RICCAR Overview

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Chief, Water Resources Section, Sustainable Development Policies Division
United Nations Economic and Social Commission for Western Asia (ESCWA)
Beirut, Lebanon

Workshop on Climate Change Adaptation in the Economic Development Sector
Using Integrated Water Resources Management (IWRM) Tools
Amman, 25-27 May 2016
Council of Arab Ministers Responsible for the Environment (CAMRE) under League of Arab States
- Issued first inter-governmental Arab Statement on Climate Change in December 2007,

**Declaration (excerpts):**

- Constitutes the base for future action and reflects the Arab position in dealing with climate change issues,
- Adaptation to ...climate change shall be fully consistent with the economic and social development .... It shall be implemented through the development and dissemination of methodologies and tools that assess the impacts of climate change and their extent; as well as through improving planning for adaptation, along with its measures and procedures, in addition to its integration in sustainable development policies; besides understanding, developing and disseminating measures, methodologies and tools that achieve economic diversity with the aim of increasing the elasticity of economic sectors vulnerable to climate change.
- Establish studies and research centers for climate change in the regions of developing countries, including the Arab region. These centers should be concerned with examining impacts and challenges facing the citizens and peoples of the developing countries as a result of climatic change.
Inter-Governmental Mandates calling for & supporting Climate Change Assessment in the Arab Region

- Arab Ministerial Declaration on Climate Change
  - CAMRE 2007
- ESCWA 25th Ministerial Session
- Arab Economic and Social Summit
  - Resolution on Climate Change & Water Project 2009
- Arab Ministerial Water Council
- Arab Permanent Committee for Meteorology
- ACSAD Board of Directors
  - Resolution 2013

Environment  Foreign Affairs & Planning  Water  Met  Agriculture
To assess the impact of climate change on freshwater resources in the Arab Region through a consultative and integrated regional initiative that seeks to identify the socio-economic and environmental vulnerability caused by climate change impacts on water resources based on regional specificities.

**RICCAR aims to provide a common platform for assessing, addressing and informing response to climate change impacts on freshwater resources in the Arab region by serving as the basis for dialogue, priority setting and policy formulation on climate change at the regional level.**
RICCAR Partnerships

Implementing Partners

ESCWA
UNEP
WMO
ACSAD
LAS
SMHI
UNESCO
Cairo Office
giz
UNISDR
UNITED NATIONS UNIVERSITY
UNU-INWEH
UNAOC

Donors

SWEDEN

Collaborating Research Institutes

• Center of Excellence for Climate Change Research/ King Abdulaziz University (CECCR/KAU) - KSA
• King Abdullah University of Science and Technology (KAUST) - KSA
• Climate Services Center 2.0 (CS2.0) - Germany
RICCAR supported & implemented through Regional Cooperative Arrangements & Mechanisms

UN-LAS Coordination Mechanism

UN-LAS Sectoral Meeting on Climate Change 2009

Arab Summit approved IWRM Project on Climate Change LAS/ACSAD - 2009

UN Regional Coordination Mechanism (RCM) Thematic Working Group on Climate Change Chaired by UNEP/ROWA - 2010

RICCAR Formulation & Implementation with Partners


VA & RKH Working Groups 2013, 2014


VA Task Force Meetings (sensitivity, AC) 2014, 2015
Implementation Pillars

Baseline Review & Knowledge Management

Integrated Assessment

Climate Change Impact Assessment
Climate Change Vulnerability Assessment

Capacity Building & Institutional Strengthening for Water Ministries, Meteorological Offices, Arab Research Centers

Awareness Raising & Information Dissemination
The Integrated Assessment Model

Step 1: Global Climate Model Selection
Step 2: Regional Climate Modeling
Step 3: Regional Hydrological Modeling
Step 4: Vulnerability Assessment
Step 5: Integrated Mapping

The Arab Region

Impact Assessment

Vulnerability Assessment

Water, Agriculture, Health Impact Assessments
Regional Climate Modeling over the Arab Domain
Inter-Governmental Panel on Climate Change:
Areas considered for regional averages in IPCC AR4

From R.K Kolli, WMO
RICCAR EGM #2 (Beirut, 2010)
Figure A1.3: Overview of the SREX, ocean and polar regions used.
Representative Concentration Pathways (RCPs)  
As first represented in IPCC AR5 Projections

Paris Agreement asks IPCC to formulate scenario that limits Global Average Temp increase to only 1.5°C by 2100 as there is no RCP for that now.

Graph adapted from: Meinshausen et al., 2010
Computing Climate Variables per Grid Box

REF: http://stratus.astr.ucl.ac.be/textbook/chapter3_node8.html
Computing Climate Variables: Scale Improving Over Time

FAR 
-~500 km (T21)

SAR 
-~250 km (T42)

TAR 
-~180 km (T63)

AR4 
-~110 km (T106)

RICCAR RCM Outputs at 50x50 km & 25x25 km

Vertical Level:
Relative position of pressure levels, or “hPa Levels” that define the thickness of grid boxes.

Horizontal Grid:
Evolution of horizontal resolution over the course of the Various IPCC reports

IPCC, 2007; Met Office, 2011
Table 1. LIST OF ESSENTIAL CLIMATE VARIABLES

<table>
<thead>
<tr>
<th>Domain</th>
<th>Sub-domain</th>
<th>GCOS Essential Climate Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Atmospheric</strong></td>
<td>Surface</td>
<td>• Air temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Wind speed and direction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Water vapour</td>
</tr>
<tr>
<td></td>
<td>Upper-air</td>
<td>• Temperature</td>
</tr>
<tr>
<td></td>
<td>(up to the</td>
<td>• Wind speed and direction</td>
</tr>
<tr>
<td></td>
<td>stratopause)</td>
<td>• Water vapour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cloud properties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Earth radiation budget (including solar irradiance)</td>
</tr>
<tr>
<td></td>
<td>Composition</td>
<td>• Carbon dioxide</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Methane and other long-lived greenhouse gases: nitrous oxide (N₂O),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs),</td>
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<tr>
<td></td>
<td></td>
<td>hydrofluorocarbons (HFCs), sulphur hexafluoride (SF₆), perfluorocarbons</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ozone and aerosols, supported by their precursors, in particular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>nitrogen dioxide (NO₂), sulphur dioxide (SO₂), formaldehyde (HCHO),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>carbon monoxide (CO)</td>
</tr>
<tr>
<td><strong>Oceanic</strong></td>
<td>Surface</td>
<td>• Sea-surface temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sea-surface salinity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sea level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sea state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sea ice</td>
</tr>
<tr>
<td></td>
<td>Sub-surface</td>
<td>• Temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Salinity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ocean current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Nutrients</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Carbon dioxide partial pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ocean acidity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Oxygen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Tracers</td>
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<tr>
<td><strong>Terrestrial</strong></td>
<td>Surface</td>
<td>• River discharge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Water use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lakes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Snow cover</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Glaciers and ice caps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ice sheets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Permafrost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Albedo</td>
</tr>
<tr>
<td></td>
<td>Sub-surface</td>
<td>• Groundwater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Land cover (including vegetation type)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fraction of absorbed photosynthetically active radiation (FAPAR)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Leaf area index (LAI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Above-ground biomass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fire disturbance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Soil carbon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Soil moisture</td>
</tr>
</tbody>
</table>

Notes:  a Including measurements at standardized, but globally varying heights in close proximity to the surface.  
  b Including measurements within the surface mixed layer, usually within the upper 15 m.
More information available at
# CORDEX-MENA/Arab Ensemble Matrix

<table>
<thead>
<tr>
<th>RCM (Institute)</th>
<th>GCM</th>
<th>Historical 1950-2005</th>
<th>RCP2.6 2006-2100</th>
<th>RCP4.5 2006-2100</th>
<th>RCP8.5 2006-2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCA4 (SMHI)</td>
<td>EC-Earth</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RCA4 (SMHI)</td>
<td>EC-Earth</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RCA4 (SMHI)</td>
<td>CNRM</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>RCA4 (SMHI)</td>
<td>GFDL-ESM</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RCA4 (SMHI)</td>
<td>GFDL-ESM</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>na (Kau)</td>
<td>GFDL-ESM-1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>na (Kau)</td>
<td>GFDL-ESM-2</td>
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<td>✓</td>
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<tr>
<td>Remo (CSi)</td>
<td>HadGEM2</td>
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<tr>
<td>RegCM4 (Kau)</td>
<td>MPI-ESM</td>
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<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RegCM4 (Kau)</td>
<td>GFDL-ESM</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Currently have 13 regional climate projections completed.
9 are available for CORDEX download.

Source: P. Graham, SMHI, RICCAR EGM 6 (Cairo, Dec 2014)
Projected changes in temperature:

- Global - GCMs and regional – RCA4(GCMs) ensembles
- Similar patterns in both global and regional ensembles
- Some differences on regional scale

Source: G.Nikulin (SMHI), RICCAR EGM-5, 11 Dec 2013
Projected changes in temperature: RCP8.5

- Global - GCMs and regional - RCA4(GCMs) ensembles
- Summer

- In coming decades both RCP4.5 and RCP8.5 are similar
- Larger warming from 2041 on for RCP8.5 than for RCP4.5

- Average global temperature has already risen by 1°C since pre-industrial times.
- INDCs submitted pre-Paris Agreement puts the world on a 3-4°C pathway

Source: G. Nikulin (SMHI), RICCAR EGM-5, 11 Dec 2013
Temperature Over Time: Climate Shifts

Winter

RCP 8.5

RCP 4.5

Draft Findings for sake of illustration

Summer

RCP 8.5

RCP 4.5
RICCAR Results

Climate Projections and Extreme Climate Indices for the Arab Region

Figure 10. Change in the Maximum Length of Dry Spell (CDD) for the time period 2081-2100 from the baseline period 1986-2005 for RCP 4.5 and RCP 8.5.

RCP 4.5
Maximum length of dry spell (CDD) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp45

RCP 8.5
Maximum length of dry spell (CDD) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp85

Issued November 2015
SU35 & SU40 were added to better reflect regional specificities associated with warmer temperatures in the Arab region, as the global indicator for summer days adopted by WMO/ETCCDI was limited to measuring the number of summer days (SU) when the daily maximum temperature (TX) exceeds 25°C. More water needed during these higher temperature periods for health & cooling.

*Source: RICCAR, Climate Projections and Extreme Climate Indices for the Arab Region (2015)*
Changes in Extreme Temperature

**Number of days with TX over SU35°C**

**Number of days with TX over SU40°C**

*Figure 7.* Change in the Summer Days with Tmax > 35°C (SU35) for the time period 2081-2100 from the baseline period 1986-2005 for RCP 4.5 and RCP 8.5.

**RCP 4.5**

Summer days, Tmax > 35°C (SU) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp45 (nr of days)

**RCP 8.5**

Summer days, Tmax > 35°C (SU) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp85 (nr of days)

*Figure 8.* Change in the Summer Days with Tmax > 40°C (SU40) for the time period 2081-2100 from the baseline period 1986-2005 for RCP 4.5 and RCP 8.5.

**RCP 4.5**

Summer days, Tmax > 40°C (SU) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp45 (nr of days)

**RCP 8.5**

Summer days, Tmax > 40°C (SU) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp85 (nr of days)

Source: RICCAR, Climate Projections and Extreme Climate Indices for the Arab Region (2015)
Change in Number of days with more than 10 mm of rainfall

Change in Number of days with more than 20 mm of rainfall

Important to thus not only look at climate parameters (T, P, etc), but also thresholds used for the analysis:

- Average Temperature or Consecutive Peak Temperature Days
- Summer Days as defined as 25°C, 35°C or 40°C
- Rainfall intensity has implication for flooding

Source: RICCAR, Climate Projections and Extreme Climate Idices for the Arab Region (2015)
The Earth System Grid Federation (ESGF) maintains a global system of federated data centers that allow access to the largest archive of climate data worldwide. The ESGF datanode at the National Supercomputer Centre, Linköping, is Sweden’s first datanode in the ESGF framework. It is a joint activity of NSC and the Swedish Meteorological and Hydrological Institute (SMHI). NSC is an independent organization within Linköping University (LIU), and is funded by the Swedish Research Council via SNIC (Swedish National Infrastructure for Computing).

https://esg-dn1.nsc.liu.se
Regional Climate and Hydrological Modeling for Climate Change Impact Assessment in Arab Region

Different GCMs for the Same RCP

General Circulation Model (GCM)

Regional Climate Model (RCM)

Regional Hydrological Model (RHM)

Ensemble Average used to reduce uncertainty at level of RCMs & RHMs

Ensembles compare findings of different RCMs & RHMs applied for same RCP & Domain

Bias Correction required

VIC, HYPE, HEC-HMS
Future Hydrological Projections

Runoff – Summer – **RCP 4.5**

**Preliminary findings**

**Source:** P. Graham (SMHI), RICCAR Scoping Meeting for the Establishment of an ArabCOF, 15 October 2014
Future Hydrological Projections

Runoff – Summer – RCP 8.5

Apr-Sep: 1986-2005

HYPE Model

VIC Model

[mm/month]

Hydro Models: 3-member ensemble

Preliminary findings

Source: P. Graham (SMHI),
RICCAR Scoping Meeting for the Establishment of an ArabCOF, 15 October 2014
RCM projections used to generate hydrological modeling projections for Arab Region, Sub-regions & Shared Water Basins

Parameters for Shared Basins:
- Mean Temperature Change
- Mean Precipitation Change
- Runoff
- Soil Moisture
- Evapotranspiration
- Groundwater interaction with surface water

Source: P. Graham (SMHI), based on AWMC & Sida Partners Consultations, RICCAR Scoping Meeting for the Establishment of an ArabCOF, 15 Oct 2014
Moroccan Highlands (Atlas)

Temperature

*Change in number of days > 35°C*

- **RCP 8.5**
- **RCP 4.5**

% Change in mean annual river discharge

- **RCP 4.5**
- **RCP 8.5**

From P. Graham, SMHI PPT to RICCAR Event at WWW 2016 (Stockholm)
Jordan River

**Temperature**

*Change in number of days > 35°C*

![Temperature Graph]

**Precipitation Intensity - SDII**

RCP 8.5

![Precipitation Graph]

**% Change in mean annual river discharge**

RCP 4.5

![Discharge Graph]

Source: P. Graham (SMHI), RICCAR Seminar, Stockholm, 25 August 2015
## 12 Nominated Hydrological Focal Points

<table>
<thead>
<tr>
<th>Country</th>
<th>Focal Point</th>
<th>Title</th>
<th>Ministry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Iraq</td>
<td>Mr. Jaafar Zamel</td>
<td>Head of Environmental Policy Dept</td>
<td>Ministry of Water Resources</td>
</tr>
<tr>
<td></td>
<td>Mr. Abdul Jabar Khalaf Fench</td>
<td>Expert, National Center for the Management of Water Resources</td>
<td></td>
</tr>
<tr>
<td>2-Jordan</td>
<td>Ms. Rania Abdul Khaleq</td>
<td>Director, Finance &amp; Int’l Cooperation</td>
<td>Ministry of Water and Irrigation</td>
</tr>
<tr>
<td>3-Djibouti</td>
<td>Mr. Ismail Elmi Habane</td>
<td>Technical Advisor to the Minister in charge of Marine Resources</td>
<td>Ministry of Agriculture, Water, Livestock, Fisheries</td>
</tr>
<tr>
<td>4-Qatar</td>
<td>Mr. Saad Abdullah El Hatmi</td>
<td></td>
<td>Ministry of Environment</td>
</tr>
<tr>
<td>5-Libya</td>
<td>Mr. Mahdi ElMejrebi</td>
<td>Director General</td>
<td>Public Water Authority</td>
</tr>
<tr>
<td>6-Oman</td>
<td>Mr. Ali Ben Mohsen Ben Jawad Lwatia</td>
<td>Hydrological</td>
<td>Ministry of Regional Municipalities and Water Resources</td>
</tr>
<tr>
<td>7-Palestine</td>
<td>Ms. Salam Abouhantash</td>
<td>Head, Water Harvesting Section</td>
<td>Palestinian Water Authority</td>
</tr>
<tr>
<td>8-Mauritania</td>
<td>Mr. Mohamed Abdellahi Ould Taleb</td>
<td>Technical Advisor responsible for Hydrology</td>
<td>Ministry of Hydrology and Sanitation</td>
</tr>
<tr>
<td>10-Saudi Arabia</td>
<td>Mr. Yaser Bin Mashfar El Asmari</td>
<td>Hydrologist</td>
<td>Ministry of Water and Electricity</td>
</tr>
<tr>
<td>11-Sudan</td>
<td>Mr. Ammar Abdelrahman</td>
<td>Water Resources Engineer</td>
<td>Ministry of Water and Electricity</td>
</tr>
<tr>
<td></td>
<td>Ms. Widad Saadalla</td>
<td>Executive Secretary</td>
<td></td>
</tr>
<tr>
<td>12-Yemen</td>
<td>Mr. Abdulkhaleq Alwan</td>
<td>IWRM Principal Advisor, Water Planning &amp; Policies, Director NWRA-SB</td>
<td>Ministry of Water and Environment</td>
</tr>
</tbody>
</table>

**Attending meetings:** Egypt Lebanon Tunisia
## Impact Assessments

### Agriculture
- FAO, ACSAD, GIZ/ACCWaM
- Forests
- In-land Fisheries
- Selected Crops
  - Irrigated
  - Rainfed
  - Mixed
- Selected Hot Spots

### Health
- UNU/INWEH under Sida Project in consultation with WHO on Neglected Tropical Diseases (NTCs) looking at:
  - Disease Vectors
  - Rodent-Borne Infectious Diseases
  - North Africa
Geographical distribution of cutaneous leishmaniasis cases due to *L. infantum*, *L. major* & *L. tropica* in North Africa.

*L. major* causes zoonotic cutaneous leishmaniasis and is the dominant form in North Africa, causing 90% of cases.

*L. tropica* largely occurs in Morocco, while only sporadic cases of *L. infantum* are reported.
Applying WADI in RICCAR: Leishmaniasis: Fall

Column A: Fall (October) ZCL exposure
1) Historical ii) RCP 4.5 2046-2065 iii) RCP 4.5 2081-2100;

Column B: Fall (October) ZCL exposure 1) Historical ii) RCP 8.5 2046-2065 iii) RCP 8.5 2081-2100

UNU-INWEH “Climate change impacts on health in the Arab region: A case study on neglected tropical disease”
RICCAR, draft report 7 Dec 2015
Column C: Summer (June) ZCL exposure
Historical
RCP 4.5: 2046-2065
RCP 4.5: 2081-2100

Column D: Summer (June) ZCL exposure
Historical
RCP 8.5: 2046-2065
RCP 8.5: 2081-2100

Applying WADI in RICCAR: Leishmaniasis: Summer
Three case studies to assess impact of climate change on crop yield (due to T, P, CO$_2$ in atmosphere, etc.)

1. Egypt: North Delta
   * Irrigated agriculture zone

2. Jordan: Karak Governorate
   * Rainfed agriculture

3. Lebanon: Orontes watershed
   * Mixed agriculture

From Mr. Ihab Jnad, ACSAD, Green Sectors Studies Workshop
(Beirut, 19 March 2016)
AquaCrop model

simulate yield response to water

predict yield under climate change scenarios

Developed by FAO

Dirk RAES, Pasquale STEDUTO, Theodore C. HSIAO, and Elias FERERES

From Mr. Ihab Jnad, ACSAD, Green Sectors Studies Workshop (Beirut, 19 March 2016)
Vulnerability Assessment Framework

Exposure

Sensitivity

Potential Impact

Adaptive Capacity

Vulnerability

IPCC AR4 approach to vulnerability assessment
<table>
<thead>
<tr>
<th>RICCAR VA Sectors</th>
<th>Impacts</th>
<th>Sub-Vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water</strong></td>
<td>Change in water availability</td>
<td>V0</td>
</tr>
<tr>
<td><strong>Biodiversity &amp; Ecosystems</strong></td>
<td>Change in area covered by forests</td>
<td>V1</td>
</tr>
<tr>
<td></td>
<td>Change in area of wetlands</td>
<td>V2</td>
</tr>
<tr>
<td><strong>Agriculture</strong></td>
<td>Change of water available for crops</td>
<td>V3</td>
</tr>
<tr>
<td></td>
<td>Change of rangeland for livestock</td>
<td>V4</td>
</tr>
<tr>
<td><strong>Infrastructure &amp; Human Settlements</strong></td>
<td>Damage from inland flooding</td>
<td>V5</td>
</tr>
<tr>
<td></td>
<td>(Damage from coastal flooding)</td>
<td>(V6)</td>
</tr>
<tr>
<td><strong>People</strong></td>
<td>Change of water available for drinking</td>
<td>V7</td>
</tr>
<tr>
<td></td>
<td>Change in health due to heat stress</td>
<td>V8</td>
</tr>
<tr>
<td></td>
<td>Change of employment rate in the agricultural sector</td>
<td>V9</td>
</tr>
</tbody>
</table>

Based on: VA Training Manual
Sample VA Impact Chain for Water Availability

**VA Components**

**Natural**
- Groundwater resources (Hydrogeology)

**Population**
- Total renewable water available per capita (TARWR)
- Water consumption per capita
- Share of water consumption in agriculture

**Legend**
- Exposure
- Sensitivity
- Adaptive Capacity
- Potential Impact

**Economic Resources**
- GDP per capita
- National Output Concentration Index
- Age Dependency Ratio: (proportion of dependents, youth and elderly, per 100 working-age population)
- ODA Index (Composite Indicator) Includes Net ODA and Official Aid/ODA per capita

**Equity**
- Female/male unemployment ratio (indicator of Gender Inequality)
- Literacy Rate: Calculated as Female Literacy Rate over Male Literacy Rate (Indicator of Gender Inequality Ratio)
- Disability prevalence
- Refugee/IDP Index

**Technology**
- Number of Scientific and technical journal articles
- Telecommunication Infrastructure (Composite Indicator) Includes: Fixed-telephone subscriptions, Households with a computer, individuals using the internet, mobile-cellular subscriptions, Adult Literacy Rate - population 15+ years

**Knowledge & Awareness**
- E-Government Readiness Index
- Number of Graduates from Tertiary education
- Adult Literacy Rate - population 15+ years

**Infrastructure**
- Access to electricity (Service)
- Energy Consumption
- Installed Desalination capacity per capita
- Area Serviced by Dams

**Institutions**
- Governance (Composite indicator) Includes: government Effectiveness, Regulatory Quality, Voice and Accountability, Rule of Law, Political Stability
• In order to aggregate these datasets into the course of the vulnerability assessment, the data first need to be transformed into a unit-less score on a common scale. This process is called **normalisation**.
Change in Precipitation: Normalized Map

Absolute change in Precipitation - rcp8.5 - 1986-2005, 2081-2100

Class VALUE  | Range (mm)
-------------|-----------
1            | >90       
2            | 71 - 90   
3            | 51 - 70   
4            | 31 - 50   
5            | 11 - 30   
6            | -9 - 10   
7            | -29 - -10 
8            | -49 - -30 
9            | -69 - -50 
10           | < -70     

KM

0  500  1,000  1,500  2,000

20°0’0”N  10°0’0”N  0°0’0”N  10°0’0”N  20°0’0”N

20°0’0”W  10°0’0”W  0°0’0”W  10°0’0”W  20°0’0”W
Change in Vegetation Cover (2000-2011)

RICCAR: Vegetation Cover

Legend
- Capital cities

Water bodies
- Lake
- Reservoir
- Rivers
- Intermittent rivers

Degradation of vegetation cover
Equal Interval of the NDVI analysis results
- Very high improvement
- High improvement
- Moderate improvement
- Slight improvement
- Very slight improvement
- Very slight degradation
- Slight degradation
- Moderate degradation
- High degradation

Redrawn from ACSAD, GIZ & Trier University at Germany, based on MODIS images (Echo-Reverb) for the period 2000-2011.
Areas serviced by Dams

Legend
- Capital cities

Water bodies
- Lake
- Reservoir
- Rivers
- Intermittent rivers

Area services by dams with actual reservoir capacity (million m³)
- >1,000
- 800-1,000
- 600-800
- 500-600
- 400-500
- 300-400
- 200-300
- 100-200
- 10-100
- 0-10

Source: Redrawn by ACSAD based on FAO dam location maps

Prepared by ACSAD
Female to Male Literacy Ratio

Legend
- Capital cities
- Water bodies:
  - Lake
  - Reservoir
  - Intermittent rivers
- No Data

Female/Male Adult literacy ratio (% of population 15+ years)
Ratio: Female Adult literacy ratio, population 15+ years (%);
Male Adult literacy ratio, population 15+ years (%)
- 52.10 - 56.62
- 56.63 - 61.14
- 61.15 - 65.66
- 65.67 - 70.18
- 70.19 - 74.70
- 74.71 - 79.22
- 79.23 - 83.74
- 83.75 - 88.26
- 88.27 - 92.78
- 92.79 - 97.30

**SHARE OF CHILDREN AND ELDERLY OF THE POPULATION**

<table>
<thead>
<tr>
<th>Indicator Fact Sheet</th>
<th>Share of children and elderly of the total population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vulnerability component</td>
<td>Sensitivity</td>
</tr>
<tr>
<td>Description (position in the impact chain)</td>
<td>Indicated the share of population most sensitive towards heat waves</td>
</tr>
<tr>
<td>Sector(s) / impacts(s)</td>
<td>Infrastructure and Settlements/Damage from inland flooding</td>
</tr>
</tbody>
</table>

**Methodology for classification and transformation of values**

The intervals were classified in equal intervals for both RKH and VA. The values for the RKH were percentages and for the VA were the normalized values of the percentages.

**Data supply and acquisition**

- Input indicators needed
- Date of processing and publication: Latest available
- Availability and costs: Immediately
- Right to use / disseminate the data: -
- Contact: UNSTAT, ESCWA and country statistical bureaus

**Download links**

- UNSTAT, ESCWA and country statistical bureaus

**Additional comments**

- The countries with higher percentages have higher sensitivities
- Data information
  - Type of data: Tables/Excel
  - Spatial coverage: Only Arab States
  - Resolution: One value per country
  - Time reference: Latest available
  - Unit of measurement: % of population 0-14 and ≥60 from total population
  - Methodology for general data calculation: One value per country as stated in the database
Preparation of a Vulnerability Index:

- **Per Sector**
  - Contains all indicators identified to assess a given sector
  - Attribution of weights for each indicator dependent on impact chains and expert judgment
  - As sector level, aggregated by component: Exposure, Sensitivity, Adaptive Capacity

- **Overall Vulnerability**
  - Aggregates vulnerability of each sector to generate an Overall VA
  - Supports identification of VA Hotspots

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Slide graphics: adelphi
Source of maps: ACSAD, SMHI
Regional Knowledge Hub

Governance

- ACSAD-ESCWA Coordinating Secretariat (Doha, 2014)
- FAO identified to provide IT Platform via FENIX
- RKH Consultative Meeting: ESCWA, ACSAD, FAO, GIZ (Beirut, 19-20 April 2015); Contracting planned in 2016

Regional Knowledge Hub on Water & Climate

- Reports
- Studies
- Briefs
- Training Materials
- EGM
- Workshop
- Working Group Documents

Data Portal for Arab Domain Outputs

- RCM Maps
- RHM Maps & Data
- Sub-Domains
- Extreme Events Indices
- VA Maps Hotspots & Data

Additional Technical & Training Materials to be provided from ACCWaM & UNDA Climate Change Adaptation using IWRM Tools Capacity Building Project, which draw on RICCAR Outputs
Regional Knowledge Hub

Arab Ministerial Water Council (AMWC)

Regional Knowledge Hub

ACSAD-ESCWA Coordinating Secretariat

FAO/FENIX IT Platform

RKH Advisors

Regional Knowledge Hub Network

Sub-Regional Nodes

Thematic Nodes

Water & Climate Node
Purpose

- Regular **seasonal forecast** products for the Arab region.
- Regional assessments of **climate extremes** based on national inputs.
- Climate/climate change **monitoring and assessment**
- Regional assessment of **climate change scenarios** and their implications.
- Improved and accurate **climate data** and enhanced monitoring capacity.
- Provision of regional climate information to help responding to **user needs** (hydrology, agriculture, health, etc.).
- Regular **capacity development** efforts and promotion of common approaches for climate services by Arab countries
- Better user awareness and sustainable platform for **user interface**.

Governance

- **Approved** by Arab Permanent Committee for Meteorology (Jeddah, 25-30 March 2015)
- **UAE** offered to host ArabCOF, with budgetary review currently underway with LAS Technical Secretariat and ESCWA.
## Workshops

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Organizer</th>
<th>Date/Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Projection/ Prediction and Extreme Events Indices</strong></td>
<td>Arab Met Offices</td>
<td>March 2012 Casablanca</td>
</tr>
<tr>
<td><strong>Applications &amp; Analysis of Regional Climate Models</strong></td>
<td>Water Ministries</td>
<td>July 2012 Beirut</td>
</tr>
<tr>
<td><strong>National Workshops for Disaster Losses Inventories</strong> (Tunisia, Morocco, Yemen, Jordan, Palestine)</td>
<td>Inter-ministerial</td>
<td>September 2012-April 2014</td>
</tr>
<tr>
<td><strong>Climate Data Rescue Sub-regional Workshop</strong> (Palestine, Jordan, KSA, Yemen)</td>
<td>Met Services</td>
<td>June 2013 Amman</td>
</tr>
<tr>
<td><strong>Linking Regional Climate Models to Hydrological Models</strong></td>
<td>Arab Water Ministries</td>
<td>June 2013 Beirut</td>
</tr>
<tr>
<td><strong>Technical Workshop on the Vulnerability Assessment Methodology Application</strong></td>
<td>Research Centers</td>
<td>May 2014 Beirut</td>
</tr>
<tr>
<td><strong>Scoping Meeting for Establishing an Arab Climate Outlook Forum (ArabCOF)</strong></td>
<td>Met Services</td>
<td>Oct 2014, Amman</td>
</tr>
<tr>
<td><strong>Moving from Impact Assessment to Socio-Economic Vulnerability Assessment</strong></td>
<td>Water &amp; Agriculture Ministries</td>
<td>June 2015 Beirut</td>
</tr>
</tbody>
</table>

## Expert Group Meetings

| EGM 1: Launching Water Environ | 2009 Beirut |
| EGM 2: Arab Domain Water Environ | 2010 Beirut |
| EGM 3: RCMs Water Environ | 2011 Beirut |
| EGM 4: Climate Ensemble & Working Groups Water Ministries Environ Agencies | 2012 Beirut |
| EGM 5: Preliminary RCM Findings for Arab Domain & VA Methodology Water Ministries | 2013 Amman |
| EGM 6: Review of RCM & RHM Findings & VA Sectors Water, Ag & Environ Ministries | 2014 Cairo |
| EGM Peer Reviews Experts, Gov’t | 2016 |
I. Introduction

II. Data, Databases and Baseline Information

III. Regional Climate Modelling Findings for Arab Region

IV. Hydrological Findings for Major Shared Basins
   A. Nile Basin
   B. Tigris and Euphrates Rivers
   C. Medjerda River Basin
   D. Jordan River Basin
   E. Senegal River Basin

V. Extreme Events Case Studies
   A. Wadi Diqah (Oman)
   B. Medjerda (Tunisia/Algeria)
   C. Nahr Al-Kabir (Lebanon/Syria)

VI. Impact Assessment Studies
   A. Agriculture (rainfed, irrigated, mixed)
   B. Human Health

VII. Vulnerability Assessment
   A. Water
   B. Agriculture
   C. Biodiversity & Ecosystems
   D. Infrastructure & Human Settlements
   E. People

VIII. Conclusion
RICCAR Assessment Outputs for informing Action

- Arab Climate Change Action Plan
- Arab Disaster Risk Reduction Strategy & Action Plan
- Arab Climate Change Working Group
- Country-Level Requests (Outputs, Inputs, Training)

- Adaptation
- Negotiations
- UNFCCC National Communications
- Capacity Building