

Assessment of Policy-Research Interaction on Climate Change Adaptation Action: Inundation by Sea Level Rise in the Nile Delta

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Abstract

Availability of reliable knowledge on future climate change impacts, vulnerability, and adaptation are considered key elements to improving adaptive capacities and developing proper adaptation actions. The Nile Delta vulnerability to Sea Level Rise (SLR) has been the subject of a relatively significant number of studies in Egypt. The research question that this paper intends to address is “to what extent have the produced scientific knowledge supported climate change adaptation policy making, concerning inundation by SLR in the Nile Delta”. To address this question, the paper begins with a review of the literature on policy-research interaction, based on which a framework of policy-research interactions is developed. This is followed by examining generated knowledge from research and the role of such knowledge on adaptation strategy development in Egypt. It was found that the research cycle has provided ample knowledge on the Nile Delta vulnerability to inundation by SLR. Additionally, the bulk of this research work and produced knowledge have been the main source of information for climate change adaptation policymaking. The interaction between research and policymaking interest in the climate change adaptation arena in Egypt confronted several challenges that may have reduced impacts of research on policymaking. These challenges included low interest in the far future, uncertain sea level rise impacts among policymakers and the uncoordinated research and varied estimates of sea level rise impacts provided by the research cycle. Moreover, the lack of proper and effective communication channels between the two cycles may have further hindered possible interaction.

Keywords

Policy-Research Interaction, Climate Change, Sea Level Rise, Nile Delta

1. Introduction

As most climate change impacts are being inevitable, adaptation is becoming a prominent component of climate change policies for any country vulnerable to climate change impacts, especially developing ones (Ford et al., 2010). Most of these countries are typically experiencing substantial competition on their limited financial and human resources to meet immediate needs of increasing population and development (Füssel, 2007). This has promoted calls for linking climate change adaptation and sustainable development in general (Eriksen et al., 2011) and SDGs, in particular (IFRC, 2009). Such calls, along with the climate change impacts uncertainties, emphasized the need for the identification of low-regret options¹, to enable taking climate action with the limited resources and uncertainties of the magnitude and spatial extent of climate change impacts.

For this to be achieved, policies and actions need to be supported by sound scientific knowledge on climate change impacts, vulnerability and adaptation measures, typically produced by academia and climate practitioners. Such knowledge should be accessible to policymakers through interactive communication network or framework linking both research and policymaking cycles (Ford et al., 2010; Füssel, 2007). Timely availability of such knowledge can have wide policy implications in terms of allowing for improving adaptive capacities and developing proper adaptation strategies (Muccione et al., 2016). However, lack thereof of such knowledge may create serious constraints on institutional and individual adaptive capabilities and perceptions of climate change risks and their impacts as well as benefits and/or costs associated with different adaptation options (IPCC, 2014).

The Nile Delta plays a crucial role in the Egyptian economy, as it is the source of about 40%, 50%, and 60% of its agriculture production, fish catch and industrial production, respectively (Abdrabo & Hassaan, 2015). Moreover, it hosts several human settlements accommodating about 39.9 million inhabitants (Figure 1), representing about 42% of the total population in Egypt (CAPMAS, 2017) (Figure 1).

The Nile Delta coastal area, as most river deltas, is low-lying land with a general elevation ranging between zero and 1 m above mean sea level and considerable parts below sea level (Frihy, 2003). Such a topography means that low-lying coastal areas would be highly sensitive to any trivial rise in sea level. Such sensitivity is compounded by annual subsidence of the northern parts of the Nile Delta, ranging from west to east between 0.5 and 4.5 mm/year (Stanley & Warne, 1993; Stanley, 1997).

It is generally agreed that deltas are climate change hotspots that are particularly vulnerable to Sea Level Rise (SLR) impacts. The Nile Delta vulnerability to SLR has, in this respect, been since the 1990s the most frequently researched

¹Low regret options refer to “low cost” options that perform reduce vulnerability to existing and future hazards and perform well across a range of climate change scenarios and thus can be implemented regardless of climate change uncertainty (Green et al., 2019).

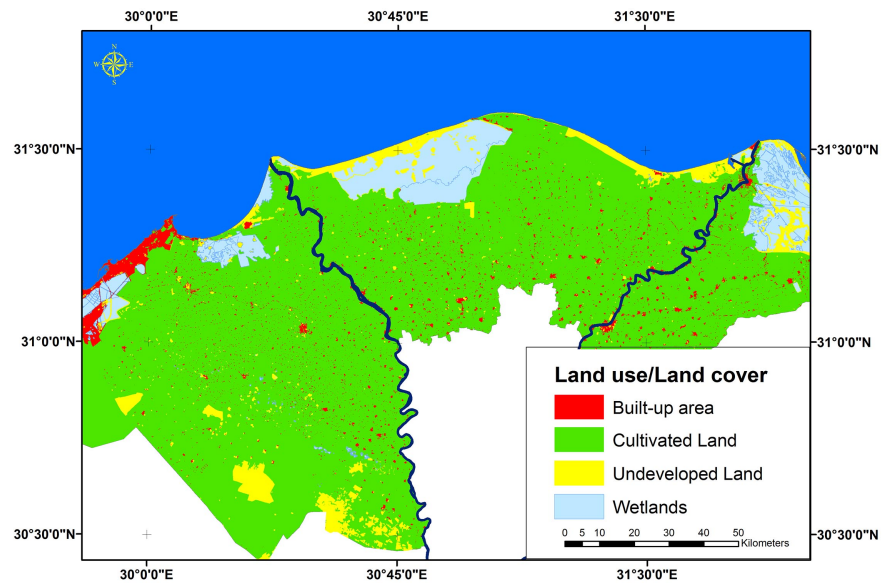


Figure 1. The Nile Delta geographic setting. Source: (Hassaan & Abdrabo, 2013).

climate change topic by Egyptian researchers (EL Raey et al., 1995; El Raey, 1997; El Raey et al., 1999; Frihy, 2003; Dawod & Mohamed, 2008; El-Nahry & Doluschitz, 2010; Frihy et al., 2010; Hereher, 2010; El Shinawy et al., 2012; Ismail et al., 2012; Haggag et al., 2013; Hassaan, 2013; Hassaan & Abdrabo, 2013; Zaid et al., 2014; Hasan et al., 2015; Refaat & Eldeberky, 2016)².

All these studies came to the same conclusion that the Nile Delta is physically vulnerable to SLR inundation, with significant yet unassessed socioeconomic impacts. It is worth noting that such research work and produced knowledge on the extent of inundation of the Nile Delta due to SLR has been the only source of information for climate change adaptation policymaking. Additionally, it was found that the authors' team involved in the development of adaptation strategy had only one specialist on SLR issues who authored a number of papers being covered in our research paper (IDSC, 2011b). Additionally, the adaptation strategy development process had no to very limited consultation with different stakeholders.

As the quality of adaptation planning depends, to great extent, on the robustness and reliability of scientific knowledge produced by researchers in the Nile Delta case, the paper in hand, accordingly, intends to address the question of “to what extent have the produced scientific knowledge supported climate change adaptation policy making, concerning inundation by SLR in the Nile Delta”.

It is worth mentioning that despite the wide-ranging results of previous research work on spatial extent and magnitude of areas vulnerable to inundation by SLR in the case of the Nile Delta, no research was undertaken to examine the impact of the generated knowledge on climate change adaptation policymaking.

To address the above-mentioned research question, the paper begins with a

²It was suggested that about 23% of research work was conducted on SLR inundation Nile Delta during the period 2007-2017 (Hassaan, 2018).

methods section establishing the conceptual research-policy interface framework that can be utilized in this study. This is followed by the results section, which examines different research work conducted on SLR inundation of the Nile Delta coastal area, their results and how they relate to the adaptation policymaking to SLR inundation projections. Thereafter, the discussion section examines the extent to which such scientific knowledge has supported adaptation policymaking. Finally, the conclusion section highlights the main findings of the study and its main recommendations.

2. Methods: Policy-Research Interaction

To address the research question posed in this paper, the literature on research-based scientific knowledge-policymaking interaction is examined, highlighting the driving factors influencing such interaction. It should be noted that research-policy interaction has been a topic of great interest for both policy and academic researchers. It is typically argued that policy and research making each has its cycle of action (Lewin, 1946)³; with the former cycle consisting of five main phases; starting with problem/issue recognition, problem/issue analysis and identification and assessment of possible actions, which contributes to agenda and priority setting. This is followed by implementation step then by monitoring and evaluation, which in turn provides feedback to the problem/issue recognition step (Stone et al., 2001). The research cycle, meanwhile, involves six phases including characterization of issues/problems deemed worth researching, reviewing associated literature and contextual factors followed by data collection and analysis, advising on possible evidence-based actions, and then evaluation and feedback (Figure 2).

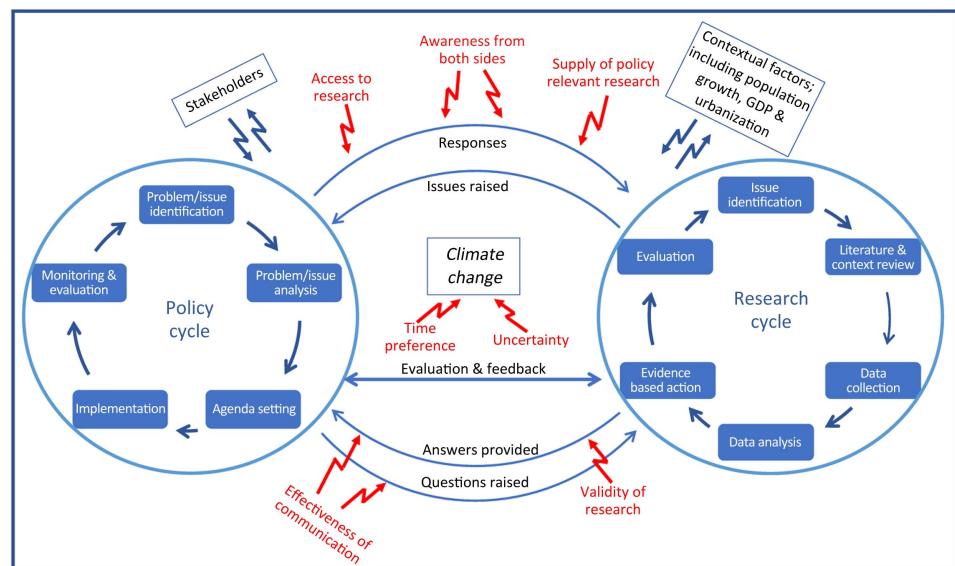


Figure 2. Schematic of research-policy interactions. Source: developed by the authors.

³The policy and research action cycles are cyclical processes consisting of a set of normally followed procedures, with the research cycle term coined firstly by (Lewin, 1946) in the context of social planning.

It is worth noting that the above-mentioned phases may differ according to approaches adopted and are not essentially linearly built as they may overlap and their order vary (Drummond & Themessel-Huber, 2007; Coghlan & Brannick, 2005). Additionally, each of these two cycles has its dynamics, negotiation processes, and timing and each has its prized output. For example, researchers most of the time prioritize research publication above advising policymaking. Policymakers, meanwhile, are more interested in practical solutions that are more publicly accepted with different stakeholder groups, even with weaker scientific evidence.

Furthermore, interaction between the two cycles may be initiated by players in any of the two cycles and at different phases. For instance, a question or an issue may be posed by a policymaking player for the research cycle to address and provide answers. Similarly, a player in the research cycle may raise an issue resulting from research with the policy cycle. Yet, it should be noted that the links between research and policy are neither linear nor guaranteed (Ahmed, 2005). Also, these cycles, their mechanisms, and the whole interaction presented here are, in reality, running at different levels and directions at the same time (Stone et al., 2001).

Such interaction, it can be argued, is usually influenced by several aspects including; for instance, the validity of research, the existence and effectiveness of communication, a supply of policy relevant-research, awareness from both sides, and access to research. This means that policymakers can face difficulties with solutions to problems that may involve limited evidence or excess and sometimes inconsistent information (Perri, 2002), thus limiting the contribution of scientific knowledge into the development of sound policies. Furthermore, it is worth mentioning that the issue is not only about the utilization of research results into policymaking but also about knowledge management and policymakers' ability to assess research results (Matson & Watts, 2003).

Moreover, the nature of climate change, being one of the most paramount challenges in the 21st century with cross-cutting impacts on almost all sectors that are long term and uncertain, may itself contribute to enhancing or damaging the research-policy interaction. These attributes may typically reduce urgency for action by policymakers already having difficulties dealing with current basic needs and problems. This is particularly evident in developing countries⁴, where greater preference is given to the present and/or the evident future issues over uncertainties surrounding time and magnitude of climate change impacts (Wang et al., 2016; Cohen et al., 2016). The influence of these attributes could be expected to be particularly greater in developing countries that are confronting gradual climate change impacts that may become evident in the far future.

Such a context emphasizes the need for a more flexible and sound deci-

⁴Time preference is one of the most fundamental concepts in economics, which is about inter-temporal choices and has been widely applied in different fields including for instance, asset pricing, project evaluation, and decisions on investment and saving, among many others (Wang et al., 2016).

sion-making process (Atela et al., 2016), which requires climate change research to provide accurate, clear, focused and sound scientific knowledge to support all stakeholders. Additionally, such knowledge should be perceived by all stakeholders, including decisionmakers, as not only apolitical and unbiased but also as reliable as possible (Scheraga et al., 2003).

Accordingly, the research based scientific knowledge-policy interaction in the case of SLR in the Nile Delta is assessed in terms of several factors that may influence potential utilization of scientific knowledge by policymakers. These factors may include SLR projections consistency, empirical aspects involved (e.g. data sources), approaches adopted by the research, magnitude of potential socioeconomic impacts as well as viability of proposed response actions; i.e. adaptation measures.

In order to assess the impact of research on policymaking in the case of vulnerability of the Nile Delta to inundation by SLR using the framework suggested in this paper, meant looking into the research and policymaking cycles as well as the interaction between the two cycles.

3. Results

It should be noted that there were no clear criteria for identifying the priorities of the research agenda, accordingly the research cycle focused mainly on some topics that were repeatedly studied. This was the case of physical impacts of SLR on the Nile Delta, where Nile Delta vulnerability to SLR, over the period 2007-2017, was at the forefront of climate change research conducted by Egyptian researchers, representing about 23% of climate change related research (Hassaan, 2018)⁵. Despite such interest by researchers in physical vulnerability of the Nile Delta to SLR impacts and the sheer volume of produced knowledge, the utilization of such knowledge by climate change policymaking in Egypt faced several challenges. One of the main challenges was the diverse estimates of the areas susceptible to inundation by SLR, which was due in part to the use of either global projection and/or hypothetical ones, with earlier studies employing hypothetical SLR scenarios in the range of 0.25 - 1 m by the year 2100 (El Raey, 1997; El Raey et al., 1999; El Raey et al., 1995) and more recent ones utilizing scenarios in the range of 1 - 2 m (El-Nahry & Doluschitz, 2010; Hereher, 2010). Other studies utilized global SLR projections produced either by the IPCC or other researchers (Hassaan, 2013; Hassaan & Abdrabo, 2013) (Figure 3).

Such varied estimates could be attributed to several factors including; the use of different datasets of elevation information and the employment of different vulnerability analysis methodologies. It was found, for instance, that most of the research on the Nile Delta vulnerability were based mainly on elevation information extracted traditionally from topographic maps scale 1:50,000 or 1:100,000, which are relatively small-scale, typically generalized and obscured

⁵Breaking down these SLR papers, it was found about one-third were either published locally or presented in conferences (Hassaan, 2018).

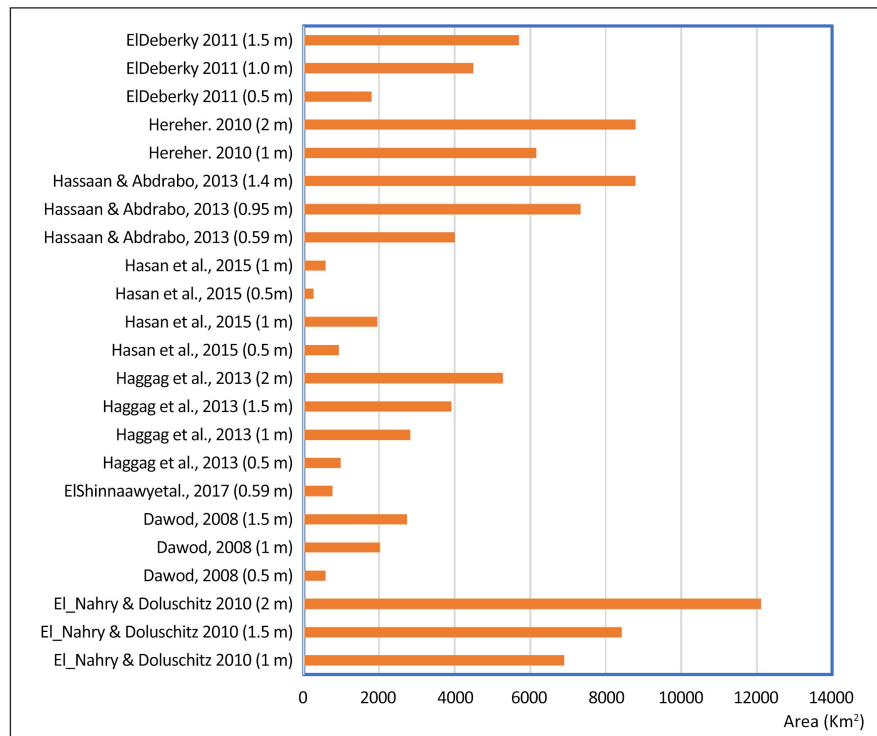


Figure 3. Estimations of areas of the Nile Delta susceptible to SLR inundation under different SLR scenarios by different studies.

subtle local features [see for example, (El Raey, 1997; El Raey et al., 1999; El Raey et al., 1995; Frihy, 2003)]. Other research work, meanwhile, employed satellite imagery-based Digital Elevation Models (DEMs) such as Shuttle Radar Topography Mission (SRTM) or Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) [see for example, (Dawod & Mohamed, 2008; Haggag et al., 2013; Hasan et al., 2015; Hereher, 2010)]. These DEMs are known to have vertical error in the range of 5 - 16 meters (Rodriguez et al., 2006; Valeriano & Rossetti, 2012; Zandbergen, 2008). Using data with such a margin of error to assess the impacts of a couple of meters of SLR projections would surely reduce the reliability of estimates of the vulnerable areas to SLR reported. It was noted, also, that the higher the SLR scenario employed, the lower the variations in estimates (Figure 3), which, it could be argued, can be due to these SLR scenarios cancelling out minor local topographical differences of the Nile Delta.

Furthermore, assessments of physical vulnerability to inundation by SLR should, normally, consider other influential factors, in addition to elevation, such as vertical land movement and spatial relationship between low-lying lands and shoreline. It was found, however, that several studies have disregarded land subsidence [for example, (Hereher, 2010; Refaat & Eldeberky, 2016)], while others ignored the spatial relationship between low-lying lands and shoreline [for more details see for instance, (Dawod & Mohamed, 2008; Haggag et al., 2013; Hasan et al., 2015)]. This meant that such assessments considered all low-lying land as vulnerable areas, irrespective of having access to the shoreline.

It should also be argued that the Nile Delta vulnerability to SLR research requires consistent, rigorous and transparent methodologies, with clearly expressed underlying assumptions. However, it was found that the methodologies and datasets used in some other research work were vague, for instance, [Eldeberky \(2011\)](#) articulated neither the source of the elevation information nor the assessment methodology employed in the paper ([Eldeberky, 2011](#)).

It could be suggested that an additional challenge to effective climate change policies in Egypt was that the research overemphasized the physical impacts while ignoring the socioeconomic impacts. It is worth mentioning that vulnerability of the Nile Delta to inundation by SLR was made more ambiguous by inexplicable estimates of socioeconomic impacts of inundation by SLR reported in couple of studies. In one case, aggregate socioeconomic impacts estimates were presented without stating or discussing the estimation process or underlying assumptions employed. For instance, it was suggested that: “*Analysis of the results indicates that for SLR of 0.5 m if no action is taken, an area of about 30% of the city will be lost due to inundation. Over 1.5 million people will have to be moved away 195,000 jobs will be lost and an economic loss of land and properties of over \$30 billion are expected over the next century*” ([El Raey, 1997: p. 31](#)). In another study, generally ungrounded unit cost estimates were employed to calculate the aggregate cost figure as it was stated that “*the estimates used for an area of 1 km² are about US\$100 million for beach and agricultural areas and US\$500 million for industrial areas. It is estimated that the economic loss (in the case of Port Said) is over US\$ 2.0 billion for a 0.5 m SLR and may exceed US\$4.4 billion for a 1.0 m SLR.*” ([El Raey et al., 1999: p. 119](#)).

It should be noted that the research cycle, focusing mainly on the risk of inundation of the Nile Delta coastal area, overlooked other climate change impacts that were not considered in the adaptation debates. For example, it was argued that very little efforts to quantify accurately future impacts of climate change and vulnerabilities at different sectors e.g. fisheries, northern lakes, tourism, biodiversity, health, livestock and food security were undertaken ([ARCA, 2017](#)).

As for the policy cycle, the National Committee of Climate Change was established as an inter-ministerial body in 2007 to coordinate climate change policies ([Gazette, 2007](#)). This committee was reformulated in 2015 ([Official Gazette, 2015](#)) and despite being meant to be convened at least bi-monthly, met only 4 times between 2016 and 2018. The committee was again reformulated into a National Board headed by the Prime Minister, in 2019 ([Official Gazette, 2019](#)). Such continuously changing structure could reflect the lack of vision and the infrequent meetings held by the committee may reflect the limited interest in the policymaking cycle in climate change adaptation.

The Ministry of Environment and its executive arm, the EEAA, within this structure, are responsible for the development and management of climate change adaptation policies and plans in Egypt ([EEAA, 2001](#)). However, the Egyptian Cabinet’s Information and Decision Support Center (IDSC), responsi-

ble for socioeconomic development reform, took responsibility for the development of the National Adaptation Strategy (NAS) in 2011⁶ (Elsehamy, 2016). This, it could be argued, means that climate change adaptation policymaking in Egypt lacks good governance in terms of accountability and responsiveness.

Due to the lack of serious efforts and official documentations that deal with climate change adaptation in an integrated manner in Egypt, except for NAS, it is used in this work as the main official output reflecting policymaking aspects related to climate change impacts, vulnerability, and adaptation in Egypt.

4. Discussion

It can be argued, in this respect, that the research cycle, in the case of the Nile Delta vulnerability to SLR, has provided fair stream of knowledge for policymakers. Yet, such knowledge provided contradicting estimates of the extent of areas vulnerable to inundation, thus generating conflicting and confusing messages to policymakers as well as other stakeholder groups. The research cycle, furthermore, provided inexplicable aggregate estimates on socioeconomic impacts, which in turn heightened the confusion. For example, it was suggested that without defenses, about one-quarter of Alexandria city would be susceptible to inundation by 2100 (El Raey, 1997), which did not materialized. Additionally, most of these studies have focused on the year 2100 as the timeframe for such inundation, with no discussion of the gradual nature of the impact, making it a far future impact. Though this could be attributed to the difficulty surrounding short and decadal projections compared to long-term ones, it limited its importance to policymakers and almost all other stakeholders.

Additionally, the extensive areas suggested to be susceptible to inundation by SLR in the Nile Delta led to the recommendation of hard-structures and expensive adaptation measures as indispensable to adaptation action. This was reiterated in almost all research as well as official documents dealing with SLR impacts. For instance, adaptation options including engineering structures such as groins, breakwaters, and other hard structures as well as reviewing policies of land use planning were proposed as key adaptation measures (EEAA, 1999; El Raey et al., 1999; El-Nahry & Doluschitz, 2010; Batisha, 2012; Frihy & El-Sayed, 2013). Others suggested reinforcing existing engineering structures (Elshinnawy, 2008; Michel & Pandya, 2010), and/or relocation of buildings, roads and other infrastructures landward (Eldeberky, 2011).

It is worth noting that some of these proposed adaptation measures may involve in addition to the massive investments significant adverse environmental and socioeconomic impacts. For instance, building a dike of 20-meter-wide and 4-meter height has been proposed to be built around Lake Borollus and a 3 meters high dike was proposed as possible adaptation measure to protect Lake Manzalla from SLR impacts. Nevertheless, it was suggested by the same report

⁶The National Environmental Action Plan of Egypt 2002-2017, developed in 2001, referred to climate change as one of the environmental issues of concern for Egypt, particularly the Nile Delta Mediterranean coast and the need for climate change mitigation (EEAA, 2001).

such adaptation measures may involve drastic negative impacts on the environment and socioeconomic conditions around the lakes including higher groundwater table levels, pollution increase, and a change in existing fisheries (EEAA, 1999). Egypt's National Adaptation Strategy to Climate Change, 2011, adopted the hard structure adaptation measures, stated above, including engineering protection works and reinforcement of existing anti-flood protection structures, and construction of new ones (IDSC, 2011a)⁷; (Nour El-Din, 2013).

Moreover, the adaptation measures and efforts have been mainly impact-or sector-specific, meaning that mainstreaming adaptation into development planning in general was lacking. The sectoral perspective also prevailed in the First and Second National Communication Reports, prepared within the framework of the UNFCCC, which were strikingly similar to the national strategy (IDSC, 2011a) (EEAA, 1999; EEAA, 2010; Nofal et al., 2014; EEAA, 2016). This could suggest that the research cycle has had superficial influence on policymaking and policy documents were merely echoing the findings of the research work, suggesting that research cycle has had very limited realistic policy implications. The superficial influence of research on policymaking is reflected in the absence of any implementation plan being developed as well as actual adaptation action on the ground. This is also reflected in the massive development investment being undertaken, by the government and the private sector, in the Nile Delta coastal areas deemed highly susceptible to inundation by SLR. Such development activities included for example, the establishment of New Mansoura City, two power plants (EDEPCO, 2019; NUCA, 2019) and an industrial zone (IMPA, 2019), involving an investment of about L.E. 93.72 Billion, equivalent to US\$5.325 billion⁸.

Overall, it can be argued that the limited policy response could be attributed to some factors: The first is the lack of awareness about climate change impacts and vulnerability in Egypt among different stakeholder groups including policymakers, dealing with was considered a priority. Thus, awareness raising, it was argued, should not only convey knowledge to these different groups but also attempt to lead to change in attitude (Hassaan & Abdrabo, 2014). The second is the uncertainty surrounding climate change impacts temporal, spatial and magnitude, which could be understood among the scientific community but not by outsiders, especially policymakers. The third is that most of the research work dealing with inundation by SLR focused either on hypothetical or global SLR scenarios by the year 2100, ignored the gradual nature of such changes and the short-term implications of SLR. The fourth is the wide-ranging research estimations that could generate conflicting and confusing messages not only to the

⁷Similar measures were also proposed by the Ministry of Water Resources and Irrigation, responsible for coastal protection work, with a budget of about EGP 35.35 billion, representing about 20% of the Ministry's total adaptation budget up to 2050 (Nour El-Din, 2013).

The exchange rate for the Egyptian Pound when these estimates were made was US\$1.00 = EGP 6.00

⁸As a result of the devaluation of the Egyptian Pound in 2017, the exchange rate became US\$1.00 = Egyptian Pound (EGP) 17.6.

general public but also to policymakers.

This, in turn, demoted the importance of climate change adaptation to policymaking and the opportunity for creating some meaningful debate on the issue of SLR and climate change impacts in general. This interpretation is in line with the argument by Smith and Stern that scientific skepticism can embrace a risk-management framework, generating meaningful public debate over different questions while reducing the level of artificial noise around present plans (Smith & Stern, 2011).

5. Conclusion

It can be argued, generally, that the research cycle, in the case of the Nile Delta vulnerability and adaptation to SLR, has provided, though diverse and sometimes contradicting, a stream of information for policymakers on the extent of areas vulnerable to inundation by SLR.

Climate change adaptation policymaking in Egypt echoed the findings of the research work, with limited focus on action. This was found to be the case with the National Climate Change Strategy, which was also found to be impact-and/or sector-specific, paying no attention to non-climate factors and with no integration into development planning in general. This was compounded by overlooking the extent of socioeconomic impacts and various stakeholders' views and concerns in this respect.

Generally, it could be argued that the interaction between research and policymaking cycles led to limited policy development and implementation in Egypt due to several challenges. These challenges were manifested in the policymaking cycle, on one hand, in the low interest in the far future, uncertain impacts of climate change in general and SLR, in particular. The challenge in the research cycle involved the uncoordinated research and wide range of inexplicable estimates of the magnitude of inundation by SLR, on the other. The consequences of these challenges were amplified by the lack of proper and effective communication channels between the two cycles.

The multidisciplinary nature of climate change studies should be promoted to provide a clearer and holistic view of SLR impacts, vulnerability and adaptation planning. There is also a need to consider, among other things, contextual factors; including socioeconomic, and land use dynamics that need to be integrated into research as well as all institutional work related to climate change. This accompanied by raising awareness among all stakeholders particularly policymakers, represents the main pillars of realm of climate change research and policymaking.

It is worth noting that assessment of vulnerability to SLR should not be the goal of such work but identifying potential low-regret adaptation options and assessing measures for improving climate resilience. This can be addressed through some synergy with sustainable development efforts in general and the achievement of SDGs.

Acknowledgements

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Key Policy Insights

1) Climate change adaptation work, in the form of Egypt's National Adaptation Strategy, just copied the findings and recommendations of the most physical scientific climate adaptation research work, while disregarding the implementation considerations, particularly their economic, socio-cultural and environmental implications.

2) Development plans of coastal areas should make provisions for inundation to SLR hotspots to reduce potential future damages and need for costly adaptation measures.

3) Climate change impacts are cross-cutting and expected to be temporally and spatially spread, emphasizing the need for integrating climate change actions into development planning, particularly with the substantial overlap between climate resilience and SDGs.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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