

Project title:

Establishing Alexandria Research Center for Adaptation to Climate Change (ARCA)

Project 106551-001

Alexandria University
Egypt

By:

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Final Technical Report

September 2018

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Executive summary

Climate change is considered to be the most profound global challenge in the 21st century, as it represents not just an environmental challenge but a multidimensional one, affecting the essence of economic system as well as socio-cultural systems. The vulnerability of human and natural systems and thus the consequences of climate change would depend upon risk magnitude and exposure, sensitivity of these systems and their ability to adapt to such a risk. This means that the vulnerability of such systems and their adaptive capacities would differ with geographic location, time and socioeconomic and environmental conditions. Developing countries are expected to face more damaging impacts due to lack of resources and limited capabilities.

Alexandria Research Centre for Adaptation to climate change (ARCA)", established in 2011 through a research project funded by the IDRC-Canada, was intended to become a sustainable outstanding hub for climate change adaptation work in Egypt and beyond. ARCA is meant to promote integrated climate change adaptation research, knowledge sharing, collaborative policy-oriented research, experience exchange, and best practices.

ARCA, since its launch, has conducted a total of **71** capacity building workshops for both researchers and stakeholders at local, national and regional levels; approximately one workshop per month. The workshops covered a variety of topics ranging between technical climate change and basic research skills topics; with large number of them (**14**) organized upon request from target organizations for their staff.

Additionally, **9** small research grants have been provided through ARCA Small Research Grants Scheme, covering a variety of topics of relevance to climate change. The core research team of ARCA have also been involved in a variety of research activities leading to a total number of **18** published research papers in peer-reviewed international journals in addition to **2** research papers presented at international and regional conferences. Additionally, the visiting researchers program, under which **4** researchers have been invited, provided support to both the small research grants scheme and capacity building activities.

Concerning partnership and networking activities, **5** MOUs have been signed with two Egyptian universities and one with the Coastal Research Institute (CoRI), which is affiliated with the National Water Research Centre - Ministry of Water Resources and Irrigation. Two MOUs were also signed with the Egyptian Environmental Affairs Agency (EEAA) – Ministry of Environmental Affairs and City of Scientific Research and Technological Applications (Burg El Arab) – Ministry of Scientific Research. These MOUs are providing good institutional settings for fruitful cooperation with those partners. Additionally, more than 1200 individual researchers, officials and civil society members are incorporated into ARCA network and mailing list.

The research problem

Economies of Arab and African countries, including Egypt, are known to be excessively relying on natural resources, and to share a number of long-standing environmental issues, including declining water quality and quantity, land degradation and desertification, coastal areas deterioration, high levels of industrial pollution and low quality of urban life. These countries, are projected to be susceptible, to different degree, to adverse climate change impacts, including reduced renewable water resources, decreased agricultural yield for most crops in countries where food imports are already significant, and increased heat stress, especially in urban areas. Climate change impacts may also include higher frequency of extreme weather events such as draughts, sudden flash floods, heat waves and sand storms. Coastal countries, Arab and African, may be exposed to significant damages due to sea level rise induced inundation and increased saltwater intrusion.

These countries have been attempting to adapt, to different extent and degrees of success, to climate change consequences and examining, among other perspectives, their economic viability of potential adaptation options. However, the status of climate change research work including climate change economics cannot perform such a prominent role in decision and policy making.

Egypt, in this respect, is expected to be highly vulnerable to climate changes. The Nile Delta is heavily populated and contributes considerably to national economy in terms of agricultural, fish and industrial production. The Nile Delta coastal zone, which exhibits a low-lying backshore between +3 and -1m from mean sea level, may adversely be affected by a small rise of sea level. Climate change impacts are expected to be cross-sectoral; with every conceivable sector expected to be affected including for instance, food security, agriculture, wetlands, fishing and livestock, health, tourism and built-up areas.

Despite such a concern for vulnerability of different sectors in Egypt to climate change, very little efforts to quantify accurately future impacts of climate change and vulnerabilities at different levels have been actually undertaken. Moreover, it could be suggested that such efforts have been mostly scattered, with no inter-linkages between the research institutions or the projects. Furthermore, almost all such projects had lacked a vital component, which had been the socioeconomic questions that could guide adaptation, financing and adaptation to climate change.

The overall objective of the IDRC supported project, is to establish a multidisciplinary and rigorous research hub to support cross-cutting decision and policy making for adaptation to climate change in the Nile Delta. Despite that the project has focused on Egypt in general and the Nile Delta in particular, ARCA was intended to become a sustainable outstanding hub for climate change adaptation work in Egypt and beyond. ARCA is meant to promote integrated climate change adaptation research, knowledge sharing, collaborative policy-oriented research, experience exchange, and best practices.

In order to attain the overall objective, a number of specific objectives were identified including:

1. Institutional capacities for research developed through the development of management structures and plans, an evaluation framework, an advisory committee, and partnerships and networks.
2. Competent research capacities supported through studentship awards, technical and research skill training workshops, and mentoring.
3. An enabling and effective policy-research interface supported through analysis of research needs for policy makers, capacity building and networking and communications,
4. Conducting rigorous research to support knowledgeable decision/policy making through a small grants project and core research on the economics of adaptation.

These intended objectives as well as their associated activities were planned as an integrated framework supporting the overall objective of the Centre. For instance, capacity building activities for researchers support the creation of an enabling environment for research in a variety of disciplines in relation to climate change vulnerability and adaptation.

The project, in hand, was intended to address these gaps by creating a research centre of excellence on adaptation to climate change attempting to build research capacities that could support efforts of assessing the impacts, vulnerability and potential, hard and soft, adaptation options in Egypt. For such efforts to attain their intended outcomes, they needed to stimulate multi-disciplinary and participation in decision and/or policy-making.

Evolution of ARCA work

The focus of ARCA work went, since its establishment in 2011, through **three** phases, that were dictated by two factors; the first of which is the lack and sometimes the complete absence of knowledge on climate change impacts, vulnerability and adaptation in Egypt. The second is the stated mission of ARCA “Establishing a multidisciplinary and rigorous hub for climate change adaptation research to support cross-cutting decision and policy making”. These two factors combined meant that ARCA had, in **the first phase**, to focus on capacity building activities on climate change fundamentals activities and initiating research work on the topic in various disciplines.

During **the second phase**, which covered the period 2014-2017, ARCA focus experienced three major changes; namely focusing on advanced capacity building activities at national and regional levels e.g. GIS applications on climate change regional workshops, more technical support to stakeholders e.g. updating National Climate Change Adaptation Strategy of Egypt, and more research publication options e.g. beginning of its working papers series.

During **the third phase**, 2017-2019, ARCA had focused on more specific, high impact, and technically focused networking at the regional level; namely economics of environment and climate change as well as GIS applications on climate change. The former discipline despite its paramount importance, had been largely absent in climate change quantitative work at national and regional levels. The later discipline had provided, through its spatial assessment and analysis tools, support to numerous applications and disciplines, in the climate change and environmental fields. Additionally, ARCA, from its capacity building and research

activities, had a significant advantage in these the two lines of work and thus had major impacts in these lines of work. Networking in these two disciplines was meant to ensure continues support and interaction for those working in these fields at the regional level, by coordinating capacity building, research activities and technical support for the targeted groups and individuals.

Project re-orientation

The evolving role and activities of ARCA during the last period of the project was based on what we had learned since 2011, the main lessons of which include:

- Large part of ARCA activities, especially capacity building activities, have been demand-driven, reflecting the need and quality of such activities. It also indicates that they filled a significant gap that existed not only in Egypt but also in the regional climate change arena.
- Lack of expertise in the climate change arena still exists, for example, the 5th round of ARCA research grants received limited number of concept notes despite broad outreach to a large number of researchers. Additionally, such lack of expertise is reflected in the limited number of climate change related research work in Egypt. This, in turns, stresses the need for more activities in different formats to support researchers, including networking, in the field of climate change.
- Such lack of expertise is also noticed at the regional level with very limited work on climate change. This, with the large demand for two regional workshops, suggests that there is a need for extending the spatial extent of ARCA activities to regional level.
- Capacity building workshops, whatever the quality of the work presented, were not considered to be enough on their own to support researchers to conduct high quality research on climate change related topics. The Climate Change and Sustainable Development (CCSD) M.Sc. Program was developed to provide a new approach towards fillin in such a gap by enabling those interested in the topic to study different climate change topics and do a thesis work on such topics.

Synthesis of research results and development outcomes

It should be noted that the intended objectives as well as their associated activities were planned as an integrated framework supporting the overall objective of the Centre. For instance, capacity building activities for researchers support the creation of an enabling environment for research in a variety of disciplines in relation to climate change vulnerability and adaptation. Taking this into account, we are going to briefly present each specific objective with the results obtained during the lifetime of the project.

Overall objective (Mission)

Establish a multidisciplinary and rigorous hub for climate change adaptation research to support cross-cutting decision and policy making.

Specific objectives, results and development outcome

Attaining this overall objective (mission) would require the attainment a number of specific objectives, each objective was reflected in a workpackage, including:

1. Institutional capacities for research developed through the development of management structures and plans, an evaluation framework, and partnerships and networks.

This specific objective was attained except for the development of M&E strategy, which was partially developed within the management strategy developed for the center.

Communication strategy: Due to the nature ARCA as a multidisciplinary hub for research for adaptation to climate change, networking and having effective and efficient communication with various stakeholders as well as similar research institutions was seen as a must for the sustainability of the centre. The goal and objectives of the communication strategy that were defined included an overriding goal of having a high caliber research center, with the associated short-term specific objectives of increasing awareness about the center and its activities, attracting the right caliber of researchers and create networks with various stakeholders. While, the medium-term specific objective was to develop networks with other regional bodies involved in the same or complementing fields of work and attract donor organizations to be involved with the center for future activities.

ARCA had had in this respect, published a variety of materials within its communication and disseminations activities including for instance:

- a) ARCA newsletter: ARCA is publishing annually a newsletter, which is intended to briefly discuss one of the topics associated with climate change as well as highlighting ARCA present and planned activities and different engagements of its core team (see: <http://www.arca-eg.org/index.php/publications/news-letter>)
- b) ARCA publication bulletin: This is an annually published summarizing all forms of ARCA publications (see: http://www.arca-eg.org/wpcontent/uploads/2018/07/publication-bulletin-2017_final...pdf)
- c) ARCA Briefs: They include policy briefs and other technical notes produced by ARCA (see: <http://www.arcaeg.org/publications/briefs/>)

ARCA management strategy: A strategic plan was developed and it focused on delivering of the core IDRC project, accelerating the disbursement of funds, strengthening ARCA's national and international network, and developing a strong relationship with its key policy stakeholder, the Egyptian Environmental Affairs Agency.

MOUs with stakeholders: Five MOUs had been signed with a number of stakeholders including the key policy stakeholder, the Egyptian Environmental Affairs Agency, which is the national coordinating body concerning climate change in Egypt.

2. Competent research capacities supported through studentship awards, technical and research skill training workshops, and mentoring

This specific objective was greatly over-achieved.

Generally, ARCA capacity building activities have a significant impacts and outcome. This is highlighted by large number of applicants to ARCA capacity building activities (2697) compared to the number of participants (1379).

Also, this is emphasized by emerging demand on training activities, where about 20% of the capacity building activities was upon requests received by ARCA from some stakeholder groups such as Faculty of Agriculture, University of Kafr El Sheikh, Coastal Research Institute (CoRI), Egyptian Environmental Affairs Agency (EEAA), National Institute of Oceanography and Fisheries, Tanta and Alexandria Universities.

A survey to evaluate the impacts of ARCA activities, in particular capacity building activities, indicated that:

- The general evaluation of about 97.9% of the sample for ARCA capacity building activities ranged between good and very good.
- 83.3% of the sample thought that these activities attained their objectives totally.
- 72.9% of the sample thought that these activities succeeded with different levels in creating opportunities for networking the researchers working in the field of climate change.
- 97.2% thought that these activities played a crucial role in raising awareness among different groups of stakeholders about climate change.
- Meanwhile, a relatively less proportions (66.7%) thought that ARCA capacity building activities succeeded in creating opportunities for networking various stakeholder groups.
- 83.3% stated that ARCA training workshops supported their research capacities in the field of climate change.
- Meanwhile, 91.7% and 87.5% of the sample thought that ARCA training workshops succeeded in supporting basic researchers' skills and technical knowledge relevant to climate change, respectively. This was highlighted by the majority of the sample

(95.8%), which stated that ARCA training workshops succeeded in supporting them in their fields of work.

- Moreover, 79.2% of the sample stated that ARCA training workshops provided them with valuable new knowledge and skills.
- 29.2% of the sample involved in the survey stated that they started to carry out research work in the field of climate change after participating in ARCA Training workshops.

Visiting researchers

ARCA invited the following visiting researchers:

- Dr. Lucia Fanini, the Hellenic Centre for Marine Research in May 2012: Dr. Fanini, was invited to contribute to the building capacity activities conducted by ARCA on climate change and marine biodiversity.
 - Mr. Xavier Vollenweider, Ph.D. student, London School of Economics in December 2012: Mr. Vollenweider acted as an instructor for a capacity building workshop on econometrics using STATA.
 - Dr. Juan Pablo Sanchiz, researcher, Animal Breeding and Genetics Department, IRTA – Lleida in December 2013. Dr. Sanchiz visited Faculty of Agriculture - Kafr El Sheikh University to review and support one of the research projects funded by ARCA Small Research Grants Program entitled "Assessing impacts, vulnerability and potential adaptation options of climate change on livestock in Egypt". Also, Dr. Sanchiz participated as instructor in one of ARCA workshops entitled "Sustainable animal production under climate change condition".
 - Dina Zayed, Ph.D. Candidate (IDS - Institute of Development Studies – UK). ARCA was contacted by Dina Zayed, who's doing her Ph.D. at the IDS, Brighton, requesting to be a visiting research at ARCA during the period Dec. 2017 – May 2018. She is working on public inclusion and participation in climate-change decision-making, with a great deal of overlap with community-based adaptation. During her stay in Alexandria, she held a number of focus groups and workshops to probe how climate issues are understood and where the right to participation comes into the picture. Additionally, she worked on gaining better understanding of the social nature of vulnerability, which is good, since we do not have any research on public perceptions and voice. A workshop, entitled "Stakeholder Engagement and Participatory Climate Adaptation" was organized by ARCA in April 2018 to utilize the visit made by Dina.
3. An enabling and effective policy-research interface supported through analysis of research needs for policy makers, capacity building and networking and communications.

This objective achievement exceeded plans and expectations, but we hope to work further on it in the future so that a real all-time effective policy-research interface is operational.

ARCA Website, as one of the main means of communication, dissemination and networking is working effectively in disseminating ARCA activities and communicating with various stakeholders. For instance, the total number of hits on ARCA websites during the period October 2017-September 2018, exceeding 118000. This revealed that ARCA website works as an effective platform communication with ARCA stakeholders.

As a result of regular update of ARCA mailing list, the number of members listed had increased steadily. The list now has about 1200 individual researchers, officials and members of different stakeholder groups both at national and regional levels. This, reflects the scale of ARCA outreach.

ARCA core-team members were repeatedly invited to a number of cc-relevant events at both national and regional level, such as:

- December 2012: Prof. Mohamed Abdrabo participated as a discussant/panelist at a day-long consultative workshop organized in Doha, Qatar in parallel to the COP18/UNFCCC negotiations.
- April 2013: ARCA participated in the 15th Cairo Climate Talks (CCT), held on 16 -17th April 2013 and was involved in the associated market place activities, including a panel talk and a subsequent discussion. ARCA's staff also displayed its work and shared their experience with the interested public.
- October 2013, Prof. Mohamed A. Abdrabo, participated in two workshops in Latin America; the first was organized by IDRC—Canada in Belem, Brazil on 2-4/10/2013. The work-shop was entitled — Synthesis of Research on Adaptation to Climate Change in Estuarine and Coastal Systems workshop, Belem, Brazil. The second workshop was held in Montevideo, Uruguay on 6-8/10/2013, under the title Regional Centre for Climate Change and Decision Making. Prof. Abdrabo did two presentations in the workshops about ARCA objectives and activities.
- November 2013: Prof. Abdrabo also participated as advisor on the UN-ESCWA VICCAR team meetings that were held on 25-26/11/2013 in Amman. The group intends to assess vulnerability of Arab countries to climate change impacts.
- May 2014: two of ARCA core-team members were invited to participate in the RICCAR/ACCWaM Workshop on applying the climate change vulnerability methodology in the Arab Region and development of a Regional Knowledge Hub held in Beirut during the period 11-13 May 2014
- August 2016: ARCA participated in the 8th Meeting of the Advisory Board for Climate Change in Cities (ABCC), held at Biblio-theca Alexandrina on 10th of August, 2016.
- December 2016: ARCA, as part of its support to activities being conducted by other bodies in the field of climate change adaptation, participated in a capacity building workshop organized by the Ministry of Foreign Affairs and EEAA for participants from African countries. The workshop, entitled “climate change impacts, adaptation and risk management”, was held in Cairo on 4 – 8 December, 2016.

- November 2017: ARCA has participated in a number of Climate change events at both inter-national and national levels. For example, two of ARCA core-team members participated in “Development and Climate Days” that was held during the period 11-12 November 2017 as a side event of COP23 in Bonn, Germany.
 - December 2017: ARCA core-team members were invited to participate in consultative meeting organized by EEAA in Cairo during the period 18-19 December 2017 to establish a center of excellence of climate change.
4. Conducting rigorous research to support knowledgeable decision/ policy making through a small grants project and core research on the economics of adaptation

The scale of research work conducted in the four research schemes.

The small research scheme has led, in addition to their technical reports, to the publication of 7 research papers in peer-reviewed journals in addition to a research paper presented in an international conference. These grants also supported 4 M.Sc. students. It is worth mentioning that 2 of those who had applied for ARCA small research grants had managed to apply for research grants and receiving them by other donors.

ARCA published research papers were found to have significant impacts, as they have 101 citations with h index = 7 and i10index =2.

Further details are provided in the Project outputs section later on.

Methodology

The project in hand, despite being a research project, has had a multitude of overlapping and coordinated activities and objectives. The proposed work consisted of four work packages, each was oriented towards a specific objective, with considerable interaction between them.

Work package 1: institutional capacities for research on climate change adaptation developed: This work package was intended to create an enabling environment for research at ARCA through development of necessary organizational and institutional capacities. This involved the acquisition of equipment necessary for the operation of the centre, and the development of appropriate management plans and processes. As the center was meant to build a coalition of research institutions oriented towards the needs of research users, through partnerships and networks with various entities and stakeholders.

Work package 2: competent Research capacities supported: Researchers' capacities had been supported through three measures; including the development of graduate students-scholarship scheme, training workshops on various research skills. Additionally, visiting researchers had been regularly invited to support research that had been conducted, interact with research students as well as other researchers for knowledge and experience exchange.

Work package 3: an enabling environment for participatory decision/ policy making created: this work package had focused on strengthening research-policy interface, ensuring that research focused around the needs of policy makers and that policy makers have access to high quality advice. This involved conducting a stakeholder analysis. In parallel, the institutional setup for climate change adaptation policy were undertaken, the processes of decision/policy making, and sources of data and information for this process. This fed into the development of the communication strategy, while attempting to strengthen capacities of different stakeholders.

Work package 4: rigorous research to support knowledgeable decision/ policy making conducted: This work package involved three measures including; research conducted by ARCA core-team, a small research grants scheme and out-sourced researchers. Each of these measures focused on a different range of disciplines and thus research themes.

Conceptual framework

In order to develop a logical and coherent methodology for the proposed project, a causal diagram that was based on the theory of change, was developed^[1] (Figure 1) The diagram began by stating the specific objectives, which were the preconditions for attaining the overall mission of the climate change adaptation centre^[2]. The items stated on the vertical blue arrows are the activities that needed for the next specific objective to be attained, while risks are represented as horizontal red arrows. This framework is in some ways the project framework can be understood as a matrix.

^[1] This framework is intended to make sense of what would otherwise be a complex picture.

^[2] It is worth mentioning that some of these specific objectives are considered as preconditions to others.

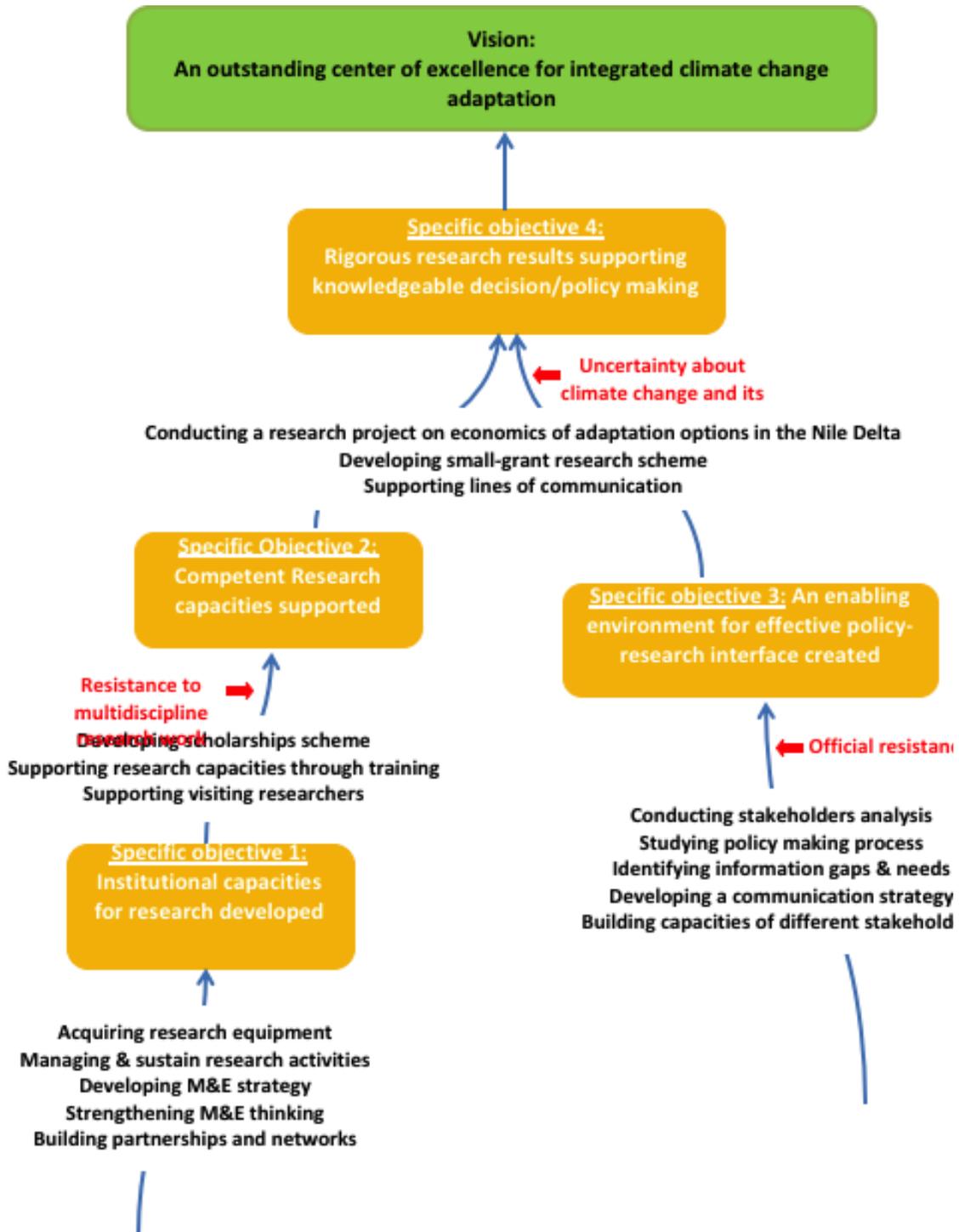


Figure 1: ARCA conceptual framework

Project Outputs

The overall objective of the research project had been to establish outstanding hub for climate change adaptation work in Egypt. This meant that the center intended to promote integrated climate change adaptation research, knowledge sharing, collaborative policy-oriented research and experience exchange. These intended objectives as well as their associated activities were planned as an integrated framework supporting the overall objective of the Centre. For instance, capacity building activities for researchers support the creation of an enabling environment for research in a variety of disciplines in relation to climate change vulnerability and adaptation. Additionally, the visiting researchers program, under which four researchers had been invited, provided support to both the small research grants scheme and capacity building activities (Figure 2).

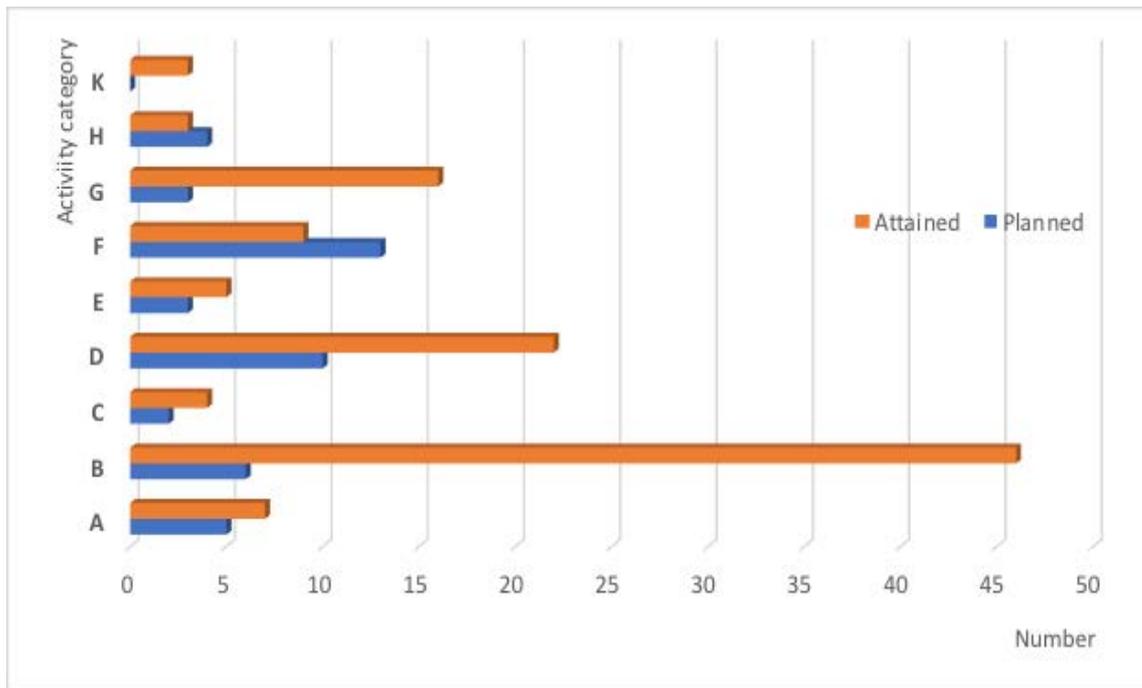


Figure 2: Main outputs of ARCA

Figure Key:

Output

- A** M.Sc studentships funded
- B** Technical and research skills training workshops held for researchers
- C** Visiting researchers
- D** Workshops for stakeholders capacity building and consultative meetings
- E** Assessment and analysis reports on the economics of adaptation in the Nile Delta
- F** Small research grants awarded
- G** International peer-reviewed journal papers produced
- H** Research papers presented at international conferences
- K** Awareness raising workshops for school children

Research Work

Research framework

Conducting good calibre research had been one of the main objectives of ARCA that would have a multitude of impacts including knowledge generation on climate change, supporting the creation of critical mass of researchers in different disciplines and supporting policy making. Due to the expertise in different disciplines to conduct this considerable research work, a variety of research mechanisms had to be employed including:

1. Research work to be conducted by ARCA staff members.
2. Research work to be undertaken by out-sourced researchers;
3. Research work to be conducted by graduate students through the scholarship program within ARCA; and
4. Research work carried out through the small research grants scheme.

The intended research work focuses on economics of vulnerability and adaptation of the coastal area of the Nile Delta to climate change, with particular emphasis on sea level rise. The main objective of such a research work is twofold; on one hand create an integrated approach to climate change research and to support decision/policy making process. The outcome of such research work would also support global efforts in understanding and devise measures to deal with climate change economics in general and economics of adaptation in particular. For such research work efforts to be carried out in an effective and efficient manner, it should be planned, well-coordinated and also integrated with previous research work.

ARCA Research work focused on four main wide themes:

- Create an integrated approach to climate change research;
- Economics of adaptation to climate change and sea level rise;
- Assessment of potential impacts, vulnerability and adaptation options on different sectors; and
- Reviewing status of climate change and sea level rise research in Egypt in specific fields of work.

1. Research conducted by ARCA core-team

During the project lifetime, a number research work was conducted by ARCA core-team, focusing on a number of topics mostly in the fields of climate change economics, GIS applications on climate change and big data analysis of climate change publication. Also, research had been conducted to assess resilience of these urban centers to climate change that considered physical as well as socioeconomic characteristics of urban areas.

2. Research conducted by out-sourcing researchers

In some instances, ARCA decided to out-source researchers to work on a specific topic, which were outside ARCA core-team fields of expertise and did not merit including it in the small research grants calls. The outcome of this work was mainly published in ARCA Working Papers Series.

3. Research conducted by Graduate Students

Another approach to conducting research had been the involvement of graduate students, mainly M.Sc. programs, into ARCA research activities and/or in the small research grants. Topics covered by M.Sc. students supported directly by ARCA included for example:

- Economic Valuation of Sea Level Rise Impacts on Agricultural Sector in Northern Governorates of the Nile Delta
- Economic Analysis of the Nile Delta Potential Vulnerability and Adaptation to Sea Level Rise Impacts.
- Assessing institutional capacities in tackling climate change. Case study: Egypt.
- Modeling Climate Change Impacts on Inland Water Bodies Using Remote Sensing Data Case Study: Wadi El-Rayan, Egypt.

Further 2 M.Sc. students were indirectly supported by ARCA through their supervisors' respective small research grants. The topics covered included for instance:

- Physiological and molecular response of the pearl oyster *Pinctada radiata* to climate changes
- Distribution, behavioral ecology and potential impact of invasive marine species along Mediterranean coast

4. ARCA Small Research Grants Scheme

ARCA small research grants scheme was considered as one of the aspects of fostering an enabling environment for research. Effective management of such a scheme meant a need for proper planning that was intended to provide guidelines and themes for each call and the mechanism for awarding research grants by ARCA to potential applicants. Under such scheme, 6 calls for concept notes had been announced in April 2012, October 2012, March 2013, May 2013, March 2016 and August 2017.

The calls covered a wide range of themes in order to provide wider opportunities for researchers in different disciplines of relevance to climate change and to help in filling existing research gaps concerning Delta impacts, vulnerability and adaptation to climate change including:

- a. Vulnerability of the Northern lakes to the impacts of climate change induced sea level rise.
- b. Modeling future socioeconomic profile of the Nile Delta coastal zone (up to 2050 and 2100).
- c. Propose and assess adaptation options to the impacts of climate change induced sea level rise on agriculture.
- d. Impacts of sea level rise on groundwater levels in the Nile Delta.

- e. Impacts of salt water intrusion on buildings and infrastructure and possible adaptation options.
- f. Potentials for using the Coastal International Highway to protect the Nile Delta from inundation by sea level rise: an engineering perspective.
- g. Climate change vulnerability and adaptation in Egypt: An institutional assessment of policy and decision-making context and process.
- h. Potential adaptation options to climate change and associated sea level rise in the field of aquaculture.
- i. Assessing climate change impact, vulnerability and adaptation options in relation to livestock in Egypt.
- j. Assessing impacts of climate change and associated sea level rise on tourism assets and antiquities in the Nile Delta coastal zone.
- k. Climate change health impacts and vulnerability in Egypt and potential adaptation options.

Due to common hesitation among Egyptian researchers to submit research project proposals and the low quality of most of submitted proposals to donors in general, the application process for the calls was divided into two phases, the first of which requested interested researchers to submit pre-structured concept notes and those shortlisted are requested in the second phase to submit full proposals. Thereafter, applicants of the selected concept notes were invited to ARCA for a one-day workshop on proposal development. During the workshop, attendees were told of the main comments and feedback on their concept notes and presented with advice on how to develop their concept notes into proposals.

ARCA had received 106 concept notes during the six calls, of which 22 concept notes were short-listed and developed in full proposals.

Finally, 9 full proposals had been funded by ARCA. These proposals covered diverse topics of significant importance to climate change adaptation in the Nile Delta including:

- a. Climate change and marine biodiversity in the Mediterranean Sea.
- b. Climate change and livestock, sea level rise and northern lakes.
- c. Groundwater and built-up areas.
- d. Vulnerability of animal production to high ambient temperature and possible adaptation options under Egyptian conditions.
- e. Downscaling sea level rise projections in the East Mediterranean Sea.
- f. Impacts of climate change on Potato production in Egypt.
- g. Downscaling atmospheric components over Egypt under different climate change scenarios.
- h. Assessment of climate change impacts on hydro-morph-dynamics of the Nile Delta.
- i. Climate Change and larger basidiomycetes of the Nile Delta: recording, monitoring, and evaluating selected species using IUCN Red List.

ARCA Publications

The research work undertaken in ARCA had led to the following publications

ARCA working papers

- Working paper 1: Stakeholder analysis: Climate change and the Nile Delta
http://www.arca-eg.org/images/Working_Papers/Working_Paper_1_Jan_2014.pdf
- Working paper 2: Climate change and livestock: Vulnerability and adaptation
http://www.arca-eg.org/images/Working_Papers/Working_Paper_2_April_2014.pdf
- Working paper 3: Climate change impacts on pests and pesticide use
http://www.arca-eg.org/images/Working_Papers/Working_Paper_3_July_2014.pdf
- Working paper 4: Aquaculture in Egypt under changing climate: Challenges and Opportunities.
<http://www.arca-eg.org/wpcontent/uploads/2017/06/Working-Paper-4-Jan.2017.pdf>
- Working paper 5: Developing a reliable Digital Elevation Model for climate change applications: Case study the Nile Delta, Egypt.
<http://www.arca-eg.org/wp-content/uploads/2017/08/ARCAworking-Paper-5.pdf>
- Working paper 6: Downscaling Global Climate Models: The Case of Egypt.
http://www.arca-eg.org/wpcontent/uploads/2018/03/ARCA-working-Paper6_Final.pdf

Published research papers

ARCA research work led to the production of **18** research papers that were published as follows:

- **15** research papers had been published in international peer-reviewed journals.
- **2** research papers were presented at two international conferences.
- **1** research paper has been accepted for publication.

Generally these publications can be classified into two main categories according to their authors; with the first category involving research papers undertaken by ARCA core-team members. This category include 9 research papers; 7 of them were published in peer-reviewed international journals and one was presented at international conference in addition to a research paper accepted for publication in peer-reviewed international journal (Table 1).

Table (1): Published research papers undertaken by ARCA core-team member

S	
	Papers published in Peer-reviewed international journals
1	Abdrabo, M. A. & M. A. Hassaan (2014) Economic Valuation of Sea Level Rise Impacts on Agricultural Sector: Damietta Governorate, Egypt. <i>Journal of Environmental Protection</i> 05: 87-95. 10.4236/jep.2014.52012
2	Abdrabo, M. A. & Mahmoud A. Hassaan (2015) An integrated framework for urban resilience to climate change – Case study: Sea level rise impacts on the Nile Delta coastal urban areas. <i>Urban Climate</i> 14: 554-565. 10.1016/j.uclim.2015.09.005.
3	Hassaan, M. A. (2013) GIS-based risk assessment for the Nile Delta coastal zone under different sea level rise scenarios case study: Kafr EL Sheikh Governorate, Egypt. <i>Journal of Coastal Conservation</i> 17: 743-754. 10.1007/s11852-013-0273-0.
4	Hassaan, M. A. & M. A. Abdrabo (2013) Vulnerability of the Nile Delta coastal areas to inundation by sea level rise. <i>Environ Monit Assess</i> 185: 6607-16. 10.1007/s10661-012-3050-x.
5	Hassaan, Mahmoud A. (2018) Using Scholarly Big Data in Assessing Contribution of National Expertise to Climate Change Knowledge; Case Study: Egypt. <i>Journal of Data Analysis and Information Processing</i> 06: 67-78. 10.4236/jdaip.2018.63005.
6	Hassaan, Mahmoud A., Mohamed A. Abdrabo & Prosper Masabarakiza (2017) GIS-Based Model for Mapping Malaria Risk under Climate Change Case Study: Burundi. <i>Journal of Geoscience and Environment Protection</i> 05: 102-117. 10.4236/gep.2017.511008.
7	Soliman, Naglaa F. , Yacout, Dalia M.M. & Mahmoud A. Hassaan (2017) Responsible Fishmeal Consumption and Alternatives in the Face of Climate Changes. <i>International Journal of Marine Science</i> 7: 130-140.
	Papers presented at international conferences
1	Abdrabo, M. A. & M. A. Hassaan (2014) Assessing resilience of the Nile Delta urban centers to sea level rise impacts. 5th Global Forum on Urban Resilience & Adaptation 29-31 May 2014 2014a Bonn. ICLEI – Local Governments for Sustainability,
	Papers accepted for publication in peer-reviewed international journals
1	Abdrabo, M. A. & M. A. Hassaan (2018) impacts of climate change on seasonal residential electricity consumption by 2050 and potential adaptation options in Alexandria Egypt, <i>American Journal of Climate Change</i>
9	Total

Meanwhile, the second category included 9 more research papers undertaken by reserachres supported by ARCA small research grants scheme, 8 of which were published in peer-revwied international journals and one was presented at an international conference (Table 2).

Table (2): Published research papers undertaken by reserachers supported by ARCA

S	Research
	Published in Peer-reviewed international journals
1	Elshely, M. & M. Khadr (2015) Hydrodynamic impacts of Egyptian coastal lakes due to climate change – Example Manzala Lake. International Water Technology Journal, IWTJ 5: 235-247.
2	Elshely, M., M. Khadr, Y. Atta & A. Ahmed (2016) Hydrodynamic and water quality modeling of Lake Manzala (Egypt) under data scarcity. Environmental Earth Sciences 75. 10.1007/s12665-016-6136-x.
3	Elshely, Mohamed (2016) Water quality assessment of Lake Manzala, Egypt: A comparative study. International Journal of Scientific Research in Environmental Sciences 4: 196-207. 10.12983/ijres-2016-p0196-0207.
4	Lotfy, W. M. (2014) Climate change and epidemiology of human parasitosis in Egypt: A review. J Adv Res 5: 607-13. 10.1016/j.jare.2013.06.009.
5	Moussa, Ragia , ostas Kapisir & Argyro Zenetos (2016) Brachyuran diversity along Mediterranean Egypt, with the addition of a new introduced species. Cah. Biol. Mar. 57: 43-49.
6	Moussa, Ragia & Ismalina Wirawati (2018) Observations on some biological characteristics of Holothuria polii and Holothuria sanctori from mediterranean Egypt. International Journal of Fisheries and Aquatic Studies 6: 351-357.
7	Mytilineou, C. H., E. H. Kh Akel, N. Babali, P. Balistreri, M. Bariche, Y. Ö Boyaci, L. Cilenti, C. Constantinou, F. Crocetta, M. ÇELİK, H. Dereli, C. Dounas, F. Durucan, A. Garrido, V. Gerovasileiou, K. Kapisir, T. Kebapcioglu, P. Kleitou, A. Krystalas, L. Lipej, I. Maina, P. Marakis, B. Mavrič, R. Moussa, L. PeÑA-Rivas, D. Poursanidis, W. Renda, S. I. Rizkalla, A. Rosso, T. Scirocco, F. Sciuto, G. Servello, F. Tiralongo, S. Yapici & A. Zenetos (2016) New Mediterranean Biodiversity Records (November, 2016). Mediterranean Marine Science 17: 794. 10.12681/mms.1976.
8	Zenetos, A. , E.H. KH. Akel, C. Aposyolidis, M. Bilecenoglu, G. Bitar, V. Buchet, N. Cha-Lari, M. Corsini-Foka, F. Crocetta, A. Dogrammatzi , M. Drakulić, G. Fanelli, G. Gi-Glio, A. Imsiridou, K. Kapisir, P.K. Karachle, S. Kavadas, G. Kondylatos, E. Lefkadi-Tou, L. Lipej, B. Mavrič, G. Minos, R. Moussa, E. Prato, M.A. Pancucci-Padopoulos, W. Renda, N. Ríos, S.I. Rizkalla, F. Russo, M. Servonnat, A. Siapatis, E. Sperone, J.A. Theodorou, F. Tiralongo & I. Tzoveis (2015) New Mediterranean Biodiversity Records (April 2015). Mediterranean Marine Science 16: 266-284. 10.12681/
	Presented at international conferences
1	Elshely, M. & M. Khadr (2015) Hydrodynamic impacts of Egyptian coastal lakes due to climate change - Example Manzala Lake. Eighteenth International Water Technology Conference, IWTC18, 2015b Sharm ElSheikh.
9	Total

Capacity building activities

ARCA capacity building activities were intended to fill the gap existing in research and awareness knowledge about climate change impacts, vulnerability and adaptation. For this purpose, ARCA organized **71** training workshops covering 35 different topics.

Table (3): Capacity building workshops undertaken by ARCA during the period 2011-2018

S	Workshop Title	No. of Rounds	No. of participants	No. of applicants
1	Applied econometrics with STATA	1	8	40
2	Assessment of socioeconomic Impacts of climate change	2	27	95
3	Basics of applied statistics	3	65	229
4	Climate change & agriculture sector	1	18	18
5	Climate change & coastal areas	1	17	19
6	Climate change & health	1	16	22
7	Climate change & livestock	1	19	19
8	Climate change & tourism & antiquities	1	11	11
9	Climate change & urban areas	1	16	20
10	Climate change & water sector	1	20	20
11	Climate change impacts on Coastal Dynamics	3	54	141
12	Climate change update: IPCC AR5	3	59	75
13	Climate change & agricultural sectors	2	65	90
14	Climate Change impacts on coastal lakes	2	31	69
15	Climate change & agricultural sector	1	19	19
16	Climate change & aquaculture sector	1	24	24
17	Critical thinking	1	9	9
18	Downscaling sea level rise in the Mideterranean under different future climate change scenarios	1	20	20
19	Dynamical downscaling: concepts & practices	1	17	133
20	Economic valuation of climate change impacts	1	9	61
21	Economics of climate change	1	15	139
22	Estimating potential impacts of climate change on Biodiversity	1	15	59
23	GIS applications in assessing Vulnrebity to SLR	6	71	142
24	GIS applications in climate change	2	34	140
25	GIS for socioeconomic applications	9	91	139
26	How to develop a project proposal	7	87	206
27	Impacts of higher levels of groundwater table on crop productivity	1	12	12
28	Introduction to climate change	3	73	91
29	Modelling hydrodynamics of coastal waters under climate change	1	8	8
30	Scientific writing	1	13	102
31	Stakeholder engagement & participatory climate change adaptation	1	26	72
32	Statistical inference	3	65	65
33	Sustainable animal production under climate change conditions	1	26	52
34	Vulnerability of Egypt to climate change	2	45	62
35	Climate change for young minds	3	274	274
	Total	71	1379	2697

The total number of applicants to these workshops was 2697 of researchers and officials, of which 1379 were selected to participate in the workshops.

Concerning the institutional affiliation of the participants, 58.7% of total participants in ARCA capacity building activities were researchers affiliated with different universities as well as research institutes affiliated with the Ministry of Agriculture, Ministry of Water Resources and Irrigation and Ministry of Scientific Research. Also, about 19.9% of participants were officials affiliated with government bodies at both national and local levels. Moreover, 19.9% of the total participants in ARCA capacity building activities were school students, who participated in introductory workshops intended to simplify climate change issues to these students. Meanwhile, 1.5% of the total participants in ARCA capacity building activities were representatives of civil society.

Capacity building activities included 3 regional workshops covering two main topics; GIS application in Climate Change and Economics of Climate change, which involved participants from Sudan, Iraq, Algeria, Tunisia, Morocco and Jordan. Regional workshops participants were affiliated to universities and governmental bodies in Arab countries (Figure 3).

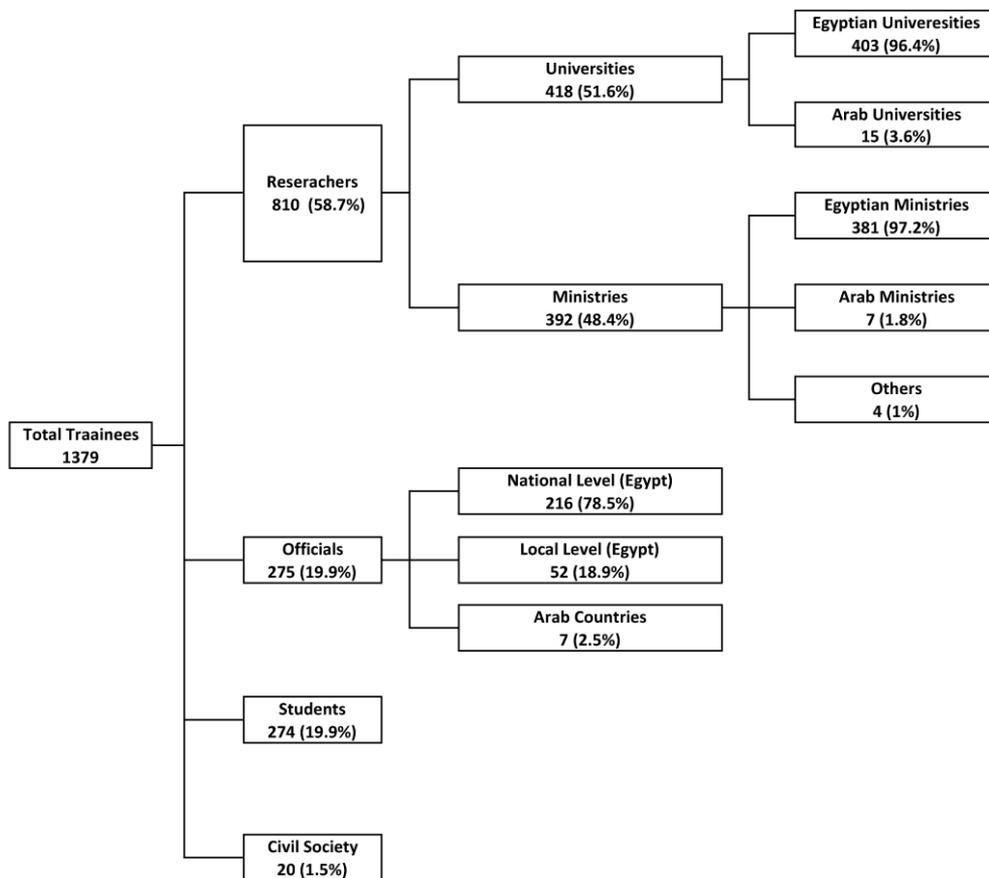


Figure (3):Cluster diagram of trainees affiliation

10 consultative workshops had been organized, involving 172 of stakeholders. These consultative workshops, with sectoral perspective, were intended to provide participants with an introduction to climate change and its implications on their sector. The subsequent

part of the workshop was devoted to participants to exchange on their views of the main impacts and adaptation options associated with the considered sector. The objectives of such consultative workshops were not only to conduct capacity building activities for members of each sector, but also to provide an insight into vulnerability and adaptation to climate change from a sectoral perspective.

It is, also, worth mentioning that gender was carefully considered in implementing ARCA capacity building activities, where 59% of the overall total participants were male and 41% were female.

Problems and Challenges

Unexpected political and institutional instability: One of the main challenges was that the project was initiated in 2011, the year of the Egyptian revolution. This meant that the project had faced significant delays, due to political and institutional instabilities, in beginning its activities and acquire equipment. This was overcome by accelerating its time schedule and plans in order to compensate for such delays.

Stakeholders' resistance: In the project proposal documents there were concerns about the risks of stakeholders' resistance to change and the view beheld by the stakeholders about the far future perspective of climate change impacts. These concerns had been overcome to great extent through proper and good quality capacity building and awareness activities. It was also supported by the concept of low-regret adaptation options and adaptation being integrated into development plans to show that climate change adaptation and resilience improvement and development are complementing aspects.

Sustainability of ARCA: Future sustainability of ARCA activities, with flexibility to modify priorities and work format for ARCA, requires sustainable financial support in the form of supervised endowment fund, thus fundraising activities are crucial for ARCA sustainability. In this context, there is ongoing negotiation with IDRC in order to initiate the endowment fund with the remaining funds of ARCA research project.

Administrative Reflections and Recommendations

1. We believe that ARCA research project experience, despite that ARCA core-team members had been involved before in a number of research projects, had been very satisfactory, rich and dense. This was due to the multi-dimensional aspects of the work and not attempting only to have temporary impacts on researchers and stakeholders but also creating an entity that could have permanent impacts.
2. In this respect, IDRC could have in place plans for fund mobilization, for promising projects, with other donors. Cooperation and coordination among donors in this respect can magnify the impacts of such projects.
3. Interactions between IDRC grant holders within the same and/or similar programs could create opportunities for exchanges and we believe if this would be given further considerations could involve researchers exchanges and possible joint activities, e.g. research work or training workshops.
4. We have to say that our experience with the IDRC grants, this one and another one before it, left a very good impression, concerning IDRC staff support to the grant holders, on one hand attempting to ensure the best outputs and outcome from the project, and providing as much support as possible to ensure smooth implementation, on the other. It is worth mentioning that being involved in a number of research projects funded by other donors, such an approach was lacking.