1-2.

Agricultural policy in the UAE has been undergoing rigorous evaluation relative to its intersection with water resource management policy. Agriculture accounts for about 80% of freshwater use but represent under 2% of GDP The UAE's only natural source of irrigation water is based on underground fossil aquifers currently extracted by over 30,000 water

wells. Intensive groundwater pumping for agriculture, however, has produced adverse effects on the water table and salinity levels. As fresh water has been depleted, saline water has replaced it in many areas, with the accompanying decline in soil fertility. The shortage of naturally occurring freshwater suitable for agricultural use has been counteracted to some extent by the use of both desalinated and recycled water. However, the costs of augmenting freshwater with desalinated water are quite high.

Table 1-2: Agricultural productivity in the UAE, 2003 (source: Ministry of Environment and Water)

Type of agricultural produce	Production (thousand tonnes)	Land area (thousand hectares)
Vegetables (e.g., tomato, eggplant, okra, green bean, squash, cucumber, cauliflower, potato, lettuce, radish)	289.9	10,815
Fruits (e.g., lime, lemon adalia, grape fruit, other citrus, guava, mango, almond, pomegranite, fig, banana)	783.6	250.8
Field crops (e.g., alfalfa, green fodder, tobacco, wheat)	3,018.0	44,280

With the water table in steady decline and incursions of saline water on the increase there has been a realization that new strategies are necessary if agriculture in the UAE is to remain a viable business. For this reason, reduction of the spread of salinization, revitalization of salinized areas and introduction of salt tolerant high-yielding crops are important issues for the UAE. While the potential role of biosaline agriculture is being actively considered, the current emphasis is on reclamation, management, and utilization of salt-affected soils, their sustainable use, and evaluation of plants inhabiting naturally occurring saline habitats.

1.13. Transportation

The UAE maintains a strong focus on the expansion and maintenance of an efficient transportation system. Ports and airports, shipping companies and airlines, together with efficient road networks, have underpinned a strategic plan aimed at developing the UAE into a major transport hub.

Dubai is a major transport hub in the Middle East, due to its busy airport and ports, which have grown rapidly in the past four decades. Dubai's main ports of Jebel Ali, Port Rashid, Hamriya Port and Dubai Creek serve more than 13,000 vessels each year and handle a significant share of the world's shipping cargo. Abu Dhabi and Sharjah have major ports as well as ports for the export of crude oil, refined products and petrochemicals. Moreover, construction began in February 2008 of Khalifa Port in Abu Dhabi, with a completion period of about 4 years.

Dubai International Airport is one of the fastest growing air transport hubs in the world, having served over 18 million passengers in 2003, travelling to more than 140 destinations on more than 100 airlines. The number of passengers travelling through the airport has been growing at between 10% and 15% a year for the past 10 years.

There have been several notable developments in recent years. For example, the Abu Dhabi emirate recently developed a Surface Transportation Master Plan and Urban Framework Plan 2030 whose focus is on the introduction of alternative forms of public transportation and ensure free flowing traffic. Specific plans include a grid of boulevards instead of large freeways to dissipate traffic flow, make roads out of dead ends, construct new freeways, parkways and truck routes, introduce a tram and metro network, as well as a rail network

with a freight line, increase the bus network and enrich pedestrian movement. When complete, the transport system will be an integrated network of highways/regional rail/metro/tram services with a parallel system of buses/taxis and park & ride facilities.

Another example is in Dubai, where a new metro was inaugurated in September 2009 (see picture at right). The Dubai Metro is driverless and fully automated with a Red Line that is partly operational, a Green Line that is still under construction, and with further lines being planned. These first two lines run underground in the city center and are elevated elsewhere. The Dubai Metro is the first urban train network in the Arabian Peninsula. More than 110,000 people, which is nearly 10 per cent of Dubai's population, used the Metro in its first two days of operation. Other transport-related expansion projects in Dubai include the Dubai Cargo Village, Jebel Ali Port, the Dubai Railway Project, Dubai International Airport's Terminal 2 expansion, and the Dubai Maritime City Free Zone.

1.14. Institutional arrangements for the national communications

In the UAE, climate change activities are coordinated by the climate change Executive Committee. This committee is chaired by the Federal Ministry of Energy and has representation of all relevant institutions (i.e., energy, agriculture, forestry, waste, industry). Since the Initial National Communication, the Executive Committee has been strengthened so as to be better positioned to undertake three key activities. Primarily, it has promoted the building of broad public awareness on climate change issues, coordination of data acquisition/data quality enhancement activities for the development of an updated GHG inventory, and the implementation of technical capacity building initiatives.

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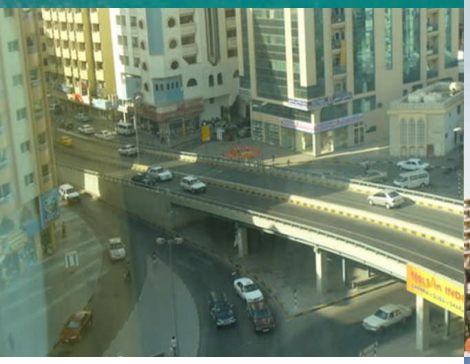
Chapter 2

National Greenhouse Gas Inventory







2.1. Introduction

This chapter presents estimates for the United Arab Emirates of national anthropogenic greenhouse gas emissions and sinks for the year 2000. The inventory includes five categories: energy; industrial processes; agriculture; land use, land use change and forestry (LULUCF) and waste.

2.2. Methodology

The methodology used to develop the inventory is based on the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* and the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (Good Practice Guidance) prepared by the Intergovernmental Panel on Climate Change (IPCC) and the *Good Practice Guidance for Land Use, Land-Use Change, and Forestry*, which further expanded upon the methodologies in the Revised 1996 IPCC Guidelines.

As recommended by the IPCC Guidelines, country specific methods have been used as appropriate for certain GHG emitting sectors. In the subsections that follow, GHG emissions are reported both in absolute units of carbon dioxide, methane and nitrogen oxide emissions, as well as in units of CO2-equivalent by applying 100-year GWPs of 1 for CO2, 21 for CH4, and 310 for nitrogen oxide.

2.3. Total GHG Emissions

Table 2-1 presents total GHG emissions and sinks for the year 2000. Total GHG emissions in 2000 were 128,286 Gg CO2-equivalent, which includes 116,114 Gg from energy; 6,466 Gg from industrial processes; 4,348 Gg from agriculture, and 2,622 Gg from waste. CO_2 sequestration by the forestry and land use sector in 2000 amounted to 9,665 Gg. Net GHG emissions are estimated at 119,885 Gg CO2-equivalent. Emissions from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6) in the UAE are negligible as the products containing these gases are not produced in the country.

Table 2-1: Total GHG emissions in the UAE, 2000 (Gg)

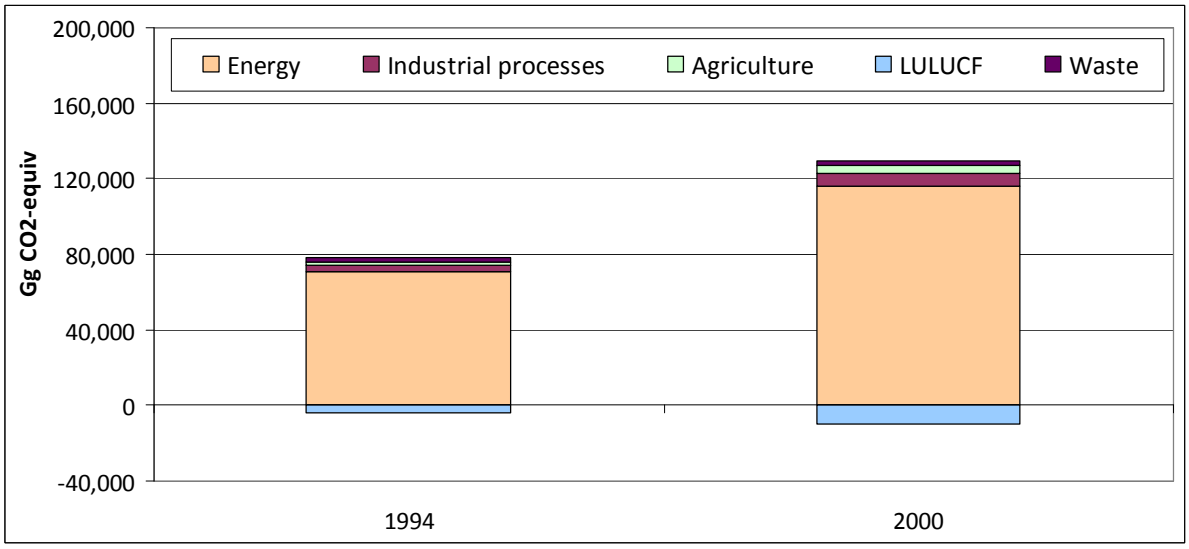
GHG Sources & Sinks	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1 Energy	116,114	96,240	796	10.2	247	362	19	8,085
2 Industrial Processes	6,466	6,466	0	0.0	1	151	21	6
3 Solvent & Other Product Use	0	0	0	0.0	0	0	0	0
4 Agriculture	4,348	0	80	8.6	0	0	0	0
5 Land-Use Change & Forestry	-9,665	-9,665	0	0.0	0	0	0	0
6 Waste	2,622	0	120	0.3	0	0	0	0
Total National Emissions	129,550	102,706	997	19.1	248	513	41	8,091
Net National Emissions	**119,885**	**93,041**	**997**	**19.1**	**248**	**513**	**41**	**8,091**

Energy-related activities accounted for the dominant portion of GHG emissions in the UAE in 2000. Not surprisingly, approximately 90% of all GHG emissions are associated with the combustion of fossil fuels or the release of fugitive emissions from oil and gas operations. Industrial processes accounted for 5% of all GHG emissions, followed by agriculture with 3% and the waste sectors accounting for about 2% of total emissions. Approximately 8% of net GHG emissions in 2000 were sequestered by the extensive system of hardwood tree plantations throughout the country.

2.4. GHG emission trends

Figure 2-1 presents the trend in total GHG emissions for 1994, the year of the initial GHG inventory submitted as part of its Initial National Communication (UAE, 2006), and the current inventory year of 2000. On a net CO_2equivalent basis, emissions in the UAE increased by nearly 61% over this period, or about 8.3% per year.

Figure 2-1: Total GHG emissions trend, 1994 & 2000

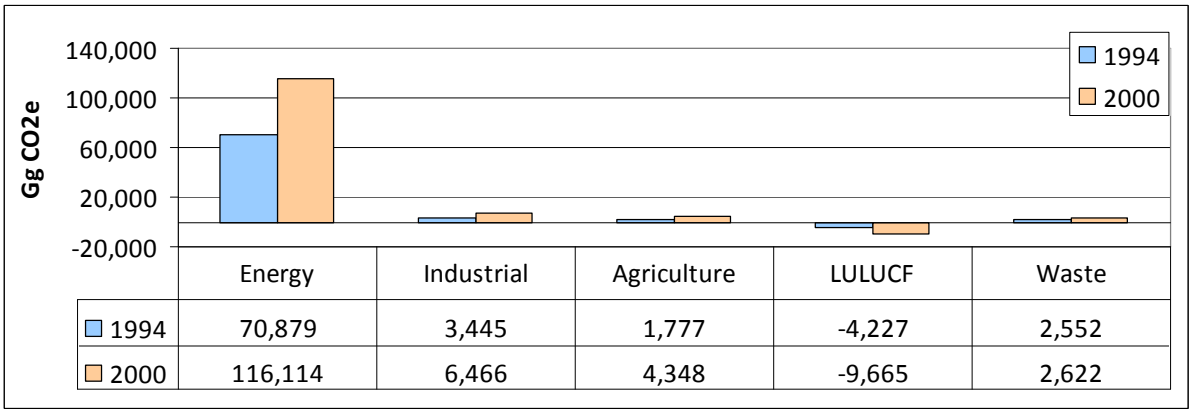


On the emissions side, GHG emissions have increased by about 64%; from 78,653 Gg CO_2equivalent in 1994 to 129,550 Gg CO_2equivalent in 2000. Emissions from energy and industrial processes increased by roughly 66% and 88%, respectively. Agricultural emissions also increased although by a smaller amount, 44%. Waste emissions show a smaller increase than evident for other sectors, about 3% greater than 1994 waste emission levels, but this is largely due to improvements in the estimation of various parameters. Regarding GHG sinks, the small but important contribution of managed green parks increased by about 130% and is consistent with local and national policies to expand and maintain green areas throughout the country.

Figure 2-2 compares GHG emissions for all sectors for the years 1994 and 2000. Over the period, CO_2 emissions from energy use have been growing about 8% per year. This is due primarily to a steep increase in energy use for power generation and process heat in manufacturing industries (a doubling in each subsector). Also over this period, CO_2 emissions from industrial processes have been growing about 11% per year. This trend is dominated by cement and iron/steel production, both of which roughly doubled between 1994 and 2000. LULUCF activities have also shown a sharp increase with a doubling of sequestered GHG emissions between 1994 and 2000.

These trends in GHG sources and sinks are largely explained by the strong demographic and economic growth that took place in the UAE over the 1994-2000 period, as well as the sustained commitment during this period to maintaining and expanding green areas. Demographic growth, for example, grew at the rate of about nearly 7% per year for the indigenous and expatriate population (see section 1.4 in the previous chapter for additional details). Economic growth, as most clearly evident in energy use patterns in the residential, commercial, industrial, and transportation sectors grew at similar levels.

Figure 2-2: GHG emissions trend for energy and industrial processes, 1994-2000



	Energy	Industrial	Agriculture	LULUCF	Waste
1994	70,879	3,445	1,777	-4,227	2,552
2000	116,114	6,466	4,348	-9,665	2,622

For example, the quantity of fuels used to produce electricity in the UAE grew about 13%/year between 1994 and 2000. Growth in the transport sector shows similar trends over this time period - the number of light duty vehicle registrations (i.e., cars and light duty trucks) climbed from 332.5 thousand to about 561.9 thousand in the UAE, or about 9.2%/year. Finally, in the land use sector, the total number of trees in plantations and green parks grew from 63.3 million in 1994 to about 144.6 million in 2000 accounting for the significant levels of carbon sequestered.

2.5. Energy

Table 2-2 summarizes GHG emissions associated with energy activity in 2000. Relative to overall anthropogenic GHG emissions, the 116,114 Gg CO_2-equivalent represented about 91% of total national emissions. Activity data for energy use was based on UAE energy and trade Statistics.

Table 2-2: GHG emissions from energy use, 2000 (Gg)

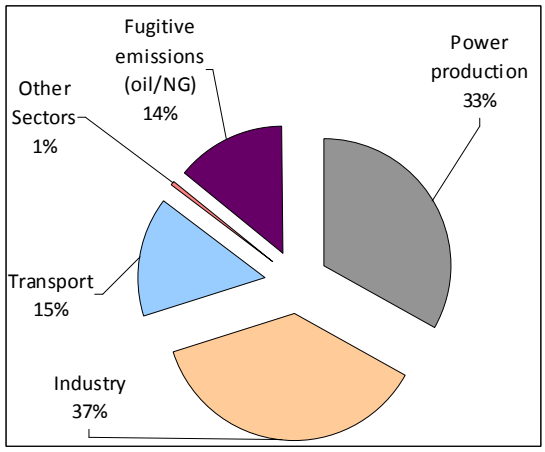
GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NM VOC	SO_2
All energy emissions	**116,114**	**96,240**	**796**	**10**	**247**	**362**	**19**	**8,085**
A Fuel Combustion Activities	*99,594*	*96,240*	*10*	*10*	*247*	*361*	*19*	*8,085*
1 Energy Industries	38,486	35,568	9	9	88	48	1	141
2 Manufacturing Industries & Construction	42,886	42,669	1	1	108	162	9	4,922
3 Transport	17,515	17,355	0	1	33	141	10	2,768
4 Other Sectors	706	649	0	0	18	9	0	253
B Fugitive Emissions from Fuels	*16,520*	*0*	*787*	*0*	*0*	*2*	*0*	*0*
1 Solid Fuels	0	0	0	0	0	0	0	0
2 Oil and Natural Gas	16,520	0	787	0	0	2	0	0
Memo Items	*15,996*	*15,996*	*0*	*0*	*0*	*0*	*0*	*9*
International Bunkers	15,996	15,996	0	0	0	0	0	9
CO2 Emissions from Biomass	0	0	0	0	0	0	0	0

GHG emissions from energy activities are due to fossil fuel combustion and fugitive emissions from oil and gas exploration activities. Fuel combustion emissions are associated with the use of a variety of petroleum products and natural gas. All fuels are produced locally, with only relatively small quantities of imported gasoline consumed. Natural gas and residual fuel oil are used exclusively for power production and process heat in manufacturing processes. Most of the diesel and gasoline are consumed in road transport

and industry, with relatively small quantities used for power production. LPG is used in the residential and commercial/institutional sectors for cooking.

Figure 2-3 illustrates the breakdown in energy-related GHG emissions in 2000 by consuming activity. Industrial activities in the form of manufacturing (mostly cement, iron and steel, and aluminum production) and construction activities accounted for about 37% of all energy-related emissions. Power production is based overwhelmingly on the use of natural gas, with small amounts of crude oil, residual oil, and diesel, and accounted for about 33% of total emissions from all energy production/consumption activities in the UAE.

Figure 2-3: **Breakdown of GHG emissions associated with energy activities, 2000**



Notably, fugitive emissions of methane, a gas that has a high global warming potential, accounted for about 14% of all GHG emissions in the energy industries sector on a carbon dioxide equivalent basis, as the UAE continues to be a major supplier of the world's energy needs. Transport emissions for road transport (where diesel accounts for 56% and gasoline accounts for 44% of total road transport energy), and domestic civil aviation (jet kerosene) accounted for about 15% of total emissions from the energy sector in 2000.

2.6. Industrial Processes and Other Product Use

Table 2-3 summarizes GHG emissions associated with industrial processes and product use in 2000. Industrial processes are the second largest emitter of anthropogenic GHG emissions in the UAE, accounting for 6,466 Gg of CO_2–equivalent, or about 5% of national CO_2–equivalent emissions in 2000. Activity data for the industrial sector was based on Trade Statistics, the national industrial license database; and surveys of key industries.

Table 2-3: GHG emissions from industrial activity, 2000 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
All industry emissions	**6,466**	**6,466**	**0**	**0**	**1**	**151**	**21**	**6**
Industrial Processes	*6,466*	*6,466*	*0*	*0*	*1*	*151*	*21*	*6*
A Mineral Products	4,680	4,680	0	0	0	0	19	2
B Chemical Industry	635	635	0	0	0	3	2	0
C Metal Production	1,151	1,151	0	0	1	148	0	4
D Other Production	0	0	0	0	0	0	0	0
E Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0	0
Total Solvent and Other Product Use	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
A Paint Application	0	0	0	0	0	0	0	0
B Degreasing and Dry Cleaning	0	0	0	0	0	0	0	0
C Chemical Products, Manufacture and Processing	0	0	0	0	0	0	0	0
D Other	0	0	0	0	0	0	0	0

Mineral products (i.e., cement production and limestone/dolomite use) accounted for the largest share of industrial process emissions, about 72%; followed by metal production (i.e., iron/steel and aluminum) at about 18% and emissions from the chemical industry (i.e., ammonia production) at roughly 10% of emissions from industrial processes.

2.7. Agriculture

Table 2-4 summarizes GHG emissions associated with agricultural activity in 2000. Relative to overall anthropogenic GHG emissions, the 4,348 Gg CO_2-equivalent represented about 3% of total national emissions. Activity data was based on national livestock statistics and census information and expert judgment by specialists in the Industrial Development Authority and the General Directorates of respective emirates.

Table 2-4: GHG emissions from agricultural activity, 2000 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
All agriculture emissions	**4,348**		**80**	**8.6**	**0**	**0**	**0**
A Enteric Fermentation	1,640		78	0.0	0	0	0
B Manure Management	392		2	1.1	0	0	0
C Rice Cultivation	0		0	0.0	0	0	0
D Agricultural Soils	2,317		0	7.5	0	0	0
E Prescribed Burning of Savannas	0		0	0.0	0	0	0
F Field Burning of Agricultural Residues	0		0	0.0	0	0	0

On a CO_2–equivalent basis, the majority of emissions from agriculture are associated with nitrous oxide emissions from agricultural soils (53%), followed by methane emitted during the livestock enteric fermentation process (about 38%). Emissions from manure management of cattle, mules, and other livestock account for 9% of agricultural emissions.

2.8. Land Use, Land Use Change and Forestry

Table 2-5 summarizes GHG emissions associated with land use, land use change and forestry in 2000. The 9,665 Gg CO_2-equivalent sequestered through managed plantations is roughly 8% of the UAE's overall anthropogenic GHG emissions. Annual activity data was compiled from a mixture of sources including annual land use management assessments available from the General Directorates of respective emirates.

The prominence of carbon sequestration in the national GHG inventory reflects a long-standing national vision to continually expand and maintain the green parks and planted forest areas throughout the country. Total government-managed green areas accounted for about 422,000 hectares in the UAE in 2000.

Table 2-5: GHG emissions from LULUCF activity, 2000 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO
All LULUCF emissions	**-9,665**	**-9,665**	**0**	**0**	**0**	**0**
A Changes in Forest & Other Woody Biomass Stocks	-9,665	-9,665	0	0	0	0
B Forest and Grassland Conversion	0	0	0	0	0	0
C Abandonment of Managed Lands	0	0	0	0	0	0
D CO2 Emissions and Removals from Soil	0	0	0	0	0	0
E Other	0	0	0	0	0	0

2.9. Waste

Table 2-6 summarizes GHG emissions associated with waste management activity in 2000. Relative to overall anthropogenic GHG emissions, the 2,622 Gg CO_2-equivalent represented about 2% of total national emissions. Sources for waste management data included expert judgment regarding municipal solid waste management in the UAE, published literature on population from the Ministry of Planning, and available data from waste treatment plants.

Table 2-6: GHG emissions from waste management activity, 2000 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
All waste emissions	**2,622**	**0**	**120**	**0.3**	**0**	**0**	**0**
A Solid Waste Disposal on Land	2,075	0	99	0.0	0	0	0
B Wastewater Handling	547	0	22	0.0	0	0	0
C Waste Incineration	0	0	0	0.0	0	0	0
D Other (please specify)	0	0	0	0.0	0	0	0

There are two main sources of greenhouse gases within the UAE's waste sector. Solid waste disposal on land accounted for 79% of total waste-related emissions. Eight cities (i.e., Dubai, Sharjah, Abu Dhabi, Al Ain, Fujairah, Ras El Khaimah, Um Al-Qwain, and Ajman) are included in the inventory. Domestic and commercial wastewater handling accounted for 21% of total waste-related emissions. These emissions are associated with the only three cities in the UAE that have centralized domestic and commercial sewage treatment facilities; Abu Dhabi, Dubai, Sharjah. There was no sewage treatment in other cities in 2000, with the wastewater directly dumped into anaerobic lagoons in the desert.

2.10. Emissions of PFCs, HFCs, and SF_6

According to the Revised IPCC Guidelines, the major emission sources of PFCs, HFCs, and SF_6 these gases are the following activities: replacement of ozone-depleting substances; HCFC-22 production; electric power transmission; production of primary aluminum; production of semiconductors; and production and processing of magnesium. Only the third activity occurs in the UAE (power transmission). PFCs and HFCs were not produced or imported/consumed as substitutes for ozone depleting substances in refrigeration and fire extinguishers because ozone-depleting substances were not banned in the UAE in 2000. The estimation of SF_6 emissions associated with electric power transmission proved to be a significant challenge due to data constraints and was assumed to be negligible.

2.11. Uncertainty Assessment

An uncertainty assessment was considered to be an essential element of the GHG emission inventory update to help prioritize efforts to improve the accuracy of future inventories. In the UAE, uncertainties are associated with data access/constraints, potential unsuitability of generic emission factors, and an incomplete understanding of the processes associated with emissions. Some of the current estimates, such as those for CO_2 emissions from energy-related activities and cement processing are considered to have minimal uncertainty associated with them. For some other categories of emissions such as animal production and commercial forest harvest, however, a lack of information increases the uncertainty surrounding the estimates presented. However, since energy activities accounted for about 91% of the overall GHG emissions in 2000, uncertainty of the overall GHG inventory is considered to be low.

Table 2-7 summarizes the uncertainty assessment for the UAE GHG inventory. Based on expert judgment of specialists participating in the development of the inventory, the confidence in the results for each source/sink category was evaluated relative to the uncertainty associated with data quality and emission factor suitability. Less than 10% uncertainty was considered to be low; uncertainty between 10% and 50% was considered medium; and uncertainty greater than 50% was considered high.

Table 2-7: Uncertainty assessment associated with the UAE GHG inventory, 2000

Sector	Activity	Uncertainty		Confidence in Inventory
		emission factor	data quality	
Energy	Public Electricity and Heat Production	low uncertainty	good quality	High
	Domestic Aviation	low uncertainty	medium quality	medium
	Road transport	low uncertainty	medium quality	medium
	Commercial/Institutional	low uncertainty	medium quality	medium
	Residential	low uncertainty	medium quality	medium
	Agriculture/Forestry/Fishing	low uncertainty	medium quality	medium
	International aviation (bunkers)	low uncertainty	medium quality	medium
Industrial processes	Cement production	low uncertainty	good quality	High
	Lime production	medium uncertainty	good quality	medium
	Limestone and Dolomite Use	medium uncertainty	good quality	medium
	Iron/steel production	medium uncertainty	good quality	medium
	Ammonia Production	medium uncertainty	good quality	medium
	Aluminum production	medium uncertainty	good quality	medium
Agriculture	Enteric fermentation	medium uncertainty	good quality	Medium
	Manure management	medium uncertainty	medium quality	Medium
	Agricultural Soils	medium uncertainty	poor quality	Low
LULUCF	Changes in Forest and Other Woody Biomass Stocks	medium uncertainty	medium quality	medium
Waste	CH4 emissions from SWD sites	medium uncertainty	poor quality	low
	CH4 emission from Domestic and Commercial Waste water	medium uncertainty	medium quality	Medium
	N2O emissions from human waste	medium uncertainty	good quality	Medium

Attention to two areas could help reduce uncertainty in the UAE GHG inventory. First, enhancing the availability of detailed and high quality activity data will increase confidence in the inventory results. Although adequate methodologies have been developed to estimate emissions for some sources, problems arose in obtaining activity data at a level of detail in which aggregate emission factors can be applied. Addressing these areas through additional capacity strengthening and development of dedicated observation networks will enhance the quality and accuracy of future emission inventories.

Second, improving the accuracy of emission factors to calculate emissions from a variety of sources is vital. Most of the emission factors noted in the above table are classified as having medium uncertainty (i.e., uncertainty between 10% and 50%). For example, the accuracy of current emission factors for enteric fermentation by animals at low altitude and subject to high temperatures throughout the year remains uncertain in the absence of local sampling and testing activities.

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Chapter 3

Vulnerability and Adaptation

3.1. Introduction

This chapter outlines the UAE's climatic, environmental and socio-economic conditions that contribute to its vulnerability to climate change. The focus is on four vulnerable sectors that were identified in the Initial National Communications and are of utmost importance to the people of the UAE, namely the coastal zones, water resources, dryland ecosystems and economic productively. This chapter also includes an overview of current and planned adaptation activities, measures and programmes that can reduce the UAE's vulnerability to current climatic variability and future climate change.

3.2. Projected Climate Change in the UAE

As discussed in Chapter 1, the UAE is located in a hyper-arid region that has coped with high average temperatures and low rainfall over its recorded history. The Intergovernmental Panel on Climate Change (IPCC) estimates that annual mean temperatures in the Middle East region could be anywhere between 2.6°C to 5.4°C warmer in the 2080-2099 period compared to annual mean temperatures in the 1980-1999 period given medium greenhouse gas emissions levels. The same IPCC report and analysis shows a much less clear picture regarding precipitation with model projections ranging between 44% less and 57% more annual mean precipitation for the same time periods.

The above temperature and rainfall projections are based on the outputs of global circulation models. A subset of such models for several emission scenarios was used to develop the initial estimates in the vicinity of the UAE relative to the 1961-1990 historical record. For 2050, the warming range was determined to be 1.6°C to 2.9°C and rainfall change ranged between 24% below and 11% higher; for 2100, the warming range was determined to be 2.3°C to 6.0°C and rainfall change ranged between 49% below and 23% higher.

It is important to note that the projections were based on GCM outputs that are very coarse in resolution (see Figure 3-1) and do not account for regional topography and local meteorological trends. In order to estimate the effect of these factors on the temperature and rainfall trends indicated above for the UAE, downscaled climate projections were developed using UAE-specific meteorological data from 1995-2004, a period for which complete meteorological data was available for six stations that span the coastal zones along the Arabian Gulf and the Gulf of Oman as well as inland mountainous areas.

Empirical downscaling was carried out using the Self Organizing Maps downscaling (SOMD) methodology based on Kohonen (2001). Of the 21 GCMs potentially available, a total of nine were considered most suitable for UAE conditions, as summarized in Table 3-1, and were applied to the SRES2A GHG emissions scenario (Jack and Dougherty, 2009). This emission scenario, corresponding to a very heterogeneous world with a strong underlying theme of self-reliance and

Figure 3-1: Nearest GCM output coordinates to the UAE

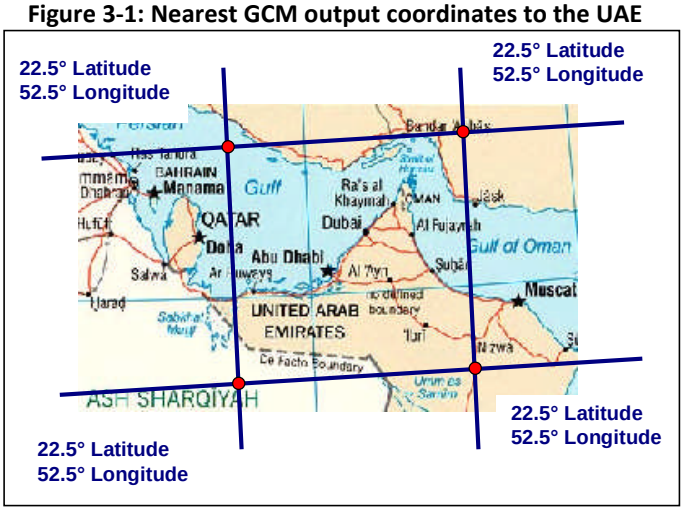


Figure 3-3 (a) & (b) : Minimum and maximum monthly temperature projections for the UAE; 2050, 2100

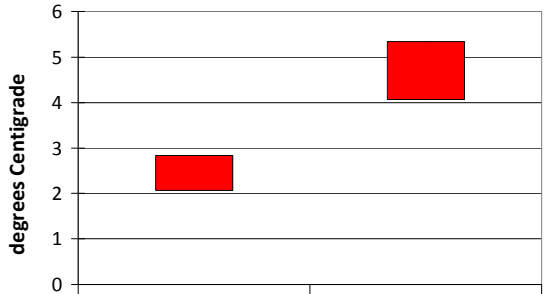
preservation of local identities, is most consistent with what are understood within the UAE to be emerging global trends.

Table 3-1: Overview of GCMs used for downscaling climatic projections

GCM name	GCM Developer
CCCMA CGCM 3.1	Canadian Center for Climate Modeling and Analysis
CNRM CM3	Meteo-France, Centre National de Recherches Meteorologiques
CSIRO mk3.5	CSIRO Atmospheric Research, Australia
GFDL CM 2.0	NOAA Geophysical Fluid Dynamics Lab, United States of America
GISS ER	NASA Goddard Institute for Space Studies, United States of America
IPSL CM4	IPSL/LM/LSCE, France
MIUB ECHO-G	ECHO-G, Germany/Korea
MPI ECHAM 5	Max Planck Institute for Meteorology, Germany
MRI CGCM 2.3.2	MRI-CGCM 2.3.2, Japan

Figure 3-2 shows projected annual mean minimum and maximum temperature change for 2050 and 2100 relative to the 20th century observed values in UAE. The height of the bars represents the difference between the 75th percentile and 25th percentile model projections and indicate the range of projected temperature change across all 9 downscaled models. Due to the relatively high spatial homogeneity of the UAE, the maximum and minimum temperature change projections across all stations are quite similar.

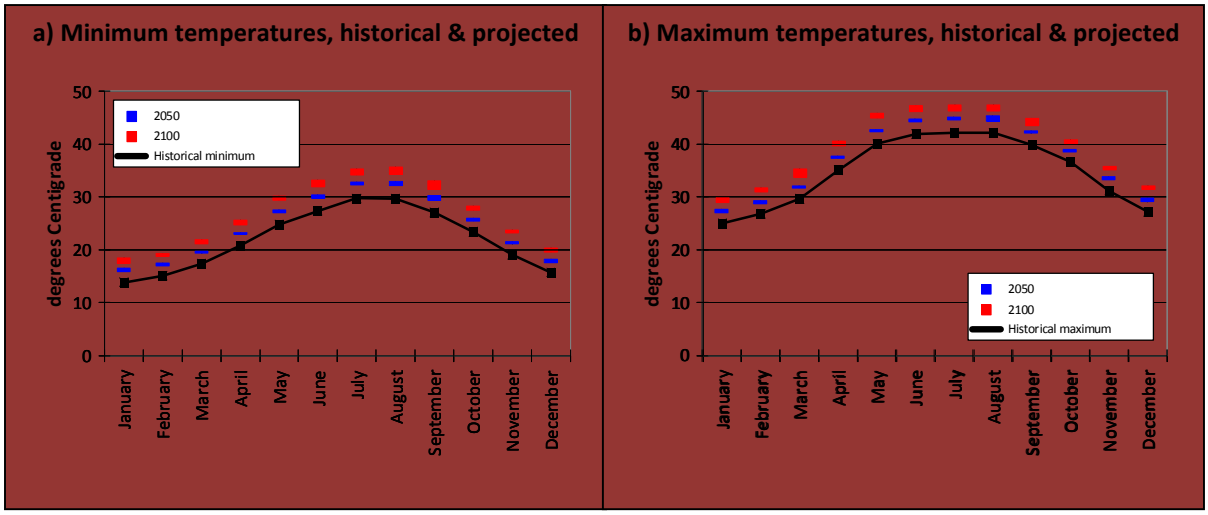
Figure 3-2: Projected annual average temperature change in the UAE from climatic downscaling analysis, 2050, 2100



	2050	2100
Minimum	2.1	4.1
Maximum	2.8	5.3

For 2050, the smallest change in minimum annual temperature relative to the historical average is about 2.1°C. This corresponds to the area around Fujarah along the Arabian Gulf and is probably a result of its relative proximity to the Indian Ocean which has a moderating effect on temperatures. The greatest maximum annual temperature change is about 2.8°C in the proximity of Al Ain, a mountainous region. This is expected due to fact that mountainous areas are likely to experience greater warming and low-lying areas. For 2100, the projected change in annual maximum and minimum temperatures relative to the historical average is between 4.1°C to 5.3°C, again corresponding to the regions of Fujarah and Al Ain, respectively.

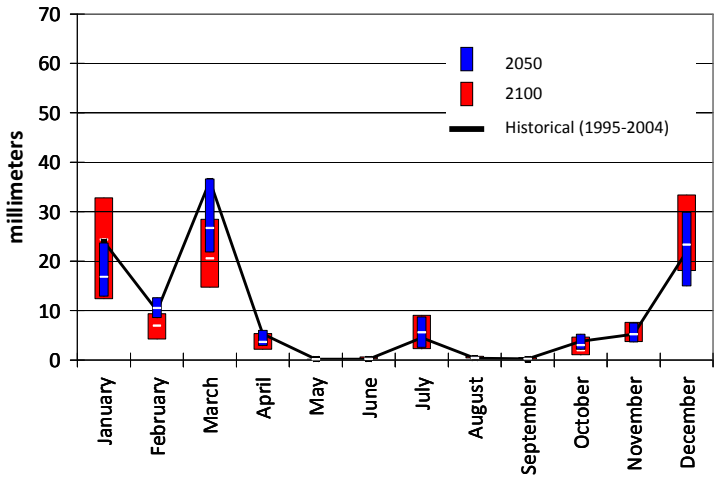
Figures 3-3a and 3-3b show projected monthly minimum and maximum temperatures for 2050 and 2100 relative to the 20th century observed minimum and maximum values for the UAE. The height of the bars represents the difference between the 75th percentile and 25th percentile model projections and indicate the envelope of projected maximum monthly temperature across all 9 models. As can be seen in the Figure, the SOMs downscaling approach captures the basic seasonal pattern of minimum and maximum temperatures. In 2050, the greatest warming is projected to happen during the months of July through August, already the hottest stretch of the year in the UAE. In 2100, the greatest warming is projected to occur during the months of March through May, currently some of the mildest months of the year.



For rainfall, downscaled projections are highly distribution with a large envelope of uncertainty. The infrequency of rainfall in the area and the fact that most rainfall will most likely be of a convective nature means that GCM fields provide very little resolution to future patterns. Convective precipitation occurs preferentially under certain synoptic conditions but is very random in both location and magnitude.

Figure 3-4 shows the range in projected monthly mean precipitation for 2050 and 2100 relative to the 20th century observed values for the UAE. The height of the bars represents the difference between the 75th percentile and 25th percentile model projections and indicate the envelope of projected monthly precipitation across all 9 models. The bars corresponding to the year 2050 are shown with a smaller width to enable a visual comparison with the bars corresponding to the year 2100. The horizontal lines within the bars indicate the median values of the downscaled projections.

Figure 3-4: Projected mean monthly precipitation in 2050 and 2100 in the UAE relative to observed mean monthly precipitation (1995-2004)



As can be seen in Figure 3-4, the SOMD methodology captures the basic monthly cycle of precipitation but with some quite large differences. The large envelopes suggest that the model projections have a high degree of uncertainty. Given this important caveat, there are nevertheless some notable trends that emerged from the downscaling that were evident across all areas in the UAE. For example, in 2050 the median projected monthly precipitation is always lower than the historical monthly average for the relatively wet months of January, March, April, and October. In 2100, the median projected monthly precipitation is lower than the historical monthly average for the months of February, March, April, and October. Finally, in both 2050 and 2100, median projected

monthly precipitation is equal to or greater than the historical monthly average for the very dry months of June and September.

In conclusion, the downscaled projections show strong agreement in projecting a significant warming in both 2050 and 2100 consistent with global scale warming projections. While median precipitation projections show high levels of uncertainty, there are some consistent trends from the downscaling analysis that suggest a drier future climate in the UAE, particularly during months when current rainfall levels are highest.

3.3. Vulnerability and Adaptation for Coastal Zones

Climate change will lead to higher sea levels, increased sea surface temperatures, and changes in wave dynamics. For coastal zones in the UAE, home to approximately 85% of the population, over 90% of the infrastructure, many sensitive ecological subsystems, and important cultural heritage sites, vulnerability to climate change is very high. Moreover, the coasts of the UAE are home to multiple ecological subsystems (Alsharhan and El Sammak, 2004) and important cultural heritage sites and artifacts (Hellyer and Beech, 2000). Climate change-induced sea level rise will adversely affect existing and new infrastructure, valuable coastal ecosystems, and planned development.

Sea level rise is due primarily to thermal expansion of the oceans and the continued melting of glaciers. Estimating future sea level rise is challenging due to the complexity of modelling ice-sheet dynamics. The most recent findings of the Intergovernmental Panel on Climate Change suggest that the expected range of sea level rise, not considering glacier melting, is between 0.37 and 0.59 meters by 2100. If glacier melting is included, the IPCC notes that 10 meters or more in climate change-induced sea level rise is possible beyond 2100 (IPCC, 2007). Unless accounted for in future adaptation planning and strategies, the economic damages for the UAE's coastal zones will be unacceptably high.

To account for uncertainty in potential levels of sea level rise, a study was undertaken that applied a scenario approach to analyze the vulnerability of the UAE to sea level rise (Environmental Agency of Abu Dhabi, 2009a). Two plausible sea level rise scenarios for the years 2050 and 2100 were considered as summarized in Table 3-2.

Table 3-2: Sea level rise scenarios analyzed

Scenario	Sea level rise (meters)	
	2050	2100
No accelerated ice cap melting	1.0	2.0
Accelerated ice cap melting	3.0	9.0

A key finding is that coastal areas are projected to be extensively inundated due to sea level rise as current shorelines migrate inland substantially. Indeed, all coastal cities in the UAE will experience progressively increasing inundation, depending on the scenario analyzed. Taking Abu Dhabi as an example, even the smallest sea level rise scenario shows that significant areas of the built environmental in coastal regions will be inundated (see blue-shaded areas in the topmost map in Figure 3-5). With the highest sea level rise scenario, the inundated area is quite extensive in comparison and leads to the shoreline migrating southward by about between 25 and 30 kilometres (see blue-shaded areas in bottommost map in Figure 3-5).

Other Emirates in the UAE show similar inundation impacts. Depending on the particular sea level rise scenario, total land area inundated in the UAE ranges from 1,155 square kilometres to almost 5,000 square kilometres, or roughly between 1% and 6% of the country's total land area, as summarized in Table 3-3. These inundation levels will lead to a

Figure 3-5: Impact of projected sea level rise on Abu Dhabi

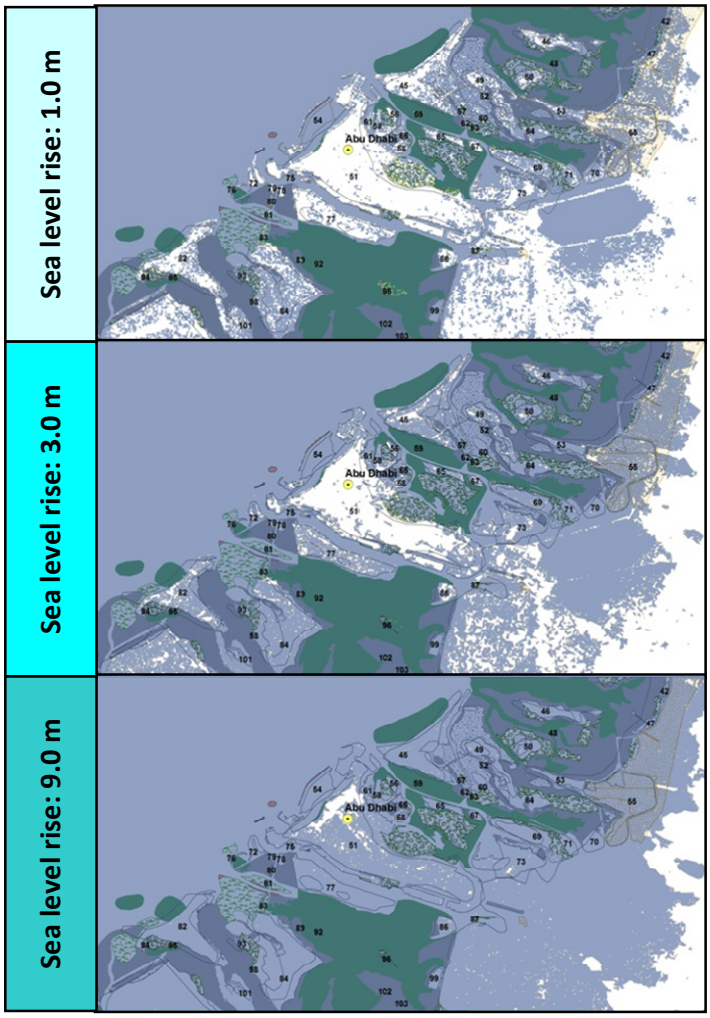


Table 3-3: Results of sea level rise vulnerability analysis

	Inundation in km2 for sea level rise of:			
Emirate	**1 m**	**2 m**	**3 m**	**9 m**
Abu Dhabi	722	983	1,405	3,904
Ajman	18	270	326	526
Dubai	217	74	87	158
Fujairah	6	24	32	59
Ras al-khaimah	82	93	106	158
Sharjah	60	66	78	143
Umm al-Qaiwain	50	9	11	36
UAE	**1,155**	**1,519**	**2,045**	**4,984**

number of adverse impacts on sensitive ecosystems and natural areas along the UAE shoreline, as briefly outlined below:

- *Sabkhat areas* are found only a few meters above sea level, and thus, highly susceptible to sea water intrusion and changed salinity. In the future, sabkhat areas will likely experience migration;
- *Mangrove forests* are sensitive to sea temperature, water depth, and salinity. Roots need to be totally exposed for certain periods of the day, which future sea level rise will make impossible unless mangroves are able to migrate upslope. If not, the UAE's mangrove forests will be destroyed due to submergence;
- *Sea grass* habitats are important for their role in maintaining local biological diversity, a critical part of dugong and hawksbill turtles and other species' food chains. Climate change-induced sea level rise undermine this habitats by increased sea surface temperature, tidal variations, salinity content, changing water depths, as well as by ocean carbon dioxide content;
- *Coral reefs* are vulnerable to thermal stress and recent increases in seawater temperature. The expected increases of 1.5 to 2.6°C will exceed coral's physiological limits and result in more frequent coral bleaching events, on par with extreme bleaching most recently witnessed in 1998; and
- *Fisheries:* Depending on how ambient and sea surface seasonal temperatures change over time, the abundance of some of the Emirate's most important fisheries like kingfish

will be adversely affected, as will hawksbill turtles and Dugongs which depend on the viability of sea grass habitats.

To address the major findings above, it is important to the UAE to understand its adaptation options in the near, mid and long-term. A strategic planning assessment is now underway to address adaptation to climate change in the UAE's coastal zones. Two near-term strategies are under consideration. The first strategy is to develop strategic information systems for coastal zones. Data collection and information development are prerequisites for coastal adaptation as technologies and measures to protect coastal areas, retreat inland, or accommodate sea level rise requires a considerable amount of data on a range of coastal parameters and dynamics.

Specifically, the study recommends the establishment of a Coastal Adaptation Center with a threefold mandate. First, upgrade coastal monitoring systems through high resolution land/sea elevation monitoring equipment, data collection systems, and information sharing across ministries. Second, increase the understanding of coastal systems through development of databases on coastal adaptation technologies and measures, preparation of planning studies, undertaking further sea level rise impact assessments, and raising awareness. And third, *u*ndertake an assessment of zoning, building codes, and other regulations to identify future planning options and approaches within an integrated coastal zone management framework.

The second near-term strategy under consideration is the iimplementation of potential win-win strategies: This refers to planning and design strategies that are consistent with both adaptation to sea level rise and sustainable development. This would be a strategic response coordinated across ministries, sectors and Emirates and has a threefold focus. First, it will establish protected inland zones to accommodate sabkha, mangrove and seagrass migration; also establish protected research reserves to improve understanding of how higher seas will impact ecosystems increasingly bordered by man-made infrastructure.

Second, the strategy will seek to enhance awareness of coastal developers and real estate entrepreneurs through national and international workshops and conferences, training programs, online courses, technical assistance, and capacity-building. And third, the strategy will seek to foster modest near-term investments in "soft" protection (e.g. beach nourishment, seawater irrigation for reforestation with local mangrove species, wetland restoration and creation). This measure also call for a full evaluation of any structures currently planned for "hard" coastal protection to identify viable "soft" alternatives.

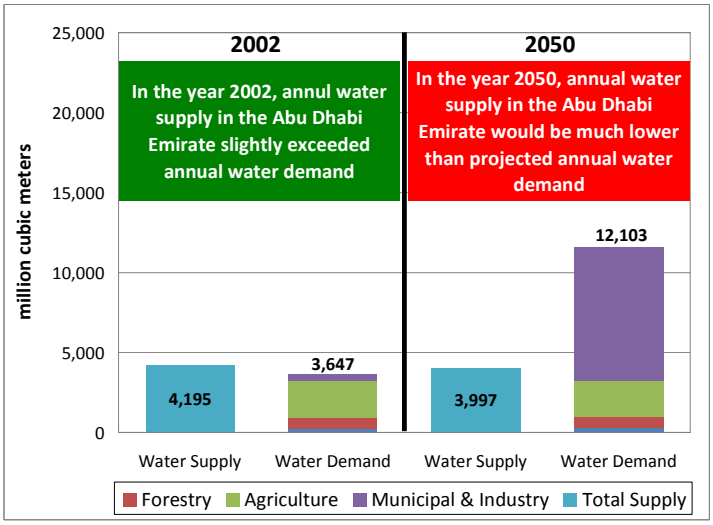
3.4. Vulnerability and Adaptation for Water Resources

The UAE has experienced explosive growth in water demand over the past decade associated with its increasing population and economic activity. The need for water for agricultural production, maintenance of green parks, industrial production, commercial services, and household activities has been met primarily by fossil (i.e., non-renewable) groundwater resources, with the balance provided by desalinated water. Economic development plans throughout the UAE strongly suggest that the need for water will continue to intensify in the future, raising serious policy challenges regarding long-term water resource management. This issue is especially critical given the downscaled rainfall projections reviewed in an earlier section.

To better understand the impacts of climate change on water resources, a study was undertaken that applied a water flow accounting methodology (Yates, et al, 2005a, 2005b) to analyze the supply-demand balance in the face of climate change for the Abu Dhabi emirate up through the year 2050 (Environmental Agency of Abu Dhabi, 2009b). Major findings of the study are summarized in the following bullets:

- *Current patterns of water use are unsustainable:* The combination of future population growth, irrigation requirements, and economic activity and business-as-usual water resource management will lead to future water demand far in excess of current supplies. New desalinated water supplies will be needed to cope with water demand that in 2050 is projected to be roughly 3 times more than current supplies, as shown in Figure 3-6.

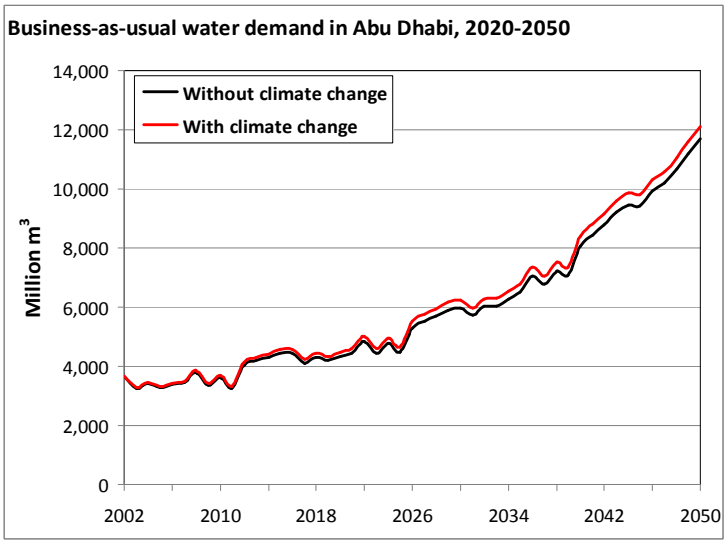
Figure 3-6: Water supply and demand balance, 2002 and 2050



- *Irrigated agriculture policy needs strategic reconsideration:* 'Greening the desert' programs and agricultural, forestry, and plantation irrigated areas make up more than 80% of the total annual water use. Groundwater will not be able to support business-as-usual expansion. In the absence of adaptation measures, reliance on costly desalinized water produced from natural gas-fired power stations (i.e., GHG-emitting) would need to expand to keep pace with projected water demand.

- *Climate change only marginally affects future water supply/demand.* Even though average annual precipitation in Abu Dhabi has reached its lowest recorded levels during the last decade, future climate change is likely to have little impact on future water supplies when compared to the effect of water demand. Even under the hottest/driest climate change scenarios, water demand in 2050 would only be about 3% more than demand without climate change (see Figure 3-7).

Figure 3-7: Climate change impacts on water demand in the Abu Dhabi emirate



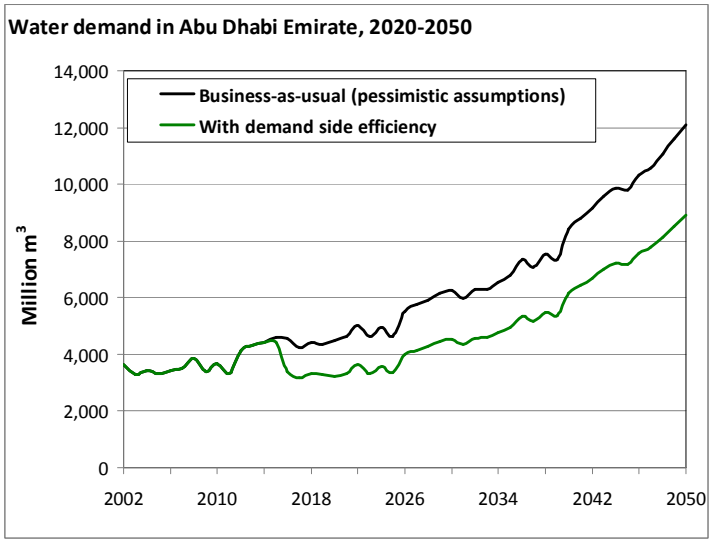
- *Reducing future water demand represents a strategic priority:* Without demand management strategies in place, projected future water deficits would need to be offset by large new supplies of water. While increased desalination levels

are viable to offset some of projected deficits, they are not without environmental impacts such as thermal discharges to the Arabian Gulf and increased levels of greenhouse gas emissions.

To address the major findings above, the study recommends exploring strategies that are able to narrow the growing gap between available water supplies and projected water demand. The central recommendation is to develop a strategy to reduce per capita water consumption by about 50% from current levels by the year 2012, with resulting level of per capita water consumption maintained through the year 2050. Key recommendations on the water demand side to achieve this ambitious goal are as follows:

- Design and implement a public awareness programme for the need for water conservation across all sectors of the economy of the UAE (i.e., residential, commercial, industrial, transportation);
- Pursue policies to increase the penetration of high efficiency water use devices, strategies, and measures (i.e., flow control, sanitary, metering, cooling, irrigation, leak detection, etc) in all new construction, as well as retrofits for certain applications, across all sectors (municipal, residential, commercial, agricultural, industrial). Such measures could decrease water demand in 2050 by 30% compared to what it would otherwise be (see Figure 3-8).

Figure 3-8: Projected water demand with and without adaptation



- Consider near-term policies to incentivize additional water reductions through implementing pay-per-unit water metering system for all users, as well as policies to decrease amenity area and summer watering by 20% and decrease forestry and agricultural area by 30% after 2015; saving more than 1,000 million cubic meters per year.
- Develop a comprehensive integrated water management and planning system whose focus would be to improve water-use monitoring systems, develop detailed databases of irrigation water used, provide publicly accessible information of water efficiency technologies, and establish a centralized water demand analysis framework, coordinate water demand investments.

On the water supply side, this will involve developing new sources of water across the full range of potentially available resources. Key options are as follows:

- Significantly increase utilization of the treated effluent for irrigation of parks, gardens and recreation facilities, and crops;
- Significantly increase utilization of the treated effluent for artificial recharge of groundwater; and

- Construct additional desalination plants to meet growing municipal demand, consistent with reduced water demand associated with demand-side management strategies.

3.5. Vulnerability and Adaptation for Dryland Ecosystems

Drylands are among the most resilient ecosystems to unfavorable climatic conditions. Of the over 450 plant species present in the UAE, many have unique adaptations to high salt levels, high temperatures and low rainfall. Most of the desert animals have also developed adaptive strategies to their dry environment. However, changes in temperature are already occurring at rates not seen historically. In the future, climate change will expected to cause shifts in the basic ecological characteristics upon which dryland ecosystems rely. There is a significant risk that highly interdependent biota will lose synchrony, impacting both local and migratory species.

To better understand the impacts of climate change on dryland ecosystems, a study was undertaken to qualitatively review the literature of the threat to such systems in the face of climate change for the Abu Dhabi emirate (Environmental Agency of Abu Dhabi, 2009c). Major findings of the study are summarized in the following bullets:

- *Ecosystem displacement and/or disappearance.* As temperatures rise and precipitation patterns change, vegetation and dependent fauna in sabkhat, dune and mountain and wadi ecosystems that thrived in one region may be displaced, shrink, or disappear altogether.
- *Reaching a "tipping point" with subsequent ecosystem collapse.* Climate change increases the risk of pushing ecosystems to a critical tipping point, or threshold. An ecological threshold is an abrupt change in an ecosystem functioning where small changes produce disproportionately large responses, even ecosystem collapse. If coastal and inland Sabkhat areas reach a threshold, they may be unable to support unique or endemic fauna. Thresholds can be crossed by changing rainfall patterns, temperature, nutrients, or increasing human pressures, such as over-harvesting.
- *Reduced biodiversity of flora and fauna.* Many bio-diverse areas of the Abu Dhabi Emirate will be threatened by changes in climate and reductions in biodiversity leaves key ecological niches unfilled and systems unstable (See Figure 3-9). A highly bio-diverse ecosystem is less likely to collapse or be adversely affected by disturbances over long periods (such as shifts in climate) or short periods (such as disease outbreaks, or flooding).

Figure 3-9: Typical dryland flora in the UAE in (*Cyprus conglomeratus*)

- *Increases in aridity and reductions in soil moisture.* A shift towards more arid soils in semi-arid grasslands and scrublands will render it increasingly difficult for even highly drought-adapted plants to survive along desert

margins. As plant systems fail, overwintering and stopover migrant birds like the houbara bustard *(Chlamydotis macqueenii),* one of the highly valued bird species of the Arab world, risk losing some elements of their food source, which will in turn affect their reproductive success.

- *Natural and managed ecosystems in mountains and Wadis are not drought-resistant; and are at risk as temperatures rise and precipitation patterns change.* Mountain species represent over a one third of the known species in Abu Dhabi (approximately 380 species.) such as mountain gazelles, where the mountain is the only habitat to many of these species.

Consequently, coping with future climate change will require planned adaptation in dryland areas. Human-induced land degradation and reduced biodiversity from urbanization and overgrazing are also major threats; climate change and increased variability only will exacerbate their effects. Key recommendations are as follows:

- *Strengthen biodiversity conservation as a policy priority in the face of climate change threats.* This would focus adaptation to climate change efforts on the restoration and rehabilitation of currently impacted dryland ecosystems. High priority should be assigned to degraded areas that have demonstrated resistance or resilience to climate change.
- *Develop an ecosystem threshold modeling capability.* The UAE would benefit from a significant investment in basic ecosystem threshold modeling capacity for better understanding the impacts of changes in temperature and rainfall on specific flora/fauna thresholds in the Emirate. The outputs of such modeling efforts would lead directly into adaptation planning and priority setting.
- *Strengthen dryland ecosystem research capacity.* According to the Intergovernmental Panel on Climate Change, investing resource in more research is one of the most promising approaches for managing for climate change impacts in dryland ecosystems. Such programmes would entail data collection, assessment, management, and monitoring to develop baseline datasets, and would represent a valuable basis for ecosystem threshold modeling.

3.6. Economic Vulnerability to Climate Change

The UAE, as an oil-exporting country, is concerned about the potentially adverse economic impacts concerning the intersection oil markets and climate change policy. Oil accounted for about 38% of the world's energy consumption in 2004 and oil sales consistently account for a significant share of the overall UAE economy. While refined oil products are compact, high-value sources of energy; they give rise to greenhouse gas emissions when they are burned. Unlike other fossil fuels such coal and natural gas, oil is primarily used in applications for which there are no convenient substitutes.

The Kyoto Protocol, the first major international climate agreement with binding GHG emissions reduction targets, requires industrial countries to reduce carbon emissions in 2008-2012 to roughly 5 percent below 1990 levels. In the years since 1997, when the Kyoto Protocol was negotiated, oil prices have fluctuated widely. In 1998-99, when prices fell below $10 per barrel, oil producing countries were naturally concerned about Kyoto's potential to cause further reductions in their oil revenues and national income. At the time

of this writing, intensive international negotiations are underway to develop a new post-2012 regime for global GHG reductions.

To explore the potential impacts on the UAE economy from GHG reduction actions by Annex 1 parties to the UNFCCC, a study was conducted to assess the long-term economic vulnerability of the UAE to reduced global demand for oil. At the time of the study, oil demand was high and a barrel of oil was selling for well over $50. Despite the lack of short-run risk of insufficient revenues for oil producing nations, the long-run question regarding the economic vulnerability of oil-producing states remains important. The Kyoto Protocol was only a first, limited step toward climate protection; the science of climate change clearly calls for more and deeper cuts in carbon emissions. Hence, a key concern is whether the later stages of climate policy may harm the economic performance of oil producing counties like the UAE.

Specifically, the study analyzed the economic vulnerability to the UAE in 2025 from changes to oil demand markets resulting from the impact of response measures that Annex I countries adopt to reduce their emissions in accordance with targets specified in the Kyoto Protocol (Environmental Agency of Abu Dhabi, 2009d). The study used a model of oil markets and prices (Kauffman, 1995) and data from the European Central Bank for oil forecasts. The model was calibrated to historical data from 1960 through 2003, and included a detailed analysis of oil demand in ten sectors for each of 133 countries, comprising the entirety of the world oil market.

A Baseline scenario and a total of six policy scenarios were considered to analyze the effect of international climate change policy on global oil sales up through the year 2025. To better understand the impact of climate change policies, these scenarios were further differentiated relative to two plausible tracks of global economic performance: stagnant economic growth and high economic growth. Each of the policy scenarios was differentiated by the level of carbon tax, ranging from $0 per barrel of oil in the baseline scenario up to $180/barrel in the most extreme policy scenario.

It is important to note that these tax levels are far above those currently being considered in current climate policy debates. In the UK, one of the countries taking climate change most seriously, the government now calls for use of a “shadow price of carbon” for planning purposes, which increases gradually over time; it is equivalent to $17 per barrel of oil in 2008, and $24 per barrel in 2025. To quantify the impact of response Annex 1 measures on global oil demand, these baseline forecast was compared to each of the policy scenarios for both the stagnant and high growth tracks.

The study found that the demand for oil is relatively insensitive to the price of oil. Up through 2025, there are not projected to be any available substitutes for petroleum-based transportation fuels, as biofuels will not be produced in sufficient quantity to threaten global oil markets. This confirmed the results of numerous other studies that have repeatedly concluded that price elasticities of demand for oil products are close to zero, implying that price changes have only small effects on sales volume.

The world demand for oil in 2025 for each of the policy scenarios and economic growth tracks is summarized in Table 3-4. There is little change at tax rates below $90 per barrel. However, even in the most extreme scenario in which a $180/barrel tax is added to the price of oil, global demand for oil in 2025 is still projected to be just over 80% of the demand level associated with no carbon tax for both economic performance tracks.

Table 3-4: Projected global oil demand in 2025 relative to CO2 tax ranging from $0/tC to $180/tC

		Global oil consumption in 2025 (million barrels/day)	
Scenario	Carbon tax ($/barrel)	Stagnant growth	High growth
Baseline	0	89.1	110.4
1	4	89.0	1104
2	9	88.9	110.3
3	18	88.8	110.1
4	45	88.2	109.7
5	90	86.1	107.9
6	180	73.5	91.2

The study concludes that the next few decades of climate policy will likely have greater impacts on solid fossil fuels, but only limited effects on oil markets. Oil producers will therefore have a window of time in which to prepare for the deeper cuts that could come later, as climate policy continues to reshape industrial economies in the future. From a long run perspective, where analysis is necessarily more speculative, cuts in near-term output could even be desirable; that is, it is possible that a slower rate of extraction would maximize the total value of oil reserves.

Much of the climate policy discussion now focuses on carbon taxes, or on tradable permits for emissions. Either of these policy instruments would establish an additional price for carbon emissions, raising the effective price of oil (and other fossil fuels). Moderate tax levels, along the lines of recent proposals in Europe and the US, would have very little effect on oil markets. Only at the highest tax levels, which are well beyond the range of politically feasible carbon prices, are noticeable reductions in oil demand in evidence.

3.7. Further Steps

The UAE is keenly aware that climate change, one of humanity's greatest environmental and economic threats, poses great challenges for the country. As outlined above, warming temperatures, disrupted rainfall patterns, and rising sea levels will produce adverse impacts on the country's coastal zones, water resources, and dryland ecosystems. Nevertheless, the sectors above are only a subset of those that are considered to be vulnerable to climate. As of this writing, studies are in progress for public health and food security, the results of which should be available for the next national communication.

Finally, through its efforts to understand the impacts of climate change on the nation's key sectors, the UAE seeks to respond aggressively to this challenge within the legal basis of the United Nations Framework Convention on Climate Change. Various government agencies are pursuing open and integrated policy discussions by which to protect hard-earned environmental gains and enhance the country's progress in sustainable development and consistent with the government's overall environmental vision and policy agenda. Adaptation to climate change, not too long a concept not well-defined, has now moved to a prominent position within national planning discussions. Further steps will see to sustain the high levels of stakeholder engagement and move toward a nationwide and integrated strategy development process for adapting to climate change.

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Chapter 4

Greenhouse Gas Mitigation

MASDAR مصدر
ABU DHABI FUTURE ENERGY COMPANY شركة أبوظبي لطاقة المستقبل

PREPARATORY COMMISSION FOR
INTERNATIONAL RENEWABLE ENERGY AGENCY IRENA

ZAYED FUTURE ENERGY PRIZE

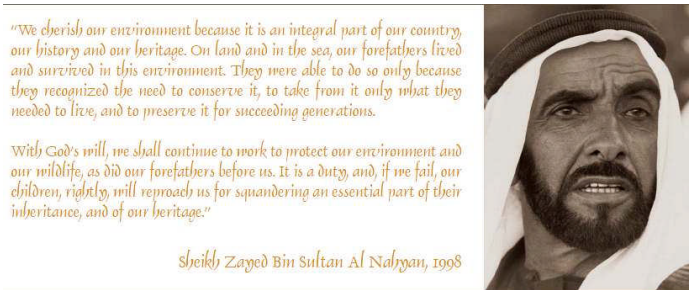
4.1. Introduction

Greenhouse gas mitigation activities have taken on increasing prominence in the UAE over the past few years. Based on the principle of common and differentiated responsibility in the Framework Convention, the UAE has embraced the shared responsibility to contribute toward a global transition to the use of clean energy sources. To this end several collaborative arrangements, with the support of the international community, have been established since the submission of the Initial National Communications to transform the UAE into a future hub of knowledge, research, investment, and examples of clean energy production and consumption. The chapter provides an overview of these initiatives.

4.2. Underlying Vision for Greenhouse Gas Mitigation in the UAE

The UAE's underlying vision for greenhouse gas mitigation is to lead by example. As an oil-exporting country that is highly vulnerable to climate change, the UAE believes that the time has come for collective and decisive action to confront climate change through new national policies, new investment decisions, and new innovative frameworks for action for a national transition to clean energy.

HH Sheikh Khalifa bin Zayed, following in the tradition established by his father the late Sheik Zayed Bin Sultan Al Nahyan, is seeking to lead by example on climate change. Recognizing that previous generations were able to live and survive in a hyper-arid environment because they understood the need to protect and conserve it, he is seeking to advance new thinking on climate change, the foremost environmental challenge of the day; and in so doing preserve the environment for succeeding generations.



The UAE appreciates its strategic role as an oil-exporting country and has embarked on a proactive, forward-looking path with respect to climate change. The blessings that the UAE enjoys as an oil-producing state must be balanced by the responsibility to find new sources of energy and to help protect the world from catastrophic climatic change. We recognize that the future of oil will be governed by the development of clean technologies for sustainable environmental management.

As the subsections below highlight, the UAE has begun a journey to a low carbon future that involves new thinking, new frameworks, and new methods. This is evident by its dramatic clean energy initiatives, engagement in international carbon emission reduction markets, promoting access to new low-carbon technologies, the development of long-term partnerships to exploit sustainable energy opportunities, and being the proud host to the new International Renewable Energy Agency (IRENA) headquarters. Through these steps, the UAE declares its solidarity with the Bali Action Plan as well as its moral, financial, and long-term commitment to promote greenhouse gas mitigation in a carbon-constrained world.

4.3. The MASDAR Initiative

The MASDAR (i.e., translated the “source” in Arabic) is a $15 billion initiative linking climate change, economic opportunity, and clean energy. The funding will go into infrastructure, manufacturing, and renewable energy projects such as solar power, hydrogen, wind power, and carbon reduction and management technologies. In the coming decade, the goal is to raise more than $200 billion dedicated to research and development of renewable energy technologies. The UAE is the first major hydrocarbon-producing nation to take such a major step in the development of clean sources of alternative energy.

A proud winner of the 2007 1st World Clean Energy Awards in the Finance and Investment category, the MASDAR initiative is a global cooperative platform for open engagement in the search for solutions to some of mankind's most pressing issues: energy security, climate change and truly sustainable human development. Through partnerships with some of the the world’s leading companies, universities, and investment firms it aims to act as a catalyst to fuse research and innovation and has the potential to fundamentally alter the world’s conception of energy and launch an historic global transition to new, clean energy sources and sustainable human development. There are four key aspects of the Masdar Initiative: the Clean Technology Fund, MASDAR City, the Masdar Institute of Science and Technology, and the World Future Energy Summits.

The MASDAR Clean Technology Fund was established in 2006 with $250 million of diversified venture capital investment. The Fund has been designed to generate long-term returns through a portfolio of clean technology and sustainable-energy companies. The Fund will facilitate the development and commercialization of technologies in renewable energy, energy efficiency, carbon capture and storage (see Box 4-1), water usage and desalination. The clean technology fund is an important part of the UAE’s strategic vision of a new partnership on clean energy and sustainable human development premised on the fact that climate change, sustainable development, and economic opportunity should be jointly and collectively addressed.

When completed in 2016, MASDAR City will be the world’s first carbon-neutral, zero-waste city. It will be 100 percent powered by renewable energy to sustain a final population of 50,000 and host 1,500 companies. The city will span about 6 square kilometers and will feature compact high density development, a photovoltaic power plant, and will exemplify how energy and water conservation can be achieved while enhancing the quality of life. MASDAR City will show how growth with a high living quality can be sustained while simultaneously avoiding greenhouse gas emissions. MASDAR City has been designated as an official “One Planet Living Community” by the World Wide Fund for Nature.

The MASDAR Institute of Science and Technology is a graduate-level research-driven engineering institution, founded in collaboration with the Massachusetts Institute of Technology (MIT), specializing in advanced energy and sustainability-related technologies. The Masdar Institute aims to become a centre of high-caliber renewable energy and sustainability research capable of attracting leading scientists and researchers from around the world. Its interdisciplinary and collaborative research and development infrastructure is intended to develop a pool of highly skilled scientists, engineers, managers and technicians capable of accelerating the development of clean energy technology and enterprise in the region and globally. The MASDAR Institute is envisioned as a world centre for developing future solutions for sustainable energy production and consumption as part of the MASDAR Research Network, a collaborative global research network driving advances in sustainable

energy and maintaining stability in the world energy markets with six leading universities and scientific research institutes in Asia, Europe, and North America.

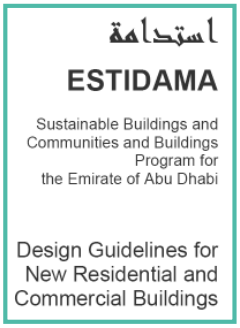
The World Future Energy Summits are the final major component of the MASDAR Initiative. The inaugural Summit was held in Abu Dhabi in early 2008 and was heralded as "the future of energy". It was the first major international conference and exhibition to address all aspects of sustainable energy solutions. Over 15,000 attendees are expected to attend the next summit, expected to be the largest meeting of policymakers, industry experts, thinkers, investors and researchers from within the renewable energy industry.

4.4. Emerging strategies to reduce GHG emissions in the UAE

There has been an ongoing process to identify appropriate strategies to reduce GHG emissions in the UAE. It is important to note that this represents a voluntary and progressive approach to the climate change challenge since, as a non-Annex 1 country under the UNFCCC, the UAE is not obliged to pursue explicit GHG reduction targets. Nevertheless, as evidenced by the discussion above, there exists a strong commitment to pursuing GHG reductions, bolstered by the sense that there will be real and long-term economic advantages to achieving them.

Energy supply and demand has been the primary focus of policy-level discussions regarding potential GHG mitigation options. As discussed in Chapter 2, electricity generation, oil and gas operations, and energy consumption in buildings, industrial facilities and vehicles accounted for 116,114 Gg of CO_2 equivalent in 2000 in the UAE, or about 91% of total CO_2 emissions in that year. Moreover, the energy sector, particularly the electricity sector, is inextricably linked to the water sector due to the use of waste heat from power plants for the production of desalinated drinking water. In broad terms, there is a recognition that any options for reducing GHG emissions from the electricity sector should also ensure continued sufficiency of potable water supplies. Investments in modern energy infrastructure, including the progressive deployment of energy efficient and renewable technologies will, over the longer term, contribute to substantial reductions in GHG emissions. Below is a brief summary of major initiatives related to GHG mitigation that are either under consideration or already underway.

- *Sustainable buildings:* The Estidama (i.e., “sustainability” in Arabic) program aims to create guidelines and regulations to ensure sustainable (green) design, operating and maintenance of all types of buildings and communities within the UAE. It has been initiated by a group of government agencies and developers within the emirate of Abu Dhabi to promote a holistic approach to minimize resource use while maintaining performance quality (ADUPC, 2008). Estidama calls for regulatory and building code changes to minimize GHG emissions through using materials which have low or off-set greenhouse gas emissions associated with construction, integrating renewable energy sources such as photovoltaic cells to utilize solar power, specifying building energy requirements derived from renewable sources, specifying the use of district cooling and heating systems, minimizing energy consumptive practices by embedding energy saving into design (natural lighting and window shading to avoid air conditioning needs), and adoption of alternative refrigerants with a comparatively low global warming potential.



- *Ecological footprint ass*essment: The Al Basama Al Beeiya (i.e., "ecological footprint" in Arabic) Initiative was launched in October 2007. Driven in part by the Living Plant report of 2006 in which the UAE was reported to have the world's largest footprint, the aim of the national effort to measure and better understand the country's ecological footprint, including its GHG emissions. The four core partners in the initiative are the Emirates Wildlife Society - World Wide Fund for Nature (EWS-WWF), the UAE Ministry of Environment and Water (MoEW), the Abu Dhabi Global Environmental Data Initiative (AGEDI), and the Global Footprint Network (GFN). The initiative involves multiple stakeholders across the UAE and consists of data collection, quantitative and qualitative analysis, assessment of UAE data used nationally/internationally, and research into the methodology of measuring the ecological footprint. Once the calculation of the UAE's footprint and analysis of the footprint are completed, Al Basama Al Beeiya will make policy recommendations regarding data management systems for tracking GHG emissions as well as natural resource management. Nevertheless, advance efforts are already underway to reduce the UAE's carbon footprint such as the *Sustainable Schools Initiative* where schools are expected to significantly reduce their carbon footprint, the *Greening the IT Initiative* to reduce the carbon footprint of the use of information technology, and the initiation of "Paperless" day on the occasion of world environment day to promote less use of paper throughout the Abu Dhabi emirate.

- *Low-carbon electricity supply:* The UAE is currently evaluating the potential application of peaceful nuclear energy to meet future base-load electricity demand. With its zero-carbon electricity production, the possible deployment of civil nuclear power plants within the UAE could make a dramatic contribution to carbon reduction, as well as increased levels of environmentally-damaging sulfur- and nitrogen oxides. Additionally, the Abu Dhabi Emirate, via the Masdar Initiative, is investing heavily in the research, development and integration of technologies that will sharply reduce the CO2 emissions of through an emirate-wide carbon capture and sequestration (CCS) network. The UAE is also pursuing high-efficiency natural gas combined cycle plants for providing baseload power. Finally, the Abu Dhabi emirate has committed to deploying renewable energy sources in a proportion equal to 7% of the Emirate's total on-grid power generation capacity by 2020. Together, these activities support Abu Dhabi's commitment to seeing that at least 30% of its electricity generation capacity is sourced from low-carbon sources by 2020.

- *Transport initiatives:* In September 2007, the Abu Dhabi emirate produced Vision 2030, an urban planning strategy emphasizing sustainable transport and land use planning. The plan calls for shifts from private modes of transport (i.e., cars and light duty trucks) to public modes of transport (i.e., metro, light rail, street cars, buses) as well as reducing congestion levels. Moreover, there are also plans underway for the use of compressed natural gas (CNG) in certain municipal vehicle fleets. However, given persistent shortages in natural gas availability across the UAE, the strategy is being reassessed in favor of greater usage of electric or hybrid vehicles. Each of these strategies, including the new

metro system in Dubai, will have a beneficial impact on overall GHG emission levels from road transport in the UAE. Regarding aircraft emissions, the UAE is currently pressing for international support for the establishment of medium and long term goals for emissions reductions and recognition of aircraft operators who have already invested heavily in modern, low emissions fleets.

- *Awareness raising:* Programmes are underway to raise the awareness of civil society groups and individuals about the causes and challenges of climate change. In particular, awareness campaigns have been developed and implemented to reach out to children, youth and teachers who represent the potential for a future citizenry to be sensitized to the challenge of climate change. Raising awareness among this group has involved targeted awareness-raising events as well as the preparation of a 6-book series on general climate change information for 8-12 year olds. Another key group is the media. Television, radio, and print are effective in shaping how the message is communicated to the general public. Through targeted outreach, the media is being educated and engaged on the climate issues to ensure that the message being communicated to the public is closely aligned to unfolding developments and avoids missteps of being overly conservative or overly certain of future impacts. Business groups are yet another key constituency of awareness rainsing efforts. The business community has been assisted through business seminars, exhibitions, dialogues, and the development of international partnerships to promote environmental education and awareness building. Chapter 5 discusses some of these initiatives in more detail.

4.5. Greenhouse gas reductions from emerging strategies

Among other commitments, every party to the UNFCCC has an obligation to regularly provide an assessment of GHG mitigation options. Specifically, the guidance provided by the COP indicates that it is important to provide information national measures undertaken to mitigate anthropogenic GHG emissions. The GHG reduction benefits of the options reviewed above have been analyzed to provide an initial quantification of the emission reductions associated with these sustainable development actions in the UAE.

Two scenarios were considered. The *Reference Scenario* assumed business-as-usual development over the period 2000-2030. Growth assumptions are based upon patterns established during the 1994 to 2000 period, the years for which GHG inventory data exists. The *Mitigation Scenario* assumes that the set of GHG mitigation options described above are introduced in the UAE over the 2000-2030 time frame. The difference between the Mitigation and Reference scenarios indicate the magnitude of GHG reduction benefits associated with the particular mitigation options.

It is important to note that the GHG mitigation analysis does not imply that the UAE is setting targets for emissions reductions. As a non-Annex 1 country under the UNFCCC, the UAE is not obliged to pursue explicit GHG reduction targets. Nevertheless, there are many initiatives that are currently either planned or underway in the UAE that will achieve substantial reductions and contribute to global efforts. The GHG mitigation analysis demonstrates the magnitude of these reductions compared to a business-as-usual approach.

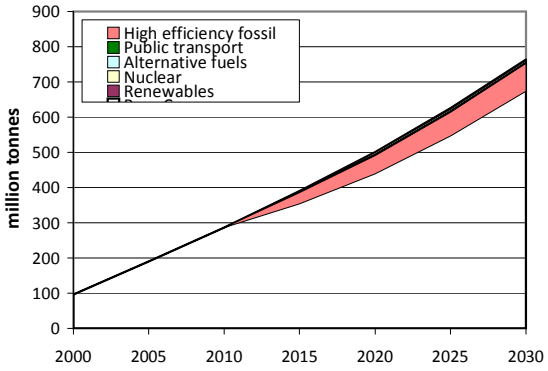
Energy supply and demand are the focus of the analysis. This is due to the fact that energy represents the largest share of GHG emissions in the UAE (see Chapter 2). Electricity generation, oil and gas operations, and energy consumption in buildings, industrial facilities and vehicles accounted for 116,114 Gg of CO_2-equivalent in 2000 in the UAE, or about 91% of total CO_2 emissions in that year. The specific mitigation options analyzed are described below; each is at some stage of consideration in the UAE.

- *Low-carbon electricity supply – renewable energy:* The analysis analyzes a commitment to deploy renewable energy sources (i.e., solar PV and wind) equal to 7% of the total on-grid power generation capacity by 2020.
- *Low-carbon electricity supply – high efficiency natural gas-fired generation:* The analysis focuses on the use of high-efficiency natural gas combined cycle units with a gross efficiency of about 58% to meet the capacity expansion requirements.
- *Low-carbon electricity supply – peaceful nuclear power:* The analysis focuses on the introduction of a single next-generation pressurized water reactor (1,000 MW) to displace equivalent baseload electricity from natural gas-fired units.
- *Increased reliance on public transport:* The analysis focuses on the component of Abu Dhabi Vision 2030 that calls for shifts from private modes of transport (i.e., cars and light duty trucks) to public modes of transport (i.e., metro, light rail, street cars, buses) and scales this initiative up to the UAE level.
- *Alternative transport fuels:* The analysis focuses on the use of compressed natural gas (CNG) in bus fleets.

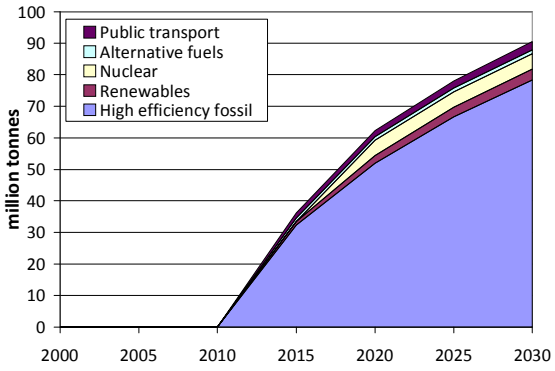
Over the period of their implementation, the above measures yield reduction of about 91 million tones of CO2-equivalent in 2030 & total of about 1.1 billion tones of CO2-equivalent cumulatively through 2030. These reductions represent roughly a 12% decrease relative to what emissions are projected to be in the Reference Scenario (see Figures 4-1a and 4-1b).

Figure 4-1 (a) & (b): Impacts of GHG mitigation measures

a) CO2-equivalent emissions



b) CO2-equivalent emission reductions



4.6. Further steps

The measures discussed in the previous sections emphasize the UAE's commitment to do its part in addressing greenhouse gas emissions. The emerging strategies reflect a desire to act in a decisive, aggressive and collaborative manner with the international community. Indeed, through the concerted actions described in this chapter - from the groundbreaking MASDAR initiative to climate change awareness-raising among our kindergarteners – a

vision of reduced greenhouse gas emissions and greater resilience against adverse physical impacts is being realized within the seven emirates of the UAE.

The strategies described in this chapter should be viewed as part of a re-visioning process for the manner in which long-term economic development should proceed in the UAE. Such a process, together with the concerted actions involved, has the benefit of harmonizing the UAE's moral duty to honor the global partnership to confront climate change as signatories to the Convention, as well as doing so in a way that reflects the unique needs of a developing, oil-dependent economy. In the next and final chapter of this Communication, an overview is provided about some of the additional steps being taken to implement the Framework Convention in the UAE.

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Chapter 5

Steps to Implement the Convention

5.1. Introduction

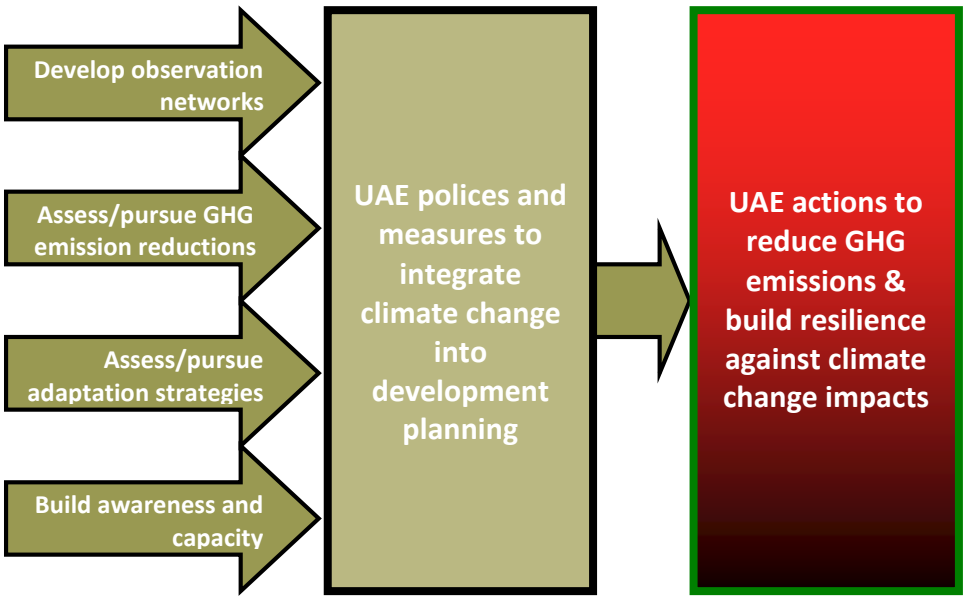
The discussion in the previous chapters makes clear that through its environmental vision, fulfillment of its international commitments, improved understanding of vulnerability to climate change, and proactive steps in promoting alternative energy investments, the UAE has already taken important steps in the implementation of the Framework Convention on Climate Change since the submission of its Initial National Communication. This chapter builds upon these activities and reports on a framework of action that is taking shape in the UAE to further integrate climate change concerns into national economic development processes and policy dialogues.

5.2. Framework for implementing the Convention

A major benefit of the climate change-related activities undertaken thus far is that they have enjoyed a broad level of participation, both from local public/private stakeholders as well as from international partners. This has served to promote a coalescing of perspectives around some of the key aspects of a process to implement the Climate Change Convention in the UAE.

The overall process, as well as the key priorities, are illustrated in Figure 5-1. This process is already well underway in the Abu Dhabi emirate, and consultations are ongoing for appropriate ways to extend the process throughout the other six Emirates (EAD, 2009). Each key priority area is briefly discussed in the bulleted descriptions below and discussed in more detail in the subsections that follow. While much remains to be done to establish implementation and coordination arrangements across national institutions, agencies, and stakeholders, the process discussed below represents an outline for a national climate change action plan for the UAE, one that enjoys increasing support and which is intended to be further refined over the months and years ahead.

Figure 5-1: Process for implementing the Climate Change Convention



- *Develop observation networks:* this refers to monitoring and GHG emission tracking systems. Implementing the Convention for this category will help to strengthen the UAE's quantitative understanding of how climate change is impacting key vulnerable sectors, how local climate patterns are changing, and how productive activities are

contributing to GHG emissions. Observation networks will be designed to be well-coordinated across institutions in order that their outputs can be incorporated into economic development plans and policies;

- *Assess greenhouse gas emission reduction strategies:* this refers to the assessment of policies, strategies and measures for reducing GHG emissions throughout the economy. Implementing the Convention for this category will help lead to concrete GHG emission reductions in certain priority sectors through the implementation of strategic interventions. Currently, the priority sectors that have been identified for increasing attention are energy supply/demand and solid waste management;
- *Assess climate change adaptation options:* this refers to actions to reduce the vulnerability of key ecosystems, structures, and communities to the adverse impacts of climate change. Implementing the Convention for this category will help contribute to near-term actions that can increase the resilience in the UAE to the adverse impacts of climate change. Five vulnerable sectors have been identified, namely coastal zones, water resources, dryland ecosystems, food security, and public health; and
- *Build awareness and capacity:* this refers to enhancing the individual, institutional and public/private capacity to address the challenges of climate change. Implementing the Convention for this category will help to produce a better informed general public about the challenge of climate change, as well as strengthened capacity in key institutions to undertake the needed analyses and studies that contribute to better decision-making.

5.3. Develop observation networks

The development of a network for observations and information sharing will facilitate better planning and capacity-building in the UAE across all impacted sectors of the economy. This initiative is being designed to address two key aims. First, it will systematically document trends in GHG emissions, the evolving state of the local climate, and changes in terrestrial and marine environments. Second, it will enhance information gathering and data management. Implementing such a system will improve understanding of key changes, and contribute to an improved predictive capability for responding to those changes.

Some climate-related observations are already taking place within formal observation networks in the UAE. Most notable among these are climatic observations as part of Meteorological Services and remote sensing as part of collaborative efforts with international research organizations (Al Habshi, 2007). Emission tracking systems are also being put in place for criteria air pollutants as part of support being provided by the Norwegian Institute for Air Research (NILO).

Data from new observation networks, combined with more traditional and ongoing surface-based observation will help to contribute towards long-term, high-quality sustained measurements needed to detect future climate change in the UAE. They will also help to establish trends in GHG emissions as well as clearly identify key emitting sectors paving the way to the establishment of effective mitigation strategies. A continuing challenge will be ensure the long-term integrity and understandability of data products provided by the observation networks. Key parts of this challenge will involve the integration of observations within existing systems and data management networks, as opposed to establishing independent protocols.

While the potential scope for observation networks across the seven Emirates is potentially quite large, there are three specific initiatives that are being considered as an initial effort in implementing the Convention in this regard. These initiatives correspond to enhanced observation and monitoring for coastal zones, GHG emissions, and regional climatic modeling. Each is briefly summarized in the bullets below.

- *Coastal zones:* Home to most of the UAE's population, infrastructure, sensitive ecological subsystems, and important cultural heritage sites, climate change will lead to higher sea levels, increased sea surface temperatures, and changes in wave dynamics. Unless accounted for in future adaptation planning and measures, the economic damages from sea level rise could be unacceptably high. Broadly, this initiative aims to strengthen existing observation systems across the UAE to better understand and address long-term sea level rise and its impacts on the built environment. The initiative involves comprehensive surveillance, monitoring, documentation, and dissemination of rates and locations of sea level rise, including the installation of surveillance equipment in coastal sites where current public–private infrastructure is particularly vulnerable to small increases in sea level. It also involves the observation, analysis, and interpretation of trends in coastal water levels, elevation, shoreline change, wetland loss, and tidal influence on water supplies. Such actions should facilitate an assessment the responses of coastal landforms and biological systems to sea level rise and to the effects of any increases in storm activity in the Arabian Gulf.
- *GHG Emission Tracking Systems:* Government agencies across the UAE are convinced that no effort to reduce greenhouse gas emissions can succeed without the accurate measuring and tracking of emissions. Today, there is currently no centralized and comprehensive tracking system for GHG emissions which proved challenging in develop the updated GHG inventory discussed in Chapter 2. By providing a centralized tracking system or registry tool, a more precise and transparent picture of the sources and amounts of the UAE's GHG emissions will emerge. This will provide an indispensable contribution to the development, implementation, and evaluation of climate change policies and strategies, including obtaining a better understanding of the country's ecological footprint. Broadly, this initiative data sharing across institutions, database development, information management, documentation, and dissemination of the levels and rates of GHG emissions through the acquisition of a comprehensive and user-friendly GHG emission tracking tool that can be applied to all GHG sources and sinks.
- *Regional Climatic Modeling:* As indicated in the latest IPCC report, "Increasingly reliable regional climate change projections are now available for many regions of the world due to advances in modelling and understanding of the physical processes of the climate system" (Christensen, et al., 2007). A key data management and information challenge for the UAE will be to develop a regional-scale climatic projection of temperature and rainfall changes. The development of a regional climate modeling system will be an important step in providing that capability. At present, the downscaled climate projections for the UAE are based on limited meteorological data for a few stations in the UAE over an 11-year period. Recognizing that this data record may be an insufficient basis for making long-term, potentially capital intensive adaptation decisions, regional climate modeling is slated to become an active area of development over coming years in the UAE. Broadly, this strategic policy goal aims to introduce a regional climate modeling capability that can be coordinated across the other GCC countries. Specifically,

this strategic policy goal aims to undertake projections of climate change in under regional anthropogenic forcing factors, based on the development or application of a coupled climate biosphere-hydrology–chemical-aerosol regional model.

5.4. Assess and pursue GHG reduction strategies

The second step in the plan to implement the Convention is the development of a strategy to assess and achieve reductions of GHG emissions. It is important to note that this represents a voluntary and progressive approach to the Convention since, as a non-Annex 1 country, the UAE is not obliged to pursue explicit GHG reduction targets. Nevertheless, there is widespread consensus in the UAE that significant reductions in emissions are feasible, cost-effective, and that there will be real advantages to the UAE in aiming to achieve them.

As discussed in the previous Chapter, there are already several existing strategies in place to pursue significant GHG reductions in the near- to mid-term. Assessing the GHG reductions from these and other strategies is important for properly accounting for the reductions to be achieved, and then to build off them through the identification and pursuit of additional opportunities for GHG reductions that are desirable and achievable given socio-economic growth and other baseline conditions. This will help to ensure that the climate change policy is both aggressive and closely linked with national circumstances and stakeholder perspectives, and will allow for effective monitoring and evaluation of policy goals.

Moreover, this initiative calls for the pursuit of strategies than can reduce long-term emissions in the UAE. At the broadest level, the initiative calls for the preparation of cross-sectoral strategies to support the achievement of GHG reduction targets through climate change awareness, evaluation of incentives, assessment of offset schemes, and pursuit of opportunities for research and development. It also involves the development of a Greenhouse Gas Reduction Action Plan, to be periodically updated, that documents the measures to be promoted and undertaken to achieve GHG reductions. Specifically, there are four areas of focus, as outlined in the bullets below.

- *Energy and water supply strategies:* The energy sector will need to make a substantial contribution to reducing greenhouse gas emissions through energy efficiency improvements and the diversification of the technologies and energy sources to include both renewable and low-carbon sources of energy. In the UAE, as in many countries of the GCC, the energy sector, particularly the electricity sector, is inextricably linked to the water sector due to the use of waste heat from power plants in desalination for the production of potable drinking water. As such, solutions related to reducing GHG emissions from the electricity sector must also feature parallel solutions for ensuring continued sufficiency of potable water supplies. Additionally, the MASDAR Initiative is investing heavily in the research, development and integration of technologies that will sharply reduce CO_2 emissions of fossil fuel-fired power generation linked with a carbon capture and sequestration (CCS) network. Some of the key actions being pursued include power plant efficiency improvements, transmission and distribution loss reductions, natural gas pipeline fugitive emission reductions, evaluation of reverse osmosis in desalination, and more efficient water distribution networks.
- *Electricity and water demand strategies:* As has been demonstrated in numerous regions of the world, one of the most cost effective ways to reduce GHG emissions is via the

application of demand-side management measures that result in reduced and more efficient consumption of electricity and water. The initiatives pursued are motivated by a desire to providing a supportive policy framework for existing initiatives and identifying other opportunities for GHG reductions in the sector. The implementation of a broad spectrum of demand side management measures, including green building codes, such as those being implemented under the Estidama Initiative for new buildings should result in a gradual and sustainable reduction in electricity use – particularly associated with space cooling - and hence GHG emissions in new buildings. Some of the key actions being pursued include the promotion of distributed generation (e.g., rooftop PV), transitioning to high efficiency light bulbs, introduction of smart electricity meters, and reduction in emissions of gases with a high global warming potential.

- *Transportation strategies:* As noted earlier, there are urban expansion/renewal plans underway on the UAE that address public transit and traffic congestion levels. Moreover, there are also plans underway for the use of alternative fuels in the transport sector. All of these initiatives are at nascent stages of implementation. The initiatives for the transport sector are motivated by a desire to provide a supportive policy framework for existing initiatives and identifying other opportunities for GHG reductions in the sector. Specifically, some of the key actions being pursued include encourage modal shifts from cars to public transport, introducing a feebate system to shift car purchases to more efficient models, and the promotion of efficient driving.
- *Waste management strategies:* The initiatives for the waste sector are motivated by a desire to provide a supportive policy framework for existing waste management initiatives and identifying other opportunities that can yield significant GHG reductions in this sector. Specifically, the key actions being pursued to implement the Convention include encouraging integrated waste management and pursuing feasible and sustainable waste to energy options, as possible.

5.5. Assess and pursue climate change adaptation strategies

The third step in the plan to implement the Convention is the development of strategies for adapting to climate change in vulnerable sectors. Adaptation strategies are intended to reduce national vulnerability to near- to long-term departures from baseline climatic trends in temperature and precipitation extremes that may adversely affect agricultural productivity, land and marine ecosystems, and other vulnerable sectors.

Hence, the overarching motivation for the initiative is the need to account for climatic risks in policies, institutions and attitudes such that enabling conditions are establish to respond appropriately. At the broadest level, this initiative seeks to build adaptive capacity in key vulnerable sectors, increase ecosystem resilience and reduce the risk of climate-related disasters, mobilize and manage knowledge for adaptation policy and planning, and take advantage of synergies and overlaps between adaptation and mitigation activities. Specifically, there are four areas of focus, as outlined in the bullets below.

- *Coastal Zones:* The major finding of the recently completed vulnerability study for coastal zones undertaken for this Communication confirms that coastal areas in the UAE will be extensively inundated due to sea level rise as current shorelines migrate inland. Given the uncertainty inherent in the IPCC sea level rise scenarios, the steps to implement the Convention call for the implementation of win-win strategies. This refers

to the implementation of planning and design strategies that are consistent with both adaptation to sea level rise and sustainable development. This would be a strategic response coordinated across ministries and sectors and would involve adopting an integrated coastal zone management planning framework, awareness building regarding coastal development risks, and investing in modest adaptation such as "soft" protection measures (e.g. beach nourishment, seawater irrigation for reforestation with local mangrove species, wetland restoration and creation).

- *Water resources:* As discussed in Chapter 3, the UAE has experienced explosive growth in water demand over the past decade associated with its increasing population and economic activity. Water for agricultural production, maintenance of green parks, industrial production, commercial services, and household activities has been supplied primarily by fossil (i.e., non-renewable) groundwater resources, with the balance provided by desalinated water. Economic development plans strongly suggest that the need for water will continue to intensify in the future, raising serious policy challenges regarding long-term water resource management. The key activities to implement the Convention include setting water consumption targets, increasing public awareness for water conservation, promoting water efficiency, adopting an integrated water resource management planning framework, and increasing the use of treated effluent for irrigation of parks and recharge of groundwater.
- *Dryland Ecosystems:* Drylands are among the most resilient ecosystems to unfavorable climatic conditions with many having unique adaptations to high salt levels, high temperatures and low rainfall. However, changes in temperature are already occurring at rates not seen historically. In the future, climate change increases the risk of pushing dryland ecosystems to a critical tipping point. Consequently, coping with future climate change will require planned adaptation in dryland areas. Specifically, the following initiatives are being pursued: establishing biodiversity conservation as a policy priority, developing an ecosystem threshold modeling capability, and strengthening dryland ecosystem research capacity.
- *Food security:* Agriculture is currently a valued sector in the UAE accounting for up to 3% of GDP. Climate change is likely to produce adverse effects on agricultural productivity although the scale and intensity of the effect will depend on crop type. Coping with food security in the context of future climate change will require planned adaptation activities focusing on conducting a study on the vulnerability of food security to climate change and developing adaptation information systems.

5.6. Build awareness and capacity

The fourth and final key step in the plan to implement the Convention is the development of a capacity strengthening strategy to support the implementation of climate change initiatives. Capacity building refers to strengthening personal skills, knowledge, expertise, and relevant institutions and organizations. In the context of implementing the Convention, capacity building encompasses outreach to the public through information campaigns and educational initiatives, as well as strengthening the technical capability of individual/institutions to evaluate and address key issues related to the reduction of greenhouse gas (GHG) emissions and the reduction of vulnerability to climate change-related impacts. It will require the participation of multiple stakeholders, including the general public, government ministries/departments, research institutions, local

communities, educational institutions, nongovernmental organizations (NGOs), students, and international organizations.

The overarching strategy for capacity building is to enhance understanding of the climate change challenge so that all Abu Dhabi stakeholders are equipped to respond appropriately. It is essential that civil society groups and individuals operate from a common understanding about the causes and challenges of climate change. This will help to mobilize public support for new policies. At the broadest level, this initiative seeks to sensitize the general public to the link between consumption patterns and climate change; and increase technical capacity to analyze and integrate climate change strategies into planning activities. Specifically, there are two areas of focus, as outlined in the bullets below.

Box 5-1: Awareness-building among children through the "Tackling Global Warming" education module

Enviro-Spellathon, an environmental education programme, sponsored by local organizations, including the Emirates Wildlife Society and WWF has been developed for use in primary/secondary schools in Abu Dhabi, Dubai, Ajman, Fujairah and Ras Al Khaimah. Delivered via a website (i.e., www.envirospellathon.com), this curriculum introduces, among other topics, the challenge of "Tackling Global Warming" for 13-14 year-olds (see opening screen above) through the experiences of Hamad, an Emirati boy, and his family as they explore the land and live their lives. A series of teacher training workshops were held in all the participating emirates to introduce the programme to some 425 teachers.

- *Building awareness among youth:* In particular, it will be important to reach out to young people. Children, youth and teachers represent the potential for a future citizenry be sensitized to the challenge of climate change (See Box 5-1). Raising awareness among this group will likely involve targeted awareness-raising events as well as updates to school curriculum.
- *Building awareness among media outlets:* Another key group is the media. Television, radio, and print are effective in shaping how the message is communicated to the general public. The media should be educated and engaged on the climate issues to ensure that the message being communicated to the public is closely aligned to unfolding developments and avoids missteps of being overly conservative or overly certain of future impacts. To this end, the UAE Chapter of the International Advertising Association (IAA) launched an initiative on behalf of the communications industry in the UAE in support of "Copenhagen", an international movement to support "ambitious, fair and effective" action in reducing GHG emissions at the United Nations' Climate Change Conference (COP15) in Copenhagen in December 2009.
- *Building awareness among business organizations:* Business groups are yet another key constituency. The business community is being assisted business seminars, exhibitions and dialogues on actions it can take to reduce GHG emissions. The ultimate aim of this efforts is to enlist the private sector's support in establishing benchmark information, standards, testing and certification procedures that promote sustainable energy use. One example is the "Earth Hour" initiative many private organizations in the UAE participated in a 60-minute event to switch off electricity that saved an estimated 2,715

kWh (about 2.5 tones of CO2) and participated in energy conservation awareness seminars. Another example is the set of regional events organized by Dana Gas, a private sector natural gas company headquartered in Sharjah, which has been working under a agreement with Eco Securities and Dubai Multi Commodities Center for the identification and development of CDM projects across the region. The partnership has launched a series of business seminars to bring together the technical, commercial and financial expertise of participating companies to work towards the goal of reducing GHG emissions from oil and gas operations.

- *Climate Change Capacity Initiative:* This aim of this initiative would be to develop technical capacity within the UAE to respond to the climate change in an integrated manner. It would be a central technical programme to coordinate activities associated with the implementation of the initiatives described above. On the basis of a comprehensive training strategy, the initiative would develop/strengthen the capacity necessary to eventually oversee all activities related implementation of the climate change policy. This involves observation/monitoring, GHG mitigation analysis, vulnerability/ adaptation research, and awareness-raising, as undertaken by various agencies and institutions. The Initiative would also be responsible to ensure that emerging knowledge is integrated into ongoing policy dialogues and planning decisions, as well as identifying where new regulations/legislation may be needed to achieve the aims of the climate change policy.
- *Engaging Society in Climate Change initiative:* This is one of the important strategic initiatives for the Abu Dhabi emirate. Consistent with the national strategy, this initiative aims to promote a more energy efficient society and greater knowledge about renewable energy. The target audiences include students at schools and colleges, the general public, and the corporate sector. Some of the key initiatives to be strengthened in the coming years includes: promoting renewable energy education in schools and teacher training; conducting environmental competitions among students; targeting higher education and youth through workshops and presentations; advising the corporate sector on ways to reduce their carbon footprint; evaluating climate change awareness through market research, and supporting community organizations and NGOs in their awareness-building efforts (e.g., the “Heroes of the UAE” campaign with EWS).

5.7. Parting thoughts

The steps outlined in the previous pages emphasize the UAE’s commitment to do its part in addressing climate change. The actions reflect a desire to act in a decisive, aggressive and collaborative manner with all stakeholders. Indeed, through concerted action among public and private entities, a vision of reduced greenhouse gas emissions and greater resilience against adverse physical impacts can and surely will be realized. Such concerted action has the benefit of harmonizing our moral duty to honor the global partnership to confront climate change as signatories to the Convention, as well as doing so in a way that reflects the unique needs of an oil-dependent economy.

Underlying many of the steps discussed is a theme of influencing consumer behavior to ensure the efficient use of electricity, conservation of scarce water resources, and reduction/recycling of municipal solid waste. There is support for the continued assessment of the full range of demand side management measures, including tariff restructuring and

customer pricing, building and plumbing codes, public awareness and educational campaigns, efficient electrical end-use appliances, drought tolerant plants, detecting and fixing leakages, energy audits, load shifting, smart metering and many options.

The implementation of these initiatives will require careful and sustained deliberations on appropriate mechanisms and coordination arrangements. Detailed assessments of key activities, institutional modalities, and effective monitoring protocols are currently under development, with the ultimate aim being the comprehensive operationalization to the benefit of the UAE, and the overall Arabian Gulf region, and the planet.

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