Climate Change Strategy for the Urban Planning and Development Sector in Qatar

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1. Introduction

The State of Qatar lies between latitudes `27 24° and `10 26° north of the equator and longitudes `45 50° and `40 51° east Greenwich line. Qatar is a peninsula situated in the middle of the west coast of the Arabian Gulf and extends northward into the Arabian Gulf. (MDP&S, 2017)Qatar is about 160 km in length from the south to the far north and about 89 km in width from east to west. Its total area is about 11,627 square kilometers. (MDP&S, 2017)Most of Qatar is a flat and rocky, sandy plain. Low hills punctuate the landscape, west and central, with massive sand dunes in the southeast.

The climate of Qatar is of a desert nature with high temperatures especially in the summer. The mean high temperatures in the summer are characterized with a relatively high humidity, especially in coastal areas. Winter in Qatar is warm in general with a drop in temperatures to low levels from time to time. Qatar suffers from scarcity of rainfall throughout the year. (MDP&S, 2017)

In the last 30 years Qatar has seen immense growth in industry, population and urban settlements. This has been driven by the oil and natural gas reserves that have been developed, contributing to one of the highest per capita Gross Domestic Product (GDP) in the world (Forbes, 2012). In response to this growth, a number of documents have been developed to guide and manage the impacts associated with these changes, including:

- Qatar National Vision 2030 (QNV 2030)
- Qatar National Development Strategy 2011-2016 (QNDS 2011-2016)
- Qatar National Masterplan (QNMP)

Qatar National Vision QNV 2030 has paid a special attention to the environmental theme, which is unparalleled in many Middle Eastern countries, and has dealt with the environmental development pillar on an equal footing with the rest of QNV four pillars; human development, social development and economic development.

Recent studies in the region reveal that the urban development and the economic growth in Qatar will be adversely affected by the impacts of climate change in near future. The 2009 report of the Arab Forum for Environment and Development on the Impact of Climate Change on Arab Countries (AFED, 2009) reveal that Qatar will be subject to high risk of inundation of its coastal areas, due to predicted Sea Level Rise (SLR) in the Arabian Gulf. Qatar's geography consists of a relatively flat terrain and as such, the inundation of the coastal areas stretches into its vast urban development, posing risks to life and causing significant property damages. Another study conducted by Qatar University in collaboration with the University of Portland, USA identified a large section of the urban settlements in Qatar that will be subjected to Heat Island Effect (HIE)[(1)] from climate change impacts, meaning extended period of relatively high temperature in certain areas, causing elevated level of discomfort, diseases and health issues. In terms of Green House Gas (GHG)

[1] Heat Island Effect :describes built up areas that are hotter than nearby rural areas (USEPA, 2016).

emission from all the relevant activities, including urban development, Qatar has the highest per capita emission in the world. Whilst the total volume of emission has not been considered significant on a global scale, the highest per capita emission poses a leadership challenge for country's leaders, as Qatar is a signatory to international protocols to reduce its GHS emission.

A number of studies and initiatives addressing climate change have been undertaken by the community and private entities in Qatar. For example, 'A climate change and temperature warning in Qatar' study was undertaken by Qatar University's Social and Economic Survey Research Institute (SESRI). From the different studies and initiatives, it can be summarized that there is a general acknowledgement and understanding of climate change and its effects in Qatar by its citizens and commercial entities. However, knowledge of certain impacts and how they may be mitigated seems limited.

Following the lead of the Qatar National Vision (QNV2030) and the Qatar National Development Framework (QNDF) a strategic spatial land use framework of the Qatar National Master Plan (QNMP), the Ministry of Municipality and Environment (MME) in 2018 has developed its Climate Change Strategy (CCS) for the Urban Planning and Development Sector for the state of Qatar.

The primary objective of the Climate Change Strategy is to address how urban planning and urban development can be managed effectively to reduce the impact of climate change. The focus on urban planning and development is achieved by concentrating on aspects directly or indirectly related to spatial land use in Qatar. Four key sectors that the strategy focuses on are: (i) adaptation to the risks of Sea Level Rise (SLR), (ii) reduction of Heat Island Effect (HIE), (iii) reduction of GHG emission and (iv) ensuring relevant emergency management systems are in place to avoid risks on life and properties.

The paper highlights the methodology and the process for developing the strategy with necessary actions and recommendations to reduce the impacts of climate change in the urban planning and development sector in Qatar. It also lays out a plan to progressively implement the proposed actions.

2. Climate change impacts in Qatar

It is a global phenomenon that climate change would have issues such as sea level rise and coastal flooding, temperature rise and Greenhouse gas (GHG) emissions affecting the development and infrastructures.

2.1 Sea level rise and flooding

All human settlements are either in or near the coastal areas, similarly, Qatar's major population centers and urban expansion also lie near the coastal areas. Therefore, Qatar's population is vulnerable due to the sea level rise. Currently, the data shows that the mean sea level at Qatar is already at an increasing rate of approximately 1.5 mm/year in Doha which is the capital city of Qatar. Within the Middle East and North Africa (MENA) countries, Qatar is the most vulnerable to sea level rise and associated flooding, as a 1m rise in sea level would affect about 3% of its area, while a 3m rise would affect 8% (UNDP,2010). The critical issue here is all these affected areas are within the current urban settlement zones that comprise approx. 8.5% of the total area of Qatar.

Climate change is almost certain to result in both higher sea levels and an increase in the frequency or magnitude of coastal flooding due to extreme weather events. Qatar currently receives a minimal quantity

of rain at approximately 80 mm per year, with the majority falling in the winter months. In any case, rainfall is increasingly likely to arrive as short, intense events, with an increased likelihood of flash floods.

Much of Qatar's land area is low lying and vulnerable, including parts of several municipalities and notably some critical public facilities e.g., major hospitals and police stations in Doha. The highest point in Qatar is only 103 m above sea level (Figure 1) and is relatively flat along the coast with relief increasing to the southwest. Urban and industrial development in Qatar has been concentrated in the low-lying coastal areas. As large tracts of land have also been reclaimed in the past 30 years, it is more likely to have increased coastal flooding from the sea level rise. The idea is that the risks and cost of flood damage can be reduced through planning by a range of methods through:

- Implementing appropriate planning regulations to guide the development in order to reduce flood risks from SLR
- Installing strategically located flood defenses
- Planning for future development away from flood-prone/flood-risk areas
- Including flood-resilient features in future designs

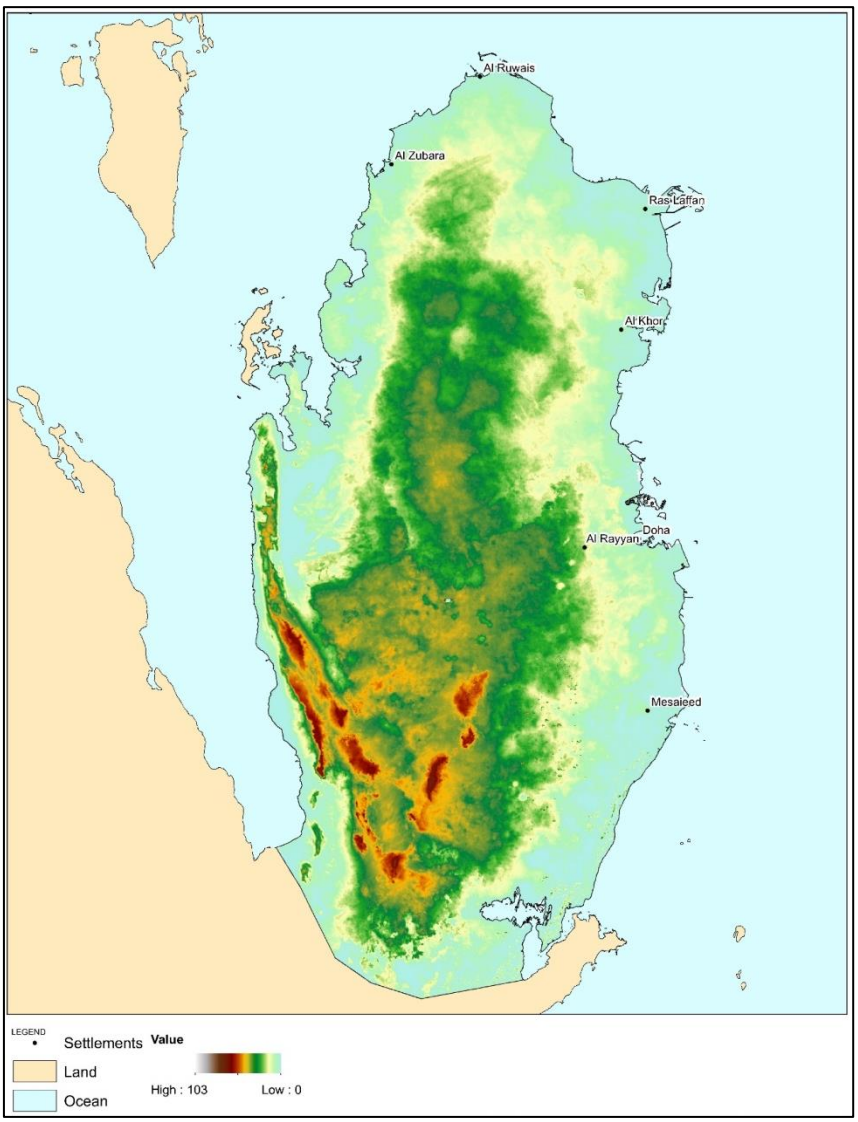

Figure 1 :The highest point in Qatar is only 103 m above sea level

Source : MME (2017). P. 2016/2: Climate Change Strategy for the Urban Planning and Urban Development Sector in Qatar. Stage 3: Situation Analysis Report. GHD Pty. Ltd.

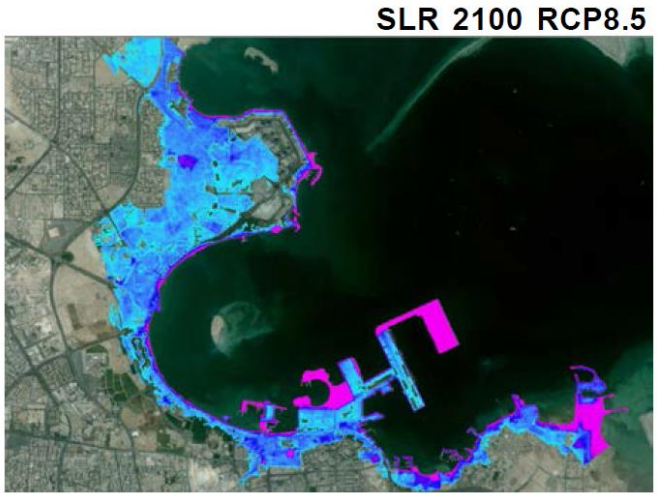

Figure 2 :figure showing the vulnerable areas from Sea Level Rise (SLR)/ Projected coastal flooding of Doha area by 2100

Source : Ministry of Municipality and Urban Planning (2014a) Integrated Coastal Zone Management Plan for the State of Qatar: Climate change and sea level rise study, Ref: MA 2.1. Dated 17 May 2014.

2.2 Increased Temperature

The International Panel for Climate Change (IPCC) expects temperatures in the Middle Eastern countries (including Qatar) to rise by about 2°C in the next 15-20 years, and by more than 4 °C by the end of the century. Recent modelling work reported in Nature Climate Change suggests that:

"By the end of the century, annual wet bulb temperatures in Doha will exceed 35°C several times in the 30 years, and the present-day 95th percentile summer (July, August, and September) event becomes approximately a normal summer day."(IPCC, 2001a)

35°C is the threshold wet bulb temperature beyond which any exposure for more than six hours would be intolerable for most humans, resulting in hyperthermia which becomes a medical emergency requiring immediate treatment to prevent disability or death. In the current climate, the wet bulb temperature rarely exceeds 31°C. Figure 2 represents an annual temperature profile between 1962-2013 showing the minimum, maximum, mean and the highest recorded temperatures.

In urban areas, increasing temperatures will be exacerbated by "heat island effect" and the key factors leading to the heat island effect include:

- Population density: Higher density corresponds to more heat (although not everywhere)
- Tower blocks with glassed outer walls
- Percentage of impervious surfaces
- Industrial activity
- Vehicular activity
- Increased frequencies of heat waves

Factors that may aid in reducing the heat island effect for future developments include:

- Parks, green areas, and water features for reducing temperatures – this is the most consistently considered factor.

- Wind flow management/ urban ventilation – consideration of urban design/planning for spaces that allow wind to flow through, especially coastal wind as this is cooler than the adjacent land areas.
- Environmental friendly city/neighborhood layouts – i.e. breaks between areas of the city through green/ shaded areas.
- Reduction of large impervious areas, particularly outdoor parking areas and wide roads with photovoltaic pavements
- Reducing traffic levels.
- Technical approaches like roof coatings, green walls, roof gardens, etc

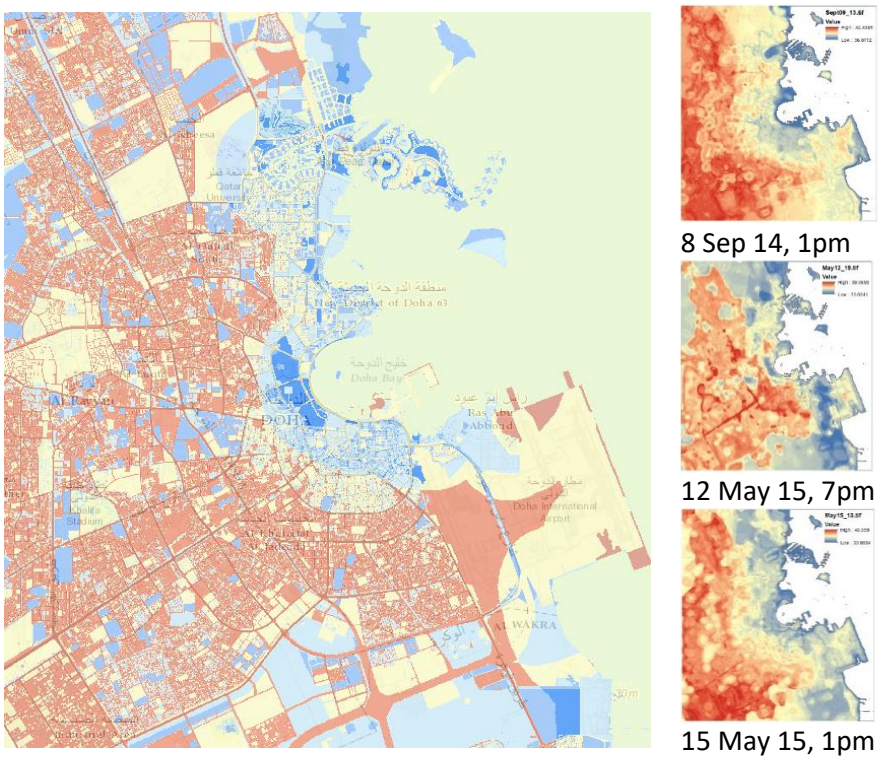

Figure 3 :Heat Island Map generated for Doha (left) with comparison of actual heat island measurements (right)
Source: NPRP research (#5-074-5-015) granted by QNRF

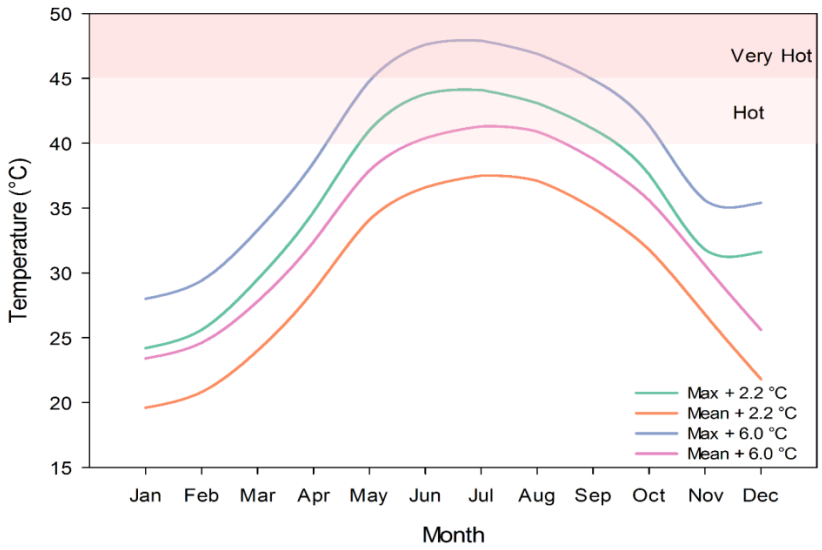

Figure 4 : The maximum, minimum, and mean temperatures in Qatar over the long-term period from 1962–2013 .

Source: Qatar Meteorology Department, 2016

2.3 Increased Green House Gas (GHG) Emission

According to the United Nations Climate Change Secretariat (UNFCC, 2015), Qatar has the highest per-person CO2 emissions in the world. Based on available data from Kahramaa (utility provider) and publicly available national greenhouse gas emissions inventory for Qatar, a baseline per capita GHG emissions of 14.7 metric tons CO_2e (CO_2 equivalent) is estimated.

The total baseline per capita GHG emissions include water and power (72%), transportation (18%), waste management and treatment (9%), and domestic use (1%). Approximately 90 % of the GHG emissions result from water and power consumption and transportation. Utility consumption data for commercial facilities/operations such as restaurants, hospitals, malls, etc. are not readily available.

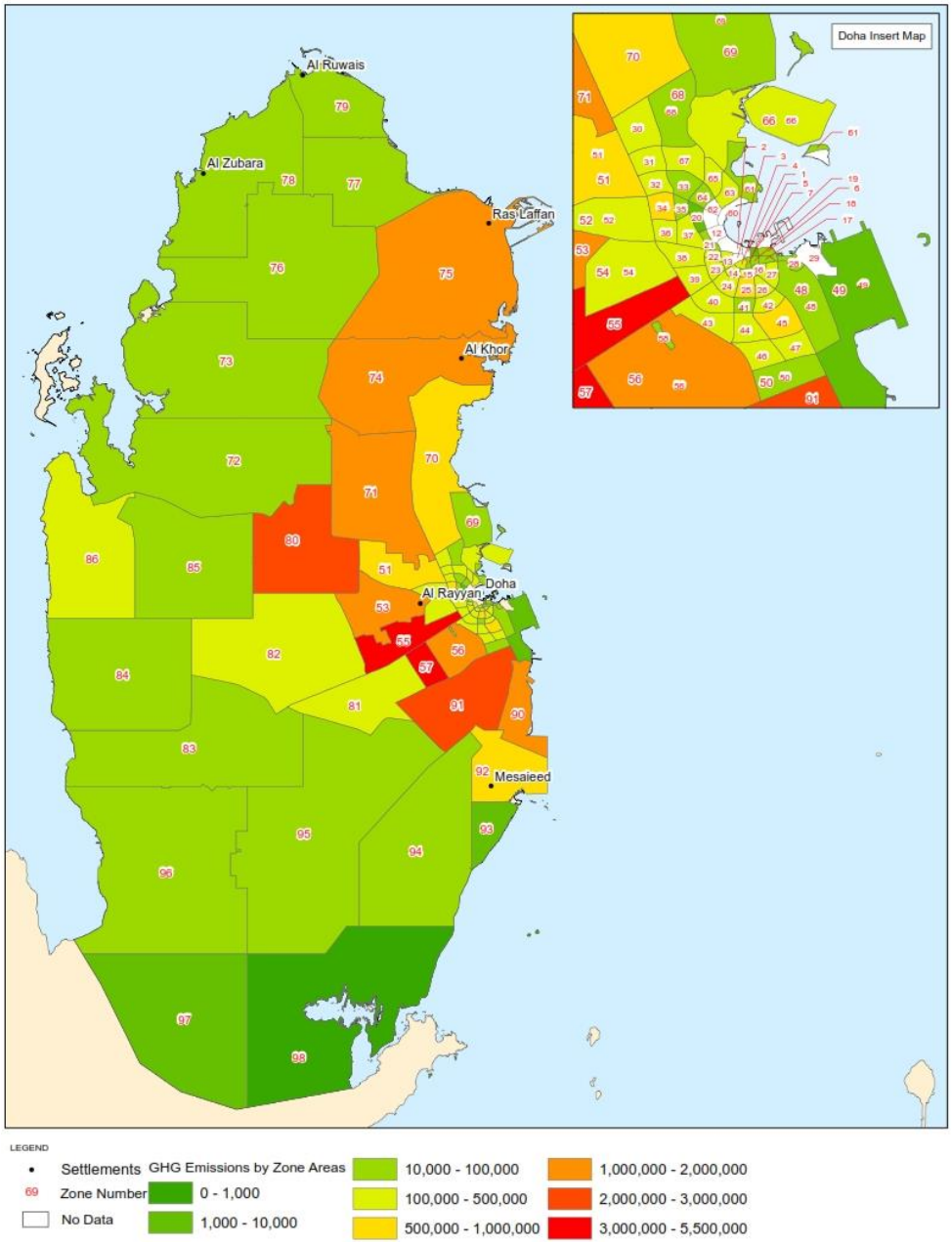

Figure5 : Baseline GHG emissions by zone

Source : MME (2017). P. 2016/2: Climate Change Strategy for the Urban Planning and Urban Development Sector in Qatar. Stage 3: Situation Analysis Report. GHD Pty. Ltd.

3. Climate Change Challenges for Qatar's Urban Planning and Development Sector

The Qatar National Vision 2030 aims to Transforming Qatar into a developed country by 2030, given that Qatar has the highest GDP in the world, capable of sustaining its own development and providing for a high standard of living for all its people for generations to come (GSDP, 2008).

This is a high level document for Qatar identifying a range of challenges it seeks to manage and address by the year 2030. It also provides roadmaps on development trends of Qatar by 2030.

There are challenges relevant to the Climate change. The aspects and relevance of these challenges to the Climate Change are detailed in Table 1 below:

Challenge	Aspect	Relevance to CC
The needs of this generation and the needs of future generations	This challenge identifies that continued dependence on hydrocarbons without developing other 'sources of renewable wealth' could be detrimental to Qatari society as hydrocarbons are a finite resource.	Utilizing hydrocarbons and associated GHG will influence the proposed mitigation and adaptation relating to land use planning.
Managed growth and uncontrolled expansion	Stress from rapid and/or uncontrolled growth can lead to financial vulnerabilities, environmental damage and widening social gaps and stresses.	Shows the value of planning and implies that the uncontrolled/ unplanned urban expansion is detrimental to the environment.
Economic growth, social development and environmental management	Acknowledges that development is likely to have a negative impact on the environment but states that development should be compatible with protecting and conserving the environment. If an environmental cost is identified from economic development, it should be "compensated with investments in technologies that help improve the environment" (GSDP, 2008).	Introduces the concept of compensation in spatial land planning and development. Places the economy before the environment, in some circumstances.

Table 1 : QNV challenges relevant to the Climate change

Source : MME (2017). P. 2016/2: Climate Change Strategy for the Urban Planning and Urban Development Sector in Qatar. Stage 2: Data and information collection and assessment Report. GHD Pty. Ltd.

The main challenges relating to Climate Change for Qatar is the development pressures for FIFA 2022 and massive infrastructure development while the ratification status on Climate Change convention that was in place since 1996 as part of the Kyoto Protocol and came into force since April 2005. Amendments to the Kyoto Protocol (https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment) requires Doha's commitments to comply with some of the UNFCCC's requirements. In 2012, Qatar hosted the Doha Amendment on Kyoto Protocol reassuring its commitments towards climate change. In November 2015 [https://unfccc.int/news/qatar-submits-its-climate-action-plan-ahead-of-2015-paris-agreement], Qatar submitted its new climate action plan to the UNFCCC. The Intended Nationally Determined Contribution (INDC) was submitted to set the target and direction of how Qatar is going to address climate change.

The commitment stated in QNDS 2011-2016 stipulates that the legacy of the FIFA 2022 must be considered when commissioning any projects, particularly in relation to the long- term socio-economic and environmental impacts. These include climate change impacts into industrial sectors to reduce CO2

emissions in Qatar; as well as improving governance on climate change impact of air pollution, environmental degradation.

For a developing country like Qatar, since there has been INDC being submitted to UNFCCC, the Ministry of Municipality and Environment (Urban Planning Department) has recognized the vulnerability of the footprint of urban sprawls and structures being constructed and developed maybe under future threats from potential climate change impacts; hence the initiation of this strategy is especially tailored for the urban planning and development sector.

4. Existing Climate Change Management in Qatar

At present, there is significant lack of awareness of the potential impacts of climate change in the region. As such no tangible initiatives have been undertaken to initiate relevant research to ascertain credible assessment of the impacts.

It should also be noted that there is a significant gap in Qatar's existing legislation and planning framework to specifically address the impacts of climate change such as sea level rise, increased flooding, and increased temperatures. Within the existing regulations and initiatives, there are no actionable measures to be implemented or supporting monitoring and review mechanisms to mitigate (if not eliminate) the identified climate change impacts.

The Climate Change Strategy (CCS) for Urban Planning and Urban Development Sector in the State of Qatar is aiming to engage stakeholders and citizens to mitigate some of the Climate Change impacts.

5. Proposed Climate Change Strategy

The Climate Change Strategy aims at comprehensively addressing how the built environment can effectively mitigate against and respond to Climate Change.

The role of the Climate Change Strategy is to:

- Guide and influence where development takes place
- Regulate urban planning, land uses and urban design
- Encourage and support household and community actions that reduce risk

Coordinate and support links between protection (disaster avoidance), disaster preparedness and post disaster response and rebuilding

Develop tools to estimate and predict GHG emissions and climate change impacts from the spatial urban planning and urban development activities in order to explore ways to minimize emission and at the same time support Qatar's commitments in the international platforms.

5.1 Strategy Vision

"*Urban development in Qatar will progressively reduce average per capita greenhouse gas emissions and be resilient to the potential impacts from climate change*"

5.2 Strategy Objectives

The strategy objectives are based on adaptation (i.e. managing the adverse impacts of current and potential future climate change to reduce associated risks) and mitigation (i.e. reducing the GHG emission to support Qatar's international commitments and its leadership) opportunities. Table 2 categorizes the key objectives as per the adaptation and mitigation potentials:

No	Strategy Objectives	Nature of the Objectives
1.	Protect members of population from effects of climate change	Adaptation
2.	Reduce travel demands and improve access to public transport in new developments	Mitigation
3.	Facilitate the optimal siting of solar energy installations through land use planning and integrate small scale solar energy generation into all new developments and major projects	Mitigation
4.	Facilitate emergency response at the planning and building permit stage for developments within high risk flood and heat island affected areas	Adaptation
5.	Design new and retrofit existing developments to be resilient against increasing sea level rise and associated flood events	Adaptation
6.	Monitor GHG emission in urban developments and make information publicly available	Mitigation
7.	Retain and protect sensitive ecosystems that sequester carbon	Mitigation
8	Incorporate 'Green Building' measures to improve the energy and water efficiency of homes and businesses	Mitigation
9	Design the urban form to reduce the urban heat island effect and energy demand	Adaptation

Table 2 : categorizes the key objectives as per the adaptation and mitigation potentials

5.3Action plans

Specific Actions have been developed for each category of key impacts, namely:

- Responding to Sea Level Rise and Flooding
- Responding to Increasing Temperatures
- Reducing Greenhouse Gas Emissions
- Protecting Biodiversity

An example of built environment mitigation/adaptation measures for each category of impact is provided below:

	Responding to Increasing Temperatures
Establish Vulnerable Coastal Zone to communicate risk and regulate development • Utilize the 1% AEP mapping to identify the Vulnerable Coastal Zone (VCZ) • Develop MSDP Zoning Regulation for VCZ to prohibit new development (with certain exceptions) • Update the existing and future zoning maps to incorporate VCZ • Continually update the 1% AEP contour as new sea level rise projections are made available with IPCC releases.	Improve green space in areas vulnerable to the Heat Island Effect • Utilize the finalized Qatar University UHI ongoing study to determine areas subject to the heat island effect and generate a hot spot map. • Overlay the hot spot map over future zoning maps to identify the need for any additional publicly accessible green space. Reallocate land use (if needed) and ensure the implementation of the green space. • Incorporate requirements for vegetation around buildings.
	Protecting Biodiversity
Create higher densities and mixed use to reduce travel demand • Require compact, mixed use development to the densities necessary to promote public transport	Introduce buffer zones to protect sensitive ecosystems • Commission a study into appropriate buffer zones and a need for migration corridors for

use • Require development to involve a mixed use (i.e. medium and high density residential and non-residential uses), with non-residential uses on the ground floor • Integrate walking, cycling and public transport networks into existing mega-projects • Implement higher residential density targets for new development. • Require new development to be sequenced, such that with development further from existing urban areas is permitted only after areas nearer the existing urban areas have been developed.	Qatar's Protected Areas and mangroves. • As an interim measure, prohibit development within 250 m of Protected Areas, mangroves, seagrass and coral reefs. • Include requirements in the MSDPs to identify and protect the buffer zones from any future development. • Provide a minimum of 250 m width 'escape routes' from Protected Areas. Where this is not possible due to existing development, provide a continuous wildlife corridor that is as wide as possible.

Table 3 : built environment mitigation/adaptation measures for each category of impact

5.4 Implementation of the Strategy

The Climate Change Strategy will be implemented by developing specific initiatives to support the above action plans. These initiatives include the following:

1. Development of a 'planning overlay flood layer' that represents the areas subject to specific categories of risks from the SLR and increased rainfall intensity. This overlay layer will then be supported by a series of land use regulations. (An example of the Policies and Policy Actions outputs of the strategy : Establish Vulnerable Coastal Zone (VCZ) to communicate risk and regulate development)

Output from actions	**SL1: Establish Vulnerable Coastal Zone (VCZ) to communicate risk and regulate development**
Specific Actions	**SL1-1**: Utilize the 1% AEP mapping to identify the Vulnerable Coastal Zone (VCZ). **SL1-2:** Develop regulations for VCZ to prohibit new development (with certain exceptions). **SL1-3:** Update the existing and future zoning maps to incorporate VCZ as an overlay. **SL1-4:** Continually update the 1% AEP contour as new sea level rise projections are made available with IPCC releases.
Mechanism	Overlay on existing and future Zoning maps (SL1-3)
Implementation responsibility	MME-UPD
In coordination with	MME-IPD (SL1-1 and SL1-4)
Timeframe	Immediate
Resource implications	Low cost (SL1-1, SL1-2) Medium cost (SL1-3, SL1-4)
Performance Indicator	Establishment of a VCZ

Table 4 : Establish Vulnerable Coastal Zone to communicate risk and regulate development

Source : MME (2017). P. 2016/2: Climate Change Strategy for the Urban Planning and Urban Development Sector in Qatar. Stage 4: Strategy Report. GHD Pty. Ltd.

2. Development of specific urban design guidance and tools that will be included in the Qatar Urban Design Compendium (currently under development phase). These tools will propose with benchmark examples the best practice neighborhood and building design guidance/ requirements that considers climate friendly design options including conservation of resources, climate friendly building materials, environmentally friendly infrastructure, waste minimization etc.

3. Specific planning requirement (with specific template) for submission of a "Climate Change related Disaster Management Plan" in the event of an anticipated emergency.
4. Tools to estimate and predict GHG emissions and reducing climate change impacts for the spatial urban planning and urban development activities. The proposed tools include the following modules:
    - **Urban Planning Module**
      Key function: To estimate and project GHG emissions and GHG intensity based on land use categories. It compares GHG emissions associated with current land use, as well as projected future land uses, for a particular parcel of land. It also has the capability to display heat island and building floor level information.
    - **Building Application Module**
      Key function: To estimates the GHG emissions associated with construction activities and materials (e.g. demolition, site preparation, and construction portion of the real estate development process). It is intended to be used once in the lifecycle of each project to evaluate the expected GHG impacts, both from emissions during the construction process and embodied carbon in the materials used. It has the capability to capture greenhouse gas emission associated with the construction process.
    - **GHG Emission Tracking Module**
      Key function: To collect annual CO2e emissions resulting from specific reportable activities undertaken by major urban emitters. This tool has the ability to capture greenhouse gas emissions associated with ongoing operations at a site.

6. Conclusion

- Qatar is subject to considerable risks from climate change impacts that poses significant threats/ hazards to life, properties, infrastructure and necessary services
- Urban planning and development sector needs to play an important role to address the impacts of climate change because careful planning with regulatory instruments can prepare a safe and resilient spatial urban settlement.
- Ministry of Municipality and Environment, being the urban planning legislative body in the State of Qatar has recognized and evaluated the risks from climate change impacts and proposed a comprehensive strategy supported by specific action plans and tools for implementing the strategy.
- Public awareness and understanding of the climate change related risks are not that strong at present, hence a comprehensive education and awareness program would be necessary at all levels of public and private sectors including the citizens through all ages and educational backgrounds. The awareness would influence taking ownership of the issue by the general public and assist in welcoming the implementation of the strategy.
- Current institutional and planning regime is already facing major challenges in implementing a recently introduced new planning regulations and planning system. The climate change related regulatory instruments are yet to be included in this new planning system and is expected to face considerable difficulties in understanding let alone implementing them. Stakeholder consultation at the time of developing the strategy and actions plans was an integral part of the project, however, because of lack of understanding and lack acknowledging the problem, the participation was not very effective.

- A comprehensive plan for on-the-job training is currently being planned for its execution for all relevant internal and external stakeholders.
- The next amendment of the planning regulations that is due in less than six months would include all the regulatory requirements of the climate change strategy.
- There will be a need for establishing an inventory to capture the GHG emission from the land use and development activities.
- The MME management needs to demonstrate a significant leadership role in facing the challenges posed by the climate change in Qatar and take ownership of the strategy actions to support implementing them

7. Acknowledgements

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