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IMPACTS OF CLIMATE CHANGE ON URBAN DEVELOPMENT IN THE UAE: THE CASE OF DUBAI

Zainab AlRustamani AlRustamani

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United Arab Emirates University
College of Engineering
Department of Architectural Engineering

IMPACTS OF CLIMATE CHANGE ON URBAN DEVELOPMENT
IN THE UAE: THE CASE OF DUBAI

Zainab AlRustamani

This thesis is submitted as a partial requirement for the Master of Science in
Architectural Engineering

Under the Supervision of Dr. Al Moataz Hassan

December 2014

Declaration of Original Work

I, Zainab AlRustamani, the undersigned, a graduate student at the United Arab Emirates University (UAEU) and the author of the thesis entitled “*Impacts of Climate Change on Urban Development in the UAE: The case of Dubai*”, hereby solemnly declare that this thesis is an original work done and prepared by me under the supervision of Dr. Al Moataz Hassan, in the College of Engineering at the UAEU. This work has not been previously formed as the basis for the award of any academic degree, diploma or similar title at this or any other university. The materials borrowed from other sources and included in my thesis have been properly cited and acknowledged.

Student's Signature Date

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Abstract

This thesis investigates the global calls to prepare for climate change impacts, and the role of cities to respond to it under their sustainable living approaches. It explores how the subject of climate change is integrated in the urban development process, highlighting the role of cities as contributors to the phenomenon and part of the solution. The response to climate change impacts was explored in the UAE and the emirate of Dubai. The main objective of this research is to highlight the future vision in action against climate change in the urban development framework of the emirate of Dubai, and how the local government in the emirate plans to respond to its consequences within the existing institutional framework. An exploration methodology was adopted using a qualitative approach to investigate the trend of climate change in the literature review and conduct semi-structured interviews with government officials to frame the local response to the international calls to combat climate change impacts. The study framed Dubai's response and suggested a framework that might be adopted by the government to increase the concern on climate change and unify the local response. This thesis intends to provide the decision makers in Dubai a general assessment of their current position of integrating climate change within the current planning process and suggest a framework to implement it based on the international experiences.

Keywords: climate change, impacts of climate change, urban development, cities resilience, urban planning response, adaptation, mitigation

تأثير التغيرات المناخية على التنمية الحضرية في دولة الإمارات العربية المتحدة

دراسة حالة مدينة دبي

الملخص

تهدف هذه الأطروحة إلى دراسة آثار تغير المناخ على المدن وكيف يتم دمجها في عملية التنمية الحضرية، وتسليط الضوء على دور المدن كمساهمة في ظاهرة تغير المناخ وكونها جزء من الحل لتحقيق استدامة دائمة في ظل مناخ متغير. تتناول هذه الدراسة استكشاف استجابة دولة الإمارات العربية المتحدة وإمارة دبي لتأثيرات تغير المناخ ضمن الإطار التنموي المتبع. الهدف الرئيسي من هذا البحث هو تسليط الضوء على الرؤية المستقبلية المعتمدة لمواجهة تغير المناخ في إطار التنمية الحضرية لإمارة دبي، وكيف تخطط الحكومة المحلية في الإمارة للرد على نتائجه ضمن الإطار المؤسسي القائم.

تم اعتماد منهجية الاستكشاف (Exploratory Research) باستخدام نهج نوعي (Qualitative Approach) للتحقيق في اتجاه تغير المناخ (Literature Review) وإجراء مقابلات شبه منظمة (Semi-Structured interviews) مع مسؤولين حكوميين لتأطير الاستجابة المحلية للنداءات الدولية لمكافحة آثار تغير المناخ. الدراسة قامت بتوثيق استجابة حكومة دبي لنداءات ضرورة الاستجابة لتأثيرات التغيرات المناخية، واقترحت إطاراً يمكن اعتماده من قبل الحكومة لتنظيم وتوحيد الاستجابة المحلية لتغير المناخ. وتعتزم هذه الأطروحة توفير تقييم عام لصناع القرار في مدينة دبي لموقفهم الحالي من إدماج تغير المناخ في عملية التخطيط الحالية واقتراح إطار لتنفيذها استناداً إلى التجارب الدولية.

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Dedication

This thesis is dedicated to all those who believe in their ability to change and make a difference.

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List of Abbreviations

CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CO₂	Carbon Dioxide
DECC	Directorate of Energy and Climate Change (UAE)
DEWA	Dubai Electricity and Water Authority
DM	Dubai Municipality
DSCE	Dubai Supreme Council of Energy
GGGI	Green Growth Planning Institute
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
MoE	Ministry of Energy – UAE
MoEW	Ministry of Environment and Water – UAE
MoFA	Ministry of Foreign Affairs – UAE
TEC	The Executive Council
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WCED	World Commission on Environment and Development
WMO	World Meteorological Organization

CHAPTER 1

INTRODUCTION

1.1 Overview

Climate change has become a challenging topic on many political and economic agendas. It represents a threat to the earth's ecosystem as well as the survival of mankind. The impacts of climate change are increasing in intensity and frequency on a global scale, along with a scientific consensus on the anthropogenic disturbance of the natural system created by the increased greenhouse gases (GHG) in the atmosphere caused by high emissions resulting from human activities and lifestyles. These impacts are not limited to national boundaries. They affect development decisions, influence strategies and national policies.

These impacts increase the burden on cities' rapid urbanization as they act as major threats raising different challenges for future sustainability planning. Climate change is expected to create millions of environmental refugees, who will face starvation, water shortages, and homelessness (IPCC, 2007; Wilson and Piper, 2010; Otto-Zimmermann, 2011; and Davoudi S., 2009).

To develop a successful response to climate change impacts, cities were considered as major players to overcome this threat. Cities were born as engines for economic growth, centers of expanding human population, and main producers and consumers of resources being part of the climate change scene intensifying the problem and contributing to the solution. In order to maintain the current rate of growth, reduce the anthropogenic impacts, and adapt to the consequences of climate change, cities need to consider climate change in their development planning to reduce

its undesirable future impacts and live in harmony with the natural changes (UNHSP, 2008).

The response to climate change impacts is led by the United Nations and is encouraging world states to take the responsibility of saving their environment and live in peace in their home, the earth. The response is developed through a climate change governance and the implantation responsibility lies on cities to adapt to the unavoidable impacts of climate change, and mitigate the anthropogenic consequences of human activities through its spatial planning system.

This research explores the climate change trend, the global response to its consequences and the role of cities to consider climate change within their spatial planning. The spatial planning approach adopted by the City of Dubai to respond to climate change impacts is being investigated in this research in light of the global trend motivated by being the researcher's home town.

Regionally, Dubai and the United Arab Emirates are located in the Arabian Peninsula where human habitation goes back about 15,000 to 20,000 years ago, but the harsh climate conditions delayed the emergence of settlements and populations were mainly nomadic unsettled tribal societies. Major cities were concentrated on the coastal regions and oases with limited natural resources and limited growth rates. The emergence of cities in the Arabian Peninsula was associated with global impacts in two eras. The first era started in the seventh century by the emergence of Islam, which converted the rival tribes into a great civilization. However, the second era can be distinguished in the twentieth century upon the oil discovery which is boosting the economy and redrawing the geo-political role of the region (Arabian Peninsula, 2011).

The transition from non-oil economy to an oil economy had a huge burden on the natural environment, raising the issue of natural unsustainability. The fast growth had negative consequences on the already scarce resources and environmental sustainability. Water reserves are decreasing, the food imports dependency is high, demand on energy is increasing, and the harsh climate is worsening. Cities in the Arabian Gulf region had boosted the economy benefiting from oil returns to build modern civilizations shaping the image of the region. This growth helped in offering a modern life style and vivid city image, the future sustainability of development gains, especially in the post-oil era, and environmental safeguard including the impacts of climate change present major challenges to local government (Luomi, 2012).

The climate change in the UAE is expected to result in warmer weather, less precipitation, droughts, higher sea levels, and more storms. The consequences of these impacts are tremendous on infrastructure, human health, and natural habitat among others, which affect various development sectors and policies including socio-economic, health and environment. On the other hand, the economic boom and population growth increase the demand on energy generation, water and natural resources which indirectly contributes to the levels of carbon dioxide emissions and climate change in general. These implications of climate change as well as the need to maintain economic development forced decision-makers to respond immediately to lots of uncertainties imposed by climate change (UAE MoE, 2012).

Fortunately, the Gulf region in general, and the UAE's government in particular are aware of this risk, and started promoting sustainable development within the framework of their strategic objectives of development. The participation in international treaties and conferences such as UN Climate Change conferences, the

initiation of energy forums such as Dubai Global Energy Forum where the climate change subject was introduced, and the intention to have a diversification of energy sources “oil, solar and nuclear” are positive signs of the good intention towards a sustainable future (UAE Ministry of Foreign Affairs, 2012; and DSCE, 2013).

In light of the above, this research explores how Dubai perceives climate change impacts, and how the response is taking place within its development plans.

1.2 Background

The world is facing growing global calls forewarning the impact of climate change on urban areas. Economic activities, buildings, infrastructure, energy and services sectors and other pillars of any city’s sustainability are threatened by the adverse impact of climate change. The high concentration of population, infrastructure, goods, and commodities are vulnerable to these changes. Unlike other environmental issues, climate change is the most complex issue confronting policy makers today. The efforts to reduce such impacts require international consensus and cooperation, which is challenged by conflicting economic interests among all countries (Otto-Zimmermann K., 2011).

In an attempt to reduce the global impacts on climate and overcome the projected risk of adverse climate impacts, the UN had formulated unified global mechanisms to respond to climate change impacts. Policy makers, planners, and scientists have prepared mitigation and adaptation strategies under the United Nations Framework Convention on Climate Change (UNFCCC). While they set mitigation targets with long term benefits, they proposed adaptation measures to live in peace with minimum level of climate threat to living environment. Both mitigation and

adaptation can take different shapes in terms of physical arrangements or institutional changes. Subsequently, it is essential to integrate these strategies into the strategic spatial planning system to maximize resilience of cities and urban centers (Wilson and Piper, 2010; IPCC, 2010; and Aall C., Carlsson-Kanyama A. & Hovelsrud G., 2012).

1.3 Research Context

This research is motivated by the urgent need to consider the climate change impacts on the strategic level of cities' development in order to achieve urban sustainability during challenging conditions of economic development and population growth. Unlike other environmental issues, climate change is a complex issue that is shared among all nations involving most of the development sectors. Nations' roles vary from being contributors, victims, or parts of the solution. Therefore, the response has to be clarified and agreed on a global level in order to maintain equity among nations (Bulkeley and Betsill, 2005).

1.3.1 Global Concern, Local Solution

Climate change is a global concern that led global leaders to discuss this subject on international levels and include it in different development agendas. As an effort to unify the global response to climate change, the United Nations had initiated the United Nations Conference on Environment and Development (UNCED) formerly called "Earth Summit" held in Rio de Janeiro in 1993 *to help Governments rethink economic development and find ways to halt the destruction of irreplaceable natural resources and pollution of the planet* (Un.org., 2013). In this summit, the United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature as a non-binding commitment to reduce the concentration of GHG in the

atmosphere reducing the impact of human anthropogenic impact on the earth's climate system (UNFCCC, 2013)

In the 1990s, the World Bank stepped in to expand its role of intervening in the economic and social policies in the Third World to monitor their rapid pace of urbanization that may threaten their resilience and sustainable growth. Through their sustainable development network, the United Nations work with policy makers, civil society, and the private sector locally to address climate change and encourage inclusion of green growth in developing countries in order to improve the quality of life, reduce GHG emissions, and prepare to face future risks (World Bank, 2010).

1.3.2 Human and Climate

The World Bank and the Intergovernmental Panel on Climate Change (IPCC) had worked to increase the awareness on the serious consequences of climate change worldwide. The first and most important sign was the increase in global mean temperature over the past 100 years. It is likely to continue increasing, which is expected to result in a modification of the land surface. Scientists at the US National Aeronautics and Space Administration (NASA) studied and simulated the impacts and effects of climate change (NASA, 2011). They divided the causes of climate change into two main categories: natural and human causes. The unavoidable natural causes are linked mainly to volcanic explosions, ocean currents that move carbon dioxide (CO₂) across the earth, orbital changes related to changes in the earth's tilt angle, continental drift, changes in GHG concentration, and changes in solar energy (Windows to the Universe, 2008; and Yuen B., Kumssa A., 2011). Human causes associated with cities' growth and anthropogenic activities are mainly related to power

generated from industrial activities, land use changes, agriculture, transportation, buildings, and waste and wastewater, as illustrated in Figure 1.1 (World Bank, 2010).

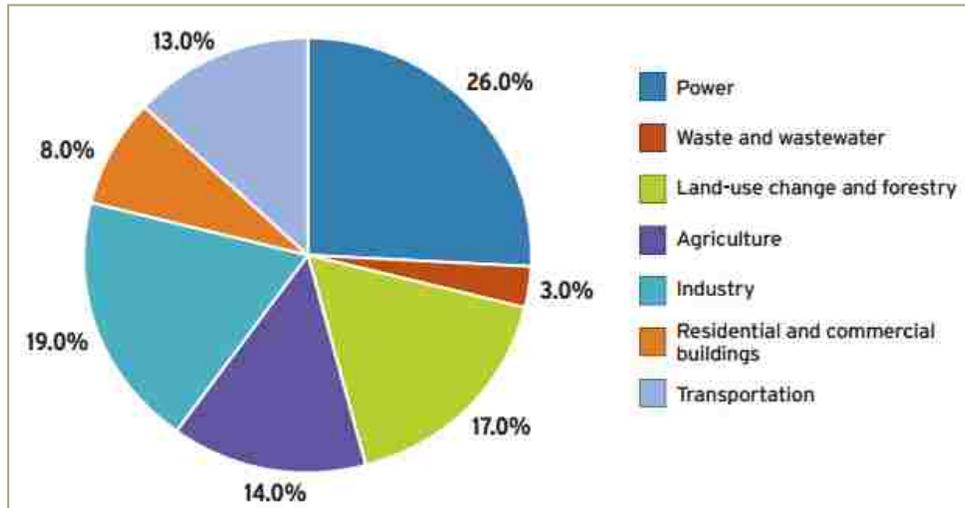


Figure 1.1: Global CO₂ Emissions by Sector (World Bank, 2010)

The projected effects on the environment and human life are numerous and varied. For example, the increase in global average temperature is assumed to result in a variety of secondary effects, namely, changes in precipitation patterns, rising sea levels, melting of Arctic sea ice, melting of glaciers and permafrost, an increase in sea surface and large lake temperatures, flooding due to increased rain levels in some regions and extreme drought in other regions. Changes in ecosystems, changes in the frequency and strength of hurricanes, acidic sea water, altered patterns of agriculture, increased extreme weather events, the expansion of the range of diseases, and the opening of new trade routes are all potential effects (Windows to the Universe, 2011). These impacts all affect the global resources that are critical to human existence such as water, agriculture, fisheries, and livestock, as illustrated in Figure 1.2 (Wunderground, 2007).

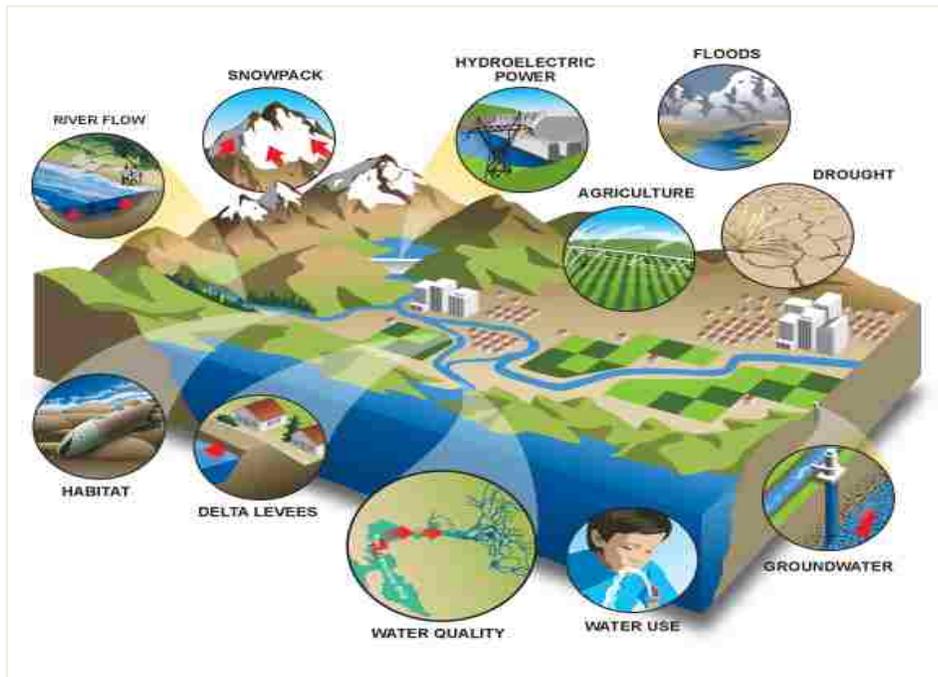


Figure 1.2: Impact of Climate Change on Global Resources (Wunderground, 2007)

Climate change effects are felt mainly in cities – but not necessarily in the cities that are emitting these gases. The most vulnerable cities in Asia and Africa, despite their low GHG emissions, suffer the most from these climatic changes (Yuen B., Kumssa A., 2011).

The relationship between human systems and climate change can be best presented by the Framework of Anthropogenic Climate Change, which was prepared by the Three Working Groups of IPCC and clarified in Figure 1.3.

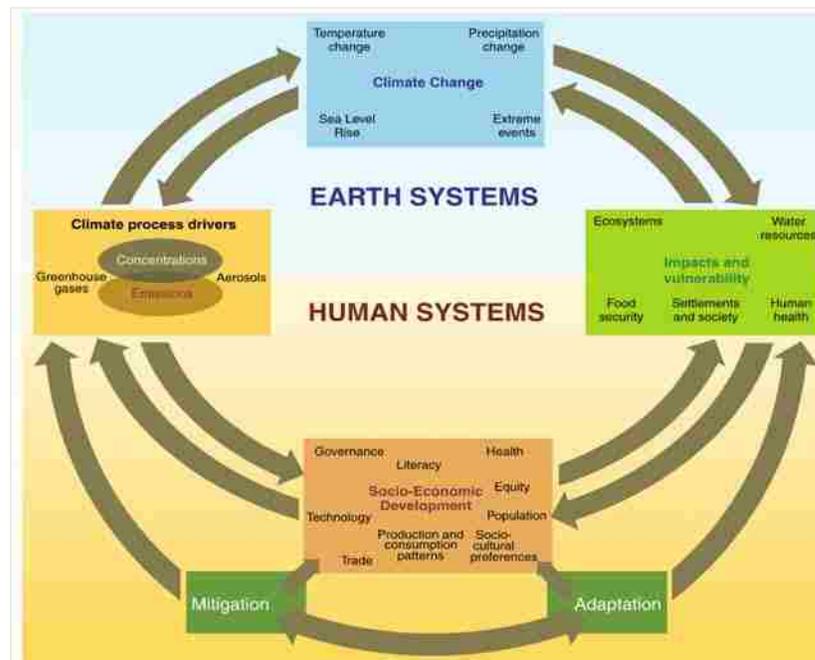


Figure 1.3: Schematic Framework Representing Anthropogenic Drivers, Impacts of (and Responses to) Climate Change (IPCC, 2007)

1.3.3 Role of Spatial Planning in Climate Change

Spatial planning¹ integrates all local, national, and regional interests to achieve sustainability aiming to build economic, social and environmental benefits as detailed in figure 1.4. It denotes the methods used by the public sector to influence the distribution of people and activities in spaces of various scales. Spatial planning involves not only land use planning, but also raises the tensions and conflicts between sectoral policies to assure integration among them in order to achieve the targeted vision. (Faludi A., 2010).

¹ It is the problem of coordination or integration of the spatial dimension of sectoral policies through a territorially-based strategy” (United Nations, 2008)

Economic Benefits
<ul style="list-style-type: none"> • Providing more stability and confidence for investment; • Identifying land in appropriate locations to meet the need for economic development; • Ensuring that land for development is well placed in relation to the transport network and the labor force; • Promoting environmental quality in both urban and rural areas, which can then create more favorable conditions for investment and development; • Identifying development that meets the needs of local communities; • Promoting regeneration and renewal; and • Making decisions in a more efficient and consistent way.
Social Benefits
<ul style="list-style-type: none"> • Considering the needs of the local communities in policy development; • Improving accessibility when considering the location of new development; • Supporting the provision of local facilities where they are lacking; • Promoting the re-use of vacant and derelict land, particularly where it has a negative impact on quality of life and economic development potential; and • Aiding the creation and maintenance of pleasant, healthy and safe environments.
Environmental Benefits
<ul style="list-style-type: none"> • Promoting the use of previously developed (“brownfield”) land and minimizing development on “greenfield” land; • Conserving important environmental, historic and cultural assets; • Addressing potential environmental risks (e.g. flooding, air quality); • Protecting and enhancing areas for recreation and natural heritage; • Promoting access to developments by all modes of transport (e.g. walking, cycling and public transport), not just by car; and • Encouraging energy efficiency in the layout and design of development.

Figure 1.4: The benefits of spatial planning (Wilson and Piper, 2010).

Spatial planning’s major role is to bring together all stakeholders from different concerned disciplines to establish a credible framework of action to facilitate achieving a target among different participants. Having a complex nature of action among different stakeholders, climate change response is believed to be achieved through a spatial planning framework to achieve a proactive response to climate change impacts on urban settlements (Wilson and Piper, 2010).

To ensure efficient implementation and firm decision-making, spatial planning processes must be integrated into the national governance system on cross-sectoral levels and vertically (Wilson and Piper, 2010), which is further detailed in Chapter 3.

This global concern had motivated the researcher to explore how does Dubai deal and respond to climate change impacts and balance it with its strategic development approach. To support this exploration, a literature review was conducted to collect in-depth information of the global trend of climate change and the international response set by the UNFCCC, supported by providing two examples of the way countries consider climate change impacts within their spatial planning approach.

1.4 Research Aims and Objectives

The main purpose of this research is to conduct an exploratory research to investigate the development planning strategy in the emirate of Dubai and assess how climate change is taken into consideration to ensure integration among the different players in the city's planning regime.

This aim could be obtained through the following objectives:

1. Review the basic facts, settings and concerns of climate change and its links to urban development.
2. Revise the risks and impacts of climate change within the UAE/Dubai context and to illustrate the UAE national and local governments' response to this global phenomenon.
3. Demonstrate the approach, which has been adopted to incorporate climate change into development planning in Dubai and to explain the strengths and the shortcomings of this process.
4. Find out the necessary measures and guidelines towards more resilience.

1.5 Conceptual Framework

Departing from the urgent need to respond to climate change, this research traces the current trend of climate change on an international level and describes the debate raised around it in addition to the global institutional arrangements that internationally agreed to lead the phenomenon. The review of this literature results at mapping the base to assess the local response to the phenomenon of climate change within the spatial planning system.

Research then describes the motives and drivers of change and the national institutional arrangement set to lead and manage the national response. On the way, research highlights the related challenges and vulnerabilities identified by the UAE federal and local government and the national desire to host and promote green sustainability conferences and researches.

Dubai is chosen as a case study to investigate the local response to climate change and examine the response mechanism within its spatial planning. Additionally, this research demonstrates interests and perceptions of the decision-makers and the power granted among key players to plan, drive and implement the local response.

1.6 The Case Study: Dubai

Dubai is a good example of a visionary driven emirate in the UAE since its inception under the leadership of Al Maktoum family. The transformation from a small fishery village to a world class city was envisioned by the former ruler Sheikh Rashid Bin Saeed Al Maktoum followed by his sons, Sheikh Maktoum and the current leader Sheikh Mohammad. However, Sheikh Mohammad set a clear vision for the

emirate and built the local capacity to have a smooth transition to a new era of development.

In 2012, the UAE had launched the green economy strategy, and in 2013, HH Sheikh Hamdan Bin Rashid had directed the Executive Council to prepare the city to respond to the impacts of climate change. From this starting point, Dubai is believed to have taken positive steps in this direction. Therefore, the researcher, as a resident of Dubai, was keen to explore and investigate the local response to global climate change phenomenon to achieve a sustainable city.

1.7 Research Questions

The research aims to explore the impacts of climate change on urban development in the context of development process. It addresses three main questions:

1. What is the current trend and debate around the impacts of climate change?
And what is the role of cities in responding to these consequences?
2. What are the internationally recognized approaches to respond to the impacts of climate change on cities? And how they are implemented?
3. What are the possible impacts of climate change on the city of Dubai? And how they are considered in the spatial planning?

1.8 Research Methodology

The mission of this thesis is to discover ideas and insights of the impacts of climate change on urban development in the UAE having Dubai as a case for exploration. As this subject is relatively newly introduced to the planning area, exploratory research approach was adopted due to the nature of the study to provide

better understanding of the situation. Exploratory research is a type of research conducted when a problem is not clearly defined.

Three methods of exploratory research were used; literature review, interviews and case analyses. These methods enabled the researcher to initially review the link between climate change and urban development, revise the anticipated impacts of the global phenomenon within the UAE with especial reference to Dubai, investigate the way the impacts of the climate change have been incorporated into the urban planning and development of Dubai and propose a set of recommendations to adequately integrate environmental protection into development planning and finally reduce the climate change impacts on the future urban development and planning within the emirate.

The literature reviews the international experiences and approaches to respond to the impacts of climate change. Despite the fact that these cases may differ in terms of the nature and significance of the likely impacts as well as the context, they still provide insights into the process which has been adopted to incorporate climate change into development planning and the key players. Furthermore, these cases offer the researcher with insights into how governments overcome climate change threats; what are their problem-solving capacities and how do they identify their climate change priorities and their impacts on building their future visions.

The investigation of the case study conducted semi-structured interviews with experts, professionals and field officers of different government entities including but not limited to: the Executive Council (TEC), Dubai Supreme Council of Energy (DSCE), Dubai Municipality (DM), and Dubai Electricity and Water Authority

(DEWA). These agencies were chosen as they are the key players in the development planning in Dubai Emirate.

Considering the diversity of actors and data sources used in this research, six narratives were used to report and summarize the findings of each interview conducted with the field experts; (1) perception of climate change, (2) climate change strategic objectives, (3) development approach to respond to climate change objectives, (4) measures to respond to climate change, (5) Adaptation and mitigation policies and their implementation mechanism, and finally (6) Strengths and weakness of the current framework.

The research adopted interviews for data collection, utilizing both “informal unstructured interviews” as well as formal semi-structured type. The first stage of interviews was informal and unstructured. This helped to establish rapport, gain trust, and draw out information, attitudes, opinions and beliefs around the climate change/ local development without pre-determined questions. While this approach allowed the interviewees to enjoy the interview, it offered the researcher a chance to establish better understanding of the main themes mentioned above and to build a wealth of knowledge on and around both the evolution of environmental development concerns and climate change response. The second stage of interviews was formal and semi-structured interviews. The reason to use this type is to tap the knowledge and experience of those with information relevant to the problem.

The interview questions focused on several topics such as the perception of the environment, climate change and the expected impacts of climate change. The questions also addressed how the aforementioned topics affected the city planning and

the objectives, roles and initiatives made to response to the impacts of climate change. The interviews, in addition, were structured to include a few more general questions in order to highlight the role of local government in relationship to climate adaptation. The questions along with the responses are available in Appendix A.

1.9 Structure of the Thesis

The researcher structured her thesis in six chapters addressing the research questions mentioned in section 1.6 in order to widen her knowledge base of the subject. While the first chapter precludes the topic and methodology, the second chapter provides an overall view about the current trends and debate around climate change and the role of cities in responding to its consequences. Chapter 3 details the global agreed tools of adaptation and mitigation, and the different approaches adopted internationally with some examples selected from cities having similar conditions with Dubai were explored in Chapters 4. Chapter 5 tackles the main case study as it highlights the UAE's development and investigates Dubai's preparedness to build a sustainable resilient development. Through this chapter, several questions were raised. How do Dubai key development stakeholders perceive climate change, and what are the major climate change impacts on the city's development process? What are the measures adopted by the government to deal with climate change? Who are the partners and key players in climate change response, and how does the coordination mechanism work? The final chapter provides a comprehensive discussion on the findings of the research, followed by conclusions and recommendations.

1.10 Research Limitations

Being a research conducted by a student, time and financial constraints were part of the limitations. Indeed, a researcher with more resources and a wide range of networks would have used different methods to gather data and analyze them.

Another problem was the culture of secrecy in dealing with politically sensitive areas. This was shown in the difficulty in dealing with development planning issues, and in obtaining data and official documents. In addition, officials are reluctant to criticize the process leaning towards praising government's achievements.

The planning power in Dubai was a major obstacle observed hindering an efficient implementation of the master planning strategy. They are dispersed between several authorities and agencies with no clear overall guiding body within the Emirate, which forms difficulties in obtaining a clear and consistent view.

It is worthwhile to mention that the subject of planning for climate change is a demanding subject that cuts across several areas of interests and specializations. Despite the researcher's efforts to cover the main stakeholders, the role of community did not feature in this research, however, it might be considered as a future research opportunity to expand.

CHAPTER 2

TREND OF CLIMATE CHANGE

2.1 Introduction

Climate change refers to both the warming of the earth's atmosphere and the increase in the natural variability of the climate. These changes pose risks to communities and human settlements such as increase in frequency of extreme weather events, changes in water availability and quality, sea level rise and changes in the performance of infrastructure.

People contributed directly to those changes through their irresponsible actions of overconsumption of resources such as the increasing demand on water and energy to cope with their luxurious lifestyle, increasing amount of industrial activities and high demand on fossil fuels. These activities have direct impacts on natural systems such as air, water and soil. Therefore, these risks draw the attention to people's responsibility and accountability to guard the natural system and keep it in a balanced state by changing their living lifestyle behavior and cities' role in minimizing the impacts of these actions on the natural systems.

In light of the above, this chapter investigates how cities prepare to respond to the impacts of climate change within their spatial planning regime.

2.2 The Current Debate

The 21st century witnessed increasing awareness calls of global warming and climate change. This global issue has occupied a significant sector in the daily thoughts of the people in different levels starting from the decision makers down to school students. The interest of this issue is shown in movies, politics, mass media, and all over the internet.

This interprets the calls to join the race that targets the positive change and adapt to climate before it is too late (Top Documentary Films, 2011). Climate change is becoming a symbol that shapes humans' relationship with the environment (Boykoff, 2011) in a way that emphasizes the humans' role in achieving the required balance in the natural systems (Abdul-Matin, 2010).

Climate is regulated by the way energy is gained from the sun and lost back into space. Solar radiation enters the earth's atmosphere and it is either partly absorbed or trapped and partly reflected back into space. The climate system¹ can balance itself and absorb the stress caused by anthropogenic activities. However the system's imbalance is observed through the increase in global temperature, which causes what is currently called global warming and scientifically linked to anthropogenic causes (Boykoff M., 2011).

The debate over the main causes of the increase in carbon dioxide (CO₂), as one of the main GHGs is still going on. The dispute occurs among whether being caused by human interference or caused by natural changes in the ecological systems and whether this increase is really causing the climate to change or not (Top Documentary Films, 2011). Since the industrial revolution, the CO₂ concentration has increased from 275 ppm² to 375 ppm and is expected to continue increasing due to ongoing rapid development,

¹ Certain atmospheric greenhouse gases (GHGs) are critical to climate system balance. These include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), tropospheric ozone (O₃), halo carbons (CFC₃, HFC₃, and HCFCs), and water vapor (H₂O) (Boykoff M., 2011).

² ppm: parts per million

urbanization and economic growth worldwide. This increase is synchronized with global warming and the current climate change trend (Luo Y., & Mooney H.A., 1999).

There is a scientific distinction between climate change and global warming, however, in the policy realm the distinction gets more complicated. For example, the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC) define the term *climate change* differently. The IPCC defined climate change as “*any change in climate over time, whether due to natural variability or as a result of human activity,*” while the UNFCCC restricted the definition to human components as a major cause of this change, with no consideration of the natural causes. The UNFCCC defines it as “*a change of climate, which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.*” (Pielke Jr., 2005)

(Pielke Jr., 2005) has argued that the limited UNFCCC definition affected the response strategies to climate change at different levels associated. It created a bias against adaptation policies and allowed policy interference. The sense behind this approach is clear: human emissions of greenhouse GHGs will lead to changes in the global climate. The logical solution is that reducing GHGs will avoid the increased frequency and magnitude of climate change impacts. Proponents of this logic are behind energy policies as a mitigation solution to climate change, with no consideration of the natural causes of the phenomenon.

Despite arguments over the definition of climate change in the political arena, climate change specialists have identified major facts that are widely consistent among them: (a) GHGs led by the increase in CO₂ are responsible for the imbalance in the earth's metabolic system. The accumulation of these gases from natural and human systems caused an increase in the earth's temperature, leading to what is known as global warming (IPCC, 2007, World Bank, 2010, and Houghton J. et al., 2001); (b) the increasing concentration of CO₂ indicates a net buildup of this gas in the atmosphere (Earth System Research Laboratory, 2009, and IPCC, 2007); (c) the global warming observed over the last 100 years is very likely due to the high release of CO₂ from human activities, driven by economic growth (IPCC, 2007); and (d) the climate is changing and cities are rapidly growing; it is the role of humans and cities to sustain the globe's metabolic system and adapt to the impacts of climate change (World Bank, 2010, and IPCC, 2007).

Nevertheless, there is a global consensus that climate change exists, and that there is a need to adapt to its consequences. In addition, there is an urgent need to reduce local and regional ecological footprint by reducing GHG emissions. This shall be embedded in the social behavior change in many developed regions, driven by political calls and an increase in environmental awareness (Boykoff, 2011, and Wilson E. and Piper, J., 2010).

2.3 Global Response Drivers

Several drivers drew the attentions to climate change and its consequences, which were followed by international actions and agendas in order to unify the efforts and manage the issue properly. These drivers represented at the change on the concentration of GHGs, aerosols, land cover and solar radiation which alter the energy balance of

climate system which are directly impacting and impacted by human settlements. Therefore, a unified international response was driven on the global political arena forcing developments to integrate climate change within their spatial planning. (IPCC, 2007)

As a result of the growing concerns and the accumulating evidence of the impacts of climate change, the UN Summit on Environment and development (1992) declared the United Nations Framework Convention on Climate Change (UNFCCC) as a political driver providing the foundation for intergovernmental response to address this problem, and minimize the human's impact on climate. (Un.org, 2013 and Change, 2013)

The convention has an ultimate objective of stabilizing atmospheric concentrations of greenhouse gases at levels that would prevent unbalanced human interference with the climate system. To achieve this objective, all the UNFCCC parties - those who ratified, accepted, approved, or acceded to the treaty - had to have general commitments placing a fundamental obligation on industrialized and developing countries to respond to climate change. (Change, 2013)

The authentication of UNFCCC comes under Kyoto Protocol which is a legally binding agreement adopted in 1997 by the world's governments as a stronger and more detailed commitment for industrialized countries, sharing the Convention's objective, principles and institutions. The dominant feature of Kyoto Protocol is its obligation to world countries to set targets to limit or reduce their greenhouse gas emission. To enable these countries to move towards achieving their GHGs reduction targets and encourage developing countries to contribute to emission reduction efforts, Kyoto negotiators

introduced three market-based mechanisms that can be adopted by world countries to reduce their GHG emissions. These mechanisms are International Emissions Trading³ (IET), the Clean Development Mechanism⁴ (CDM), and Joint Implementation (JI) shown in figure 2.1.

International Emissions Trading (IET)	<i>Article 17 of the Kyoto Protocol</i>
<ul style="list-style-type: none"> • Countries with commitments under the Kyoto Protocol can acquire emission units from other countries with commitments under the Protocol and use them towards meeting a part of their targets. An international transaction log, a software-based accounting system, ensures secure transfer of emission reduction units between countries. 	
Joint Implementation (JI)	<i>Article 6 of the Kyoto Protocol</i>
<ul style="list-style-type: none"> • Through the JI mechanism, a country with an emission-reduction limitation commitment under the Kyoto Protocol may take part in an emission-reduction (or emission removal) project in any other country with a commitment under the Protocol, and count the resulting emission units towards meeting its Kyoto target. JI projects earn emission reduction units (ERUs), each equivalent to one tonne of CO₂. As with the CDM, all emission reductions must be real, measurable, verifiable and additional to what would have occurred without the project. 	
Clean Development Mechanism (CDM)	<i>Article 12 of the Kyoto Protocol</i>
<ul style="list-style-type: none"> • The CDM allows emission-reduction (or emission removal) projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one ton of CO₂. These CERs can be traded and sold, and used by industrialized countries to a meet a part of their emission reduction targets under the Kyoto Protocol. 	

Figure 2.1: Kyoto Mechanisms (Change, 2013)

The latest Climate Change Conference was held in Doha Qatar in December 2012.

This conference had reflected an enhancement in global efforts in climate change

³ A market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants.

⁴ One of the flexibility mechanisms defined in the Kyoto Protocol (IPCC, 2007) that provides for emissions reduction projects which generate Certified Emission Reduction units which may be traded in emissions trading schemes.

mitigation, however, the global GHG emission continued to rise. Kyoto Protocol was amended to ensure its continuity as a legal binding agreement. These amendments were summarized by UNFCCC as mentioned in Figure 2.2.

Doha - 2013	Amendments of Kyoto Protocol
<ul style="list-style-type: none"> • Governments decided on an 8-year second commitment period, which started on January 1st 2013. • The legal requirements that will allow a smooth continuation of the Protocol were agreed, and the valuable accounting rules of the Protocol were preserved. • Countries that are taking on further commitments under the Kyoto Protocol agreed to review their emission reduction commitments at the latest by 2014, with a view to increasing their respective levels of ambition. • The Kyoto Protocol's Market Mechanisms – the Clean Development Mechanism (CDM), Joint Implementation (JI) and International Emissions Trading (IET) – will continue. • Access to the mechanisms remains uninterrupted for all developed countries that have accepted targets for the second commitment period. • A key element was added to the measurement, reporting and verification (MRV) framework for developed countries with the adoption of the tables for the biennial reports known as common tabular format, thereby strengthening transparency and the accountability regime. • Surplus assigned amount units (AAUs) can be carried over without limit from the first to the second commitment period of the Kyoto Protocol by Parties included in Annex I that have a target for the second commitment period, but with restrictions on the use of these carried-over AAUs for the second commitment period and quantitative limits on how many of these units may be acquired from other Parties. 	

Figure 2.2: Amendment of the Kyoto Protocol (Change, 2013)

Political drivers however, were followed by several international responsive agendas in order to mitigate and adapt to the climate change impacts. Unifying and managing the response to climate change among all nations is daunting for scientists and economists. The global common nature of the subject makes it difficult to balance the multi-dimensional and cross-sectoral decision-making levels among the world's countries

(Nordhaus, 1994, and Bulkeley & Betsill, 2005). Therefore, the United Nations led the discussion of climate change concerns and managed to institutionalize the international response.

The World Meteorological Organization (WMO) unified the individual calls to respond to the climate change and convened the first World Climate Change Conference in 1979. The conference acknowledged the significant role of humans in increasing CO₂ emissions, in addition to the natural causes. This increase was defined as a main contributor to the global rise in temperature, which has led to environmental, economical, and social consequences on human and ecosystems (Wilson E. and Piper, J., 2010).

Following the WMO conference, subsequent conferences generated different protocols and developed global policy on the national and local levels, evolving the focus on climate policy. These conferences highlighted the need for cities to reduce their impact on the natural system and adapt to the unavoidable consequences of climate change and led to the creation of an international framework to respond to it within an international hierarchical system (Wilson E. and Piper, J., 2010).

Researchers from different UN working groups also established the link to sustainable development, emphasizing the need to integrate adaptation and mitigation measures into sustainable development policy to increase cities' resilience. In 1988, the WMO and the UNEP established the IPCC with the main objective of preparing a comprehensive review and recommendations on the state of climate change science (Wilson E. and Piper, J., 2010 and Ipcfacts.org, 2013).

The UNFCCC's core responsibility is to raise global awareness and concerns about the responsibility of developed countries in the current rise of GHGs. The Convention was drafted in 1992 and adopted by more than 150 countries. According to the UNFCCC, the high pace of urbanization and development activities in the 19th and 20th centuries, followed by the adoption of the same growth model by developing countries in the 21st century, is believed to worsen the case of blaming human activities for the ongoing climate changes. Accordingly, the UNFCCC's main aim is to set targets to reduce GHG emissions on a global level; its primary objective is to stabilize GHG concentrations in the atmosphere to prevent dangerous anthropogenic interference with the climate system (UNFCCC, 1992).

In 1997, the UNFCCC adopted the Kyoto Protocol as a legally binding international treaty that commits industrialized countries to reduce their accumulated emissions by 5.2% compared with 1990 emissions levels. The first commitment period of Kyoto Protocol, which ended in 2012, was reviewed at the Rio12 Conference, and a new framework was negotiated and ratified. The Convention encouraged industrialized countries to stabilize GHG emissions, but the Protocol commits them to do so (Wilson E. and Piper, J., 2010).

Assessing those efforts, and according to (the Guardian, 2012), the first phase of Kyoto, which ended in December 2012, has failed to slow global carbon emissions. Delegates from nearly 200 nations agreed in the Qatari capital to extend the Protocol limiting GHGs until 2020. The conference highlighted the Protocol's unachieved goals. The main focus was on a small group led by the European Union and Australia, which

aimed to stick to Kyoto targets of cutting industrialized nations' emissions beyond 2012. These commitments represent only 15% of the world emissions. Russia, Japan, and Canada withdrew from the Protocol, claiming its uselessness as big emerging nations led by China and India have no goals, and the United States never ratified Kyoto. This action weakened the Protocol and again stressed the importance of local actions to reduce GHG emissions. The same was confirmed by Reuters (2012) and AlJazeera (2012).

Nevertheless, the UN emphasized the importance of cities in facing climate change. The link between climate change and urbanization brings several threats and opportunities. While city development is vulnerable to the adverse impacts of climate change, cities are centers for innovations that offer opportunities in mitigation and adaptation to climate change (UN Habitat, 2011). However, both mitigation and adaptation to the consequences of climate change needs the intervention of the political, economic and administrative authority that is discussed in the following section of governance.

2.4 Climate Change Governance

In less than three decades, climate change has developed from a scientific topic to a top priority in the political agenda that must adapt other sorts of problems to handle the climate change concerns in development planning. To overcome and unify the responses, climate change governance was introduced. Climate change governance is the diplomacy, mechanisms and response measures aimed at steering social systems towards preventing, mitigating or adapting to the risks posed by climate change. Long term climate

governance in relation with international, national and local levels help to develop an effective, timely, and coordinated response (Meadowcroft, J. 2009 and UNDP, 2013).

Climate change governance is handled at the international arena down to the national and local levels. On the international level, climate change is mapped out in building global institutions; the Intergovernmental Panel on Climate Change (IPCC) is responsible for knowledge-generation, the United Nations Framework Convention on Climate Change (UNFCCC) established the basic legal structure to stabilize GHG concentration globally, and Kyoto Protocol is the legally binding agreement and raises funds and financial resources to support the system. It is observed that the whole system is driven by UN member states. (Bernauer, T. & Schaffer, L. 2010).

While the global authority (UNFCCC commission) level coordinates and mediates, the power for implementation lies at the national/ local level, the combined efforts of the decision makers and administrative should govern the spatial planning of the city bearing in mind the drivers of the climate change in addition to all the international aforementioned responses. This can be tackled in three different levels; international, national and local.

2.4.1 Response on International Level

International actors are actively developing strategies to encourage the implementation of the Kyoto Protocol. The United Nations, one of the main actors at the international level, embarked on an initiative to ensure consistency and coordination in the climate change response. Five areas of focus were identified in the UN's climate

change response through its different entities: adaptation, technology transfer, reduction of emissions from deforestation and degradation, financing mitigation and adaptation action, and capacity building.

Multilateral actors, such as the World Bank, were tasked with enforcing countries' engagement on climate change issues. Its role within the urban context falls into four areas: learning between cities, city-level networks and knowledge platforms, knowledge exchange and structured learning, and customized support to selected cities. It also plays an active role in promoting the role of carbon finance for sustainable urbanization and poverty reduction.

2.4.2 Response on National Level

National governments are important players in the climate change framework. They are responsible for signing international agreements, limiting GHG emissions, and responding to the climatic consequences. The role of national actors focuses mainly on mitigation measures related to energy, transportation, and the built environment. Attention to adaptation actions is increasing.

The national response to climate change varies between nations. The United States and China, for example, have established national climate change initiatives, although they did not support international climate change policy. The UK and Germany are key promoters of climate change policies and have taken serious actions to reduce their GHG emissions, although they have yet to reach their target emissions. The developing

countries are far behind developed countries in climate change actions. Nevertheless, international efforts have been invested to introduce national programs in these countries.

2.4.3 Response on Local/City Levels

Although climate change is a global phenomenon, effective actions are built locally. City-level actors are responsible for participating in climate strategies, projects, and programs. Local authorities, community organizations, private sectors, academics, and individuals are the main stakeholders in the response plans. To effectively implement mitigation and adaptation plans, multi-level governance across national boundaries among all players has to be developed. Developing municipal capacity to tackle the response to climate change has proven to be the best way to facilitate the exchange of information and experiences, and provides access to expertise and external funding.

In addition, city authorities, individuals, households, and community-based organizations are recognized non-governmental constituencies in the UNFCCC. Their actions help facilitate and cascade the response strategies within the community and support the implementation of actions decided by the local government.

The actions either directly or indirectly focused on energy use and demand. Most of these actions can be grouped in the following categories: saving in energy use, renewable energy sources, public transportation, infrastructure design, GHG inventory tracking, incentives to reduce use of private vehicles, land use planning, zoning and building codes, and waste management system.

The following section describes the relation between cities and climate change and the mechanisms adopted by cities to combat climate change impacts under the international climate change governance.

2.5 Cities and Climate Change

Human concern about the climate change impacts on their settlements started in the early 19th century when the “paleoclimate⁵” was suspected to change and the greenhouse effect was first identified. By the end of the 19th century, scientists identified the role of human emissions resulted from development activities in changing the climate. Nevertheless, the development wheel did not stop, and the global industrial boom continued to pollute the atmosphere in the 20th century. The 21st century had reflected a global consensus on the opinion of humans’ responsibility for global warming and legal treaties were set to ensure the governments’ buy-in (IPCC, 2007).

The effects are felt mainly in cities, where impacts vary from one place to another; however, they are not necessarily seen in the cities that emit these gases. The most vulnerable cities in Asia and Africa, despite their low GHG emissions, suffer the most from these climatic changes (Yuen & Kumssa., 2011).

Coastal cities are the most vulnerable to these climate change impacts. Low-elevation coastal zones represent 2% of the world’s land area and accommodate 13% of its urban population. Sea levels are expected to rise from 22 to 34 centimeters from 1990–2080 (UN Habitat, 2011). The relationship between cities and climate change takes

⁵ climate change over time

different forms. It is a two-way relationship where cities contribute to climate change, and simultaneously suffer the consequences of this phenomenon.

2.5.1 Impacts of Climate Change on Cities

Climate change is expected to have different social, economic, and environmental impacts across the globe. Recent researches indicated current projections of climate change result in increased temperature, sea level rise, change in rainfall and precipitation patterns (flooding and drought), variations in wind speeds and frequency of extreme event. For example, the rise of sea level puts coastal cities in huge risks such as Venice, Italy. (Society, 2013). Extreme droughts on the other hand became a common phenomenon. Australia for example had prolonged drought that continued for five years, and the heat waves in Europe in 2003 led to the death of almost 40,000 persons. (WWF, 2013)

Impacts and risks associated with climate change pose a severe threat to cities' reputations as service providers and their ability to meet their vision for growth and development impacting vital sectors such as health, food production, water resources, coastal areas, infrastructure and economy. Impacts vary from sector to another as highlighted in Figure 2.3

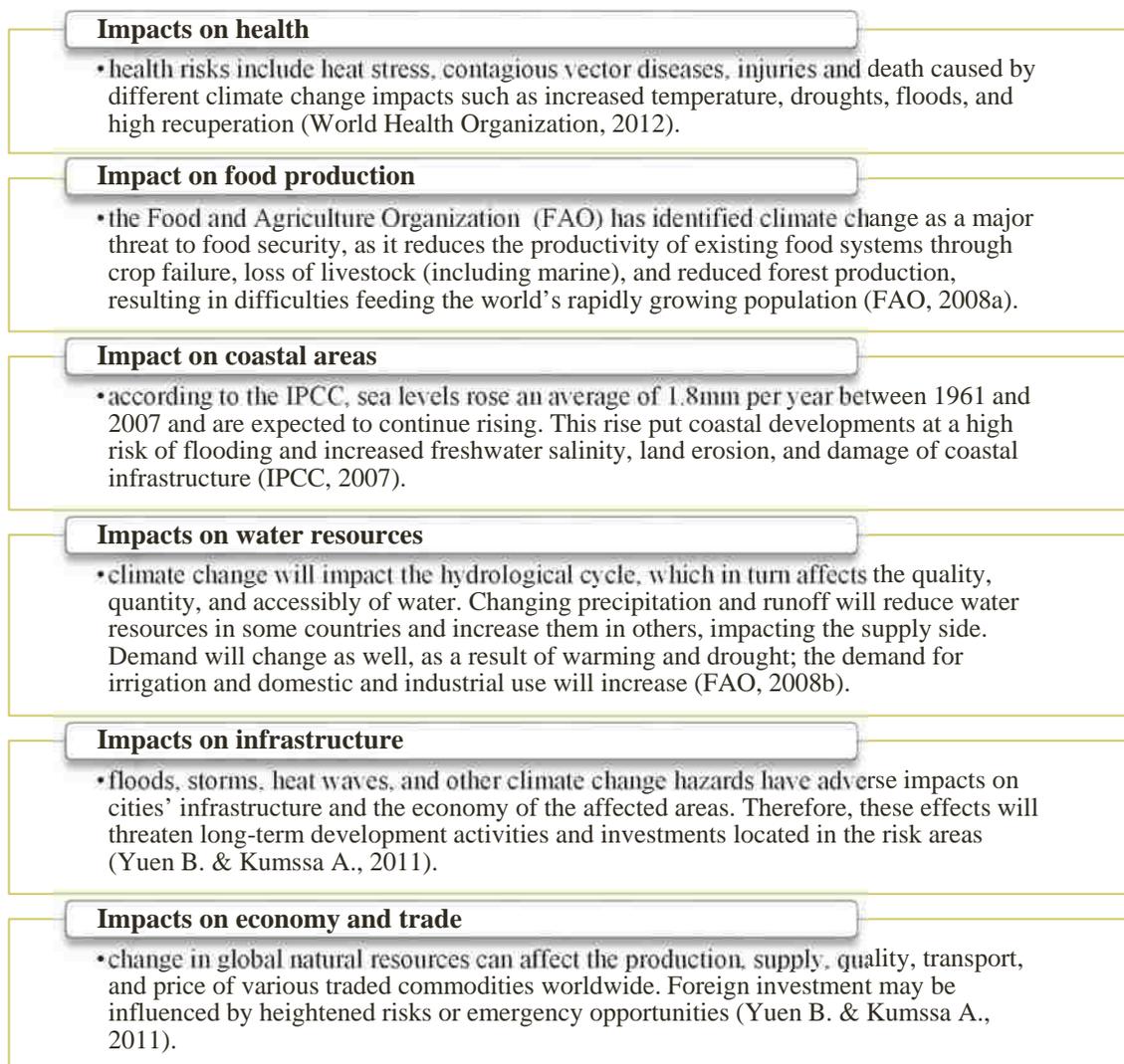


Figure 2.3: Impacts of climate change on cities

The rapid expansion of cities especially in the developing countries put them at a very high risk of insufficient and unsustainable growth. Climate change variability will raise new challenges that will necessitate sound management to ensure resilience and enable a balanced sustainable economic growth (Otto-Zimmermann, 2011).

2.5.2 Cities' Contribution to Climate Change

Economic growth and urbanization move in cycle, as economic growth and GHG emissions have increased for at least the last 100 years. Most economic activities are concentrated in urban areas, therefore, cities have a crucial role to play to combat climate change. Prosperity and lifestyle choices contributed GHG emissions, and historically developed countries have had greater emissions than developing countries. As the world urbanizes quickly under the current economic trend where GHG emission increases with the high demand on energy, emissions will also increase dramatically. (World Bank, 2010).

The unsustainable pattern of consumption and production in urban areas in both developed and developing countries is a major issue that threaten sustainable development. Addressing climate change as an environmental subject is a key component of sustainable development. The patterns of lifestyle are directly associated with increasing demand in energy production, which depends mostly on nonrenewable sources of energy with high level of emissions. Being conscious about emissions will reflect the seriousness of cities about reducing their impact (Bulkeley & Michele, 2005 Yuen & Kumssa, 2011).

2.5.3 Cities' Response to Climate Change

Cities are significant arenas through which climate change can be addressed for four main reasons. First, cities are the main energy consumers and waste producers, and as such have a municipal system available to manage and supply energy, administer transport supply and demand, plan land use, building codes, water management and advise

local communities. Second, through the local Agenda 21, local authorities are engaged with the issue of sustainable development and translate the global calls for sustainability into local plans. Third, local authorities can facilitate information and experience sharing with other national governments, and have the capacity to conduct pilot projects in which they can monitor GHG emissions and conduct profitability analyses of sustainability systems. Fourth, local authorities have experience in energy management, transport and planning, and measures and strategies to reduce their impacts on climate change (Bulkeley H. & Betsill M., 2003).

Responding to climate change is a choice made by different decision makers at different levels, starting with world leaders and ending with individuals. Countries, cities and local governments, the business sector, non-governmental organizations, federal governments, and several other players can contribute to efficient response mechanisms. The governance of all these efforts is important to achieve an efficient response through a unified system, as detailed earlier (U.S. National Research Council, 2010).

National-level responses to climate change require leaders' commitment and informed decision making that is based on reliable, understandable, and timely climate information for each climatic zone. Local authorities need improved information databases and tools to plan for emissions reduction and adapt to the impacts of climate change (National Research Council, 2010).

Argued in Bruntland Report in Article 9, cities should be the focal point in achieving sustainability, as the majority of the world's future population will live in urban

areas (WCED, 1987). Therefore, decision makers need to develop several mechanisms in order to respond to climate change such as national framework, climate action plans, local strategies and climate change into development plans in light of Kyoto Mechanisms mentioned earlier.

Cities' responses should be organized and governed in different levels, including local, national and international levels within an international climate change governance mechanism. To activate their response, cities must work within national climate action plans, local strategies, and policies to integrate climate change into development plans. Chapter 4 provides a brief overview about the UK and Malaysia's experience in climate change.

2.5.4 Cities' Response within an International Governance Framework

According to (Corfee-Morlot et al., 2009), the role of cities is managing and planning in a knowledge-based, rapidly growing world led nations to adopt an institutional multi-level governance framework that calls for narrowing and closing policy gaps through both vertical (across levels of governance) and horizontal dimensions.

The vertical dimension is a two-way relationship – a “top-down and down-up approach” – to assure the cascading of national policies and decisions down to local levels. This dimension recognizes the importance of local capacity in implementing national strategies and empowering the local level to reach its goals as agents of change. This will lead to an effective implementation of national climate strategies without working closely

with regional and local governments; however, local government has to coordinate closely with other parts of government.

The horizontal dimension of multi-level governance acknowledges the need to share knowledge and encourage learning and cooperation between different specialized institutions. On local levels, forming networks to fill the gap between local fragmented institutions, where many strategic decisions are made and services are provided, represents the horizontal relationship. Improving coordination among local institutions is a major element of successful spatial planning.

Policy and investment decisions made today have an important role in shaping the climate for future generations. Therefore, climate change faces difficult inter-governmental challenges when it comes to balancing and making decisions related to long-term environmental impacts. For instance, decisions involved in economic growth include (but are not limited to) the production and use of energy, modes of transportation, and land use. These expansion decisions conflict with global calls for reducing GHG emissions and vulnerabilities to climate change. Therefore, political decisions need to balance the economic and environmental long-term benefits (Corfee-Morlot J. et al., 2009).

Good multi-level climate change governance is characterized by being driven by powerfully enabled national policies on climate change adaptation and mitigation policies, creating close collaboration among local and national authorities to build a climate change capacity where local authorities will exploit the potential for cost-effective mitigation and

adaptation mechanisms, and building up effective cross-sectoral regional strategies driven by the climate change imperative where climate change mitigation and adaptation are seen as potential opportunities for economic development (UN Habitat,2011). Figure 2.4 illustrates the roles and decisions of the effective parties responsible for successfully responding to climate change, organized in a hierarchical arrangement.

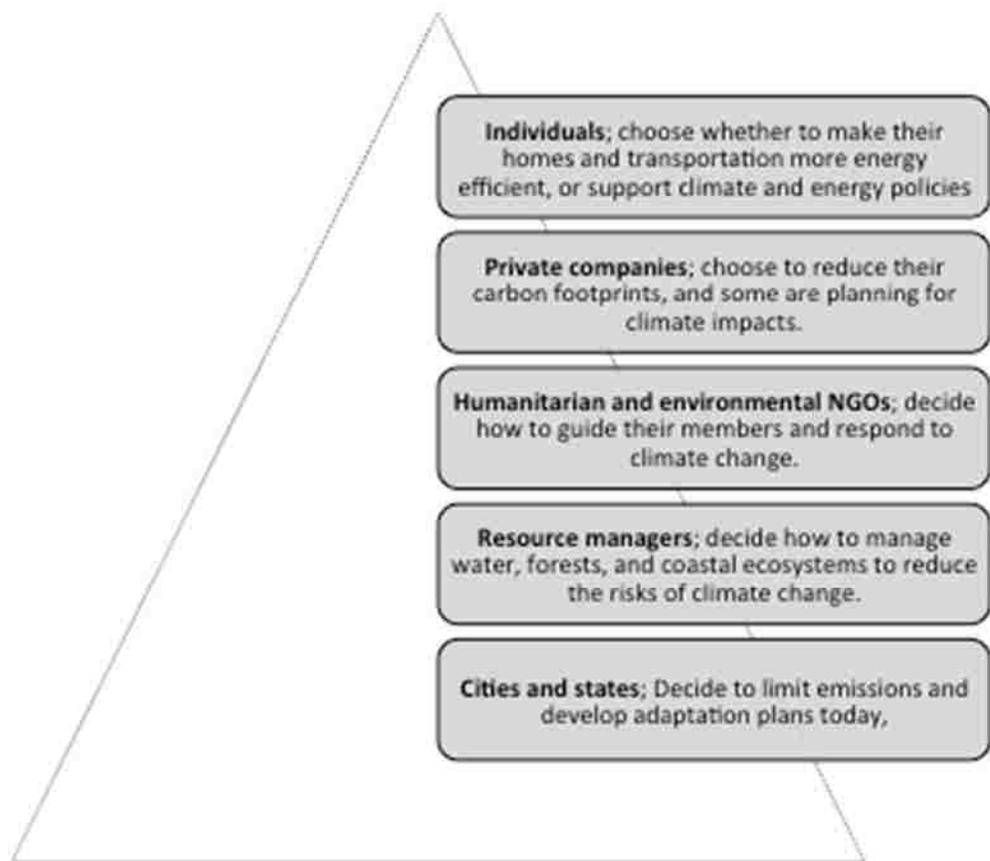


Figure 2.4: Hierarchical Responsibility to Respond to Climate Change (UN Habitat, 2011, illustrated by the researcher)

To integrate the city role in climate change governance, Meadowcroft, J. (2009) had explored four main dimensions for a successful climate change governance that

supports implementation. First, building strategic capacity that emphasizes on four main areas of success: the engagement of top political leadership, provision of expert advice to assure knowledge transmission, define and prioritize national interest and balance it with climate change concerns and building organizational focus on low carbon emission economy. Second, integrating climate change into development decision making across all economic sectors. Third societal mobilization through the engagement of communities, business, families and individuals through changing daily behavior and contribute to the sustainability of their community. And finally to set the ground to understand and learn how to do climate change governance and integrate it within the spatial planning system.

The implementation mechanism of climate change governance and strategies are developed and implemented currently through different treaties, however, the results are currently under monitoring as it is still early to judge on its workability. According to the Tompkins, E., & Adger, W. (2003) the implementation of climate change strategies and policies within the governance system is challenged by key obstacles ranging from issues of authorities, capacity, and resources: lack of delegated authority in different relevant areas (i.e., buildings, transport, etc.), political tension among national and local priorities and change preferences, failure to diffuse change incentives in the market and investment systems as environmental issues are dealt with narrowly, absence of legal and regulatory frameworks at the disposal of national government and institutions, and lack of coordination among ministries and governmental authorities (both horizontally and vertically).

2.6 Conclusion

The subject of climate change and the trend of preparation of a unified global response to its impacts increase the awareness of global responsibility to combat the phenomenon and make the earth a better space for its inhabitants to live and work. This can be done through reducing the harmful anthropogenic activities and set the plans to adapt to unavoidable climatic changes.

Climate change governance is handled in different levels, starting from the international arena down to national and local levels. The overall system is led by political leaders through UN member states to assure global buy-in.

While the setting up of the governance system is set by the top political leaders, the implementation lies on shoulders of cities' operators to make it successful. Cities have a major role in adopting adaptation and mitigation strategies and assure the climate change considerations within their spatial planning system which is explored in the coming chapter of this research.

CHAPTER 3

PLANNING FOR CLIMATE CHANGE

3.1 Introduction

Chapter 2 demonstrated the general trend of climate change and the way international response mechanisms were adopted by the United Nations Convention Framework of Climate Change (UNFCCC) and World Bank to guide nations to set their individual targets and develop their own response plans, and the role climate change governance drives the international response to the impacts of climate change.

This chapter details the role of spatial planning in addressing climate change benefiting from the planning reorientation from forecasting to backcasting method of prediction that support decision makers to get prepared for future changes in accordance with their visionary development planning.

3.2 Climate change and sustainable development

In 1987, the United Nations World Commission on Environment and Development (WCED) released *Brundtland Report* to mainstream the global efforts pursuing sustainable development together. It defines “Sustainable Development” as a *development that meets the need of the present without compromising the ability of future generations to meet their own needs*. It comprises two main concepts; meeting human needs and the idea of resource limitations. It attempts to balance the three pillars of sustainability; economic, social and environmental with human needs, resources limitations and economic growth (Wilson, E. and Piper, J. 2010).

On the other hand, Satterthwaite (2010) had claimed that the term “sustainable development” has been widely used to mean different terms such as “sustainable cities”

and “sustainable urbanization”. When applied to cities, sustainability comes down to two main goals; having healthy, enjoyable and resilient places to live and work meeting the need of the present, and ensure that the draw of populations’ consumption and enterprises’ production on local, regional and global resources and sinks is not disproportioned. Under the climate change debate, and rising concern of global warming, the goal of sustainability involves action now to stop and then reduce GHG emissions globally.

Sustainable urban development has become a powerful tool to draw a responsive framework for cities to develop solutions that improve the quality of life on a local level responding to the broader global environmental crises and increase cities’ resilience. Therefore, it is assumed to be the most suitable tool to respond to climate change impacts (Heberle and OPP 2008).

Cities’ sustainable response to climate change depends on the way they are planned, managed, and governed. Planning sustainable cities plays a vital role in changing the way conventional land-use planning deals with development activities. It manages the integration with the city’s visionary future, and assures a proper cross-sectoral coordination amongst all decision-making players in development authorities to achieve a sustainable way of living as detailed in this chapter.

3.3 Planning and climate change

Planning is an effective tool that guides nations to shape countries and organize places where their citizens live and work. It supports the government in achieving

balanced social, environmental and economically sustainable ways of life considering current position and future predictions (Wilson, E. and Piper, J. 2010).

Planning for the future is the core activity in city planning. Predicting an accurate future is impossible, however, a wide range of techniques are available to predict it. These techniques are categorized to forecasting and backcasting methods. Forecasting traces the current trend and tend to draw the future in a way similar to the current trend. This approach is criticized by having short term expectations that struggle to anticipate surprises. On the other hand, backcasting starts with defining a desirable future and then works backwards to identify policies and programs that will connect the future to the present rather than taking steps that are merely a continuation of present methods extrapolated into the future (Giddens, A. 2009).

Backcasting ¹ planning had made a major shift in spatial planning from a command and control approach to a pro-active approach that supports the response to climate change and build resilient cities. Considering the future vision, along with defining risks of climate change impacts can support spatial planners to increase cities' resilience and prepare for future risks (Vergragt, 2011).

3.4 The Role of Spatial Planning in Climate Change

Spatial Planning is *“an approach to ensure the most efficient use of land by balancing competing demands within the context of sustainable development”* (OPDM,

¹ “generating a desirable future, and then looking backwards from that future to the present in order to strategize and to plan how it could be achieved”

2005). It is an essential tool to achieve a long-term sustainable framework for social territorial and economic development within and between countries. The main role of spatial planners is to mediate the tension between short-term political goals and long-term urban settlements that are sustainable, desirable and affordable in the short, medium and long terms.

Spatial planning goes beyond traditional land use planning. From a visionary perspective, it adopts backcasting methods to set the strategic objective of city's planning approach. To set the operational objectives and plans, spatial planning assures a proper cross-sectoral coordination among decision makers and stakeholders. It integrates development and land use policies with other policies and programs that influence the nature of places and how they function. This reflects the holistic strategic approach of spatial planning in managing development growth, which is expected to bring a visionary, wide ranging, participative, integrating, responsive and deliverable growth using backcasting mechanism. It involves legislative and regulatory frameworks for the development and use of land and includes the institutional and social resources to implement, challenge and transform these frameworks (Vergragt, 2011).

The main objective of planning for climate change aims basically at reducing GHG emission and adapt with the expected changes which were defined as adaptation and mitigation. These tools set the road map to spatial planners to constitute a place-based problem solving mechanism to achieve a sustainable development in where "places are envisioned (backcasting), assessed, negotiated, agreed and expressed in policy, regulatory and investment terms" (ODPM, 2005).

Spatial planning is experienced in three interrelated arrangements; proactive interventions through determining the way places are developed, regulatory intervention to standardize the way others commence their own activities, and strategic coordination to assure community's involvement and policy integration among different levels of government. These three considerations might be applied in different planning approaches in order to achieve the good planning and implementation among the development stakeholders. The mechanism of using these interventions are illustrated in table 3.1 (Davoudi, 2009).

Type of Intervention	Mechanisms
<i>Proactive Intervention</i>	<ol style="list-style-type: none"> 1. Identifying spatial opportunities and constraints 2. Land allocation for specific uses 3. Lands assembled for major development projects.
<i>Regulatory Intervention</i>	<ol style="list-style-type: none"> 1. Protective regulations to safeguard assets, social opportunities and environmental resources and reducing vulnerability to climate change risks. 2. Developmental regulations: to promote better standards of building and areas design, enhance quality of life and public realm, introduce a degree of stabilization in land and property development process, and deliver the required infrastructures for transition to low carbon economy
<i>Strategic Coordination</i>	<ol style="list-style-type: none"> 1. Engagement of different sectors as strategic partners (public and private). The coordination can bridge the gap between both sectors, and bring together multiple policies and other stakeholders and integrating their activities in specific places.

Table 3.1: Arrangements of spatial planning (Davoudi, 2009).

The entry point of climate change into development planning might take different shapes such as energy generation and demand management, low carbon economic development, transport planning and low carbon built environment. Adaptation and mitigation are the globally recognized tools agreed to respond to climate change, and their areas of implementation in cities' planning for climate change (IPCC, 2007).

A successful response to climate change depends mainly upon the strategy spatial planners adopt to respond to the climate change impacts. Their role is mainly to act as catalysts and facilitators striving for guarantees, where solutions have to be found considering risks, opportunities and maintaining a balanced routine life of citizens. The success factors for planning for climate change starts from political leaders who should encourage thinking ahead and backcasting threats. Managing risks is also critical to protect the development activities against any unforeseen force, in addition to the increase of public awareness about their role in protecting their cities and environment and keep them safe for their future generations. Table 3.2 details the role of spatial planners in preparing the response against climate change impacts as summarized by Giddens (2009).

This model of the role of spatial planning will be considered as a benchmark to study the readiness of Dubai's development planning process to respond to climate change impacts.

1. Think ahead
<ul style="list-style-type: none"> • Political leaders have to prepare the state to think ahead for the long term. Governments should encourage a shift towards long term thinking among all sectors; public, private, third-sector groups and individuals. Rigorous plans has to be set apart from hugging, puffing and promises, as the emissions in the atmosphere continues to amount and serious actions must be taken and planned for immediately.
2. Manage risks
<ul style="list-style-type: none"> • Manage climate change and energy risks in the context of other risks faced by contemporary societies. Major adjustments have to be made to limit the impacts of past-accumulated emissions. At the same time, risks and opportunities will arise, and great deal of social and economic policy will evolve. All in which require an appropriate management and resource allocation.
3. Promote political and economic convergence
<ul style="list-style-type: none"> • Promote political and economic convergence, as the main forces driving climate change and energy policy. This convergence is the foundation for forward planning, when a large scale social and economic restructuring involving low-carbon economy will take place.
4. Counter business interests
<ul style="list-style-type: none"> • Counter business interests which seek to block climate change initiatives.
5. Keep climate change at the top of political agenda
<ul style="list-style-type: none"> • This includes increasing awareness on the importance of climate change and energy policy, and introduces them in the routine of daily life. Raising the awareness in future generations is also important, where climate change should feature in schools' curriculum.
6. Develop a framework to move towards a low-carbon economy
<ul style="list-style-type: none"> • A holistic approach is needed to carbon taxation with continuous auditing in terms of its generic impact upon economic behavior and lifestyles, considering subsidies for new technologies in the beginning to compete with fossil fuels.
7. Prepare to adapt to the consequences of climate change
<ul style="list-style-type: none"> • These consequences will not be felt now, however governments cannot wait and see. Anticipation scenarios have to be prepared and proactive plans have to be set to counter or minimize them.
8. Integrate local, regional, national and international aspects of climate change policy
<ul style="list-style-type: none"> • This requires robust national programs and international agreements, integrated with an international collaboration.

Table 3.2: Role of spatial planners in climate change response (Giddens, A., 2009)

The success of spatial planning starts from the political top leaders to guarantee their buy-in to support any decision when it comes to the short term development priorities and the long term change impacts. This will shorten the ambiguities among development stakeholders. Spatial planners play a vital role as mediators among different concerned parties on international, national and local levels to draw the road map for the development

policies and action plans among different development sectors. It is work to highlight here the importance of the role of research and development (R&D) parties to enhance the development activities, and build a unified system responding to climate change impacts through setting up of adaptation and mitigation plans.

3.5 Adaptation and Mitigation; tools to respond to climate change

Climate change is experienced globally in different forms and scenarios ranging from change in temperature, precipitation, rise in sea level and extreme weather events. The Intergovernmental Panel on Climate Change (IPCC) developed and unified strategies to respond to climate change, which can be integrated in any development process to ensure a common understanding among nations. Adaptation and mitigation were introduced to reach a common understanding and create a unified global approach to respond to climate change (Bedsworth et al., 2010).

Adaptation and mitigation strategies are available in diverse policy domains and communities. In most cases, these tools are treated separately, while it is believed that having an integrated approach among them, considering trade-offs will have a positive impact on responding to climate change. The uncertainty factor about the impacts of climate change challenges policy makers in creating national climate policy, however, the integration of these tools in a good governance system and an integrated spatial planning approach is believed to be the best solution (Tompkins and Adger, 2003). To build consistency among different interested groups, IPCC (2001) defined Adaptation and Mitigation having a clear distinguish between them as defined in table 3.3.

	Adaptation	Mitigation
Definition	“Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory & reactive adaptation, private and public adaptation, and autonomous and planned adaptation” (IPCC, 2001).	“Technological change and substitution that reduce energy resource inputs and emissions per unit of output” (IPCC, 2001). It is mainly Measures to reduce GHG concentrations in the atmosphere, & thus ultimately the magnitudes of climate change. Measures include energy conservation, using renewable energy such as wind or solar energy instead of coal, oil, or gas; & planting trees that absorb carbon dioxide from atmosphere (Prasad, N. et al. 2009).
Aim	To manage the unavoidable by preparation for the losses expected from climate change consequences.	To avoid the unmanageable by reducing the GHG emissions caused by human activities.
Objective	Adjustment in the process, practices, interactions and decisions that support the economy and society to adapt to the climatic impacts.	Investment in technological research and energy efficiency and change in the way energy is addressed.
Area of concern	Local and national levels.	A global concern and has to be coordinated on a local level.

Table 3.3: Adaptation versus mitigate (IPCC, 2001)

The researcher had noticed a lack of adequate consideration in the planning literature to mainstream adaptation and mitigation. Planning efforts focused mainly on mitigation as an immediate response to the rapid increase of GHG, while adaptation was observed as an ad-hoc response reflected in disaster risk management, without sufficient attention to examine the conceptual and practical relationship between the two. The most relative research developed in framing the role of spatial planning to respond to climate was the one developed by Dr. Davoudi, however it highlighted only the actions taken in this subject without highlighting the framework of planning process.

3.5.1 Planning for Mitigation

With a main aim to cut GHG emissions of built form and human activities, mitigation policies and action plans are usually negotiated on international and national levels. However, the delivery of these targets depends mainly on the local innovation and leadership (Davoudi, S. et al. eds.,2009).

According to the Fourth Assessment Report of the IPCC (2007), the global GHG emissions have grown since the pre-industrial era with a 70% increase from 1970 till 2004. This evident increase has forced the UNFCCC to raise its concerns about this rapid change by encouraging the local governments to reduce GHG emissions and enhance sinks and reservoirs through its development planning that promotes sustainable living using what is called “mitigation” to limit the magnitude and rate of long-term climate change. It generally involves reductions in human (anthropogenic) emissions of greenhouse gases (GHGs). Mitigation may be achieved by increasing the capacity of carbon sinks through reforestation. (IPCC, 2007).

Urban planning has become an increasingly important tool to mainstream mitigation into urban development as more than 50% of the world’s population live in urban areas increasing emissions from transport, home and office buildings, industrial production and energy generation. To help nations build their own mitigation plans to reduce GHG emissions, UNFCCC had introduced Kyoto Protocol to operationalize the convention by seeking the commitment of industrialized countries to limit GHG emissions.

Climate change mitigation was addressed mainly in the developed countries in the past two decades. Responses were built at different municipal levels to reduce GHG emissions. The policy approaches adopted by municipalities varied in terms of GHG source of emissions, and the response mechanism. The Climate Alliance's Compass² had adopted a five stages planning approach; initiation, inventory, institutionalization, climate action programme and monitoring and reporting to help local authorities set their climate action plans. Scope of each stage is summarized in Figure 3.1 (E.V., 2007).

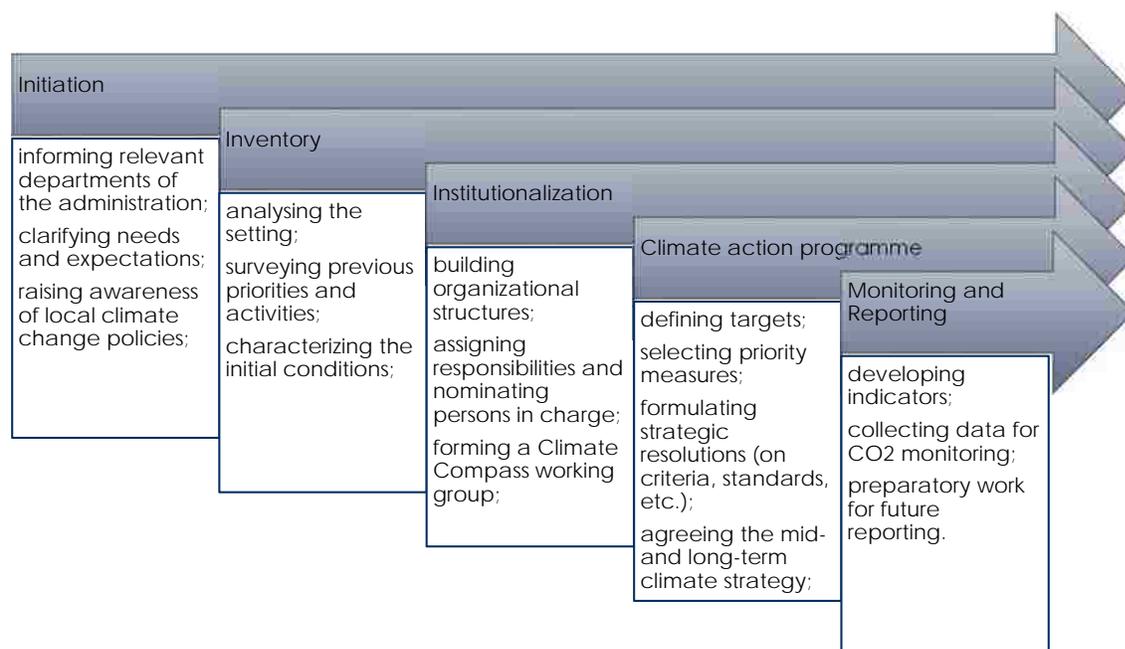


Figure 3.1: Strategic approaches to urban climate change policy (E.V., 2007).

The consideration of climate change mitigation in cities' planning takes three main forms according to Wilson, E. and Piper, J. (2010); energy management supply and

² Climate Compass is a Climate Alliance methodology to help local authorities get a climate change action plan up and running in the shortest time. <http://www.climate-compass.net>

demand, planning for low carbon economic development and transport, and finally plan for low carbon built environment (buildings and infrastructure) taking into account new developments and retrofitting of old structure. These planning aspects come in the form of planning regulations, policies and building regulations in different fields such as land use planning, the built environment, urban infrastructure and transport as summarized in table 3.4. The application of these instruments was explored in the case of the UK and Malaysia in chapter4, as well as in the case study of Dubai in the following one.

Mitigation in the transport sector is achieved by shaping the pattern of development and influencing the location, scale, density, design and mix of land uses, planning that can help to reduce the need to travel, reduce length of journeys and make it safer and easier to access shopping, leisure facilities and services by providing public transport, walking and cycling facilities leading to a remarkable cut in GHG emissions.

Energy at the built environment is a major contributor to GHG emissions and therefore to climate change. Energy efficiency is governed by building codes, while spatial planning sets aspirations for future development through urban design, layout and building design through setting up of policies to promote energy efficiency and low carbon development. This leads to a great impact on energy supply and demand reducing GHG emissions and contributing positively to climate change.

The reduction of GHG has become a multi-level endeavor involving action in all parts of the society. Key success factors in mitigation are the buy in from the decision makers on national and local levels, as they are too often viewed as consumers pushing unsustainable economic growth to achieve quick revenues with minimum attention to the

environmental impacts, and the governance system set to achieve and monitor coordinated implementation plans.

Planning Intervention		
Proactive	Regulatory	Strategic Coordination
Land-use planning		
<ul style="list-style-type: none"> ◆ Limitation of urban expansion ◆ Reduce travel ◆ Increase efficiency of urban built form 	<ul style="list-style-type: none"> ◆ Planning regulations ◆ Transportation regulations 	<ul style="list-style-type: none"> ◆ Coordination among municipalities, building regulators, proponents, developers & decision makers (cross-sectoral)
The built environment		
<ul style="list-style-type: none"> ◆ Energy efficiency ◆ Adoption of renewable energy sources instead of fossil fuels 	<ul style="list-style-type: none"> ◆ Green building codes ◆ Energy strategy 	<ul style="list-style-type: none"> ◆ Coordination between energy sectors, proponents, developers and buildings' users
Urban Infrastructure		
<ul style="list-style-type: none"> ◆ Use of alternative energy supply ◆ Landfill gas capture ◆ Alternative water supply ◆ Waste recycling & reuse ◆ Energy and water efficiency and demand reduction. 	<ul style="list-style-type: none"> ◆ Infrastructure policies and regulations 	<ul style="list-style-type: none"> ◆ Coordination among stakeholders
Transport Sector		
<ul style="list-style-type: none"> ◆ Use of low-carbon transport infrastructure ◆ Enhance fleets technologies ◆ Enhance energy efficiency ◆ Reduce demand on private cars & enhance public transportation. 	<ul style="list-style-type: none"> ◆ Transportation policies 	

Table 3.4: Role of mitigation initiatives in spatial planning (Davoudi, 2009) “Modified by the author”

3.5.2 Planning for Adaptation

Planning for adaptation is a process of reworking actions over time and building up adaptive capacity over time. The justification comes from our obligations to the current and future generations. Backcasting in planning makes the future a visible part of present

decision making process, and planning is expected to give more attention to the implementation and delivery through setting policies and regulation to assure implementation among different key players.

Climate change impacts are expected to cause serious damage to cities' development. Heat waves and drought for instance are expected to damage physical assets resulted from the expansion and contraction activities between building materials and surroundings, change in precipitation might overload the existing infrastructure leading to flooding, change in biological and chemical processes, and the rise in sea level might cause coastal erosion, damage and loss of physical infrastructure and salt water intrusion. The response to these impacts is the prime role of adaptation planning to maintain resilience of development locations with respect to future climate change, and ensure protection of natural resources and minimize their overconsumption.

Most physical planning approaches design based on forecasting future trends, economic and population growth without room for possible changing future. This approach works under stable conditions in a short span of time; however, under a changing environment and a high level of unpredictability and complexity in social, economic and environmental pillars of sustainability, the approach to planning system should be revised where backcasting will play a vital role in setting cities' future visions (Quay, 2010).

Reducing vulnerability to changing conditions, or increasing resiliency are two main approaches of adaptation strategies. In simple words, it is the "ability to respond back once the changes are felt" (Bedsworth et al., 2010). Planners can consider climate

change adaptation in many fields in accordance with climate vulnerability study of the region by allocating new developments away from areas of risk, having a resilient design and layout of buildings and urban forms and promoting sustainable water management.

Adaptation measures are classified based on the timing, goal and motive of their implementation. They may include reactive and anticipatory actions, or can be planned or autonomous as illustrated in Table 3.5 (IPCC, 2001). *Reactive adaptation* takes place upon living the impact of climate change while *anticipatory adaptation* occurs before the impacts are obvious which can be classified as a proactive intervention in planning process that requires regulatory and coordination interventions. Adaptation in a natural system is reactive and autonomous by nature, while in a human system it can be both reactive and anticipatory.

Adaptation planning concerns mainly *anticipatory adaptation*, a new approach to respond to climate change joining both adaptation and mitigation tools. It is usually imbedded in the governance system, and results from a deliberate policy decision.

			Anticipatory	Reactive
Natural Systems	Autonomous		X	<ul style="list-style-type: none"> ◆ Changes in length of growing ◆ Changes in ecosystem composition ◆ Wetland migration
Human Systems	Planned	Private	<ul style="list-style-type: none"> ◆ Purchase of insurance ◆ Construction of houses on stilts ◆ Redesign of oil-rigs 	<ul style="list-style-type: none"> ◆ Changes in farm practices ◆ Changes in farm insurance premiums ◆ Purchase of air conditioning
		Public	<ul style="list-style-type: none"> ◆ Early warning system ◆ New building codes and design standards ◆ Incentives for relocation 	<ul style="list-style-type: none"> ◆ Compensatory payments / subsidies ◆ Enforcement of building codes ◆ Beach nourishment

Table 3.5: Adaptation response to natural and human systems (IPCC, 2001)

The anticipatory nature of backcasting in building future developments, leading and “upcoming” enterprises changes the nature of how we plan. Proactive planning plays an important role in managing different types of businesses as it enables them to make better decisions faster. Proactive planning described a mind-set or a strategic approach to problem-solving and situation preparedness. The application of proactive planning depends on the context in which it is used and the environment in which it is applied. (IBM, 2010)

Anticipatory actions in spatial planning is an essential element in building resilience and through preparing developments to face any risk threats the community, encourage investment and facilitate more sustainable development. This occurs by setting the right conditions for the operation of effective spatial planning at the regional and local levels. National governments can determine the appropriate proactive measures and set their priorities through constitutional or other law and by establishing a framework of planning tools and procedures (UNECE, 2009).

Anticipatory adaptation can be undertaken in three different levels: sectoral, trans-sectoral and cross-sectoral. Sectoral adaptation measures aim at actions for individual sectors that could be affected by climate change. For example, in agriculture, reduced rainfall and higher evaporation rates would call for new means of irrigation practices. Such a change would require a national policy framework which integrates traditional coping mechanisms along with new practices, and emphasizes on the importance of including climate change as a long term consideration while formulating policies.

The trans-sectoral approach aims at actions that draw from various sectors. It is like looking at a particular problem through different lenses. It cuts across various sectors, for example, integrated management of water, river basins or coastal zones. Linking adaptation to climate change, with management options identified in various conventions, could serve as a multi-sectoral approach.

And finally, the cross-sectoral approach is an integrated measure, which looks at the objective in a very holistic manner, for example, science, research and development, and technological innovations such as the development of drought-resistant crop varieties, or new technologies to combat saltwater intrusion.

Adaptation can achieve its best results at local level decision-making. This is mainly due to three main reasons. First, because the impacts of climate change are demonstrated locally affecting livelihood activities, local businesses, and human health providing insights for understanding the political economy of climate change policy. Second, each area has its specific nature determining its level of vulnerability and adaptation capacity, which cannot be shared in a national level. Third, impacts are observed on local level, therefore, local authorities are the best to monitor the impacts, determine the best adaptation methodology to suite its economic growth and safeguard its livelihood and conduct adjustable learning and action plans to adapt with any expected impact (OECD, 2009)

3.5.3 Adaptation and Mitigation – an integrated framework

A possible concern about raising conflict between adaptation and mitigation measures is undergoing. Davoudi S. (2009) had summarized these conflicts in two main points: challenged synergies between adaptation and mitigation arguing that developments adapting mitigation measures might not be able to adapt due to the catastrophic unavoidable impacts. Others claimed that the rising attention on adaptation might reduce the investment on mitigation, which is considered an urgent need to reduce GHG globally. Spatial planners were urged to adhere to the three key principles when planning for climate change: first, in terms of priority, mitigation has the priority in planning, second, consider mitigation as a primary form of adaptation, and last, local adaptation has to consider long terms global perspective (Davoudi S. 2009).

Both adaptation and mitigation can be integrated with spatial planning through the three modes of intervention (proactive, regulatory and strategic) to ensure a successful implementation of response planning.

According to (Swart, R. and Raes, F. 2007), the integration of climate change adaptation and mitigation offers opportunities for an effective response to climate change. Economic, environmental and institutional dimensions determine the nature of this integration. They developed five ways to develop the link between adaptation and mitigation measures: first, avoid trade-offs between the two and in designing adaptation measures take into account the consequences for mitigation strategies. Second, identify synergies between the two in response to options within specific policy sectors, notably

through spatial planning and design. Third, enhance both adaptive and mitigative response capacity simultaneously and put such capacity into action. Fourth, build institutional links between the two and bridge the communication gap between policy makers. And finally, mainstream climate policies into the overall sustainable development policies at all levels of governance.

3.6 Conclusion

Three major planning considerations were outlined in this chapter to achieve an effective climate change response in development planning, mitigation, adaptation and R&D. The optimum plans set to respond to climate change impacts require synergy among the use of adaptation and mitigation. In order to achieve this integration, spatial planners should follow a consistent strategic planning approach across all development sectors.

Climate change adaptation and mitigation policies can take different forms in different sectors. Some practical examples of adaptation and mitigation practices in development processes are provided in Appendix A (Table 1).

To explore the practical implementation mechanisms adopted by different nations, the UK and Malaysia were selected in Chapter 4 as case studies adopted by the researcher to trace the approach climate change is integrated in their development planning process through the main themes discussed in this chapter, i.e., adaptation and mitigation.

CHAPTER 4

PLANNING RESPONSE TO CLIMATE CHANGE

A REVIEW OF UK AND MALAYSIAN'S EXPERIENCES

4.1 Introduction

Cities have different approaches to respond to climate change impacts from a planning perspective as highlighted in chapter 3. Different strategic responses to climate change challenges are explored in terms of both mitigation and adaptation. Land use planning, transportation planning, energy planning and water management are examples of some strategic approaches being explored in this section.

This chapter explores the planning approach to respond to climate change in two cases, the United Kingdom and Malaysia using a desk based review. These cases were chosen due to different considerations. The cases were selected considering the two main issues: maturity of spatial planning process, and similarities in economic growth to the UAE. The United Kingdom is deemed to have matured spatial planning mechanisms being a developed nation being the first to binding climate change act to reduce GHG emissions. On the other hand, Malaysia shares some similarities with the UAE as being an ambitious country with a federal system aiming at being a developed country by 2020 using a backcasting planning process.

4.2 The United Kingdom's planning response to climate change

The United Kingdom is one of the believers of the importance of adopting long term planning approaches to reduce GHG emissions in the built environment. It is an Annex-1 Party of the Kyoto Protocol and the first country to have a legally binding carbon budget putting the way for the UK to cut 80% of GHG by 2050 to achieve 1990 level. The Climate Change Act 2008 is intended to drive the progress towards becoming a low-

carbon economy supporting the UK's effort to secure a global deal on climate change (Legislation.gov.uk, 2013).

The UK has adopted the concept of low carbon economy¹ to achieve their ambitious target of carbon reduction. Actions were taken in the sectors of energy, transport, waste, land use planning and buildings, and the renewable energy.

Recent climate studies and climate projection simulations had leaned towards a serious change in the UK's climate pattern. The temperature has risen by a degree Celsius since the 1970s, with 2006 recording the highest temperature on record. Rainfall patterns are less certain than changes in temperature. The shift is being observed towards general wetter winters and a greater proportion of precipitation to fall as heavy events. Summers are likely to be drier and winters are getting wetter (DECC, 2009).

It is observed from the 5th National Communication to the UNFCCC (2009) and the UK climate change risk assessment (2012) that the government's response to these uncertainties were taken in *three* key themes; mitigation, adaptation and R&D² in three overlapping steps: first, mitigation starts with admitting the urgent need to minimize the risk of significant climate change by committing to cut its GHG emissions. On a global scale, the UK plays a leading role internationally to reach a global agreement to reduce GHG. Domestically, the Climate Change Act 2008 encourages the transition to a low carbon economy in the UK through legally binding emission reduction targets.

¹ Low carbon economy is a kind of economic model featuring low energy consumption, low pollution and low emission, human being's another big leap forward after agricultural civilization and industrial civilization. (Nc.gov.cn, 2013)

² Research and Development

Then, adaptation theme is reflected in the UK's recognition of the fact that the current and historic emissions is leading to an unavoidable warming. Therefore, the UK had acknowledged the need to adapt to the impacts of climate change. Finally, the increasing platform set for research and development activities support a better understanding of vulnerability to the current climate to reduce the associated financial, societal and environmental impacts. A major achievement of this theme was the establishment of the UK Climate Change Risk Assessment (CCRA) which enabled the UK to understand its current position and future expectations. Refer to figure 4.1.

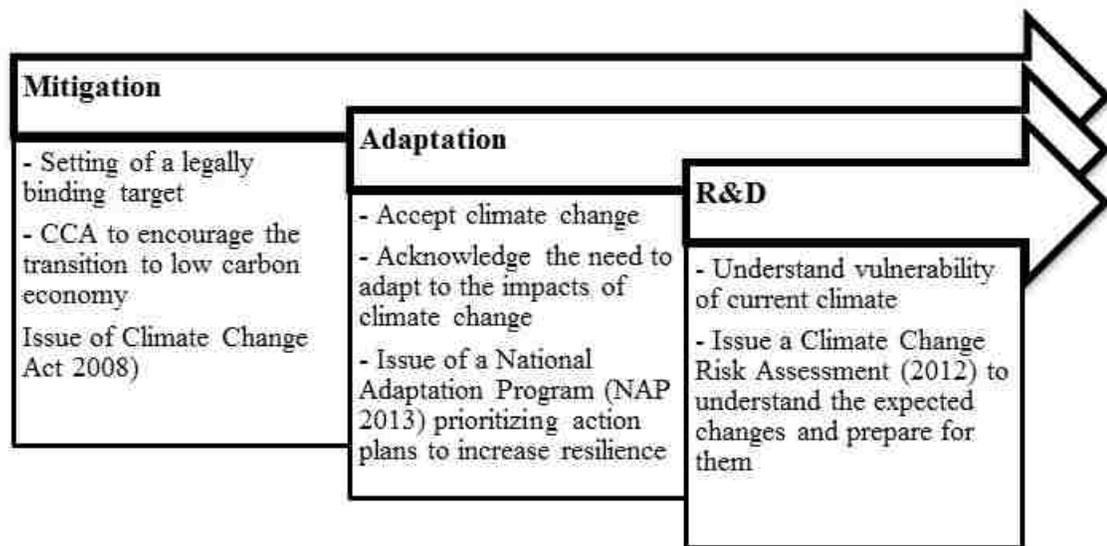


Figure 4.1: The UK government's response to climate change uncertainties (Author)

4.1.1 Climate Change Institutional Arrangement

In order to achieve a successful implementation of climate change policies, the UK government had established a Department of Energy and Climate Change (DECC) to coordinate UK policy on climate change at official level through inter-departmental

committees chaired by DECC. Figure 4.2 illustrates the key stakeholders in climate change institutional arrangement.

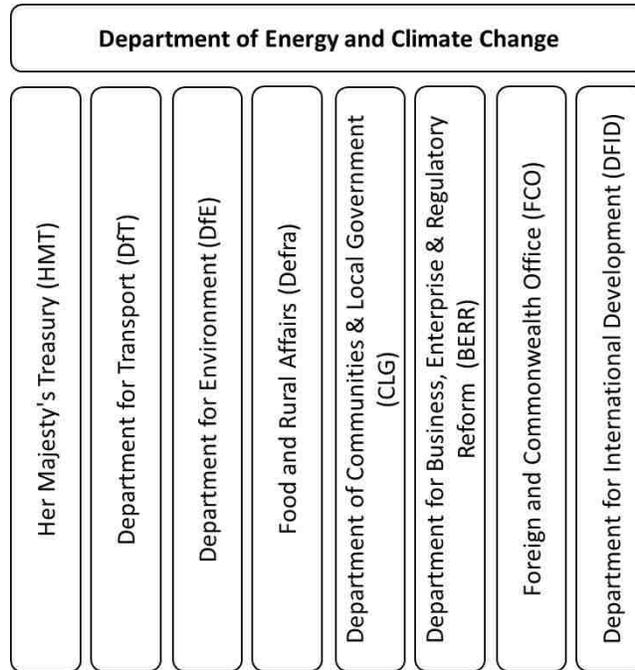


Figure 4.2: UK Climate Change Institutional Arrangement (DECC, 2009)

The UK government has an overall responsibility of ensuring that a program is put in place to deliver the Kyoto Target, and the devolved administrations in Scotland, Wales and Northern Ireland support the government's program by taking the appropriate actions to meet the target. The UK's strategy to reduce emissions is based on three main elements: carbon pricing³, technology policy and behavioral change.

³ Carbon Pricing is an administrative approach imposing a cost on the emission of greenhouse gases which cause global warming. Paying a price for carbon spewed into our atmosphere is a way of motivating countries, businesses and individuals to reduce carbon emissions. It also provides an incentive to invest and deploy renewable energy technology that does not emit carbon to our atmosphere. Such a pricing mechanism would also act as a disincentive for electricity generators to use relatively more polluting coal, gas and oil fired stations (Global-greenhouse-warming.com, 2013).

Under the Climate Change Act, the government had formed an independent statutory body called the Committee on Climate Change (CCC) reporting to the parliament and holding an advisory role to the UK government and devolved administrators on emissions targets and report to the parliament on progress made to reduce GHG emissions leading the preparation for climate change with two main committees: the Adaptation Sub-Committee to advise and report on the progress of adaptation and the Audit Committee to control and govern the implementation of climate change policies and prepare for risk assessments (DECC, 2009).

4.1.2 Climate Change Mitigation Planning

The planning for climate change mitigation in the UK is part of its commitment to the European climate Change Program (ECCP). The first priority set to respond to climate change was to mitigate it by reducing emissions. The energy sector was the main driver in this reduction by increasing the investment on renewable energy and energy demand management. Different Kyoto mechanisms were explored on the national level: Emission Trading Scheme (ETS), Clean Development Mechanism (CDM), and Joint Implementation (JI) in addition to energy efficiency supply and demand in the fields of transport, agriculture, industry, waste, forest and others. The UK is following different European Directives such as a Directive on the EU Emissions Trading System, Directive on Renewable Energy Sources, and Directive on geological storage of carbon dioxide.

The UK was the first nation to have a legally binding long-term framework to reduce GHG emission to 80% below 1990 levels by 2050 in its Climate Change Act issued in 2008. And their national policies were established to assure the reduction of GHG emission using energy efficiency mechanisms as economic measures such as the Climate

Change Levy (CCL)⁴, Carbon Reduction Commitment⁵, and the EU Emission Trading Systems (EU ETS)⁶.

On a national planning level, the UK had several initiatives to manage its developments under the risk of climate change. These initiatives covered five main sectors; power, buildings, transportation, buildings, public sector and agriculture and forestry under the Climate Change Act 2008 as detailed in table 4.1.

	Institutions	Tools	Sectors	Policy Influence / Initiatives
1. Mitigation	Climate Change Committee	Climate Change Act 2008	Power	<ul style="list-style-type: none"> • Focus on early power sector decarbonization; fundamental reform of the electricity market; long-term contracts for low-carbon generation; 2030 carbon-intensity target. • New coal fired power generation to be fitted with CCS; gas CCS to be included in the demonstration program • Focus on biomass conversion of existing coal plant rather than investment in new dedicated biomass • Ambition for renewable power generation. • 2020 funding under the levy control framework.
			Buildings / Domestic	<ul style="list-style-type: none"> • Building regulation based on energy efficiency → came to force in 2006 • Code for sustainable homes: voluntary standards beyond building regulations • Energy performance of buildings Directive (2006) • Market transformation program (MTP) • Eco-design of energy using products
			Transport	<ul style="list-style-type: none"> • Alternative Fuel Framework (2003) → promoting sustainable alternatives for fossil fuels • Improving fuel efficiency • Future Transport white paper

⁴ A taxation system on energy use aims to encourage the public sector to improve their energy efficiency.

⁵ A mandatory emissions trading scheme covers UK business and public sector organizations.

⁶ places emissions cap on large electricity producers and energy intensive industries creating carbon price driving the cut in carbon emissions.

			Business	<ul style="list-style-type: none"> • Climate Change Levy • Carbon trust → independent company help UK moves towards low carbon economy • UK emission trading scheme (2002) • Building regulations
			Public sector	<ul style="list-style-type: none"> • National Planning Policy Framework • Planning Policy Statement (PPS)
			Agriculture/ Forestry	<ul style="list-style-type: none"> • Have not included GHG emission or climate change mitigation as a specific goal

Table 4.1: UK Climate change mitigation initiatives (DECC, 2009) developed by the author

4.1.3 Climate Change Adaptation Planning

The UK had accepted the fact that the current and historical GHG emissions have already impacted the climate, and the UK is currently experiencing the change in climate in terms of changing in temperature, weather patterns, precipitation and sea level rise. The government had set up the adapting to climate change program (ACC) to compile the work already being led by the government and the public sector on adaptation and to coordinate and drive forward the adaptation program in the future. The ACC has conducted a series of workshops with 700 organizations and 2 information consultations to identify the most important areas of the National Adaptation Program which is planned to be released in November, 2013. The NAP report is intended to reflect and encourage government policies to take climate change into account to build a resilient nation to current and future climate.

The Climate Change Act 2008 created a framework for the UK to adapt to climate change by first having a climate change risk assessment every five years, preparing a National Adaptation Program reviewed every five years. The power of obtaining public authorities and statutory undertakers to report on their mechanism of climate risk

assessment to their work and how they tackle their risk falls under the government's jurisdiction.

Several adaptation initiatives and numerous examples were developed in the UK in different sectors summarized in table 4.2.

Sector	Policies / Initiatives	Objective
Water	Future Water	<ul style="list-style-type: none"> • sets out a long-term vision for water policy and management
	The Welsh Assembly Government Strategic Policy Position Statement on Water	<ul style="list-style-type: none"> • highlights the challenges posed by a changing climate for water services in the future.
	Flood Management - Making Space for Water	<ul style="list-style-type: none"> • takes forward the developing strategy for flood and coastal erosion risk management in England
Planning and Construction	Planning policy Statement (PPS)	<ul style="list-style-type: none"> • sets out clear expectations on how adaptation should be integrated into planning • sets out policy on development and flood risk
	Eco-Town Proposals	<ul style="list-style-type: none"> • developing resilient cities to the future climate, economic and social circumstances that future climate conditions will bring
	Building regulations	<ul style="list-style-type: none"> • introduce higher standards for buildings new affordable housing
	Regulations on energy efficiency	<ul style="list-style-type: none"> • introduce requirements on developers to consider heat gains as well as heat losses in domestic buildings and to prevent solar gain.
Transport	Setting Priorities for Department for Transport (DFT)	<ul style="list-style-type: none"> • ensure effective transport networks continue to operate effectively as they are planned & designed to be resilient to future climate change • raise awareness among stakeholders of the UK legislative requirements set out in the CCA • identify synergies between adaptation measures for transport and other sectors. • integrate a risk-based approach to adaptation into the new transportation planning • ensure regional and local transport authorities are encouraged and supported to take action to assess and address climate change impacts

Table 4.2: UK's Adaptation Initiatives (DECC, 2009) developed by the author

4.1.4 The UK's holistic exploration nature of spatial planning

The rapid pace of urbanization and the global economic growth necessitates the UK to develop in a holistic strategic approach facing the climate change challenge. That includes the built environment and new developments, balancing the needs of most of the societies' stakeholders and the pre-existing sets of planning concepts, and the nation's need to increase its economic growth and balance them with the need to reduce GHG emissions. The UK had developed "market friendly" policies to address climate change in different sectors as detailed in Table 2 in Appendix A

The role of planning in climate change in the UK was framed by Davoudi (2009) based on the regional spatial strategy as detailed in chapter 3 and summarized in figure 4.3. She emphasized on the importance of a planning system to respond to climate change across the policy sectors, and classified the UK's response to climate change into three interrelated methods to frame the work of planning in climate change: (1) proactive intervention in the way places are developed, (2) regulatory interventions in how others undertake their own activities and (3) strategic coordination which enables participation and policy integration. According to her, climate policies were classified into three key areas: energy supply, energy demand and adaptation. For each category, she identified policy areas related to planning intervention conceptualizing the framework of planning for climate change. Table 4.3 summarize the outcome of her study:

		Types of planning interventions			
		Proactive Through plans, strategies, resource mobilization	Regulatory Through development control	Strategic coordination Through consultation/ collaboration	
Key Climate Change Policies	Energy Supply (Mitigation)	Large Renewables	Site allocation / identification	Infrastructure Planning Commission	Renewable energy industry/ local communities etc
		Small Renewables	Specific requirements (e.g. Merton Rule)	Permitted development	
	Energy Demand (Mitigation)	Reducing Travel	Settlement size, density, mixed use location and accessibility, parking		Developers / transport authorities, etc
		Energy Efficiency		Planning conditions, Code for Sustainable Homes	
	Adaptation	Heat waves	Protecting & enhancing green infrastructure	Planning conditions, Design standards	Coordination with private sector
		Drought	Water Management	Planning conditions, Design Standards	Coordination with private sector

Table 4.3: Spatial planning interventions and critical climate change policies in the UK (Davoudi, 2009).

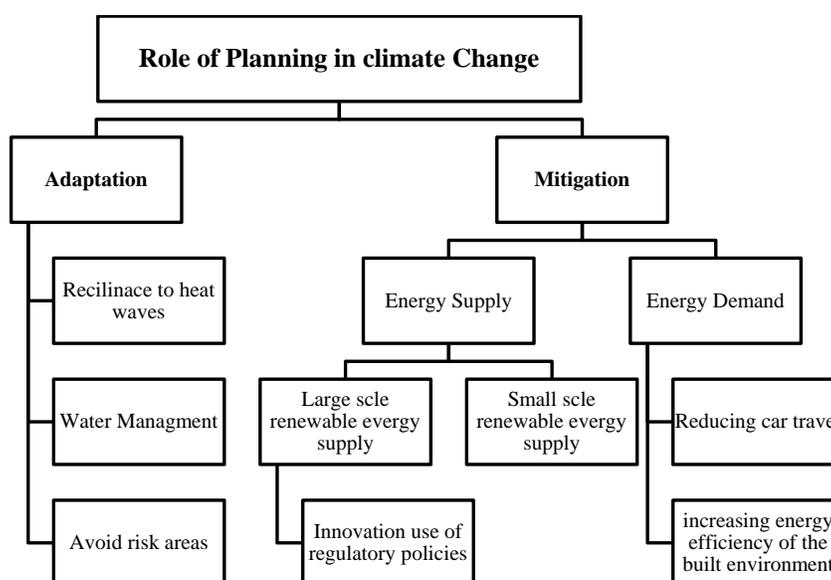


Figure 4.3: Framing the role of planning in climate change (Davoudi, 2009) (Author).

It is noticed that the climate change response in the UK is driven by the European calls to respond to climate change impact. In addition, the national level is still under the preparation of a unified planning approach to respond to climate change impacts, however, in a local level, the Scottish government is more advanced in preparing their state to combat climate change. More reading can be obtained from the Scottish Government website (Scotland.gov.uk, 2013).

4.3 Malaysia's planning response to climate change

Malaysia is a federal constitutional monarchy in East Asia. It consists of thirteen states and three federal territories. The national development planning is structured on a three-tiered administration system; the federal government, the state governments and local authorities. Malaysia has set an ambitious vision to become a developed country by 2020. This target is associated with the high rate of urbanization and economic growth increasing the demand on energy and consumption of natural resources. These shared national circumstances with the UAE encouraged the author to set it as a case study for this research.

Malaysia is a Non-Annex 1 party in Kyoto Protocol. With high rate of urbanization and economic growth to achieve the country's vision to be a developed country by 2020, a huge pressure on energy and natural resources had raised sustainability and environmental concerns. Under these circumstances, Malaysia's carbon emissions growth is one of the fastest by growing 221% from 1990 to 2004 (UNDP Human

Development Report 2007/2008) led by the robust expansion in industrial and automotive sectors.

In its National Communication to UNFCCC, Malaysia had taken a voluntary reduction up to 40% carbon emission intensity of GDP by the year 2020 compared to 2005. To achieve this target, a National Climate Committee (NCC) was formed in 1995 adopting the government's approach of having a 'precautionary principle' policy with action to mitigate or adapt to climate change. The NCC includes various government agencies and stakeholders from the business and civil society groups. The committee had adopted a strategy that reduces the heavy reliance on fossil fuel in energy sector, promotes renewable energy and energy efficiency, conducts public awareness programs, sustains forest management, ensures food sufficiency, and undertakes coastal vulnerability index study that serve as a basis for the development of adaptive measures to mitigate the impact of sea level rise. (MNREM, 2009)

The Federal Department of Town and Country Planning had reflected the concept of livability by defining a clear objective for the national urbanization policy. Their goal is to "create a visionary city with a peaceful community and living environment through sustainable urban development" adopting the backcasting method, which had a direct influence on its spatial planning (FDTCP, 2006).

Similar to the UK, the researcher traced three main themes in planning for climate change guided by the UNFCCC. These themes are: planning for adaptation, planning for mitigation and research and development (R&D).

The national climate change response to climate change is set by the Department of Environment as illustrated in figure 4.4. Two major themes are demonstrated: adaptation and mitigation. The R&D is presented in the development and economic sectors which are determined by specialized teams of researchers and development specialists of each sector.

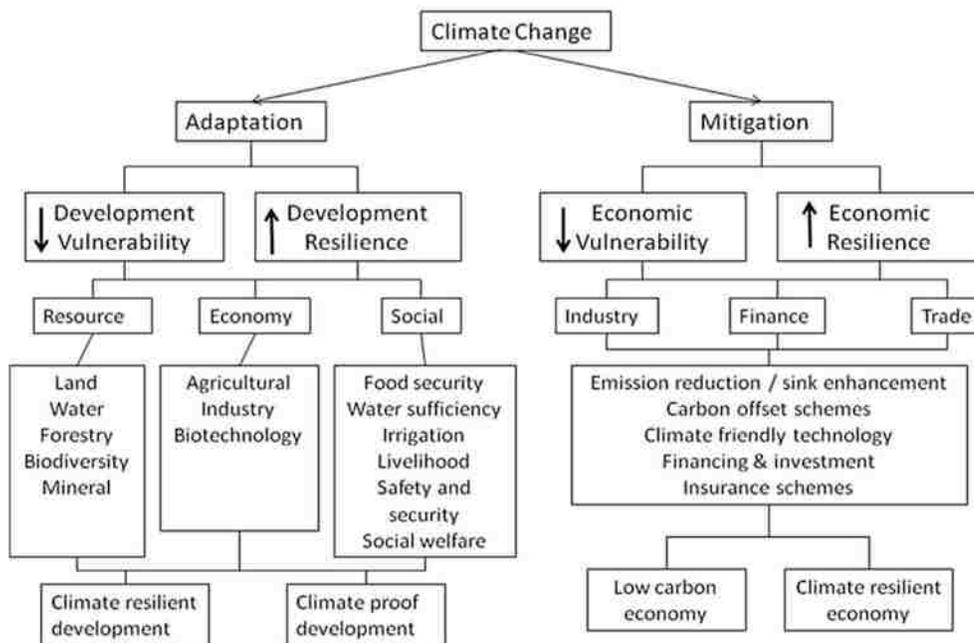


Figure 4.4: Overall framework of Malaysian national climate change policy (Yusoff, 2011).

4.3.1 Climate Change Institutional Arrangement

In July 1994, Malaysia ratified the UNFCCC and subsequently established a *National Steering Committee* on Climate Change chaired by the Minister of Environment and Natural Resources with partnership of different agencies related to climate change. The main objective of this committee is to formulate and coordinate national policies and action addressing climate change concerns. The Initial National Communication to the

UNFCCC was issued under the stewardship of this committee which was renamed to *Coordinating Committee* after the establishment of the Cabinet Committee on Climate Change.



Figure 4.5: Malaysian National Steering Committee on Climate change (Author)

The *Cabinet Committee on Climate Change* was established in 2008 to lead Malaysia's commitment in addressing climate change and integrate climate change agenda into national development planning. This committee is chaired by the prime minister aiming at determining the policy direction and strategy for addressing the issue in terms of mitigation and adaptation. (PMO Malaysia, 2006)

The determination of programs and activities that consider impacts of climate change is addressed by several *Steering Committees*. These committees propose necessary adaptation and mitigation measures. Government agencies, representatives of the corporate sector, non-governmental organizations and academia will be assimilated into the steering committees.

The researcher observed that efforts put to mainstream climate change are set on a federal level, reflecting its strong influence in the country's planning decisions. However, according to Shamsudin, K. and Neo, S. (2011), the participation of local agencies is weak due to the absence of an effective implementation mechanism which is yet to be developed at state and local government levels. To overcome the gap, the *State Planning Committee* has provided planning policies, strategies and action plans with regards to climate change concerns. This might reflect an absence of a mechanism to cascade the information pertaining climate change decisions from federal to local levels.

The climate change policy study had three main approaches. First, a critical review of different international and local research papers and public documents related to post-2012 responses, decision documents of the UNFCCC and Kyoto Protocol and the state policies and planning processes. This phase resulted in a solid national position with UNFCCC and Kyoto Protocol. Second, comparative studies of national policies and strategies on climate change from selected counties were conducted resulting in national policy "strategies and actions". Third, consultation sessions were conducted with different

stakeholders through national and regional workshops, interviews, and surveys carried out in four overlapping phases that resulted at state policy and action plans.

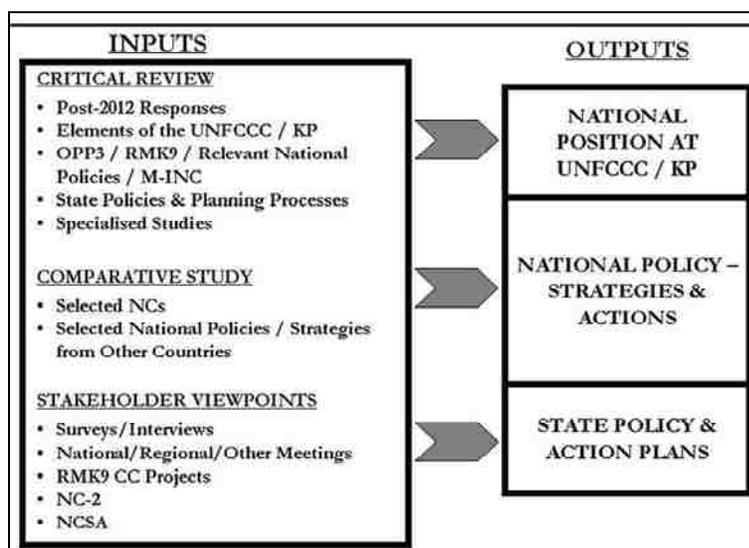


Figure 4.6: Malaysian Climate change policy study approach and expected outputs (Yusoff, 2011).

4.3.2 Climate Change Mitigation Planning

As a developing country, Malaysia is urged to adopt a sustainable economic growth and work on mitigation plans to reduce the increasing level of GHG. The Malaysian National Communication to Climate Change had defined five main sectors as major players in the Mitigation Working Group; energy, industrial processes, agriculture, land use change and forestry (LUCF) and waste.

The studies resulted from the Second National Communication had identified potential mitigation options in key sectors as shown in table 4.4. Malaysia had adopted certain policies to achieve sustainability, and the climate change studies showed that GHG

reductions can be achieved with the implementation of these policies within the high emission sectors.

Sector	Potential Mitigation Options			
Energy	Implementation of Renewable Energy for power generation	Implementation of EE in the industry, commercial and residential sector	Implementation of RE in the industrial, commercial and residential sector	Transpiration – Hybrid (hydrogen, fuel cell) & electric vehicles, integrated public transportation system, bio fuels, low carbon petrol & diesel
LUCF	Maintain existing forest cover	Reduce emission from forest and land use related activities	Where appropriate, to increase existing forest cover	
Waste	Encourage methane capture facilities at new sanitary landfills	Encourage palm oil millers to capture biogas for power generation	Encourage composting of organic waste, especially food waste and 3R (Reduce, Reuse and Recycle)	
Agriculture	Rice Management with water saving production: <ul style="list-style-type: none"> • Intermittent flooding • Aerobic rice 	Livestock waste management through <ul style="list-style-type: none"> • Aerobic manure composing • Biogas capture 		
Industrial Processes	Employ processes to reduce clinker use in cement production			

Table 4.4: Potential Mitigation Options in Key Sectors in Malaysia (DECC, 2009)

The mitigation initiatives are addressed in the National Physical Plan (approved in 2005) by setting up strategies to integrate physical planning and natural resource utilization within a management process aiming at achieving sustainable development goals and a better quality of life. Several policies in the National Physical Plan contribute to the reduction of GHG emission aiming at: the establishment of an integrated national transportation network recognizing the inter-relation between land use and transport, promote transit oriented development concepts and establish an integrated public transport system in major urban centers

4.3.3 Climate Change Adaptation Planning

The adaptation policies are addressed in the National Physical Plan as environmental protection policies such as: integration of Environmental Sensitive Areas into the management of land use and natural resources (NPP 18), the establishment of a central forest spine (NPP 19), protect the sensitive coast and use in a sustainable manner (NPP 20), strictly control the development in highlands to safeguard human safety and environmental quality (NPP 21), and safeguarding all surface and ground water resources as strategic national resources (NPP 22)

Initiative	Adaptation Policies / Initiatives	Mitigation Policies / Initiatives
<ul style="list-style-type: none"> • Environmental policy goals of the government 	<ul style="list-style-type: none"> • Integration of Planning and Resource Management Framework into spatial development polices 	
<ul style="list-style-type: none"> • National Physical Plan • Integrate physical planning and natural resource utilization within a management process aimed at achieving sustainable development goals 	<ul style="list-style-type: none"> • Promote compact urban development • Optimize the utilization of existing & future infrastructure & utilities 	<ul style="list-style-type: none"> • Integrated national transportation network • Promote Transit Oriented Development (TOD) concept
<ul style="list-style-type: none"> • National Urbanization Policy 	<ul style="list-style-type: none"> • Land Use Planning Appraisal for Risk Areas (LUPAr) 	<ul style="list-style-type: none"> • Integrated and efficient urban transport system • Creation of conducive living environment that promotes the green building concept
		<ul style="list-style-type: none"> • Green Building initiatives
		<ul style="list-style-type: none"> • Smart and cool homes technology

Table 4.5: Adaptation and mitigation policies and initiatives in Malaysia.

The spatial framework has taken into consideration the global commitments of the Malaysian government by promoting a sustainable development approach in Agenda 21 and combining climate change concerns addressed by UNFCCC in the National Physical

Plan. Malaysia is currently developing a strategy to protect the country's water resources, coastal ecosystems, highlands, and biodiversity and conserve the forests to act as a carbon sink. Different spatial planning initiatives were recommended to be considered in the national physical planning such as: the consideration of Environmentally Sensitive Areas (ESAs) in the land use and natural resources management, the establishment of Central Forest Spine, protect the sensitive coastal ecosystems and safeguarding of all surface and ground water resources.

4.4 Conclusion

The two cases presented in this chapter show the global trend of responding to climate change. A consensus in the approach was mapped using three main themes: mitigation, adaptation and R&D. Each country can adopt these themes in its development process, however, the success of this plan depends on having a proactive plan built on a backcasted visionary approach, and a proper communication plan connecting the global trend with the national strategies and local plans.

Differentiations among plans appear depending on the countries' political and development planning systems and the level of priorities against economic growth. The successful implantation of climate change response is driven by the state's willingness to combat the phenomenon and backcast its future in light of a developed risk management system. Having a centralized body for climate change can support decision makers to establish the baseline for future planning as presented in the UK's case that drive, empower and collaborate the implementation efforts among different stakeholders.

CHAPTER 5

THE CASE OF DUBAI

5.1 Introduction

The global calls to combat climate change impacts impose two main challenges on cities as discussed in chapter 3 contributing to climate change and the urgency to combat its impacts in order to build cities' resilience against climate change consequences. These concerns will influence the planning process of cities interrupting their physical characteristics and the dynamic nature of cities' operation.

To respond to climate change consequences, cities must mainstream adaptation and mitigation in their urban development process as detailed in chapters 3 and 4. This integration requires collaborative efforts among decision makers, city planners, scientists, local authorities and utility providers.

The emerging government of the United Arab Emirates has raised the focus of the subject of climate change believing in the importance of achieving a green economy that reduce the high dependence of fossil fuel leading to a natural sustainability (MOE, 2010). In this chapter, the researcher explores the UAE and Dubai's response to climate change impacts. The first part provides general information about the UAE and the second part investigates the planning process, climate change approach and means of implementation.

5.2 The UAE Context

The UAE is an Arab country located on the southeastern region of the Arabian Peninsula. It is a federation of seven emirates namely Abu Dhabi, the capital, Dubai, Sharjah, Ajman, Um AlQaiwain, Ras Al Khaima and Al Fujairah. The federation was established in 1971 under the leadership of HH Sheikh Zayed bin Sultan Al Nahyan.

The UAE spans approximately 83,600 sq.m with 1,318 km of coastline overlooking the Arabian Gulf and the Gulf of Oman (Figure 5.1).



Figure 5.1: Location of the United Arab Emirates (Google 2013).

5.1.1 Demography

According to the UAE Ministry of Energy (2010), population growth was increasing in all emirates for the period spanning from 1975 till 2009 associated with the economic growth especially in the leading emirates, Abu Dhabi, Dubai and Sharjah. (Figure 5.2), with a highly urbanized population. This increase has a direct impact on the consumption of natural resources and the increasing demand on energy.

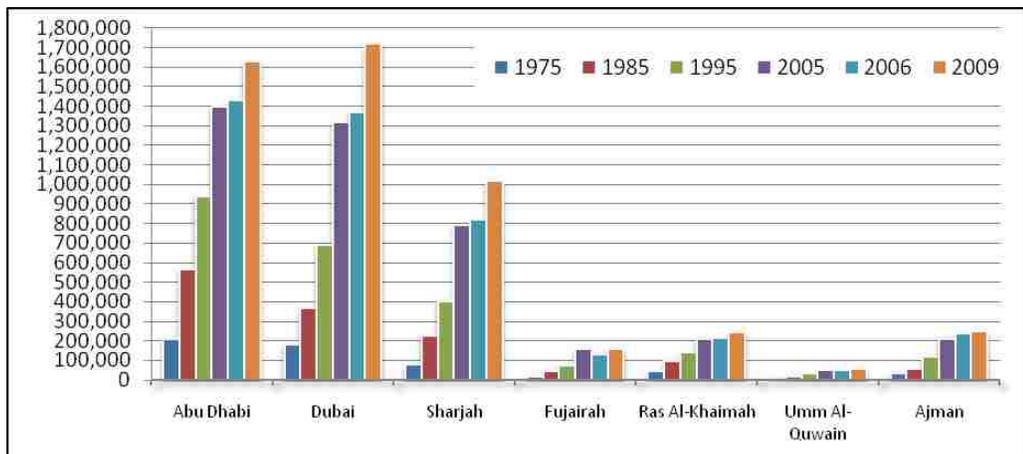


Figure 5.2: Emirates' population changes over time from 1975- 2006 (MOE, 2010).

5.1.2 Political System

The UAE is a federal presidential system with two tiers: national and emirate. Each tier derives its authority from a source legally superior to the UAE constitution. The emirates' and national governments perform a number of overlapping functions; however, they exist and operate in parallel fashion. Local governments represented by executive councils are legally inferior to the emirates and they provide means for state and national ways to be adapted to local circumstances (UAE government, 2013), (Tertrov, 2006). This institutional set has a direct impact on defining the roles and responsibilities of national and local response to climate change impacts in accordance to UNFCCC guidelines.

5.1.3 Economy

As a major oil exporting country, oil has dominated the UAE economy transforming the country from a pearl trading, fisheries and agriculture economy to a land of significant opportunities for investments. Mega infrastructure development and transformational processes had emerged. However, the leadership realized the risk of overconsumption of natural resources, and adopted a diversified economic strategy and attraction of foreign investments (MoE, 2010).

The UAE's GDP increased rapidly upon the increase of oil prices and the attraction of foreign investments. This economic growth is driven by a clear government vision to develop the country to elevate it to compete with the developed countries. The UAE GDP reached AED 1,409.8b (US\$ 383.8) in 2012 from AED 947.3b (US\$ 257.9) in 2007, AED 383.1 (US\$ 104.3) in 2000 and AED 241.3b (US\$ 65.7b) in 1995 (Data.worldbank.org, 2013). The UAE had transformed its economy

from oil dependence to a diversified economy. The highest economic growth according to the central bank had taken place in the construction, industrial, real estate, finance, transportation & communication and tourism sectors. The composition of the economy is illustrated in Figure 5.3.

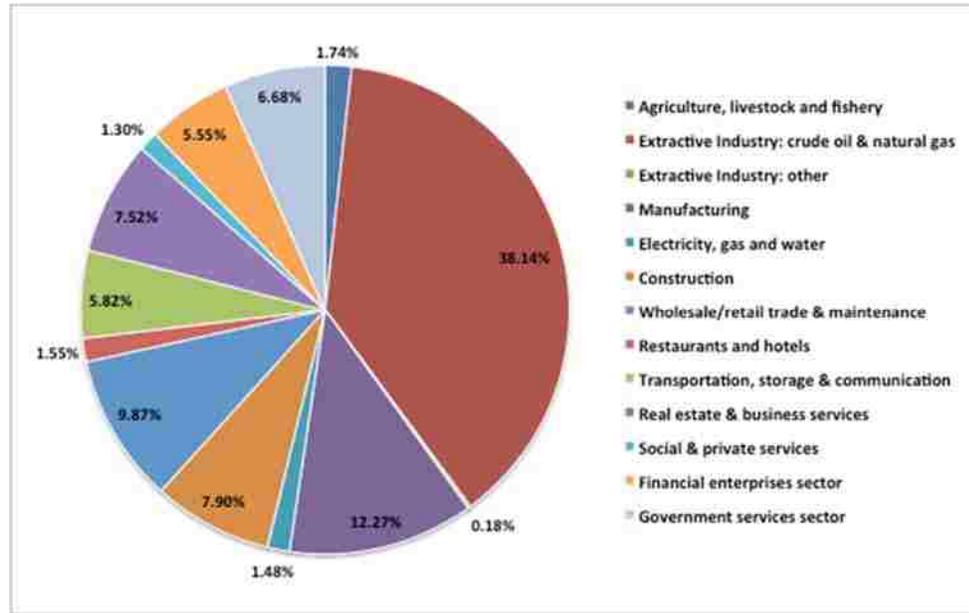


Figure 5.3: Composition of UAE economy, 2007 (MoE, 2010).

5.1.4 UAE and the Environment

Preserving the environment was one of the main priorities set by the UAE founder Sheikh Zayed Bin Sultan Al Nahyan. He is remembered as a man who turned the desert green by investing the oil returns in projects to improve the harsh desert environment.

"On land and in the sea, our fore-fathers lived and survived in this environment. They were able to do so because they recognized the need to conserve it, to take from it only what they needed to live, and to preserve it for succeeding generations."

Sheikh Zayed Bin Sultan Al Nahyan (Zayedpeace.com, 2013)

To support its environmental commitment, the UAE established the Zayed International Prize for the Environment in 1999 to recognize and encourage environmental achievements, supporting and promoting the implementation of Agenda 21 and the Johannesburg Plan of Implementation for sustainable development¹.

5.1.5 Ecological Footprint and GHG Emissions

Despite the national concern of the environmental sustainability, the UAE was found to have a high ecological footprint² (ranked the third globally after Qatar and Kuwait) driven by the high emission of GHG (Oerlemans, 2012).

According to UAE ministry of Energy, four main sources of GHG emission in the UAE were identified: Energy, industrial processes, agriculture and waste. As a main source of GHG emissions, the energy sector received greater attention in order to reduce the levels of emissions and subsequently, mitigate one of the main local contributors to climate change. (MOE, 2010).

5.3 Climate Change Impacts

The UAE lies in a hot arid zone, with a climate characterized by high temperature in summer, and moderate winter accompanied by irregular rainfalls (MoE, 2010). According to the IPCC and the National Communication to UNFCCC,

¹ The scope of this foundation is to promote sustainable development through environmental initiatives and propagating environmental awareness, addressing sustainability issues, conducting international and regional conferences and workshops

² A measure of human demand on the Earth's ecosystems.

the UAE with its hot and arid climate, and low-laying, highly populated coastal zones is vulnerable to climate change.

As a response to the global concerns of climate change, the government had established three studies specific to the UAE on the possible impacts of climate change: two national communications in 2007 and 2010 to the UNFCCC by the Ministry of Energy, and a threefold study of climate change in the UAE (Impact, Vulnerability and adaptation) by Abu Dhabi environment Agency in 2009³. Considering the proximity to Dubai and largely sharing the same micro climatic conditions, the impacts of climate change prepared for Abu Dhabi are considered the same on Dubai.

The studies demonstrated three main threats with potential harmful effects: i) increase in temperature; ii) rise in the sea level; and iii) potential low precipitation. They pose threats to the UAE's sensitive coastal zones; water resources, dryland eco systems, agricultural production, human settlements, public health and energy infrastructure.

The studies exhibit a change in temperature that is expecting a rise of 2.1–2.8°C by the year 2050 and between 4.1–5.3°C by the year 2100. The rise in temperature is likely to impact most of development sectors such as human settlement, agricultural productions, health, and energy supply and demand.

The second threat, the sea rise in the form of inundation, erosion and flooding carries a significant risk to the UAE. A recent study by the World Bank in 2007

³ It is worth to mention that the efforts in determining the climate change impacts were driven by Abu Dhabi leaders Shaikh Mohammad Bin Zayed the Crown Prince of Abu Dhabi and Sheikh Abdallah Bjn Zayed, Minister of Foreign Affairs in association with Abu Dhabi Environment Agency.

demonstrates that the UAE may lose approximately 1-4% of its total land area and 2-4% of its GDP, and will affect 5-12% of its total population due to the sea rise. Dubai is the second most vulnerable emirate, following Abu Dhabi, with potential loss of 217 km² (approximately 5-6% of its total area) as a result of only 1 meter rise in the sea level.

The third threat is the extreme scarcity of rainfall driven by the geographic location in a hot arid zone where the average annual rainfall is 78 mm over a total land area of the UAE 93% which is occupied by desert. The increasing demand on water in the UAE associated with growing population, economic growth, irrigation and lack of management of water resources will increase the demand of water desalination leading to another set of problems related to increase of energy consumption and change in the biological balance of coastal ecosystem. Renewable water resources dropped from a range of 50 to 400 m³ per capita in early 2000s to 22m³ per capita in 2009 considerably below the average water scarcity level of 1,000 m³ per capita. In Abu Dhabi, underground water supplied 71% of total water demand and the share of desalinated and treated wastewater was 24% and 5% respectively. The combination of effects of increased temperature and scarcity of water increases the aridity of the region and reduced soil moisture lead to the risk of drought in the region.

The four major threats of increasing temperature, rise of sea level, water scarcity and drought are the main climate change threats that might have an adverse impact on urban development in the UAE. Defining these threats shall enable the UAE and Dubai government to mainstream and structure their response to climate change impacts within their different development arenas.

5.4 UAE Approach to Respond to Climate Change

Overtime, the UAE's response to climate change impacts can be described as an ad-hoc response compelled by the increased dependence on technological substitution as adaptation tools to its harsh climate, supported by the positive economic performance and high GDP. The unsustainable consumption pattern had led to environmental damages and increase in GHG emissions that require immediate intervention to medicate its adverse impacts (Assaf, 2012)

However, the recent calls of the UNFCCC to respond to climate change impacts had unified the global response to some extent as demonstrated in Chapter 4 in the cases of UK and Malaysia. The UAE approach to combat climate change impacts comes in two folds: i) deciding the guiding principle led by the adoption of the Green Growth⁴ Planning concept for a sustainable growth; and ii) creating the institutional arrangements that would be responsible for the coordination and implementation of plans and objectives.

5.3.1 UAE Green Growth Planning

At the opening of the World Future Energy Summit held in Abu Dhabi in January 2013, the Minister of Environment announced the nation's plan to develop the National Strategy on Green Growth with the support of the Global Green Growth Institute (GGGI)⁵ outlining how to reduce the UAE's environmental impacts across

⁴ Green Growth is a term to describe a path of economic growth that fosters economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies.

⁵ An international organization dedicated to green growth in developing and emerging countries.

different economic sectors; which was announced in September 2013⁶. A steering group led by the minister of environment was established to fulfill this task, consisting of members from the Prime Minister's Office, the Ministry of Environment and Water (MoEW) and the Ministry of Foreign Affairs. The main objective of the Green Growth Plan is to define low carbon green growth opportunities in key sectors of the UAE economy including oil and gas, water and electricity, industry, transport, building, waste, land use and biodiversity, in addition to the development of implementation roadmaps, responsibilities and institutional requirements.

The researcher tried to obtain more information from officials working in the climate change initiatives from the MoEW but unfortunately with no results. According to an official from the Ministry of Foreign Affairs, the main concern facing GGGI is the lack of a unified database as a single source of information. However, regular workshops are conducted with GGGI, Ministry of Foreign Affairs and Ministry of Water and Environment to discuss the progress on the green growth action (GGGI, 2012)

At the federal level, the government in collaboration with the Global Green Growth Institute (GGGI) is developing a green growth plan for the country which aims at providing planning policies and action plans to address climate change concerns. The GGGI is working to identify the synergies among different initiatives of various government agencies. The federal strategy was supposed to be finished in September 2013, but it is yet to be published according to Ms. Aisha Al Abdooli (GGGI, 2012m and Todorova, 2014).

⁶ Not yet released as of September, 2014 still under review.

5.3.2 UAE Institutional Arrangement to Respond to Climate Change

On the national level, the federal government represented by the Cabinet is responsible for streamlining the international and national response in terms of setting up responsibilities among different ministries. The responsibility of responding to climate change on the national level is divided among two main ministries, the Ministry of Foreign Affairs, responsible for the international communication with the UNFCCC, and the Ministry of Environment and Water, responsible for the intergovernmental communication by setting up the objectives of climate change among concerned ministries, coordinating among different business sectors and rationalizing the communication between the international agendas and national plans.

The collaboration between the Ministry of Foreign Affairs and Ministry of Environment had resulted in the establishment of the Directorate of Climate Change (DCC) under the Ministry of Foreign Affairs playing a diplomatic role with the NFCCC to prepare and negotiate the National Communication prepared by the National Climate Change Committee in the Ministry of Environment⁷.

The UAE signed up to the UNFCCC in 1996 as a non-Annex 1 Party⁸, with no obligations to cut emissions. However, the government recognizes the need to respond

⁷ It is worthwhile to mention that the first and second National Communication were prepared by the Ministry of Energy under the direction of the Minister of Environment who is heading the Climate Change Committee.

⁸ Parties are mostly developing countries. Certain groups of developing countries are recognized by the Convention as being especially vulnerable to the adverse impacts of climate change, including countries with low-lying coastal areas and those prone to desertification and drought. Others (such as countries that rely heavily on income from fossil fuel production and commerce) feel more vulnerable to the potential economic impacts of climate change response measures. The Convention emphasizes activities that promise to answer the special needs and concerns of these vulnerable countries, such as investment, insurance and technology transfer.

to climate change. The first and second National communication⁹ were submitted to UNFCCC in 2007 and 2010 respectively.

Despite the claims that the Ministry of Environment had already prepared a national policy for climate change, the policy document was not available and the local government of Dubai is not aware of any policies at the federal level. There seems to be a lack of communication between the federal and local governments in coordinating and planning climate change initiatives. This is likely to mirror the unbalanced relationship between federal and local governments where the local institutions are more powerful and well-resourced than the federal counterparts.

The following section maps Dubai's planning approach to respond to climate change impacts in light of the national agenda and green economy strategy.

5.5 Dubai Response to Climate Change Impacts

Dubai is the second largest emirate in the UAE occupying 4,114 square kilometers. It is located on the southwestern corner of the Arabian Gulf sharing the borders with Abu Dhabi and Sharjah. In less than forty years, Dubai had been transformed from a simple fishing, pearl and sea trade dependent city to a large



Figure 5.4 Dubai's Original settlements featuring the creek, Deirah (left), Al Shindagha (below) and Bar Dubai (above). (Ramos S., 2009)

⁹ A document submitted in accordance with the Convention (and the Protocol) by which a Party informs other Parties of activities undertaken to address climate change.

commercial and tourist hub in the region under the leadership of the Al Maktoum family who have ruled Dubai since 1833 (Dubai.ae, 2013).

5.4.1 Development of Dubai Urban Structure

The development of Dubai's urban structure had gone through four main stages since 1900 until date (Ramos, S. 2009) and (Pacione, 2005). The first phase spans from 1900 until 1955 where a slow urban expansion could be traced in some areas represented by residential and minor commercial areas without a defined master plans. A combat development led by HH Sheikh Rashed Bin Saeed Al Maktoum was developed between 1955 and 1970, when the first master plan was prepared by an English town planner, John Harris, in 1960 driven by the creek dredging. The third era was a planned urban growth that spanned 1970 until 1993 when a detailed master plan was issued with a diversified land use to cope with the city's expansion plans. The fourth phase stated from 1993 until date, when a governed master plan was issued with the involvement of the private sector responsible for developing cities within Dubai City. Figure 5.5 summarized the four development phases in the city.

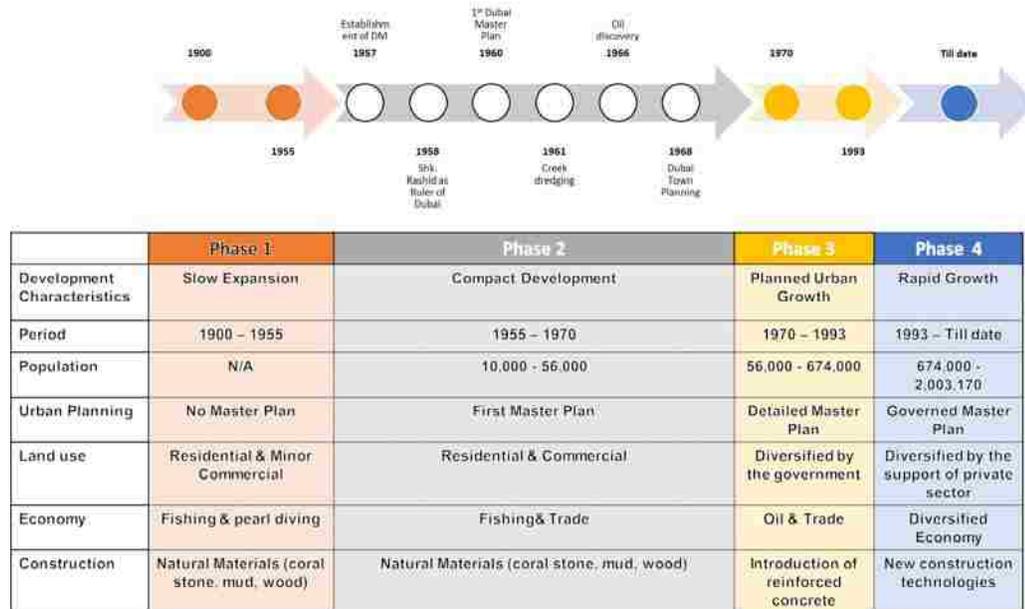


Figure 5.5: Development of Dubai Urban Structure (Ramos S., 2009), developed by the author.

During the first phase of development, and prior to oil discovery, the inhabitants used to depend mainly on agriculture, fishing, pearl diving and sea trading to sustain. The economic growth associated with oil discovery in the second phase of development reshaped the city's economy and encouraged the ruler to enhance Dubai's infrastructure to cope with the introduction of a diversified economy, such as trading and oil industries. The government recognized the need to increase the dependence on the non-oil economy when it started to rely on a planned economic growth and moved towards developing a mechanism for a diversified economy, where trade, transport, real estate, construction, tourism and finance are the focus of Dubai's economy. The contribution of the non-oil economy to the city's GDP from 1975 to 2007 is illustrated in figure 5.6 (DeNicola, 2005), (Fazal, 2008) and (Pacione, 2005).

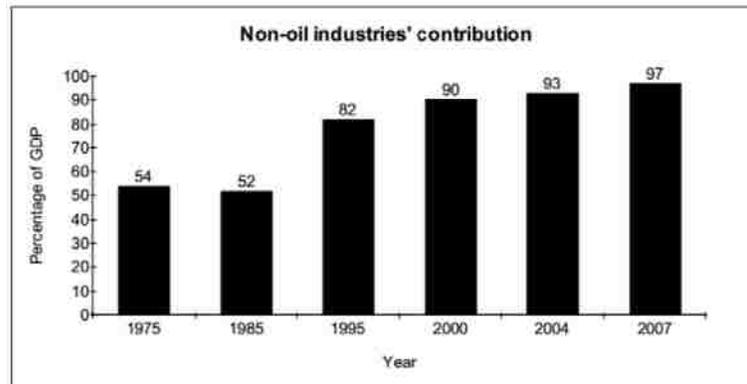


Figure 5.6: Contribution of the non-oil sector to the total GDP of Dubai (Fazal, 2008).

The high dependence on construction and real estate economy was seriously hit by the economic crisis in 2008, however, it was a chance for the city planners and decision makers to reevaluate the master plan and develop a governed master plan taking into account the requirements of all service authorities and actual requirements linking them with the visionary growth set by the government.

Dubai's economy is challenged by different factors in its way to develop a green sustainability. Scarcity of oil and natural resources, high consumption pattern, luxurious lifestyle and a diversification strategy reliant on energy-intensive development pattern had increased the burden on the environment and natural resources. Therefore, Dubai had undergone profound transformations on its leadership development planning and governance structure that boosted the economy and changed the shape of the city. High population and resource demand growth had increased the domestic pressure and forced the leadership to consider wisely the environmental sustainability in its planning for green growth.

5.4.2 Dubai and the Environmental Concerns

A consensus on the environmental problems was observed among interviewees. The main environmental concerns raised by the experts were the depletion of underground water and renewable sources of water especially with the overconsumption and low precipitation, increase of air temperature, drought, increasing frequency of extreme weather conditions, environmental sensitive areas which require special attention, coastal erosion which increased after the construction of the artificial islands, protection of fauna and flora, air pollution that resulted from the high demand of nonrenewable fossil fuels in transportation industrial activities and households which led to the increase on GHG emission.

The official from Dubai Supreme Council of Energy DSCE refused to use the term “problem” preferring to use the “challenges” instead. He summarized these challenges in four main concerns: lack of public awareness on people’s role to protect the environment, lack of recycling facilities to conserve the environmental resources, absence of an integrated waste management facility on the national level, and the consideration of GHG reduction on a national level.

Most of the interviewees agreed that the environmental debate is raised as a consequence of economic growth due to the overconsumption of natural resources and the high GHG emissions that resulted from the high demand of energy generated from fossil fuels. The planning expert at Dubai Municipality considers this debate as a pure commercialized subject as the environmental change is a natural phenomenon since the early creation of eco system, and human’s role is to adapt to this change to the best of their knowledge and available technology.

Despite the different points of view observed, the government had reflected its commitment to protect the environment and preserve it for future generations as part of its commitment towards green economy. The integration of climate change impacts and environmental concerns is being explored in this research through the urban planning process adopted by the government of Dubai

5.4.3 Dubai Planning Process and Approach

Dubai developed a modern vibrant city enjoying a global reputation as an economic hub and a reliable place for foreign investments. Underpinning this position was the vision set by HH Sheikh Mohammad Bin Rashid for Dubai as *a modern Arab city and a vibrant regional gateway to the world*. The collaborative approach to develop the city's spatial planning was driven by the Executive Council defining the direction for achieving the strategic targets.

The Dubai Executive Council is the emirate's top decision making body chaired by the crown prince of Dubai HH Sheikh Hamdan Bin Mohammad Al Maktoum who receives strategic analysis and policy advice from the five sectoral committees responsible to implement the strategic plan. The Executive Council of the Emirate of Dubai was founded under Law No. 3 of 2003 issued by HH Sheikh Maktoum bin Rashid Al Maktoum, ruler of Dubai, in order to assist the ruler in the performance of his duties and exercise his powers. The council aims at the fulfillment of the scope of work summarized in Figure 5.7 (TEC, 2013).

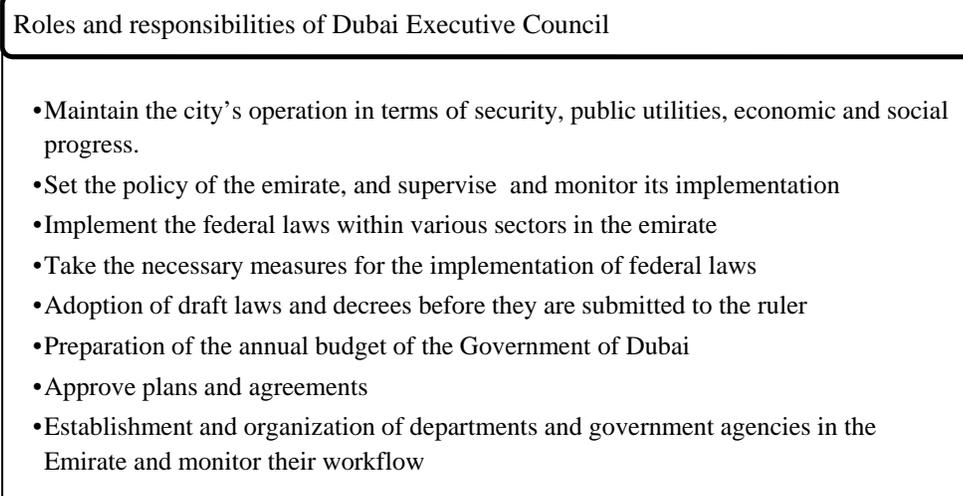


Figure 5.7: Roles and Responsibilities of Dubai Executive Council (TEC, 2013).

The sectoral committees are chaired and managed by executives from each entity. These committees were established under the Executive Council Resolution No. (7) for the year 2005, followed by Resolution No. (26) for the year 2009, which re-launched the sectoral committees “Economic Development Commission, Commission on Security and Justice, Infrastructure Committee and the Environment, Commission for Social Development, and Committee on Health and Safety”. The objectives of the sectoral committees of the Executive Board are summarized in figure 5.8.

Roles and Responsibilities of the Executive Committees

- Support the Executive Board to carry out & optimize their assigned roles.
- Strengthening policy-making and decision support in various government sectors.
- Review the proposed programs and studies for the development of government sectors.
- Coordinate the work of government agencies and sectoral committees to ensure harmony among them.
- Follow up the cross-sectoral concerns among members of committees:
 - Overseeing the preparation, implementation and updating and follow-up plans of each of the sectors that make up a whole Dubai Strategic Plan and in accordance with the approved program for the Executive Council.
 - Propose initiatives and policies for the development of areas that fall within the jurisdiction of each committee and submitted to the Executive Council for approval.
 - Review and evaluation of policies and initiatives related to the industry and submitted by the concerned government authorities through the Secretariat, and raise the appropriate recommendations to the Executive Board.
 - Suggesting topics and issues which the Committee considers processed or released under the legislation, and submit them to the Executive Board for approval.
 - Ensure proper execution of policies and initiatives adopted by the Executive Council and evaluated periodically.
 - Cooperation and coordination with the relevant authorities within the State for the implementation of joint plans and policies with those agencies.
 - Help the Statute of the sectoral committees of the Executive Board including its content of the rules and provisions to regulate the functioning of the sectoral committees and support in achieving its objectives and functions.

Figure 5.8: The Executive Council of Dubai - Sectoral Committees (TEC, 2013)

The rapid growth era (phase 4) started with a rise of different master developers with increasing competitiveness to create cities within the city of Dubai as free zones taking the role of planning on behalf of the government. This approach resulted at having non-centralized urban planning authorities which had positive and negative impacts on the city's development. The executive council realized the importance of streamlining these developments. Therefore, The Dubai Urban Planning Steering committee was established in 2010 including members from all operational sectoral departments¹⁰ with a contribution and participation from different stakeholders under

¹⁰ The Dubai Urban Plan Steering Committee includes members from Dubai Municipality (DM), Roads and Transport Authority (RTA), Dubai Electricity and Water Authority (DEWA), Dubai Civil Aviation Authority (DCAA), and Dubai Land Department.

the Infrastructure and Environment Committee¹¹ of the Executive Council to establish the Dubai Urban Master Plan to be the reference for development activities in the emirate. The Dubai Urban Master Plan 2020 was issued covering four main areas: first the Urban Planning Framework, second, utilities framework that includes Energy, Electricity and Water, third, Roads and transportation and finally the Environment. Figure 5.9 illustrates and summarizes the role of each member in the Dubai Urban Master plan against each sector of environment and infrastructure.

The planning process adopted in the preparation of Dubai master plan 2020 was handled by the Urban planning steering committee in each of the defined sub sectors in five main steps: first, identify the elements and components of Dubai Urbanization; second, analysis and synthesis of elements and components; then, establish strategies and policies for future urbanization with consideration to the legal aspects of all land committed for development before 2008; fourth, prepare comprehensive strategic spatial structure plan; and finally promote implementation tools including legal framework. This process was used in addressing all the issues related to the master plan, where the responsibilities were distributed to the concerned parties depending on their areas of specialization. The subject of climate change has been recently introduced as illustrated in the following section of the research, where TEC is preparing the scope of work for the Climate Change concern.

¹¹ Dubai Master Developers (National property development companies, ie, Emaar, Nakheel .. etc.) and other departments and agencies of Dubai government, statistics teams, and the planning research section team of DM who was responsible on the daily communication, administration and management of this project under the direction of the head of steering committee

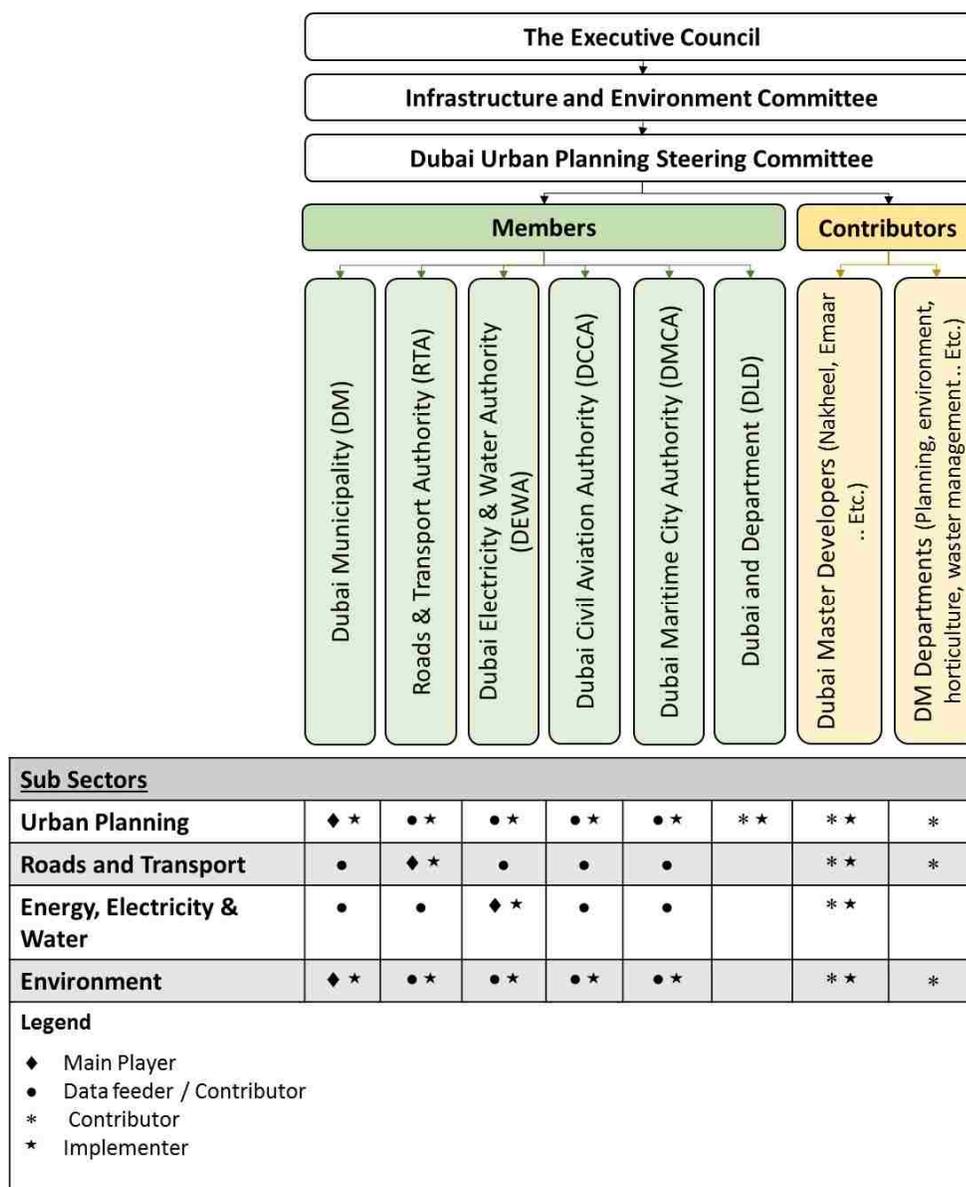


Figure 5.9: graphical illustration of the Urban Planning Steering Committee defining the responsibilities of each member in the Urban Planning sub sectors (TEC, 2012), developed by the author.

5.4.4 Integration of Climate Change in Dubai Development Process

Climate change is a cross-sectoral concern that should be mainstreamed into government's policies, programs and plans for better efficiency and greater

effectiveness. Integration of climate change into the development planning process is inevitable. Dubai's government is committed to uplift the socioeconomic status of their people. In January 2012, HH Sheikh Mohammad bin Rashid Al Maktoum had announced the launch of a long-term national initiative to build a green economy in the UAE under the slogan "A green economy for sustainable development" with three main aims: first, to make the UAE one of the global pioneers in green economy; second, be a hub for exporting and re-exporting green products and technologies, and; finally build a country that preserves a sustainable environment that supports long-term economic growth.

Dubai had followed the national green growth target and developed a plan to achieve this target. According to an official from Dubai Municipality, the green economy initiative consists of various programs, projects, legislation, and policies in six major fields, Green Energy, Green Economy, Green City, Climate Change, Green Life and Green Technology as detailed in figure 5.10.

Green Energy	Green Economy	Green City	Climate Change	Green Life	Green Technology
Renewable Energy	Production of Green Products	Urban Planning	Carbon Emissions	Water Efficiency	Carbon Capture
Related Technologies	Import & Export of Green Products	Buildings Efficiency	Organic Agriculture	Electricity Efficiency	Waste into Energy
Clean Fuel	Job Opportunities	Sustainable Transport	Biodiversity	Natural Resources	
Efficiency of Energy	National Cadres	Healthy Environment	Ecological Balance	Recycle Waste	
			Wildlife	Awareness	
			Marine Environment	Environmental Education	

Figure 5.10: UAE Green Economy Initiative: "Green Economy for Sustainable Development" (Azayem, K. 2013).

Combating climate change under the green initiative comprises six main areas of attention: carbon emission, organic agriculture, biodiversity, ecological balance, wildlife and marine environment. The most active approach observed by the researcher related directly to climate change is the intention to reduce carbon emission in different sectors of the development arms, demonstrated in different initiatives targeting reducing GHG emissions.

To prepare Dubai for this transition and response to climate change impacts, the Crown prince instructed the Executive Council to include the climate change subject in the 2013 agenda of the Executive Council regular review meetings. To achieve that, an expert was appointed to look into subject under the urban planning steering committee. According to him, they are currently at a very early stage (stage 1 of the planning process: identify climate change elements that impact Dubai's urbanization) where the executive council is working on defining the scope of climate change subject closely with Dubai Carbon, which was established in 2011 to facilitate the transition to a low carbon economy as an enabler and knowledge repository in that process to cope with the global calls to reduce GHG emissions. Dubai Carbon conceptualizes, manages, executes and monetizes GHG reduction measures. By doing so, they address climate change and promote sustainable development across the region in an economically viable way.

Despite the fact that climate change was not covered in the Dubai 2015 strategic plan and Dubai Urban Master Plan 2020, environmental sustainability and environmental sensitivity were the base in developing the urban master plan to protect the natural resources from over consumption and misuse, which is considered as a good base to prepare the city against climate change impacts.

Comparing the above against the criteria set in chapter 3 defining the role of spatial planners in preparing for climate change, Dubai is deemed to have an excellent foundation to commence planning for climate change. Dubai's visionary political leaders led by H.H. Sheikh Mohammad are eager to lift the city up, and sustain its resources to future generation led by the green development concept. The introduction of climate change in the agenda is a positive step towards unifying the climate change response initiatives. However, this issue is needed to be tackled by spatial planners trained and educated to deal with the subject from different views, reporting to a powerful body to ensure all sectoral cooperation and coordination. In addition, planning for climate change requires risk management and decisions that might contradict social and economic targets, compromise decisions have to be studied from different point of views, and the sectoral committees of TEC are the best to discuss this issue with the spatial planners.

Climate change is currently addressed in different sectors under different objectives led mostly by environmental, energy, and GHG reduction targets under different means, initiatives and policies. The following section highlights how climate change is addressed in Dubai as adaptation and mitigation means.

5.4.5 Addressing Climate Change

The subject of climate change has been recently introduced to the government agenda as mentioned earlier. However, the calls to preserve the environment and reduce the GHG emissions had been already incorporated. This section explores climate change related initiatives that are integrated in the current planning system adopted by the government of Dubai. This can be achieved by mapping the climate

change concerns against the response mechanisms of climate change addressed by the UNFCCC: Adaptation and Mitigation against the three types of interventions: proactive, regulatory, and strategic coordination.

An agreement among interviewees was observed about the climate change phenomenon supported by the international calls to reduce CO₂ emissions, and the need to develop a sustainable economy that preserve the environment and reduce GHG emission. The most climate change impacts on cities' development highlighted were in the increase in average temperature, low precipitation, scarcity of water, rise of sea level and drought.

Means of Climate Change Mitigation

Climate change mitigation addresses mainly GHG emissions in the energy sector in terms of supply and demand. The consequences of economic growth and the new luxurious lifestyle promoted in the city were defined as major contributors to climate change. This new trend increases the demand on electricity and water desalination, use of private cars and transportation operated by fossil fuels, increasing demand on cooling to adapt to the harsh climate. The accumulated impacts result in an increase of CO₂ emissions, increase of temperature and urban heat island, drought and scarcity of renewable water resources. Therefore, the reduction of these emissions can be tackled in three main mitigation themes, energy supply, and energy demand and energy efficiency.

The renewable energy supply is addressed in the Dubai Master plan 2020 which had set an objective to generate 10% of its energy demand from alternative renewable energy sources. The Dubai Supreme Energy Council, responsible for

setting this target, has decided the 2020 and 2030 Targets for the share of renewable/alternative energy in Dubai as 1% and 5% respectively. DEWA started to achieve this target using large scale renewable energy by commencing the first solar park in the city to generate 10 MW of energy generated from solar power. On small scale renewables, the green building code issued by Dubai Municipality promotes the use of domestic energy generation for basic needs such as lighting and water heating.

Energy demand was addressed in Dubai Master Plan 2020 aiming at a reduction of energy demand per capita by 30%. This target is not yet agreed by DEWA, who recommended to reduce the target to 15% subject to detailed investigation. The responsibility of achieving the target was given to all governmental entities each in its own area of specialization. Energy demand target is still under negotiation.

Transportation planning in the Dubai Master Plan 2020 had set three objectives to reduce energy demand: first, by 2020, 30% of households in Dubai will be within 400 meters of public transport with a peak service frequency of at least one service every 10 minutes, second: by 2020, 80% of the population will be within 15 minutes walking time of grouped community facilities, and finally, by 2020, 90% of residents can meet their principal health, education, recreation and retail needs within a 10-kilometer radius of where they work or live. In addition, RTS is working to achieve its mission to develop integrated and sustainable transportation systems and provide distinguished services to all stakeholders to support Dubai's comprehensive growth plans through preparing policies and legislations, adapting technologies and innovative approaches, and implementing world-class practices and standards as part

of their commitment to green economy. These targets can reduce trip generation and reduce the use of private cars and subsequently reduce GHG emissions.

Another area of reducing GHG emissions is energy efficiency, where the government represented by DM and DEWA are promoting new technologies that reduce the energy consumption and increase the awareness on green buildings regulations. The incentives were introduced by revising the tariff structure and increase the cost of energy. At the same time, public awareness was increased on the energy conservation in domestic use of lighting, cooling and major appliances.

By addressing energy supply and demand, a major reduction is expected to be achieved under the green economy realm. By 2020, Dubai Executive Council set an objective to generate 10% of its energy demand from alternative renewable energy sources. However, the Dubai Supreme Energy Council, responsible for setting this target, has decided the 2020 and 2030 targets for the share of renewable/alternative energy in Dubai as 1% and 5% respectively. Different initiatives were introduced to implement this objective on different levels, including large scale renewables and small to medium scale renewables as summarized in Table 5.1.

Sector	Sector /Responsible Entities	Initiative
Mitigation: Energy Supply		
Large Scale Renewables	Energy /Dubai Electricity and Water Authority (DEWA)	Solar Energy Plant Launch of the first phase (10MW PV Solar Plant) of the solar power generation project. Plan to diversify the energy [sector] in Dubai and to increase solar power to 1 per cent by 2020 and 5 per cent by 2030, aiming to reach a capacity output of 1,000 megawatts (MW) by 2030
Small to medium scale renewables	Building Regulations /DM, DEWA and buildings' owners	Green Building Codes: 1. On-Site RE - Small to Medium Scale Embedded Generators For all new buildings: Where a building incorporates on-site generation of electricity from small or medium scale embedded generators using renewable energy sources; the equipment, installation and maintenance of the system must be stand-alone (off-grid) and therefore not connected to (DEWA) network and DEWA will provide electricity supply to the building when needed without parallel connection. 2. On-Site RE - Solar Water Heating System For all new villas and labour accommodations, a solar water heating system must be installed to provide (75%) of domestic hot water requirements.
	Infrastructure /Roads and Transport Authority (RTA)	Small scale renewable energy to operate equipment's such as parking machines, radars and roads signals
	Waste management / DM – Department of Waste Management	1. Landfill Gas (LFG) Recovery, Flaring and Electricity generation The methane (CH ₄) produced from landfills is classified as GHG with 21 times global warming potential as compared to CO ₂ . This gas is recovered and flared or combusted in engine to convert into electricity of about 1 MW. The equivalent amount of CO ₂ eq reduction is 268,622 metric tons per year. 2. Use of bio-fuel (Bio-diesel) Produce biodiesel from waste vegetable oil and converted to use in motor vehicle fleet of few companies. The CO ₂ is reduced by 5% as compared to diesel fuel.

Table 5.1: Climate Change Energy Supply Mitigation Initiatives in Dubai.

With regards to energy demand, Dubai had a reducing energy demand target to 30% by the year 2020. This target is not yet agreed to by DEWA, which recommended to reduce the target to 15% subject to detailed investigation keeping this target open to be agreed as the work progressed with their ongoing initiatives. The energy demand reduction initiatives is handled in different sectors including transportation, the built environment, and district cooling in addition to setting up different policies and regulations by the government under the leadership of Dubai Supreme Council of Energy to regulate and reduce energy demand as summarized in table 5.2.

Sector	Sector /Responsible Entities	Initiative
Mitigation: Energy Demand :		
Transportation Planning	Land use and Transport / DM – Planning Department, Roads and Transport Authority (RTA)	<p>Planning Objectives; By 2020</p> <ul style="list-style-type: none"> • 30% of households in Dubai will be within 400m of public transport • 80% of the population will be within 15 minutes walking time of grouped community facilities. • 90% of residents can meet their principal health, education, recreation and retail needs within a 10-kilometer radius. <p>Provide mass transport facilities to serve a vast population from different categories to reduce private vehicular trips and reduce energy consumption:</p> <ol style="list-style-type: none"> 1. Dubai’s bus system, with a daily ridership of around 314,000 passengers. 2. Water taxis also serve some 42,000 passengers daily. 3. Dubai metro is planned to provide transport for 12% of all trips in Dubai.
Energy Efficiency of the built environment	Building Regulations /DM, buildings’ owners	<ol style="list-style-type: none"> 1. Government buildings and commercial establishments preferably hotels have been mandated or volunteered to control indoor ambient temperature settings, replace conventional lightings to LED lights and implement solar energy lighting in public parks and water heating in hotels and DM abattoir 2. In November 2010, DEWA, launched a 20K smart meters pilot program to evaluate consumption in residential areas
District Cooling	DC providers (Tabreed and empower) /DM/ owners	Dubai had promoted the use of District cooling services as a centralized service aiming at reducing energy consumption
Policies and Regulations	The government of Dubai under the leadership of Dubai Supreme Council of Energy (DSCE)	<ol style="list-style-type: none"> 1. Tariff policy for water and electricity 2. Introduction of a number of regulatory policies to promote public/private partnership for energy projects, particularly clean energy generation. 3. Significant reduction of government subsidy to power & water cost. 5. Synergy between DEWA and DUBAL for power cogeneration which results in substantial savings. 6. Establishment of GHG Emissions project GHG MRV (Monitoring, Reporting and Verification) to establish baseline data

Table 5.2: Climate Change Energy Supply Demand Initiatives in Dubai.

Means of Climate Change Adaptation

Developing city resilience against climate change impacts is important to protect the city’s infrastructure and investments. The continuous adaptation of human kind to their local environment comes naturally as a means to survive in any development. Historically, Dubai adaptation responses to climate change over time was reflected in the use of local building materials, and building technologies such as

barjeels to cope with the increased temperature, rely on the available natural resources from underground water to cope with the harsh environment.

Upon the discovery of oil and the introduction of electricity and cooling systems followed by the technological renovation in the region, adaptation was introduced as an upgrade of lifestyle using air conditioning systems to overcome the harsh weather, extract underground water mechanically, and use of desalination technology to overcome the water shortage. This adaptation is necessary for the development of the city, yet the mitigation planning regulates and reduces the high dependence on nonrenewable energy to reduce the GHG emissions. Apart from climate change, environmental degradation and depletion on natural resources are the main areas of considerations in spatial planning in Dubai.

As indicated above, four areas of climate risks have been at the center of adaptation effort in the planning effort for increasing city's resilience: increased temperature, sea level rise, low precipitation and drought. This harsh climate and increasingly scarce water resources renders the city's water and food security crucial to the continuity of city's growth and its inhabitants.

The planning response to these risks was taken from an environmental and sustainable development perspective. The Environmental Department at Dubai Municipality had identified the environmental sustainable areas in the emirate where they identified the locations of aquifers, ground water level, natural vegetation areas, dunes, and beaches exposed to erosion. The city's land use plan was developed based on these sensitive areas, and environmental considerations were taken prior to the commencement of mega projects by the implementation of Environmental Impact Assessment process.

Dubai Urban Master Plan 2020 addresses the preservation of the coastal line, as Dubai has more than 70 km of coastline consisting of sandy beaches. Expensive urbanization activities had been developed since early 1970s including development for trade, tourism, recreational activities, marine industries and residential. The advantage of having shallow sea water within 12 nautical miles encourages the local developer to develop off-shore man-made islands, however, the construction of these islands have interrupted the natural coastal movement of waves and ecosystem, disturbing the long shore sediment transport, environmental systems, waves patterns, fisheries and coral reefs causing a negative impacts on the natural coastal resources. To monitor and plan for these risks, Dubai Municipality had developed a coastal zone monitoring and forecasting program to carry out coastal related studies such as Lidar surveys and produced coastal development guidelines setting out existing conditions and directions for future developments as an adaptation to the current situation and prevent future possible impacts. The global sea level rise wasn't considered in this study, however, a forecasting system was established for short term monitoring of the sea pattern.

Increase of temperature and urban heat island were addressed in the Green Building code issued by Dubai Municipality emphasizing the need to increase buildings efficiency, which should contribute positively to the urban heat island by reducing heat emission, subsequently, reduce heat generation. The city planning promotes the increase of green spaces by building parks and encourage public and private developers to invest in open spaces. It was also observed that the private developers rely mainly on sustainable development concepts to promote their project. However the extensive use of water bodies increases the demand on water

consumption contradicting the obligation towards water scarcity.

Water management is a means to adapt to water scarcity. It is managed through the water tariffs imposed by DSCE¹² and DEWA and the encouragement of using water saving equipment and water outlets and irrigation systems to respond to the risk of water scarcity. Noticeable results were observed according to DSCE reflected in changing water consumption and irrigation patterns. To overcome water shortage, different technologies are used such as desalination and sewerage treatments. Dubai had opened the largest power and desalination plant in April, 2013 providing 140 million gallons of water per day in addition to DUBAL's desalination plan which produce 30 million gallons of water per day. Water management is a forthcoming risk facing Dubai, and the availability of a water management system is an immediate need which lacks of attention due to the substitute made by the available affordable technology. In the meantime, however, future long term planning is required to adapt to the current and future shortage of water.

Drought is another concern of climate change impacts in Dubai. It basically affects the agricultural production. Dubai is adopting the agricultural guidelines set by the Ministry of the Environment and Water to regulate the use of water, and use of modified genes in plants with drought tolerance.

Climate change adaptation is still in a very early stage. The absence of detailed studies to determine climate change impacts on the emirate might hinder promoting adaptation. The current prosperity of Dubai substitutes the change in climate in the short term, however, there is a high risk of oil depletion, and the unsustainable reliance

¹² Dubai Supreme Council of Energy

on non-renewable energy will impose a serious risk on the city on the long term. Therefore, a climate change vulnerability study and analysis on development has to be conducted.

5.5 Conclusion

Addressing climate change in Dubai's planning process is still in a very early stage. It imposes a challenge not only on the planning system, but also across policy legislative sectors. Dubai's Government had established a unique spatial planning system that copes with the rapid development occurred in the city during the rapid growth era that started from 1993 until date, where the development expansion increased dramatically associated with a low interference from the central urban planning authority in Dubai at that time. The introduction of sectoral committees in the government supported the decision makers to ensure the cross coordination among the different disciplines in the government with clear responsibilities and continuous evaluation of performance.

Integrating climate change within the development process is still in a very early stage. Nevertheless, mitigation climate change became essential in the development strategies as the UAE is taking the responsibility to reduce its GHG emissions to prepare it for a sustainable way of living and convert the economy to a green economy. Climate change adaptation requires further studies to identify the actual risks and impacts on the development activities in the emirate and increase the government and public awareness on the importance of city planning to adapt to climate change impacts.

Synergies between the different disciplines is required, and climate change is

affecting not only the infrastructure and environment areas but also other disciplines such as health, agriculture, housing and business development as a cross disciplinary subject. Planning for climate change is not only a technical concern, but also appreciation of humans' right to cope with change to exist.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Discussion

The research intended to explore the finding of the impacts of climate change on the urban development planning in Dubai. Research methodology adopted by the researcher had started from building a general understanding of climate change trend which showed an international emphasis on the cities' leading role to combat climate change impacts and address sustainability in chapter 2. This exploration was followed by a literature review of the role of planning to respond to climate change impacts that showed a lack of available literature on the planning frameworks, and inconsistency among planning agencies to respond to climate change impacts. The common factor between most of the world countries was the submission of the National response to climate change to the UNFCCC which is guided by Kyoto Protocol that sets the stage to plan the responses. The response mechanism is classified into two main planning methods, adaptation and mitigation, and these methods were examined in two cases in Chapter 4: the UK and Malaysia. Data gathering concerns mainly the inventory of GHG emission which guide the planning for mitigation, and the research of vulnerabilities to identify the areas of increasing cities' resilience to plan for adaptation.

Upon setting the framework of planning response to climate change, the response of the UAE and Dubai were explored in Chapter 5 providing answers to the research questions. First, climate change is perceived as an environment issue within planning stakeholders and its impacts are considered as challenges to planning and city development. The response to the increase of GHG emission is grouped under mitigation planning which was reflected in the efforts made to increase buildings efficiencies, reduce

energy demand and invest in renewable sources of energy to reduce emission. Adaptation response is rather ad-hoc or a response to environmental concerns due to the absence of a climate change vulnerability studies and absence of local experience on the subject of climate change in the planning sector.

The major climate change impacts on Dubai were generalized from the National communication submitted by the Ministry of Energy to the UNFCCC and climate change report prepared by Abu Dhabi Environment Agency, which identified four major threats of climate change: increase of temperature, low precipitation and water scarcity, drought and sea level rise. These changes will have a direct impact on the essential factors of human settlements ecosystem, agriculture, human health, food security, marine ecosystem and many unexplored areas. Climate change impacts were not addressed in a long planning strategy, while the planning response was built on the current environmental management system. These studies were mainly conducted by Abu Dhabi Environment Agency. The same kind of studies is advised to be conducted by a climate change agency recommended to be formed within the planning arm of the Executive Council.

6.1.1 Dubai Process of Development Planning

The planning process in Dubai is found to be flexible to cope with the rapid unique growth of the city under the leadership of a unique ruler, Sheikh Mohammad Bin Rashid who encouraged innovation, positive spirit and competition among everyone, from decision makers to small students. The involvement of private sector to develop the city with the government had resulted into the establishment of sectoral committees within the Executive Office to tackle all associated interrelated issues in the government in order to

define roles and responsibility of the government entities to assure the best service provided to the city's inhabitation, and set clear policies, processes and legislation to protect everyone's right and ensure justice.

The investigation indicated that the climate change mitigation is driven by the green growth target set by the UAE government aiming at a reduction of GHG emissions and preserving the natural resources for future generations. The governmental entities under the urban planning committee under the Infrastructure and Environment Committee of the Executive Council represented by RTA, DM and DEWA set their individual targets to reduce GHG emissions as carbon reduction as part of the environmental conservation to build a sustainable city.

The introduction of Dubai Supreme Council of Energy is a positive step towards building a comprehensive mitigation response as an immediate response to climate change until the development of a comprehensive framework. The Executive Council is currently working to include climate change in the 2013 agenda. A team was formed to identify the scope of work for the project, however, a clear planning framework is yet to be developed, and TEC team leans towards planning for mitigation only as the DSCE is already having mitigation plans on board. The coordination among stakeholders pertaining to climate change is yet to be developed. A centralized body to mainstream efforts and set a planning response to climate change impacts is recommended to be established.

It was observed that the development planning process adopted in Dubai is limited to government bodies, adopting a top down mechanism to implement planning objectives. In addition, the nature of secrecy, and lack of transparency might endanger the

implementation process. An obvious absence of major stakeholders'¹ involvement in development planning was noticed which is considered to be a major deficiency in the planning process, especially with a subject like climate change where solutions lay mainly in changing people's behavior and lifestyle to live in harmony within their surroundings, and taking the responsibility of their life.

6.1.2 Dubai Approach to Climate Change Impacts

The exploration of the local government response to the climate change impacts had resulted at an observation that the approach adopted to respond to climate change impacts on a national level is focused on the requirement to fulfill Kyoto Protocol, and the implementation framework is limited mainly to Abu Dhabi's initiatives and the efforts conducted by the Environmental agency in Abu Dhabi to identify the risks associated with climate change.

At the institutional level, the effort of the government of Dubai reflected a deficiency of knowledge and information regarding future climate change, vulnerability and appropriate planning response. For instance, the environmental planning in Dubai Urban Master plan is built on a short term environmental planning as observed by the researcher.

Four main barriers were recognized when comparing Dubai's response with the cases of Malaysia and the UK's literature: lack of information, lack of resources, institutional limitations and weak national coordination. In terms of lack of information,

¹ community, NGOs and private sectors

it is important to emphasize on the need for information related to GHG emissions inventory classified by each development sector, and research on the climate change vulnerabilities on a long term span according to specific locations priorities and existing capacity of different stakeholders. The findings had shown a lack of research about the impacts of climate change on the development of the city, and absence of clear carbon reduction targets, despite the fact that each sector had developed strategies to reduce emissions.

An important implication of this research is to encourage the development of climate change response under the government which enable it to distinguish between the information needs of different types of climate hazards, define impacted sectors and the implication on business agendas, and promote the interventions which enable the government to prioritize and coordinate actions to avoid duplications and balance economic growth priorities.

The case study provides an insight into the recognized constraints of institutional limitations. The first constraint is the absence of a centralized body to establish frameworks, define roles and responsibility, monitor and control implementation, reflected in the tendency to link climate change to the environmental planning in both mitigation and adaptation with no consideration of the sensitive nature of climate change that impacts human development. This link comes from the inherited perception of climate change as an environmental concern. The challenge for the government is to recognize climate change as a cross-sectoral issue which is still underestimated by decision makers. In the case of Dubai, the planning process is flexible to accommodate any new concern and integrate it with the city's development planning, however, the

nature of climate change required an independent body to confront it on a cross sectoral level to set clear vision, objectives, define stakeholders, set responsibilities and monitor implementation.

The power of leadership in integrating climate change into development planning is essential to support, develop and implement the response framework. The leadership on sustainability matters in local government comes from a wide range of levels from junior staff to senior executives, therefore a well-coordinated good governance can be driven among all involved parties.

The researcher had defined three challenges that might hinder the implementation of an integrated planning response: (1) lack of an overall integrated urban development and urban vision at both emirate and federal levels (except of Abu Dhabi). Dubai for instance, is having different development control agencies directly reporting to the infrastructure committee and the privilege of having a direct approval from the ruler result in a weak integration on master plan that weaken the urban development, (2) lack of national, and federal urban development strategy, which is reflected in the urban sprawl phenomenon that increases the environmental burden and worsens the climate change situation in urban areas, and (3) lack of regulatory and institutional setup for urban planning and development especially upon the introduction of mega projects developers such as Nakheel, Emaar and Dubai Properties who develop mega sites based on business models and attractive architectural perspectives to sell and increase market reputation putting environmental impacts as a second priority dealing with all its consequences during design development or even after execution.

On a local level, the challenge is the consideration of climate change impacts as

an environmental subject as a sectoral concern rather than a cross sectoral body responsible for the overall coordination of the environmental dimensions of each sector. As highlighted in the literature, the threat of climate change will impact different sectors such as health, education, agriculture, urban planning, energy sector and other sectors. Having a centralized body to address all these concerns will increase the city resilience and reduce the future impacts of climate change

6.2 Conclusion and Recommendations

As a local government responsible for the administration arm to respond to climate change in the context of place-based impacts and vulnerabilities, Dubai's response to climate change was investigated within the conceptual framework developed in the literature. Dubai is a rapid growing city challenged by economic, social and environmental constraints. In less than forty years, and under the leadership of the Al Maktoum family, it was successfully transformed from a small city depending on trade and fishing to a global city approached by international businessmen and tourists. This transition was based on the experience of developed countries guided by the local vision of HH Sheikh Mohammad, however the rapid growth lead to an environmental burden on the city which was classified as one of the largest countries in its ecological footprint in the world according to the World Bank.

To adequately plan, mitigate and adapt to climate change challenges, the government of Dubai is advised to set a framework to respond to climate change in its development planning agenda with clear roles and responsibility of related stakeholders in a good governance setup. The absence of a centralized planning body in the city is

reflected in the overlap of activities in climate change mitigation, and the absence of a long term climate project scenario hinders the development of a proactive planning response to climate change.

It is recommended to have a central body to plan for climate change response, set policies, have a cross sectoral coordination to monitor progress and achieve a successful implementation. Local government needs to show leadership in three core areas: first, to push for reform at higher levels of government (either under the Executive Council or the Planning Agency if it was formed) to enable changes in the planning frameworks to include climate change mitigation and adaptation framework in its development planning strategy; second, mainstream all mitigation efforts and set clear carbon reduction target to monitor performance, and finally; move beyond mitigation to include a focus on adaptation and integrate it into a wide range of governmental entities.

From the researcher's point of view, adaptation to the increased temperature is undertaken by the increasing demand of air conditioning systems that increase the demand on energy generation. The use of district cooling systems and innovative building materials had minimized the demand to some extent, however, the lifestyle and the nature of new projects in the city increase the cooling demand, and the city's resources which is currently substituted by the nation's wealth and city's diversified economy, however, the future city planning requires a serious consideration of energy consumption planning.

People's involvement in the development planning is essential to assure a successful implementation and increase their sense of responsibility towards their nation and future generations, as they are considered the main actors in implementing the planning process, in addition to their expectation from their governments to be honest,

accountable, and responsive to their needs. Having this balanced relationship between the government and local community will assure a successful implementation of climate change act, and can set an example to other governments, especially that Dubai is setting a good example to the Arab region and the Middle East in its uniqueness in changing the city from a small city to a world city and economic hub attractive to lots of world nations.

For national policies to be adopted and implemented by Dubai Government and local authorities, effective communication and consultation mechanisms should be established particularly in the policy planning and development stages. Local government could play a vital role in implementing the adaptation responses through good governance.

Presently, initiatives to implement obligations of the national conventions and calls to climate change are taken individually by a number of ministries, local authorities, private and non-governmental bodies by their direct involvements in international conventions and regional conferences. The implementation scenario is rather ad hoc, and misses the long term planning and vision. Climate change agenda should be addressed within the framework of the governmental planning and development policies formulation. Therefore, the current approaches will have to move to a trans-disciplinary framework to identify areas of overlap, understand conflicts, and aim at arriving at win-win scenarios.

To serve this purpose, the researcher suggests an operational structure (figure 6.1) to confront climate change. The response has to be supported by the highest authority represented by The Executive Council, who is urged to develop an urban planning council who shall act as a centralized body responsible for planning the city. A department of climate change is advised to be introduced under the urban planning council to strategize

the plans to combat climate change and make the necessary arrangement to adapt and mitigate climate change in terms of conducting research studies, set strategic development plans, and assure a cross-sectoral and vertical coordination among stakeholders.

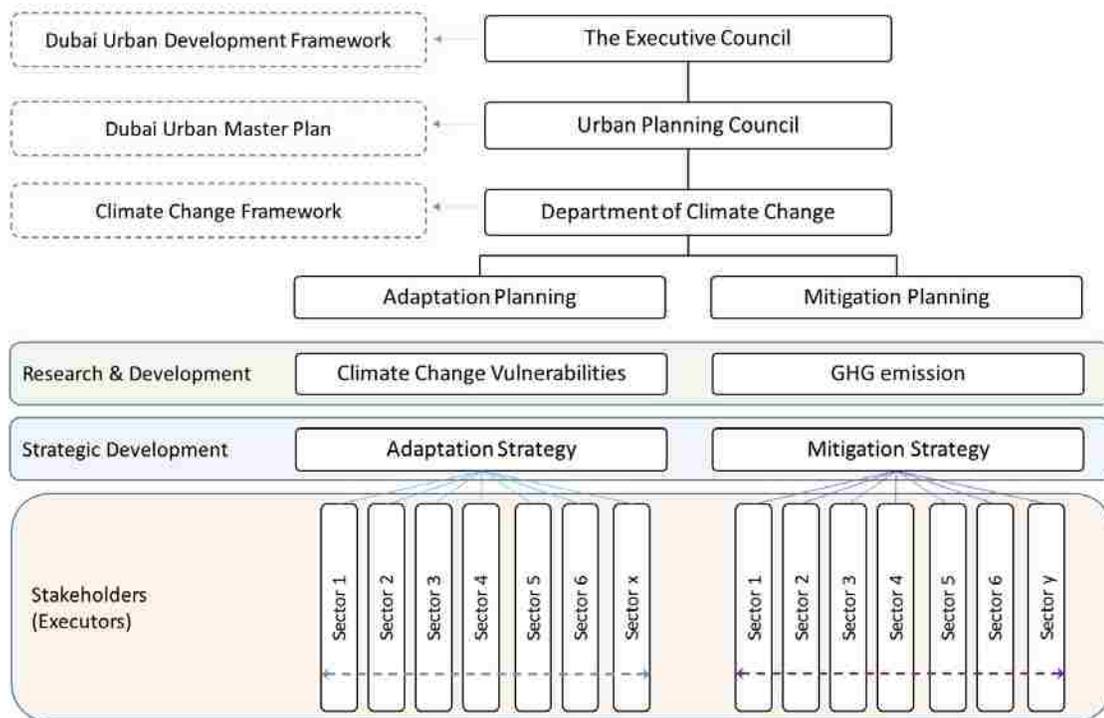


Figure 6.1: Suggested operational structure to plan for climate change response.

6.3 Further Research

Literature reviewed in this research didn't have a standard development planning framework to respond to climate change. This might be because of the problem nature which is tailored to the individual area specific consequences. This departing issue can set the stage for further studies and researches recommended to be conducted such as:

1. Develop a framework to respond to climate change on the national level and build a mechanism and develop visions and objectives to coordinate the response among all emirates.

2. Build a national climate change observation center to monitor the climate change and identify major risks on each emirate.
3. Invest on research and development centers in each emirate to identify the vulnerabilities of climate change. This task might be coordinated with the academic institution to encourage the integration between public, private and academic sectors.
4. Have a unified representation in the international treaties and negotiations through the climate change committee to represent the strategies and progress in climate change as an integrated response.
5. Develop a backcasting planning mechanism to develop the city planning by setting a long term urban vision for the city in accordance to the local government's vision. Subsequently, risks can be identified, and priorities can be set in accordance to the economic growth and the vision of the city.
6. Increase the public involvement to the climate change subject, and encourage them to participate in saving their environment and natural resources for their future generation
7. Educate school students on the important role they play to sustain and protect their world.
8. Target households and involve women and families to attract their attention to their important role in preserving the earth's resources and prepare for climate change impacts.

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APPENDICES

Appendix A:

Examples of Adaptation and mitigation actions (Refer to Chapter 3, Page 64)

Sector	Mitigation	Adaptation
Buildings	Energy efficiency measures	Building regulations. Adaptability in changes in climate extreme
Electricity Generation/Distribution	Fuel mix; use of renewable; transmission loss	Robustness of electricity infrastructure
Heating/Cooling	Energy demand management; renewable energy use	Robustness of cooling / heating infrastructure; Exacerbation of heat island effect
Waste Disposal	Shipping of waste; Methane emissions mitigation (capture/co-gen)	Waste to energy technologies
Transportation	Modal mix; Vehicle efficiency;	Effects of climate on infrastructure (roads, mass transit systems); Changes in use patterns
Land-use planning	Land-use regulation (increased density, increased proximity); Energy efficient development	Land-use regulation (reduce development vulnerability);
Water Provision	Emissions related to pumping	Long-term availabilities studies; water use measures

Appendix B:

A timeline of UK climate-change policies. (Source: Center for Climate Change Economics and Policy, 2010) (Refer to Chapter 4, Page 75)

Year	Policy	Policy Target	Sector	
1989	The Non Fossil Fuel Obligation (NFFO) & Scottish Renewables Obligation (SRO)	Support nuclear and renewable electricity generation	Energy	Mitigation
2000	Climate Change Program	Reduce CO ₂ emissions by 15-18% below 1990 levels by 2010 and overall GHG emissions by 23-25%.	Cross-sectoral	Mitigation
2001	Climate Change Levy (CCL)	Tax on non-domestic energy use, designed to incentivize energy efficiency and emission reductions.	Industry and public sector	Mitigation
2002	The Energy Efficiency Commitment (EEC)	Assisting the implementation of home energy efficiency improvements, equivalent to a reduction in domestic emissions of approximately 1%.	Energy	Mitigation
2005	European Union Emissions Trading System (EU ETS)	Ensuring compliance with the Kyoto obligations	Cross-sectoral	Mitigation
2007	The Code for sustainable Homes	Establishing minimum performance standards for the design and construction of homes and covers energy, water, materials and waste.	Building	Mitigation
2008	Climate Change Act	Legally binding target of 80% reductions in emissions from 1990 to 2050.	Government	Mitigation
2008	Carbon Emission Reduction Target (CERT)	Replaced EEC, aims at household energy saving	Energy & households	Mitigation
2008	Renewable Transport Fuel Obligation (RTFO)	Requires suppliers of fossil fuels to ensure that a specified percentage of UK road fuel supply is from renewable fuels.	Fossil Fuel Suppliers	Mitigation
2008	Energy Performance Certificates (EPS)	Energy efficiency rating from buildings required whenever they are built, sold or rented out	Buildings	Mitigation

2009	Community Energy Saving Program (CESP)	Carbon reduction and addressing fuel poverty by requiring energy suppliers to achieve 19.25 million tonnes CO2 lifetime savings in the most deprived areas, promoting area-based and whole-house approaches to energy efficiency improvements.	Energy and communities	Mitigation
2010	Carbon Reduction Commitment Energy Efficiency Scheme (CRC EES)	Established under the Climate Change Act 2008, the scheme covers emissions by firms and public bodies not already subject to the EU system or substantially covered by other agreements. The CRC EES is complemented by several other policies to promote energy efficiency in residential buildings.	Cross-sectoral	Mitigation
2010	Feed-in Tariffs (FITs)	Accelerate investment in renewable energy technologies, by offering long-term contracts to renewable energy producers.	Energy	Mitigation
2010	Carbon Capture and Storage (CCS) - £1 billion Demonstration project	Capturing waste carbon dioxide (CO2) from large point sources, such as fossil fuel power plants, transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground	Energy – power stations	Mitigation
2011	Carbon Plan	Government - wide carbon reduction plan, including domestic and international emissions.	Government – cross sectoral	Mitigation
2012	Green Investment Bank (GIB)	Attract private funds for the financing of the private sector's investments related to environmental preservation and improvement.	Government – private sector	Adaptation
2012	Renewable Heat Incentive (RHI)	Payment system for the generation of heat from renewable energy sources	Non domestic sector	Mitigation

Appendix C:

Summary of interview responses by entity

	Dubai Supreme Council of Energy (DCE)	Dubai Municipality (DM)	Dubai Electricity and Water Authority (DEWA)
Role in planning process	Setting up energy related policies	Consideration of environmental constraints in city planning	Executing water and electricity plans
Q.1. What is your perception and general understanding of the environmental debate and its impact on the cities' development?	<p>This debate raised form the over consumption of energy and natural resources, which is a natural need for any developing country strive to grow globally. Economic development and urban growth is essential to maintain sustainability for all nations. However, a balanced approach must be applied to main environmental quality and preservation of natural resources.</p>	<p>Since the early existence of human being, people used to protect themselves from the environmental challenges to create their own comfort secure zone. Caves, buildings with local available materials and other means of shelters. The introduction of new building materials and technologies had led human to enhance human's life and change the standards of comfort level. Environmental issues are beyond people's control due to the dynamic nature of the solar system and the earth nature. These natural changes are getting commercialized to some beneficiary groups. They do</p>	<p>The impacts of economic growth had resulted at increasing demand on natural resources and energy and the shortage were substituted using new technologies, which increases the demand on energy leading to a direct increase in GHG emissions that pollute the environment and have a direct effect on climate change, in addition to other types of environmental depletion such as noise pollution, un balanced eco-system, shortage in renewable water resources</p>

		impact the cities development, and cities have to adapt to these impacts, and residences' lifestyles have to be modified to cope with the changes.	
Q.2: What are the environmental problems in the UAE	I would not call them 'problems' but rather challenges of implementation since the government has taken huge steps to preserve environmental quality in the UAE. Some challenges can be summarized below: <ul style="list-style-type: none"> • Lack of effective awareness program to influence people behavior and their responsibilities to protecting the quality of environment and understanding their 	<ul style="list-style-type: none"> - Depletion of underground water - Increasing temperature - extreme weather conditions - environmental sensitive areas such as aquifers, surface water, moving desert dunes increasing the risk of desertification - coastal erosion which was worsen upon the construction of artificial islands in Dubai - the protection of fauna and flora 	<ul style="list-style-type: none"> - Shortage in renewable sources of water - Drought - Low precipitation - Increasing temperature - Increase of CO2 emission.
Q.3: perception about Climate Change as phenomenon	role in making it daily lifestyle. <ul style="list-style-type: none"> • Lack of conversion facilities for recycling of some waste materials (glass, paper, others). • Integrated waste management facilities across the UAE. <p>Collective approach at national level for waste management can provide economically viable solutions.</p>	The current climate change trend is concerns mainly about the increase in ghg gas emission, but yet it is not proven to be a man-made issue, and the increase earth temperature is not proven to be the main cause of climate change, which happened before without human's interference in the era of ice age.	Climate change became a serious subject discussed worldwide. TEC had added it to 2013 objectives, and it is currently working with the DSCE to regulate the response to climate change. From my point of view, the major issues are the increasing emission of CO2, rising temperature, shortage in renewable sources of water, and

	<ul style="list-style-type: none"> • Increased level of GHG (particularly CO₂) must be addressed at national level by introducing alternative transportation fuel (Hybrid Cars, Biofuel) and increase mass transportation means (Metro). In addition, reduce emissions from industrial plants. 	<p>Melting of the north and south poles is a good example of the irrelevance of the subject. The melt wasn't from the surface, but from the bottom of the sea, which means the earth is heating from inside not from the atmosphere. So mitigating climate change is not the main issue. Energy consumption is highly needed in Dubai to minimize the impacts of the extreme weather conditions (adapt to the increasing temperature). Our priority in planning as highlighted above is the adaptation to the environmental consequences, and preserve the environment as much as possible.</p>	<p>desertification are the main issues pertaining climate change. The immediate response to these impacts is important to limit the undesirable future risks</p>
<p>Q. 4: what are the main sources, which contribute to this/these problem(s) in the case of Dubai?</p>		<p>Economic growth and lifestyle contribute to the problem. Monitoring of environmental degradation and increasing awareness of the impact of lifestyle is necessary to preserve the environment. the environmental department in DM is</p>	<p><u>CO₂ emission</u>: the high demand on transportation, high use of nonrenewable source of energy, the luxurious lifestyle adopted in Dubai, the high level of consumption in the emirate, the preference of economic priorities over the</p>

		responsible to monitor the environmental through the environmental policies set in the development process.	environmental concerns, the increasing use of A/Cs as an adaptation method to increasing temperature <u>Rising temperature:</u> . Dubai contributes to this increase by the high demand of fossil fuel consumption in transport, cooling, high use of electricity <u>Drought and lack of natural sources of water:</u> Dubai's modern life increased the demand of water, and water scarcity is a major risk substituted using desalination technologies.
Q.5: What are the threats, climate change may have, on urban development/ planning in Dubai?	- Increase of annual temperature - adverse impact on environment.	We don't consider climate change impacts as threats. They are challenges might be converted to opportunities if they passed the threshold of being a challenge. For example, the coral reefs challenges is currently converted to an opportunity with an economical base by conserving the coral reefs in near Jebel Ali Palm.	From my own point of view as water and electricity provider, the increase of CO2 emission and water scarcity are the major risks
Q.6: What are the measures that have been adopted by the government of Dubai to deal with climate change?	Dubai defined environmental targets in its Strategic Business Plan and has integrated performance measures	- Limit the development both inland and in the sea, - Identify environmental sensitive areas and try	The green economy initiative launched in 2012 by HH Sheikh Mohammad

	<p>in the implementation process. Government entities drive several initiatives to preserve environment and minimize adverse impact as it continue development of Dubai infrastructure and growth.</p>	<p>to preserve it and adapt to climate impacts.</p> <ul style="list-style-type: none"> - On buildings' level, Green codes were established by DM and it is already implemented on the government buildings and going to be enforced to all developments starting next year. - From an implementation point view on a city level, different key players are taking the responsibility to reduce CO2 emissions as directed by the government such as RTA, DEWA and Dubai Supreme Council of Energy under the direct supervision and monitoring of the Executive Council. 	
<p>Q.7: What are the main objectives of the strategic framework and what is the time frame to achieve these objectives?</p>	<p>Please refer to The Executive Council for copy of Dubai Strategic Business Plan (or you may search it online). The same for the questions below....</p>	<p>The objectives of Dubai urban strategic master plan are:</p> <ul style="list-style-type: none"> • Identify the urbanization parameters • Facilitate a competitive and sustainable spatial planning • Continue promoting responsive planning system and governance framework to streamline and guide 	<p>DEWA's contribution in Dubai's strategic framework is limited to:</p> <ul style="list-style-type: none"> • Reuse 95% of treated effluent water by 2020 • Reduce energy demand per capita by 30% by 2020 • Generate 10% of Dubai's energy demand from alternative renewable energy sources by 2020.

		<p>future spatial urbanization</p> <p>The timeframe set for this plan is 2020.</p> <p>However, every key stakeholder responsible for implementation is responsible to set its own short-term objectives to achieve the overall objectives</p>	
Q. 8: Who is leading the government action and what are the implications for coordination if any?	N/A	The coordination is the sole responsibility of The Executive Council under the leadership of the Infrastructure Committee.	In the energy sector, DSCE is leading all issues related to energy supply and demand. In issues related to carbon reduction, DCC is a leading knowledge repository on Carbon matters with a specific regional focus; accessible to all stakeholders in order to create strategies and climate change funds.
Q.9: What is the role of your organization in this framework?	Setting up energy policies aiming at reducing GHG emission	Consider the environmental constraints in the city planning	Diversify and increase supply efficiency and reduce demand for both electricity and water
Q.10: What are the adaptation and mitigation policies set to respond to climate change impacts?	<ul style="list-style-type: none"> - Electricity and water tariffs - Renewable energy polies 	As mentioned above, the adaptation measures in planning are to minimize the depletion of water resources, reduce coastal erosions, reduce desertification, and apply green building codes. These policies are set by the	<ul style="list-style-type: none"> • execute electricity and water tariff for all DEWA customers • Increase public awareness on the need to reduce consumption through conducting awareness campaigns, participation on the international

		operational departments in DM (environmental department and buildings)	campaigns such as Earth Hour, and providing tips to reduce electricity and water consumption to all DEWA customers • Constructing the first renewable energy project in Dubai (Dubai Solar Energy Park)
Q.11: How does your organization deal with climate change? (policies and actions)	DSCE set policies in coordination with different stakeholders such as DEWA, DM, RTA, (refer to DSCE organization structure available online)	Through the building permit process where it goes through different stages of NOCs (planning, environmental, Building, Roads and utilities)	- The control over demands (tariffs fees) - increasing awareness on the need to reduce consumption under a financial incentives. - Adaptation to the impacts of climate change will result in an increase of CO2, as a result on increasing cooling loads, therefore adaptation here is reducing consumption
Q.12: From your own point of the view, what are the main Strengths and Weaknesses associated with the current framework (policies and practice)?	N/A	Strength of the establishment of the government committees is the high flexibility of the framework that adapts the economic growth of the city that enables Dubai's leaders and decision makers to make quick decisions. However, the system is threatened by the lack of legislative laws to control environmental	No clear framework is available to tackle climate change, however the establishment of DSCE is a positive step towards setting up policies that respond to lots of environmental constraints that falls under the risk of climate change impacts

		<p>and urban planning and development.</p> <p>Key weaknesses from my point view are:</p> <ul style="list-style-type: none"> • Lack of coordination among key players (especially development control authorities) impacts the master development of city's spatial development. For example, the TIS is not properly studied by major developers and the impact of the new developments on existing areas are not considered effectively. • Lack of supportive Legislation • The confidentiality trend of developers impacts the coordination with the master plans set by the strategic plan • Lack of Community facilities (design and planning standards) among mega developments 	
<p>Q.13: How these weaknesses should be handled? In other words what should to be done to achieve resilient Dubai?</p>	N/A	<p>The establishment of Urban Planning Council was one of the recommendations issued to TEC to be the highest authority responsible for urban planning development in the emirate, but it is yet to be approved.</p>	