

Lima Adaptation Knowledge Initiative (LAKI)

**Workshop on Prioritizing Adaptation Knowledge Gaps
in the Gulf Cooperation Council (GCC) Subregion**

15-17 June 2015
Abu Dhabi, United Arab Emirates

Workshop Report

October 2015

A. Introduction

Climate change adaptation knowledge gaps have been repeatedly identified as a barrier to widespread and successful adaptation actions.

The Lima Adaptation Knowledge Initiative (LAKI) is a collaborative effort between the United Nations Framework Convention on Climate Change (UNFCCC) Nairobi work programme (NWP) and the United Nations Environment Programme (UNEP) (see the joint action pledge of UNEP and UNFCCC¹). It aims to remove knowledge barriers that impede the implementation and scaling up of adaptation action through a reiterative process of knowledge gap prioritisation and subsequent implementation of response actions.

The LAKI was endorsed and launched by the COP 20 President as a component of a set of actions to further address adaptation to climate change under the UNFCCC. The Subsidiary Body for Scientific and Technical Advice (SBSTA), at its 41st session, welcomed the LAKI for the Andean subregion and encouraged its replication in other subregions, particularly in vulnerable developing countries such as the least developed countries, small island developing states and in Africa.²

This priority-setting workshop for the Gulf Cooperation Council (GCC)³ subregion is the second one after the pilot for the Andean subregion in 2014.

This report summarizes the outcomes of the priority-setting workshop for the GCC subregion. The Annex outlines in detail the proceedings of the priority-setting workshop. This report has been reviewed and revised with inputs from MSG members.

B. The priority-setting workshop for the GCC subregion

The priority-setting workshop for the GCC subregion was held on 15-17 June 2015 in Abu Dhabi, the United Arab Emirates (UAE), with the support of the UAE Government.

It was organized by the UNEP Regional Office for West Asia (ROWA) and hosted by the Abu Dhabi Global Environmental Data Initiative (AGEDI), the subregional coordination entity for the GCC subregion with the following objective:

- Identify adaptation knowledge gaps for the GCC subregion;
- Prioritise these knowledge gaps using a prioritisation methodology;
- Identify actions to respond to the priority knowledge gaps through synthesizing, repackaging and disseminating existing information and knowledge.

The workshop consisted of a series of sessions, ranging from plenary presentations, group discussions and individual prioritisation activities.

Participants acknowledged that there are a wide range of work undertaken in the GCC region on climate change adaptation, but more could be done, particularly on data collection and information/best practice sharing.

Figure 1 below provides an overview of the various sessions that took place during the course of the three-day workshop.

¹ The joint action pledge of UNEP and UNFCCC is available at https://www3.unfccc.int/pls/apex/f?p=333:31:3841983047222871::NO::P31_ID:521.

² See FCCC/SBSTA/2014/5, paragraph 20, available at http://unfccc.int/documentation/documents/advanced_search/items/6911.php?preref=600008364#beg.

³ The member states of the GCC are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.

Figure 1. Sessions of the priority-setting workshop

DAY 1	DAY 2	DAY 3
1. Opening and introduction	3. Identification and weighting of criteria for prioritization	5. Refinement of priority knowledge gaps
2. Identification of a pool of adaptation knowledge gaps	4. Prioritization of knowledge gaps	6. Identification of response actions
		7. Next steps and wrap up

C. Multidisciplinary stakeholder group (MSG)

The workshop participants comprised of experts and policy makers from a wide range of backgrounds pertaining to issue areas focused in the meeting (see Supplements to Annex).

D. Priority adaptation knowledge gaps for the GCC subregion

The main goal of the workshop for the GCC subregion was to produce a list of the priority climate change adaptation knowledge gaps, while taking into consideration existing work and ongoing efforts in the region to adapt to the impacts of climate change.

The top ten priority adaptation knowledge gaps which the MSG prioritized for the GCC subregion are contained in Table 1 below.

Table 1. Priority adaptation knowledge gaps for the GCC subregion

Theme	Priority adaptation knowledge gap
Water	Limited availability and access to observed data on quantity and quality of conventional (groundwater reserves, surface water, shared transboundary flows, recharge levels) and non-conventional (treated wastewater, desalinated water) water resources
Cross-cutting	Limited availability and lack of access to scenario data at various spatial scales for projected climatic variables, including temperature, precipitation, wind, evapotranspiration, drought, flash floods, sea level, extreme events, etc.
Terrestrial ecosystems	Fragmented baseline data (biological, ecological and climate) and lack of standardized methodologies for consolidating information on terrestrial ecosystems at the GCC level
Marine ecosystems	Incomprehensive data and information as well as lack of integrated approaches related to climate change impacts on coastal and marine ecosystems' goods and services
Marine ecosystems	Inadequate knowledge and awareness on coastal defence and protection services provided by coastal and marine ecosystems and their response to a changing climate

Marine ecosystems	Insufficient technical capacity for monitoring, assessing and projecting impacts of climate change in the marine ecosystems
Food security	Limited knowledge of climate smart agricultural practices
Health	Lack of information and knowledge on the direct and indirect impacts of climate change on human health
Cross-cutting	Limited knowledge on developing adaptive measures and projects
Marine and terrestrial ecosystems	Lack of knowledge of the costs of climate change impacts and adaptation investment opportunities for sustainable development in the marine and terrestrial ecosystems

Workshop participants prioritising the adaptation knowledge gaps



E. Potential response actions

The MSG identified potential response actions to each of the priority adaptation knowledge gaps, including deliverable(s) and format, actions to produce the deliverable(s), users of the deliverable(s) and best placed implementing entity(ies), as indicated in Table 2.

Table 2. Potential response actions to address priority knowledge gaps

Priority knowledge gap	Deliverable and its format	Action to produce the deliverable	Users of the deliverable	Best placed implementing entity
Fragmented baseline data (biological, ecological and climate) and lack of standardized methodologies for consolidating information on terrestrial ecosystems at the GCC level	Semantic agreement on ontology GEO BON	Expert meeting to define and agree on baseline and standardization (called by GCC in collaboration with UNEP ROWA): <ul style="list-style-type: none"> - Glossary - Select indicators - Agree on protocol and methodology - Agree on threshold of the baseline data 	National implementers Environmental agencies Research institutes Public authorities Academia	AGEDI UNEP ROWA
Incomprehensive data and information as well as lack of integrated approaches related to climate change impacts on coastal and marine ecosystems' goods and services	Habitat map ecosystem services	Inventory of existing work Countries to present what they have Expert meeting	Environmental hubs in the region Decision makers	ROPME AGEDI KISR EPA Kuwait Ministry of Environment and Water- UAE
Inadequate knowledge and awareness on coastal defence and protection services provided by coastal and marine ecosystems and their response to a changing climate.	Early warning centre for coastal area <i>Markaz alrasd albee'ey</i>	Empower the Centre and building the knowledge Networking Engage civil society have a role and the Centre has a role Produce targeted awareness	NGO Decision-makers Academia CSO	Centre for environmental monitoring – Dubai Early warning centre – Muscat
Insufficient technical capacity for monitoring, assessing and projecting impacts of climate change	Joint program for capacity building	Design a specific targeted training module for monitoring, assessing and projecting impacts of climate change	Municipalities Planners Policy makers	Environmental programs in different universities PERSGA Sultan Qaboos University Modelling centres
Lack of knowledge of the costs of climate change impacts and adaptation investment opportunities for sustainable development	Common methodology for cost benefit analysis and cost effectiveness analysis	Financial tools Forum for disseminating best practices and lessons learnt Shared decision makers Legislative framework Use the climate change working group under the GCC green initiative to disseminate the knowledge of the costs of climate change impacts and adaptation investment opportunities for sustainable development	GCC Secretariat General Ministries	GCC secretariat Ministries AGEDI

Limited availability and access to observed data on quantity and quality of conventional (groundwater reserves, surface water, shared transboundary flows, recharge levels) and non-conventional (treated wastewater, desalinated water) water resources.	<p>Well- trained personnel and technical people</p> <p>Well-structured national/regional databases</p> <p>Integrated climate and hydrological models on regional/national levels</p> <p>Detailed technical reports and policy briefs</p>	<p>Assessment of the existing resources</p> <p>Design capacity development programs to meet the requirements</p> <p>Evaluate, upgrade and enhance existing databases</p> <p>Publishing and dissemination of reports and policy briefs</p>	<p>Decision makers</p> <p>Planners</p> <p>Media</p> <p>Researchers</p> <p>CSO</p> <p>Ministries of environment, water, agriculture and energy</p>	<p>UN regional organizations (capacity building)</p> <p>GCC secretariat</p> <p>IUCN ROWA</p> <p>AGEDI</p>
Limited availability and lack of access to scenario data at various spatial scales for projected climatic variables, including temperature, precipitation, wind, evapotranspiration, drought, flash floods, sea level, extreme events, etc.	<p>Well-trained personnel</p> <p>A comprehensive regional climate model</p>	<p>Assessment of the existing climate regional models</p> <p>Upgrade/ enhance of existing climate models</p> <p>Coordinate the availability of model inputs/data</p> <p>Design/ capacity development programs to meet the requirements</p>	<p>Climate modellers</p> <p>Researchers</p> <p>Climate change stakeholders</p>	<p>GCC secretariat</p> <p>Centres of excellences in the region</p>
Lack of information and knowledge on the direct and indirect impacts of climate change on human health	<p>Enhanced continues health education programmes on climate related health problems</p> <p>Statistical reports to link between health and climate change on geographical distribution basis</p>	<p>Form environmental health department to be the owner of this mandate</p> <p>Field and medical surveys related to climate diseases</p> <p>To develop curriculum on climate health related issues</p> <p>Develop database on to link hospitals, health centres and clinics</p>	<p>Ministries of health</p> <p>Faculties of medicines</p> <p>Syndicate of pharmaceutical</p> <p>WHO</p> <p>Health agencies</p>	<p>Ministries of health</p> <p>WHO (capacity building)</p> <p>RAED</p> <p>AGEDI</p>
Limited knowledge on developing adaptive measures and projects	<p>Tools and methodologies for vulnerability assessments</p> <p>Well trained personal</p> <p>Technical reports</p>	<p>Participatory process to: Assessment of the existing vulnerability approaches</p> <p>Design/ capacity development programs to meet the requirements</p>	<p>CSO</p> <p>Local communities</p>	<p>Local authorities</p> <p>IUCN ROWA</p> <p>RAED</p>
Limited knowledge of climate smart agricultural practices	<p>Well- trained personal on smart agriculture concept</p>	<p>Benchmarking of smart agricultural practices</p> <p>Selection of the most appropriate ones for the region</p> <p>Establishing communication and cooperation mechanisms with the international agencies</p> <p>Design/ capacity development programs to meet the requirements</p>	<p>Consumers and producers</p> <p>Farmers</p> <p>Decision makers</p> <p>Ministries of agriculture</p> <p>AGU</p>	<p>Authorities working on agriculture and food security</p> <p>FAO</p> <p>ICARDA</p> <p>ACSAD</p> <p>KISR</p> <p>ICBA</p>

ANNEX: Proceedings of the priority-setting workshop

Prior to the workshop, MSG members were provided with the following set of documents:

- Agenda for the workshop;
- Scoping paper containing initial pool of knowledge gaps based on a literature review (see item 2.1. below) for their inputs and comments after which the scoping paper was revised prior to the workshop;
- Background information on the LAKI;
- Summary of the methodology for prioritizing knowledge gaps under the LAKI to be applied during the workshop.

This section provides further details on each of the workshop sessions as in Figure 1 above, including the activities carried out during the session and outputs of the sessions.

1. Opening and introduction

The priority-setting workshop was opened by Mr. Ahmad Baharoon, Director of the Abu Dhabi Global Environmental Data Initiative (AGEDI).

His welcome speech was followed by three opening statements by the co-conveners and the host country government, as follows:

Dr. Abdul-Majeid Haddad, Regional Climate Change Coordinator, Manager of Implementation, United Nations Environment Programme (UNEP) Regional Office for West Asia (ROWA)

Dr. Xianfu Lu, Team Leader, Impacts, Vulnerability and Risk, Adaptation Programme, United Nations Framework Convention on Climate Change (UNFCCC) secretariat

Mr. Ali Al Shafar, Deputy Director, Directorate of Energy and Climate Change, Ministry of Foreign Affairs, United Arab Emirates

Mr. Hamid S. Al Sadoon, International Policies Analyst, Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia, delivered a keynote speech and presentation on adaptation in the context of the sustainable development agenda in the GCC.

Dr. Bill Dougherty, who moderated the workshop, introduced the structure of the workshop and the method and mode of work.

A full list of the attendees of the workshop is contained in Supplement 1 to this annex.

2. Identification of a pool of adaptation knowledge gaps for the GCC subregion

2.1. Literature review and development of the scoping paper on knowledge gaps

Prior to the workshop, a scoping paper was developed to serve as a starting point of the discussions of the MSG. The scoping paper was based on desk research and literature review of over 40 sources, including National Communications to the UNFCCC, Global Environment Outlook reports, Arab Environment Outlook 2010 report and scientific publications. The scoping paper identified 19 adaptation knowledge gaps, along with their context-specific substantiation, for the GCC subregion clustered into following themes: water, ecosystems (terrestrial and marine), coastal zones, public health, security, cross-cutting.

Gaps were identified considering the following:

1. Scarcity of scientific literature in the region, especially literature dealt with climate change;
2. Scarcity of integrated research on identified issues;
3. Gaps identified by national communications of the countries in the subregion;
4. Available information contained in national, regional and international reports.

The paper was shared with the MSG members for their inputs and additions to the knowledge gaps.

Taking into consideration the inputs provided by the MSG, the paper was further streamlined and presented as a basis for discussions on the first day of the workshop.

2.2. Identification of knowledge gaps during the workshop

Using the pool of adaptation knowledge gaps identified and supplemented before the workshop as a starting point, the MSG members divided into four thematic breakout groups according to their areas of expertise, as follows:

1. Water resources;
2. Marine biodiversity and coastal zones;
3. Terrestrial ecosystems and food security; and
4. Public health, security and cross-cutting issues.

Each breakout group discussed, amended, substantiated and deleted the initial thematic knowledge gaps as identified in the scoping paper, and/or added new knowledge gaps.

To assist the MSG in defining knowledge gaps, the following scope was provided as to what constitutes a knowledge gap within the LAKI context:

Adaptation knowledge gaps that:

- Can be addressed through more informed application of, and/or through repackaging/synthesis or increasing accessibility of existing data, information and knowledge.
- Do NOT require new research or generation/collection of new data.
- Are NOT related to coordination, institutional processes or practices.

A rapporteur from each thematic breakout group presented in plenary the outcome of the group discussions. Table 3 below represents the number of gaps prior to and after the discussions in each thematic breakout group.

Table 3. *Number of knowledge gaps prior to and after the thematic breakout group discussions*

Thematic breakout group	Number of knowledge gaps prior to breakout group discussions	Number of knowledge gaps after the breakout group discussions
Water resources	14	19
Marine biodiversity and coastal zones	12	26
Terrestrial ecosystems and food security	12	19
Public health, security and cross-cutting issues	14	17

All identified knowledge gaps were compiled with a small number of entries marked out as needing further clarification/articulation. At the beginning of Day 2 the compiled list of all identified knowledge gaps was presented to the MSG. The Group, in a plenary setting, deliberated on the marked entries on the list of knowledge gaps resulted from Day 1. During this process, some entries were merged or deleted.

As a result of the plenary discussion, MSG retained a total of 72 knowledge gaps which were used as a basis for prioritization. These knowledge gaps are contained in Supplement 2 to this annex.

3. Identification and weighing of criteria for prioritization of knowledge gaps

As a next step in the process of gap prioritization, the MSG members were requested to identify criteria for prioritization. The MSG members decided to use the criteria used in the pilot LAKI for the Andean subregion as a starting point of their discussions.

The MSG discussed in plenary each of the criteria from the Andean subregion and grouped these in three clusters: temporal, spatial, and policy related criteria. They reframed some of the criteria and merged two criteria. As a result, the MSG agreed on a total of seven prioritization criteria as indicated in Table 2 below.

Further, using a scorecard, MSG members assigned a score between 1 and 5 to each of the seven criteria, with 5 denoting a criterion as the most important, 1 least important for considering whether a knowledge gap should be filled. The scoring resulted in each criterion being assigned a (relative) percentage weight (the total percentage weights total 100%) (see the last column of Table 4).

The output of this session was a list of weighted criteria to be used for the prioritization of the knowledge gaps, as presented in Table 4.

Table 4. *Weighted criteria for prioritization of knowledge gaps*

ID	Cluster	Criterion	Description	Weight
C1	Temporal	Urgency (rapidity of determining actions over the short term)	Closing the gap would generate benefits in the short term or address urgent adaptation needs or reduce high potential threats [early warning systems]	16%
C2	Policy-related	Positive effects on populations, goods, and public services with minimal trade-offs	Closing the gap would generate positive effects on socio-economic development as well as other amenities	14%
C3	Policy-related	Efficacy for influencing policy-making and management processes (over time)	Filling the gap supports policy-making and management processes at the national, local and sectorial levels	14%
C4	Global/policy-related	Potential to support climate resilience across sectors and systems	Filling the knowledge gap would help increase climate resilience	14%
C5	Spatial	Significance of impact on closing the gap	Relevance for closing a critical gap of a thematic, national, or regional character as well as reducing the associated uncertainty	14%
C6	Policy-related	Co-benefits for closing other gaps (conditioning for closing other gaps)	Addressing the gap will have a positive impact and synergies on other gaps	14%
C7	Temporal	Long-term sustainability of benefits	Addressing the gap would achieve benefits and sustainability over the long term	13%

4. Prioritization of knowledge gaps

With the pool of knowledge gaps and weighted criteria ready, the MSG members were requested to undertake the exercise for prioritization of knowledge gaps against criteria. They received via email a formatted electronic scorecard with the 72 knowledge gaps on the vertical axis and the seven criteria on the horizontal axis.

Working individually, the MSG members assigned a score between 1 and 5 to each gap against each criterion, with 5 denoting addressing the specific gap as most important with relation to the concerned criterion, 1 being the least important. Each of these scores was automatically multiplied with the weight of the respective criterion. The sum of all weighted values for a gap produced a priority score for each knowledge gap. MSG members could see their personal ranking of the knowledge gaps as they move from one gap to the next. The final completed scorecards were submitted via email.

All individually weighted priority scores were transferred to one master file. The sum of all individual priority scores produced an overall priority score for each of the knowledge gaps, whereby the highest score signifies the highest ranking knowledge gap.

As a result of the prioritization exercise, all 72 knowledge gaps were ranked. Supplement 2 to this annex contains the ranked list of knowledge gaps for the GCC subregion.

5. Refinement of priority knowledge gaps

With the results from the prioritization exercise, the MSG members engaged in a plenary discussion, moderated by Dr. Abdul-Majeid Haddad, on the top ranking knowledge gaps, and made refinement and amendments, and produced a final list of priority gaps.

The refinement involved merging two of the top priority gaps and some textual changes, resulting in ten priority adaptation knowledge gaps covering all thematic clusters (water, terrestrial ecosystems, marine ecosystems, food security, health and cross-cutting), as presented in Table 1 above.

These ten gaps were accepted by MSG members as the final list of priority gaps for further consideration of response actions where the respective ranks of the gaps were deemed irrelevant (i.e. all priority gaps are equally important to be addressed).

6. Identification of potential response actions

In order to identify response actions, MSG members divided, according to their expertise, into two breakout groups. One group focused on the five priority knowledge gaps under the themes of marine and terrestrial ecosystems, while the other group on the five priority knowledge gaps related to water, food security, health and cross-cutting issues.

The two breakout groups identified response actions, including deliverable(s) and format, actions to produce the deliverable(s), users of the deliverable(s) and best placed implementing entity(ies), as indicated in Table 2 above.

7. Feedback by the MSG members

MSG members were invited to provide feedback on the various sessions of the workshop, which are summarized below. These inputs will be considered by the co-conveners for implementation of the LAKI in next subregions:

- The scoping paper was considered as a useful starting point. However, the level of detail and context-specificity needed to be strengthened, including through review of “grey” literature.
- Involvement of the MSG in refining the scoping paper should start at an earlier point in time.
- Future workshops may include in their agenda an information sharing session by participants before embarking onto the gap identification exercise.

- MSG members need to possess the relevant thematic expertise; therefore careful and balanced selection of experts is needed, so that the MSG is thematically balanced.
- MSG members suggested that each thematic group, no matter how large, comes up with an equal maximum number of gaps, so that there is no dominating theme in the overall pool of knowledge gaps.
- Using the criteria identified in previous LAKI priority setting workshops was considered a useful starting point.
- The number of criteria needs to be reduced as this makes the prioritization of gaps difficult. Given that all the criteria were between the range of 13-16 %, the relative differences among them were insignificant.
- Urgency was considered as a most important criterion. However, in the prioritization process its weight tends to get lost. A MSG member suggested using temporal criteria of urgency (short-term, mid-term and long-term) only.
- Once themes/ thematic clusters are prioritized, the MSG could decide how many of each top priority gaps from each theme/ thematic cluster will be taken forward from the pool of priority gaps. This approach will ensure that knowledge gaps from all themes/thematic clusters are adequately represented in the pool of priority gaps.
- A MSG member suggested that further to the suggestion in the bullet above, a second round of prioritization should be carried out by all MSG members to determine the ranking of the priority gaps.

Supplements to the Annex

Supplement 1. Attendees at the workshop⁴

Co-conveners	<p>The co-conveners of the LAKI for the GCC are: UNEP and the UNEP Regional Office for West Asia (ROWA) UNFCCC, represented by:</p> <p>Dr. Abdul-Majeid Haddad, UNEP ROWA* Ms. Toko Toshiko Ohga, UNEP/GAN Dr. Xianfu Lu, UNFCCC Ms. Petya Pishmisheva, UNFCCC</p>
Subregional coordination entity	<p>The subregional coordination entity is a local organization with a proved track record of expertise in the subregion, which provides technical and logistical support to the co-conveners for the organization of the priority-setting workshop and helps coordinate response actions to the priority gaps.</p> <p>The subregional coordination entity for the GCC subregion is the Abu Dhabi Global Environmental Data Initiative (AGEDI), represented by:</p> <p>Mr. Ahmad Baharoon, AGEDI Ms. Jane Glavan, AGEDI</p>
Members of the Multidisciplinary stakeholder group (MSG)	<p>The multidisciplinary stakeholder group (MSG) is composed of the participants in the GCC subregion priority-setting workshop.</p> <p>Ms. Abeer Yousef Al-Aysah, National Bureau of Statistics of UAE* Dr. Ahmed Salaheldin Mohamed Khalil, PERSGA* Dr. Emad Adly Abdelaziz Nada, RAED* Dr. Ghazi A. Al-Rawas, Sultan Qaboos University* Dr. Hassan El Banna Awad, ROMPE* Dr. John Burt, New York University, Abu Dhabi, UAE* Dr. Layla al-Musawi, Kuwait Environment Protection Society* Dr. Mahmoud Medany, Agricultural Research Center* Dr. Malik Al Wardy, Sultan Qaboos University* Dr. Mansour Malik, Department of Transport, Abu Dhabi, UAE* Dr. Mehdi Ahmed Jaaffar, Environment Society of Oman* Mr. Mufleh Aref Haza's Alalaween, IUCN* Dr. Rachael A. McDonnell, International Center for Biosaline Agriculture* Dr. Sabah Al-Jenaid, Arabian Gulf University* Ms. Safia H. Al-Ajlan, Kuwait Foundation for Advancement of Sciences* Ms. Suaad Al Harthi, Environment Society of Oman* Dr. Tarek Sadek, UN-ESCWA* Dr. Yassine Charabi, Sultan Qaboos University* Mr. Ali Al Shafar, Ministry of Foreign Affairs of the UAE Ms. Shaima Al Aydarous, Ministry of Foreign Affairs of the UAE Ms. Ameirah Al Dahmani, Ministry of Foreign Affairs of the UAE Mr. Obaid Al Zaabi, Ministry of Foreign Affairs of the UAE Ms. Naoko Kubo, Ministry of Foreign Affairs of the UAE Ms. Marwa Alawadhi, Ministry of Environment and Water, UAE Dr. Fatima Alaiclrou, National Center of Meteorology & Seismology, UAE Dr. Amal Akanafi, National Bureau of Statistics of UAE Dr. Abeer Sajwani, Urban</p>

⁴ MSG members who took part in the prioritization of the adaptation knowledge gaps are marked with an asterisks (*).

Planning Council, UAE
 Dr. Abeer Sajwani, Urban Planning Council, UAE
 Mr. Hussein Ibrahim Hamed, Environment Agency – Abu Dhabi, UAE
 Ms. Maria Cordeiro, Environment Agency – Abu Dhabi, UAE
 Ms. Ruqaya Mohamad, Environment Agency – Abu Dhabi, UAE
 Dr. Simon Pearson, Environment Agency – Abu Dhabi, UAE
 Dr. Fares Howari, Zayed University, UAE
 Dr. Ahmed Salaheldin Mohamed Khalil, PERSGA
 Dr. Ali Abdulla Al Hawash, ROPME
 Dr. Ashraf Nour Eldin Shalaby, League of Arab States
 Mr. Hamid S. Al Sadoon, Ministry of Petroleum and Mineral Resources of the Kingdom of Saudi Arabia
 Dr. Mehdi Dussi, FAO
 Dr. Mona Radwan, UNEP/ROWA

Supplement 2. Ranked list of adaptation knowledge gaps for the GCC subregion after the first round of scoring

Rank	Adaptation knowledge gaps	Total priority score
1	Insufficient availability and limited access to observed data on groundwater reserves, recharge levels, shared transboundary flows, water quality and water consumption of this resource across sectors	72.88
2	Lack of biological, ecological and climate data required for analysing the linkage between biodiversity and climate change	69.57
3	Insufficient availability and lack of access to scenario data for climatic variables (temperature, wind, evapotranspiration, rainfall, drought frequency)	69.47
4	Insufficient comprehensive data and information related climate change impacts on marine ecosystem products (fisheries) and services	68.50
5	Lack of baseline data and consolidated information at the GCC level (e.g. use of different methodologies, inconsistent use of methodologies, partial IUCN list)	68.37
6	Insufficient availability and limited access to data on treated wastewater, water quality and water consumption of this resource across sectors	67.87
7	Limited knowledge on developing adaptive measures and projects	65.24
8	Insufficient technical capacity for monitoring and projecting impacts of climate change	65.15
9	Lack of knowledge on environmental costs (“environmental price tags”) of terrestrial ecosystems versus urbanization and development	65.14
10	Lack of knowledge related to the coastal defence and protection services provided by marine ecosystems (e.g. coral reefs, mangroves, etc.) and how these protective functions would change in a changing climate	64.53
11	Insufficient availability and limited access to observed data on surface water, shared transboundary flows, water quality and water consumption of this resource across sectors	64.48
12	Lack of data and information on the impacts of and vulnerability to climate change and adaptation of ecosystem products and services	64.40
13	Inadequate/insufficient data and information on future climate projections at local scale with appropriate (spatial) resolution	64.29
14	Lack of understanding of the potential socioeconomic and environmental effects of climate change and coastal development on coastal ecosystems	64.25
15	Limited knowledge on the effectiveness of technological options for adaptation to climate change concerning water resources	64.02

16	Limited local level datasets and simple climate-linked computer watershed models that are relevant to the region to allow water managers to assess impacts and to evaluate the functioning and resilience of relevant systems	63.97
17	Lack of access to and exchange of data, information and knowledge related to the effects of climate change at the regional level on transboundary sectors (e.g. sea level rise, shared groundwater resources, terrestrial and marine ecosystems, infrastructure development and tourism)	63.90
18	Insufficient understanding of the impacts of extreme events such as HABs, cyclones, climate oscillations, and dust storms	63.73
19	Lack of definitions and methodologies for understanding the cause-effect relationships between climate change and biodiversity (rather difficult to identify whether impacts are a result of climate change or human activities)	63.69
20	Limited knowledge of climate smart agricultural practices	63.54
21	Limited knowledge on methodologies to make the general concept of sustainable water resource management operational on the ground	62.94
22	Lack of knowledge on the direct and indirect impacts of climate change on human health	62.49
23	Lack of a common platform for sharing and accessing information for the general public on best practices, research findings, case studies, etc.	62.46
24	Incomplete understanding of temporal and spatial trends in ecosystems	62.33
25	Lack of basic health data (accessibility, geo-referenced data, metadata, cross functionality, fragmentation of health systems, empirical evidence of climate change impacts and health – heat, vector borne diseases – and indirectly through migration)	62.11
26	Lack of knowledge on coastal vulnerability and associated risks (e.g. pollution, erosion, flooding, etc.) to sea level rise at regional scale	62.10
27	Insufficient knowledge and information on good practices related to, adaptation options to respond to climate change vulnerabilities	61.74
28	Insufficient availability and limited access to desalinated data and water consumption across sectors	61.63
29	Limited information and knowledge of impacts of climate change on non-renewable water resources at the strategic and operational levels	61.50
30	Lack of integrated information on coastal characteristics, dynamics and patterns of human behaviour for both the present time and under a changing climate in the future	61.33
31	Limited knowledge/resources on the use of relevant quantitative, analytical methods and hydrological and climatological tools (e.g. models) and calibration data to assess climate change (including rainfall change) impacts on water resources	61.26
32	Limited national water budget allocation modelling that considers the different climate change scenarios	61.17
33	Lack of knowledge in appropriate methods, tools and techniques for vulnerability assessment, adaptation prioritization, microeconomic assessment, and stakeholder engagement	61.13
34	Lack of knowledge (and capacity) on methods and tools for downscaling global scenarios to the regional and national level at high resolution.	61.01
35	Insufficient and inconsistent monitoring of sea level	60.96
36	Insufficient mapping of vulnerabilities using indexes (using GIS systems)	60.90
37	Need for regional-based spatial-temporal rainfall distribution models taking into account extreme rainfall events required for the design of water resources structures	60.85
38	Need for a synthesis of existing studies on the health-related effects of climate change, from which policy makers would benefit	60.57

39	Limited knowledge on how to effectively/appropriately use climate change related data/information, in the light of deep uncertainty, in near- and mid-term sectoral/resource planning	60.52
40	Limited methods and procedures to facilitate the standardization of observational data across agencies and countries related to water resources and occurrence of extreme events	60.47
41	Lack of understanding of the interlinkages between climate change, biodiversity and desertification	60.23
42	Lack of databases illustrating the causal-effect relationship between climate change and public health	60.19
43	Insufficient processing/analysing and dissemination of information on climate change impacts on biodiversity	60.16
44	Lack of knowledge on vulnerability of marine habitats	60.12
45	Insufficient knowledge of how climate change would interact with disturbances related to human activities	60.01
46	Insufficient availability of basic, relevant, accurate and up-to-date data and information on the natural and socioeconomic processes occurring in coastal areas	59.89
47	Data reliability and quality control/assurance	59.74
48	Lack of information on “real” cost of agricultural production /ecological footprint (how much does it cost without subsidies) so that future production projections can be produced	59.73
49	Lack of data for understanding the extent of sustainable protected buffer zones for mangroves and salt marshes	59.55
50	Insufficient availability and limited access to data on state of distribution systems	59.31
51	Lack of knowledge on the economic costs and benefits of adaptation to climate change in respect of food security, socio-economic impacts of climate change on food availability and cost of inaction	59.10
52	Lack of an effective information network and database, easily accessible to public and private sector entities	59.08
53	Insufficient information on adaptive capacity of socio, economic, environment systems (important to understand vulnerability of sectors and communities)	59.07
54	Lack of knowledge on the impact of climate change on the upwelling in the Arabian Sea	58.64
55	Need for wider understanding of the extent to which climate change has been integrated into (strategic) national water resource management plans	58.41
56	Limited availability of decision support tools and science-policy interface (to trigger action)	58.10
57	Lack of readily accessible and easily understandable relevant case studies of best practices and success stories related to the interlinkages between climate change, biodiversity and desertification for decision makers and the general public	58.00
58	Lack of knowledge related to the implications of climate change for security and conflicts (e.g. related to coastal loss, water scarcity, biodiversity loss, health impacts, food security, infrastructure, societal demographics, extreme events etc.)	57.84
59	Lack of knowledge on mechanisms for resolution of climate change induced conflicts related to displacement and migration across national borders	57.69
60	Incomplete knowledge on the inter-connectivity between ecosystems	57.38
61	Lack of knowledge on the effects of climate change on cardiovascular, respiratory diseases and vector-borne diseases as well as death and injury post (extreme) events	56.88
62	Lack of understanding of the connectivity of coastal ecosystems for supporting different stages of marine fauna and/or transfer of energy/nutrients among ecosystems	56.84
63	Limited knowledge on effectiveness and cost-benefit analysis, social impacts, feasibility of alternative adaptation measures	56.58
64	Lack of regional health data standards	55.81

65	Absence of data/information on the magnitude of impacts of fallen dust on marine biogeochemistry and ecosystem services, acidification and shift of carbon dioxide cycle, nutrients cycle and productivity, consequences on fisheries and food security. a. Lack of understanding of integration of climate change/ desertification/ dust storms/ acidification and changes in seawater chemistry and impacts on the ecosystem; b. Absence of research effort for the assessment of impacts of fallen dust on the marine biogeochemistry in the Gulf Region; c. Absence of considering the risk assessment of SDS (Sand and Dust Storms) impacts on the Gulf Marine environments and on ecosystem services in national and international assessment planning for the region	55.52
66	Inadequate assessment of Marine Protected Areas and whether they provide adequate protection for climate change, or if there is a need to review/expand existing protected areas	55.10
67	Inadequate understanding of which areas and zones are vulnerable to, and which countries are prone to conflicts and displacement	53.96
68	Limited knowledge on economic alternatives for adapting to reduced fossil fuel energy intensity	53.90
69	Insufficient knowledge on technology options (e.g. building code) related to address impacts of climate change on air conditioning requirements	53.87
70	Limited documentation of best practices in stakeholder engagement to showcase and inform new integrated water resources management policies and plans	53.11
71	Limited knowledge on impacts and thresholds of water desalination (technologies)	52.61
72	Limited availability of relevant information and media products in Arabic	49.24

Supplement 3. Abbreviations

ACSAD	Arab Center for the Studies of Arid Zones and Dry Land
AGEDI	Abu Dhabi Global Environmental Data Initiative
CAMRE	Council of Arab Ministers Responsible for the Environment
CSO	Civil society organizations
FAO	Food and Agriculture Organization
GCC	Gulf Cooperation Council/ Cooperation Council for the Arab States of the Gulf
ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Center for Biosaline Agriculture
IUCN	International Union for Conservation of Nature
JCEDAR	Joint Committee on Environment and Development in the Arab Region
KISR	Kuwait Institute for Scientific Research
LAKI	Lima Adaptation Knowledge Initiative
MSG	Multidisciplinary stakeholder group
NGO	Non-governmental organizations
NWP	Nairobi work programme on impacts, vulnerability and adaptation to climate change
RAED	Arab Network for Environment and Development
ROMPE	Regional Organization for the Protection of the Marine Environment
PERSGA	Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
UAE	United Arab Emirates
UNEP ROWA	United Nations Environment Programme Regional Office for West Asia
UNFCCC	United Nations Framework Convention on Climate Change
UN-ESCWA	United Nations Economic and Social Commission for Western Asia
WHO	World Health Organization