

Sustainable Coastal Cities between Theory and Practice (Case Study: Egyptian Coastal Cities)

Ingy M. El Barmelgy¹ & Sarah E. Abdel Rasheed¹

¹ Architecture Department, Faculty of Engineering, Cairo University, Egypt

Correspondence: Ingy M. El Barmelgy, 12 hanora tower, El barmelgy street of Al bahr El Azam street, Giza, Egypt. Tel: 12-2234-5178. E-mail: i_barmelgy@yahoo.com

Received: June 15, 2016 Accepted: June 29, 2016 Online Published: July 30, 2016

doi:10.5539/jsd.v9n4p216

URL: <http://dx.doi.org/10.5539/jsd.v9n4p216>

Abstract

Climate change is no longer considered an environmental or scientific issue but rather a developmental challenge that requires urgent, dynamic policy and technical responses at the regional, national and local levels. Its actions and responses impact sustainable development, ensuring the integrity of all ecosystems and the protection of biodiversity. There has been an intensive discussion and research about sea level rise (S.L.R) one of the most negative impacts of climate change which affects many coastal cities around the world. Egypt is considered one of the top five countries expected to be impacted with S.L.R in the world, especially northern areas of the Nile Delta and cities located on the Mediterranean coast.

This paper aims to evaluate the impact of S.L.R on the urban development strategies of the Egyptian northern coastal cities; highlighting the national response to global efforts regarding this problem in order to enhance the capacity for the adaptation and mitigation of potential impacts in the long term. Finally, it suggests some recommendations and framework actions to be taken to help Egyptian coastal cities in dealing with climate change over different timescales.

Keywords: climate change, coastal erosion, Egyptian coastal cities, sustainable development goal 13, sea level rise, urban development

1. Introduction

Coastal cities represent a point of attraction for both residents and activities all over the world. On the global level, coastal areas represent 20 % of Earth's total surface and a large portion of the total urban population lives in the major cities located in them. Ports and their related economic activities such as shipping and maritime transporting, in addition to activities that depend mainly on ecosystem resources such as tourism, fishing and aquaculture are the main activities that are based on coasts and work as a point of attraction for large numbers of workers and the population (Cummins, O Mahony, & Connolly, 2002). These qualities provide coastal settlements with a plethora of advantages, based on the coast's economic, ecological, aesthetic and scientific values.

This attraction poses a grave risk to both coastal environments and the people that live in them due to the intensity of urban development along the coastal strip. This has accelerated markedly, especially in low and middle income countries over the last half century. It is estimated that more than half of the world's coastal countries; at least 80% of the national population lives within 100 kilometers of the coastline. Additionally, 16 of 23 megacities around the world –cities with ten million or more inhabitants – are located in the coastal zone. This urbanization became a critical driver of environmental transformation on the coast, as it led to increased exposure of human life and assets to a wide range of hazards associated with a coastal location including coastal flooding, cyclones and tsunamis. Environmental health concerns and the added pressures of climate change impacts that are faced by both the environment and society include S.L.R and coastal erosion (Blackburn & Marques, 2013).

Climate change and its negative impacts, S.L.R and coastal erosion, is considered the biggest threat facing sustainable development elements (socio-political, economic, and environmental sustainability) at coastal areas as it threatens the population, economies, and limited resources of the countries of these zones. Therefore the United Nations emphasizes that the fight against climate change requires urgent actions, according to the provisions of the United Nations Framework Convention on Climate Change (United Nations [UN], 2012). Also, Mediterranean Strategy for Sustainable Development (MSSD) confirmed that without facing the climate change

problem, it will pose a serious risk to economic growth and may jeopardize the achievement of the Sustainable Development Goals (SDGs) in most Mediterranean countries (United Nations Environment Programme – Mediterranean Action Plan [UNEP/MAP], 2016).

Egypt is one of 21 countries bordering the Mediterranean, located in the southern part. The Mediterranean represents the northern borderline for Egypt with 1550 km length as one of the longest Mediterranean shores in North Africa, Egypt's Mediterranean coast and the Nile Delta have been identified as two of the most vulnerable areas to climate change and S.L.R as the dominant feature of Egypt's northern coastal zone is the low lying delta of the River Nile. The Intergovernmental Panel on Climate Change (IPCC's Fourth Assessment Report 2007) posits an upper boundary for global sea-level rise by 2100 of 0.59 which means that 3.3% of total land area of the Nile Delta will be lost to the sea by the coming decade, including submersion of approximately 16 km² of valuable currently cultivated land in the absence of adaptive action (United Nation Development Programme [UNDP], 2009).

Alexandria, Damietta and Port Said are highly populated cities and effective economic spots located at this coastal zone. These cities are centers for most of the importing, industrial and tourism activities. Moreover, trading, transportation networks, and a large number of harbors are found on these coasts, along with their important role in providing income and food security for a broad sector of inhabitants in this area and the whole country (El Raey, 2010). The potential impacts of sea level rise will affect all these sectors including agricultural quality and productivity, freshwater availability, public health and socioeconomic welfare.

This paper will draw attention on the risks that face the urban development of the Egyptian Mediterranean coastal cities due to the potential impacts of S.L.R on built-up areas, roads and economic / social effects of job losses and population displacement, also it will discuss the government's response to address this problem and the challenges in practice that reduce response efficiency. Finally, a set of recommendations will be discussed to develop an effective framework covering the gaps that reduce the efficiency of integrated protection, mitigation and adaptation plans into national programs.

2. Sea Level Rise Impacts on Mediterranean Coastal Cities

Mediterranean coastal areas have always been attractive points for development. The population of its countries grew from 276 million in 1970, and 412 million in 2000, to 466 million in 2010, and predicted to reach 529 million by 2025. Overall, more than half of the population lives in countries on the southern shores of the Mediterranean and that proportion is expected to grow to three quarters of the population by 2025. The biggest problem in continued population growth and infrastructure is the linear nature of coastal urbanization resulting in nearly 40% of the total length of the coastal area already being occupied. In fact, more than one third of the population lives in coastal administrative entities totaling less than 12 % of the surface area of the Mediterranean countries. The population of the coastal areas of the Mediterranean grew from 95 million in 1970, to 143 million in 2000, and could reach 174 million by 2025 (UNEP/MAP, 2016), figure1.

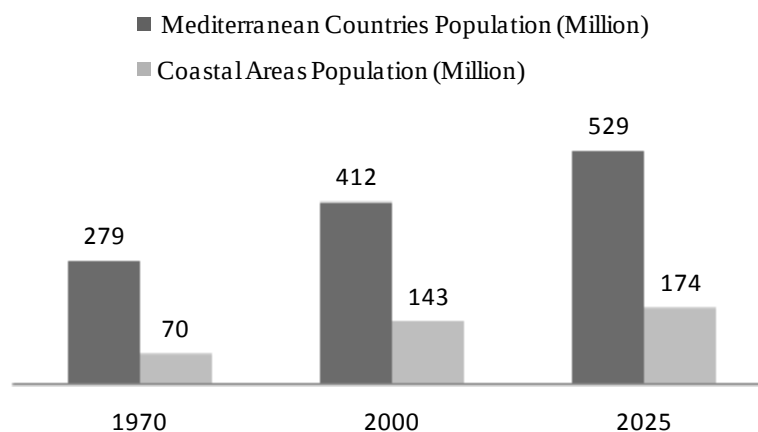


Figure 1. Total population of Mediterranean countries & Coastal areas (million)

In its recent Fifth Assessment Report (2014), the Intergovernmental Panel on Climate Change (IPCC) considered the Mediterranean region as “highly vulnerable to climate change” and stated that it would “suffer multiple

stresses and systemic failures due to climate changes”. Furthermore, according to the conclusions from the project on “Climate change and impact research: the Mediterranean environment” funded by the European Union: the sea level of the Mediterranean might increase, causing adverse impacts on coastal areas. The projected mean sea-level rise expected in the period 2021–2050, owing to thermal expansion and salinity-density compensation of sea water, might be in the range of about +6/+11 cm (UNEP/MAP, 2016).

On the Southern and Eastern rims of the Mediterranean, over 50% of the urban population (18% of total urban areas) lives in coastline areas located within 10 meters of the current sea level (low-lying zones) (United Nations Environment Programme – Mediterranean Action Plan (UNEP/MAP, 2009).

Egypt, the ninth of ten nations ranked as having the largest urban populations in low-lying zones, has more than 10 million inhabitants. This figure is expected to increase over the coming years, which doubles the risk from the impacts of sea-level rises that are estimated to increase from 18cm to 59cm up to the end of the 21st century (Satterthwaite, 2008).

3. The Impact of Sea Level Rise on the Mediterranean Egyptian Coastal Cities

The Mediterranean Sea is the northern borderline of Egypt; it extends for 1550- km from Rafah in the east on the Sinai Peninsula to Sallum in the west on the Egyptian-Libyan border. Egypt, with 3 other countries, account for about 60 % of the total population of the Mediterranean region: Turkey (81 million), Egypt (72 million), France (62 million), and Italy (60 million) (United Nations Environment Programme – Mediterranean Action Plan [UNEP/MAP], 2012).

Egypt possesses 36 coastal cities located in 4 coastal regions; these cities include 22 cities located at northern coast, as shown in table 1. (*Egyptian Census*, 2006) indicates that Alexandria is the biggest coastal city in Egypt (4.084 Million P.); while Gamasa is the smallest coastal city (2.074 Th. P.).

Egypt faces serious risks from climate change, as its weather is already hot and dry. Higher temperatures alone increase the need for water supplies, create more heat stress, exacerbate already high levels of air pollution and affect fisheries. In addition, S.L.R threatens settlements and agriculture in the Nile Delta and cities located on the northern coast of Egypt due to its relatively low elevation.

(Smith, McCarl, Kirshen, & Abdrabo, 2013) confirmed that Egypt could face a significant reduction in agricultural production, both losses of property and higher coastal protection costs with losses in tourism revenues. Unemployment would increase due to land losses in the agricultural sector and total economic losses by 2060, could be several hundred billion EGP per year. In summary, Egypt would be worse off and threatened under projected climate change.

Table 1. Distribution of the Egyptian Mediterranean coastal cities on governorates and regions

Regions	Governorate	Number of coastal cities	Coastal cities
Suez Canal	North Sinai	4	Arish – Beer Abd – Rafah – Sheikh Zowid
	Port Said	1	Port Said
Delta	Damietta	4	Damietta – Ezbet Borg – Ras Elbar – New Damietta
	Dakahlia	1	Gamasa
	Kafr El Shikh	1	Baltim
	Behera	2	Edko – Rosetta
Alexandria	Alexandria	2	Alexandria – New Borgarab
	Matrouh	7	Matrouh – Hammam – Negela – Saloum – Dabaa – Sedi Brani – Alamin

Nile Delta is considered the main region that comprises the majority of the population and activities of the state (50% of Egypt's population and about 70 % of the nation's industrial and commercial activities). This region is highly exposed to S.L.R impacts due to its low land elevation and local land subsidence. In addition, erosion has an effect on its shoreline as shown in figure 2. Millions of people could force displacement due to the expected probability scenarios of climate change and sea-level rise, which concluded that S.L.R could cause inundation and saltwater

intrusion for a large percentage of the Nile Delta lands (El Raey, 2010).

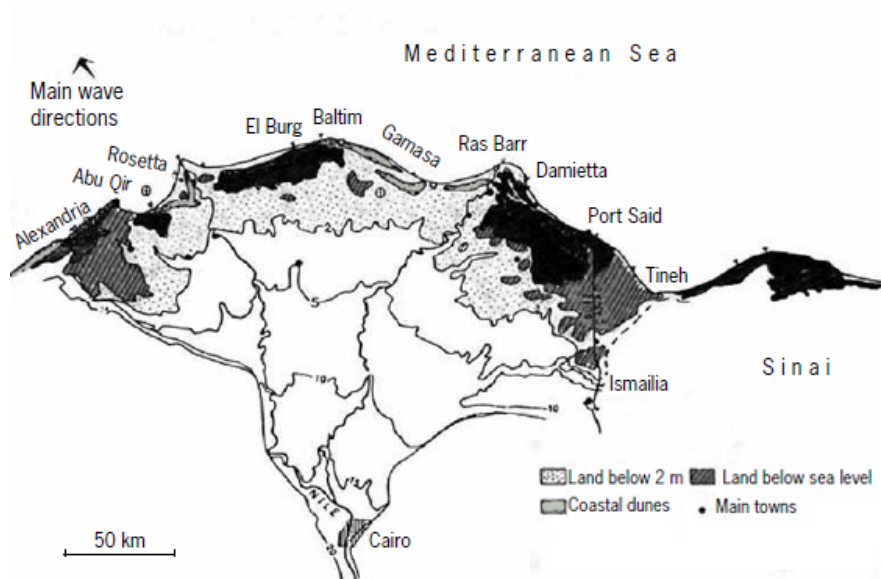


Figure 2. Topography of the Nile Delta Region

3.1 The Impact of Sea Level Rise on Urban Development

This part focuses on the expected impacts of S.L.R and coastal erosion on the urban development of coastal cities as it considers one of the most affected sectors that reflect on all sustainable development dimensions. Egypt as a developing country all the attention in development plans is being paid for housing, infra structure, agriculture and economic projects. The unstable political and financing situation puts the governmental plans in problem solving situation never in planning risk avoidance.

3.1.1 Agriculture Lands

The low-lying Nile Delta is Egypt's most productive agricultural region, table 2 displays the amount and percentage of agricultural land in the Nile Delta that would be inundated by 2060, in instances when the Nile Delta is unprotected and protected from S.L.R. Protection reduces potential losses to close to zero (Smith et al., 2013).

Table 2. Amount and percentage loss of agricultural lands in the northern Nile Delta in 2060

	Northeast Nile Delta		North-Middle Nile Delta		West Nile Delta	
	Km ²	%	Km ²	%	Km ²	%
Climate scenarios for SLR						
High S.L.R 2060 protected	25.8	1.8	137.2	2.7	15.0	0.3
High S.L.R 2060 unprotected	774.3	52.7	523.9	10.4	625.6	13.2
Low S.L.R 2060 protected	4.8	0.4	31.2	0.6	0.0	0.0
Low S.L.R 2060 unprotected	449.3	30.6	129.5	2.5	10.6	0.2

3.1.2 Urban Settlements and Roads

Alexandria, Port Said, Damietta and Rosetta are the major Mediterranean Egyptian coastal cities that encompass the urban population. A large portion of the 50 km wide coastal strip lies below 2m above mean sea level and is protected from inundation and flooding by only a 1 to 10 km wide coastal sand belt. It's estimated that 1.3 million people could be displaced from these areas by 2050 due to the rapid erosion that faces the sand belt, which also protects coastal lakes and lagoons. This result from the low rate of sediment associated with the construction of the Aswan high dam and sea-level rise.

Previous studies on sea-level rise impacts conveyed that without any additional adaptation, 1m of S.L.R could lead

to a loss in agricultural lands and cause population displacements, making Egypt the first and second most impacted developing country (of 84 developing coastal nations), due to inundation and erosion problems (Brown, S.Kebede, & J.Nicholls, 2011). Table 3 shows the estimated annual value at risk (billion EGP) for S.L.R different scenarios.

Table 3. Annual value of housing units and roads in the Nile Delta at risk from S.L.R (billion EGP)

S.L.R scenario	Housing units		Roads	
	2030	2060	2030	2060
	Pessimistic		Optimistic	
Low	1.0	1.9	1.4	4.4
Middle	1.0	2.4	1.5	5.5
High	1.1	7.2	1.6	16.3

With expected continuing sea-level rise, major Mediterranean cities will be highly affected. Alexandria, Egypt's second largest city has 35% of its land area below mean sea level. It is expected that 68% of its land could be inundated and the whole of its population (4 million according to assuming the population of 2006) could be forced to move if there is no upgrade in protection levels. Also, Egypt's second largest harbor and an important industrial, trade and tourist centre, Port Said city, is exposed to losing assets worth more than US \$2.2 billion, in case of 0.5m rise in sea level due to losses 0.5 of 13% (0.05km²) industrial, 8% (0.46km²) urban area and 1.6% (21km²) beach area, and other physical and socio-economic losses in Port Said governorate. For other Egyptian Mediterranean coasts, although there are no certain statistics that evaluate their vulnerability to sea-level rise, any tourism and infrastructure developments at low lying areas may be significantly at risk from relative sea-level rise (Brown et al., 2011).

Also it is important to highlight one of the most vulnerable urban areas of the coastal cities, slum areas; where poorer groups that moved from rural to urban areas searching for jobs are concentrated often near to the shorelines as they depend on the sea for living (fishing, boating industry and primary jobs that depend on the waterfront). These areas are more exposed to the significant risks resulting from climate change and are least able to avoid the potential effects of sea level rise through living in planned areas with planned infrastructure networks and homes that are built according to building codes. They cannot either change their jobs as their livelihoods depend on the coast.

Slum areas can found at 16 of 22 Mediterranean Egyptian cities. The largest found at Edko city- Behera governorate and estimate by 93% of total urban area of the city, and the smallest at Ras El Bar city – Damietta Governorate and is about 1.6% of total urban area of the city (*National map for unsafe areas*, 2015).

4. Theoretical Responses to Potential Impacts of Sea Level Rise on the International and National Levels

The United Nations has warned of climate change and its negative effects, particularly on developing countries that already suffer from these effects. Also it stressed that these changes would affect efforts to eradicate poverty, achieving sustainable development and threatening the safety and survival of these countries by increasing droughts, extreme weather events, S.L.R, coastal erosion that threaten food security and the economic bases of these countries.

Therefore, the United Nations called all countries for cooperation through participating in an effective international response to put urgent actions and draw policies to reduce these effects (UN, 2012).

The United Nations Framework Convention on Climate Change adopted in New York in 1992, started international political response to climate change by developing a framework which aims to stabilize greenhouse gas levels in the atmosphere in order to avoid rising temperatures. In 1997, an international agreement linked to The United Nations Framework Convention on Climate Change "The Kyoto Protocol" was adapted to commit the international community with internationally binding emission reduction targets. Several roundabouts were held over the past years in Copenhagen, Canon, Durban, Doha, Warsaw, Lima in order to address deficiencies and enhance the performance of those agreements. In 2015, The United Nations Framework Convention on Climate Change adopted the Paris Agreement which aims to strengthen the global response to the threat of climate change. In the context of the 2030 Agenda for sustainable development, in particular its 13th goal (Take urgent action to

combat climate change and its impacts), eradicate poverty and increase the ability to adapt to the adverse impacts of climate change (*Framework Convention on climate change*, 2015).

Also a Strategic Framework for Adaptation to Climate Change in the Mediterranean Marine and Coastal Zones is currently being developed by UNEP/MAP and should be followed by detailed Regional Climate Change Adaptation Action Plans with common regional priorities in order to increase the resilience of the Mediterranean to climate change, as confirmed by The Mediterranean Strategy for Sustainable Development (UNEP/MAP, 2016).

(The World Bank [WB], 2010) and (UNEP/MAP, 2016) explained the difference between adaptation and mitigation actions that: adaptation impacts primarily on a local scale. Actions are based on specific needs of the affected regions and it's not "only" about responding directly to the impacts of climate change but also about tackling wider sources of existing vulnerabilities, while mitigation is a global effort requiring broad changes of behavior, technological advancements and require fundamental changes to urban systems. It's not "only" about avoiding dangerous climate change but also an opportunity to re-orientate the way we use natural resources to sustainable paths.

Since 1992, Egypt has shown a strong response to the international and regional efforts that aim to enhance the capacity for adaptation and mitigation to the potential impacts of climate change and sea level rise to protect its land. Furthermore, it tried to work on an integrated approach that considers mitigation, adaptation and urban development.

As a response to the international demands related to mitigation actions, Egypt has committed with all international and regional agreements and protocols that have been established since Kyoto Protocol, finished the first and second national reporting reports, which include an inventory of emissions, proposed policies and measures to counter the effects of climate change, and expanded in the field of international and regional cooperation for climate change and clean development mechanism. It did this by establishing The Egyptian Council for Clean Development Mechanism, The National Committee for Climate Change and finally The National Council for Climate Change (2016) as an executive step in the context of dealing with the Framework Convention on Climate Change. This resulted from the Paris conference 2015 (*Egypt vision 2030*, 2016)

On the national level (adaptation efforts), The Law for the Environment (Law No.4 for the year 1994) regulated protection of the marine environment and authorized construction of coastal structures to protect some vulnerable coastal areas from erosion (UNDP, 2009). In 2008, the Global Environment Facility (GEF) cooperation and Egypt launched the project of Adaptation to Climate Change in the Nile Delta through Integrated Coastal Zone Management (ICZM), in order to reduce the potential impacts of S.L.R on low lying areas of the Nile Delta. Also it aimed to enhance the ability of reducing the possible risks and developing infrastructure networks in addition to developing an integrated coastal zone management framework (Nile Delta ICZM) by documenting lessons learned and best practices for climate change adaptation responses (UNDP, 2009). Also, it prepared The National Strategy for crisis management and disaster risk reduction (2010). The National Adaptation Strategy for Climate Change and Disaster Risk Reduction for the Resulting (2011) produced several projects and programs regarding the vulnerability and adaptation of climate change, climate change risk management and low emission capacity building "www.eea.gov.eg".

5. Challenges in Practice Facing National Efforts

Egypt's government is facing many challenges that mitigate and adapt with climate change and S.L.R issues such legal, institutional, financial, rising awareness and activating participation for different stakeholders challenges, which may reduce the expected output of the national efforts, that mentioned before, these challenges can be summarized in:

First, decision making challenges, there is limitations and Jurisdictional conflicts over who can or must take action on specific initiatives, as there is no legal basis in Egyptian law for defining roles and coordinating between responsible ministries for ensuring coastal protection, the absence of UN Framework Convention recommendations related to adaptation actions in the short term national plans (including coastal erosion and beach protection, sea-level rise, etc.) and measures absence that respond to the existing threat of coastal erosion, future impacts of S.L.R and consider an essential tool for early vulnerability assessments. All these aspects will affect adaptive actions for protection threaded coastal areas as there is no future vision on specifically expected losses (UNDP, 2009).

Second, financial challenges, (UN, 2012) confirmed on the importance of allocating resources to implement the requirements of sustainable development that corresponds with Egyptian plans. So far, Egypt has managed to

accomplish a limited proportion of the required facilities for coastal protection due to the limited availability of resources and poor coordination between the competent authorities, which is causing the acceleration of coastal erosion (UNDP, 2009), so the risks of S.L.R to settlements and other uses of coastal areas need to be considered when allocating resources among the concerned ministries as this issue will greatly affect the rest of all development sectors.

Third, technical capacity and awareness raising challenges, on the governmental level, national agencies do not have the needed technology to monitor the effects of climate change, in particular S.L.R. As well as there are no appropriate indicators to assess or anticipate the current and future conditions, causing ongoing degradation of shoreline and marine habitats through erosion, especially with the absence of a clear vision of the role of shore protection projects (UNDP, 2009). According to State of Environment (2016), lack of community participation to preserve the environment and the low environmental awareness are the main reasons for doubling the impact of sea-level rise and coast erosion. There are no legal or institutional mechanisms to identify how to include public participation in the planning process or in the decision-making stages. Also there is no basis to ensure users have access to the relating information of coastal environment state, which complicated the process of conflict management among users of coastal resources.

Finally, adding new patterns of development and the rapid urban development for the North Coast area, the social pressure on the government to meet the needs of the increasing population, unemployment, competition for utilization available resources, indiscriminate development plans and investments are other important reasons for delaying national efforts results (*State of Environment*, 2016).

6. Discussion and Recommendations

In relation to decision making challenges, it's well known that climate change has impacts on various development sectors such as urban areas, including infrastructure networks and transportation, economic sectors, such as agriculture and energy, and the public health sector. The public sector requires high levels of cooperation and coordination between all actors involved in the adaptation and mitigation processes, whether they are governmental, non-governmental (local communities, non-profit organizations and academic institutions), or private sector entities. Due to the conflicts and shortage of legal and institutional procedures at the national level, The World Bank (2011) shows that by developing a framework that determines the specific roles of the responsible parties for adaptation policies implementation, determining all variables and addressing all the gaps and problems affecting the capacity building process, cities can come up with a strong administrative system that is flexible towards the implementation of adaptation policies and sustainable development principles.

Regarding financing challenges, The World Bank explained that Climate finance is a complex field, and adaptation-specific funding is still relatively limited as all of international climate funding will be channeled through national governments. City access to funding remains uncertain, especially as climate change activities are usually assigned to Ministries of Environment, which do not focus on urban issues (WB, 2010). It suggests some methods that cities can activate to provide private resources for funding experiments and innovative effective tools for adaptation projects such as the use of national allocations for each municipality, resources and grants from donors or the private sector (WB, 2011).

In rising awareness filed, cities need the efforts of all concerned groups to assist in raising the efficiency of adaptive operations. International and national organizations, academic institutions, non-governmental organizations (NGOs), residents and the private sector are the main involved groups. The World Bank (2011) has suggested different methods to benefit from these groups' efforts in developing adaptation strategies such as: helping stakeholders to understand what their city faces due to the potential impacts of climate change and how can cities reduce these impacts through adaptation plans, policies, and actions to ensure their well-being. Also encourage citizens to propose ideas and solutions that can be integrated into the decision-making processes in order to achieve flexibility when dealing with climate change problem.

This discussion can be used to build a reliable framework that brings climate adaptation and mitigation into Egyptian short term operation actions as well as into long term planning processes. This proposed framework has 4 axes:

First, building a comprehensive legal / institutional framework for coastal protection and management. This framework contents: Jurisdictional coordination across national governments, strengthening laws and regulations that organize the roles and tasks of individual agencies, establishing a strong coastal monitoring, assessing and enforcing laws and identifying and protecting vulnerable areas.

Second, establishing an efficient financial system. Many cities do not have access to necessary resources to

address climate change, take advantage of developed countries' grants by channeling them appropriately in accordance with national priorities, to build public-private partnerships. In addition to promoting long term investments in infrastructure, transport, residents' awareness and job training as they are core methods to confront climate change challenges.

Third, building technical capacity by using external experts, local universities and regional collaborations are developing technical aspects and raising the degree of technical competence in the assessment processes. Also, they are developing and implementing effective coastal zone management strategies by improving related information to climate change impacts and knowledge-sharing mechanisms.

Fourth, raising awareness and participation for different stakeholders to clarify all the potential effects of climate change on various development sectors, especially at the local level, as well as helping local governments in decision-making development processes by incorporating the views and priorities of the community and various stakeholders regarding adaptation process.

In addition to the proposed framework, Egypt government should address the urban challenges resulting from S.L.R and coastal erosion; that the (*State of Environment*, 2016) summed it in two main points. First the destruction of the weak parts in the sandy coastal tape, which protects the shallow lakes and low-elevation reclaimed land. Second the construction threat due to the low-elevation areas at Alexandria and Port Said cities which affected all development sectors and road networks along the coastline.

Concluded recommendations from several studies. Restrict land use in areas subject to S.L.R. Developing land regulations and building codes to reduce the expected losses from climate change hazards (Rosenzweig, D. Solecki., A. Hammer & Mehrotra, 2011). Creation of wetlands or dunes in vulnerable areas. Strengthening the international coastal road to act as a second defense line to protect the northern zone of the Delta (El-Ganzori, 2012). Expand marine protected areas (Smith et al., 2013).

References

- Blackburn, S., & Marques, C. (2013). Mega-urbanization on the coast. In M. Pelling, & S. Blackburn (Eds.), *Megacities and the Coast: risk, resilience and transformation* (Chapter 1, pp.25-26), London and New York: Routledge. Retrieved from www.researchgate.net/publication/261511434_Megacities_and_the_Coast_Risk_Resilience_and_Transformation
- Brown, S., Kebede, S. A., & Nicholls, J. R. (2011). *Sea-level rise and impacts in Africa: 2000 to 2100* (pp.10). School of Civil Engineering and the Environment. University of Southampton. Southampton, UK. Retrieved from <http://www.unep.org/climatechange/adaptation/Portals/133/documents/AdaptCost/9%20Sea%20Level%20Rise%20Report%20Jan%202010.pdf>
- Cummins, V., Mahony, O. C., & Connolly, N. (2002). *Review of integrated coastal zone management & principals of best practice* (pp.7). Environmental Research Institute. University College Cork, Ireland. Retrieved from <http://www.heritagecouncil.ie/marine/publications/>
- Egypt vision 2030 - Sustainable development strategy*. (2016). Retrieved from www.sdsegypt2030.com
- El Ganzori, A. (2012). *Towards a climate change adaptation strategy for the water sector in Egypt* (pp.87). Climate Change Risk Management in Egypt. United Nations. Educational, Scientific and Cultural Organization (UNESCO). Cairo.
- El Raey, M. (2010). Impacts and implications of climate change for the coastal zones of Egypt. In Michel, D., & Pandya A. (Eds.), *Coastal zones and climate change* (chapter 3, pp.31-32-34-35-45-46). The Henry L. Stimson Centre, Washington. Retrieved from http://mercury.ethz.ch/serviceengine/Files/ISN/116078/ichaptersection_singledocument/d7d42ace-24f8-4922-90d7-ae6af614bf2/en/3.pdf
- Final censuses for Egyptian coastal governorate*. (2006). The Central Agency for Public Mobilization and Statistics, Egypt.
- Framework convention on climate change*. (2015). Report of the conference of the parties on its twenty-first session. Decisions adopted by the conference of the parties. United Nations. Paris. Retrieved from http://unfccc.int/meetings/paris_nov_2015/session/9057.php
- Ministry of Environment. Egyptian Environmental Affairs Agency. (2016). <http://www.eeaa.gov.eg/en-us/topics/air/climatechange.aspx>

- National map for unsafe areas*. (2015). Slums development fund. Ministry of State for Urban Development and the slum areas, Egypt.
- Rosenzweig, C., Solecki, D. W., Hammer, A. S., & Mehrotra, S. (2011). *Climate change and cities: First assessment report of the urban climate change research network* (pp. xxii). Columbia University. Cambridge University Press, New York.
- Satterthwaite, D. (2008). *Climate change and urbanization: Effects and implications for urban governance* (pp. 4-6-28). United Nations Expert Group Meeting. Population Division. Department of Economic and Social Affairs. United Nations Secretariat, New York.
- Smith, J., McCarl, B., Kirshen, B., & Abdrabo, M. (2013). *Potential impacts of climate change on the Egyptian economy* (pp. 27-49-115-116). United Nations Development Programme. Cairo, Egypt.
- State of environment* (pp.103-284). (2016). Ministry of Environment, Cairo, Egypt.
- The World Bank. (2010). *Cities and climate change: an urgent agenda* (Vol. 10, pp.10-11-34), urban development series knowledge papers. Washington. Retrieved from <http://siteresources.worldbank.org/INTUWM/Resources/340232-1205330656272/CitiesandClimateChange.pdf>
- The World Bank. (2011). *Guide to climate change adaptation in cities* (pp. 6-22-23-27-38), Sustainable Development Network, Washington.
- United Nations Environment Programme – Mediterranean Action Plan. (2009). *Plan Bleu: state of the environment and development in the Mediterranean* (pp. 83). UNEP/MAP- Plan Bleu, Athens.
- United Nations Environment Programme – Mediterranean Action Plan. (2012). *State of the Mediterranean marine and coastal environment* (pp. 26). UNEP/MAP – Barcelona Convention, Athens.
- United Nations Environment Programme – Mediterranean Action Plan. (2015). *Draft Mediterranean strategy for sustainable development 2016-2025* (pp.2-4-24). (UNEP), Floriana, Malta.
- United Nations. (2009). *Adaptation to climate change in the Nile Delta through integrated coastal zone management* (pp.13-14). Ministry of Water Resources and Irrigation. The Egyptian Shore Protection Authority. Egypt.
- United Nations. (2012). *Report of the United Nations conference on sustainable development* (pp.5-11-12-37-48), New York.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).