Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR)

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RICCAR Coordinator

Expert Group and Inception Meeting of UNDA Project “Strengthening National Capacities of Conflict-Affected Countries to Manage Water Scarcity and Drought” (Beirut, 25 June 2013)
Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR)

Objective

**Drought Preparedness is a central component of Climate Change Adaptation in the Arab Region**

The Regional Initiative aims to provide a *common platform* for addressing and responding to climate change impacts on freshwater resources in the Arab region by serving as the basis for *informed dialogue, priority setting and policy formulation on climate change adaptation at the regional level*. 
**RICCAR: UN-LAS Regional Mandates**

**Mandates**

- Arab Ministerial Declaration on Climate Change (Dec 2007) - adopted by Council of Arab Ministers Responsible for the Environment (CAMRE); first joint Arab statement on Climate Change.

- ESCWA 25th Ministerial Session Resolution on Climate Change (May 2008) - called for the preparation of an assessment of the vulnerability to climate change impacts on water resources (Sana’a).

- Arab Summit for Economic and Social Development (Jan 2009) - accepted the preparation of a project to assess impacts of climate change on water.

- Arab Ministerial Water Council (AMWC) (July 2010) - approved the IWRM project brief submitted by LAS & ACSAD called “Assessment of Climate Change Impacts on Available Water Resources in the Arab Region” based on UN-LAS Regional Initiative concept note prepared based on RICCAR EGM#1 outcomes.

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- 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.

1. **Requests** the (ESCWA) secretariat to prepare an assessment of the vulnerability to climate change of economic and social development in the region, with particular emphasis on fresh water resources;

1- Build a regional integrated database electronically connected with international and global databases in an interactive manner in order to continuously update it and connect it with GIS to be able to follow-up the development in climatic trends in the Arab region;

2- Application of regional climate models in the Arab countries to improve its performance and accuracy;

3- Assess the impact of CC on several sectors including biodiversity, agriculture, food security, land use, forestry, water resources, population and human settlements, and social economics, specifically on sustainable development in general;
UN-LAS Coordination Mechanisms for RICCAR

**Coordination Mechanisms**

- **UN-LAS 9th Sectoral Meeting focused on Climate Change (June 2009)** - called for UN-LAS joint action on vulnerability studies to assess climate change impacts on water, land, drought, desertification, biodiversity, health and agriculture.

- **Regional Initiative Core Group (Oct 2009)** – UN-LAS core partners established group following 1st expert group meeting (Oct 2009); Annual EGMs.

- **Regional Coordination Mechanism/Thematic Working Group on Climate Change (Nov 2010)** - Initiative adopted & reported on as a joint UN-LAS inter-agency initiative by UNEP.

- **AMWC: Ministerial Council, Executive Bureau, and Technical Scientific & Advisory Committee (June 2011, Jan 2012, June 2012, Jan 2013, June 2013)** – Receives updates on RICCAR by ESCWA.

- **Arab Permanent Committee for Meteorology/Climate & Climate Change Sub-Committee (Jan 2012, March 2012, March 2013)** – Endorsement of RICCAR; follow-up via APCM.

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**RICCAR Expert Group Meetings (annual)**

**Vulnerability Assessment Working Group**

**Regional Knowledge Hub Working Group**

**Coordination with Complementary Regional Initiatives for a Common Science Base**
RICCAR Implementation Framework

4 Pillars

Baseline Review & Knowledge Management
- including climate and hydrological data collection and rescue

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
Pillar 1: Knowledge Base

Regional Knowledge Hub

- Climate Data
- Water Data
- Socio-Economic Data
- UNFCCC Communications
- IWRM Plans
- Geo-Spatial Integrated Maps
- Vulnerability Hotspots
- Outputs from Regional Climate Models
- Password Protected Access to RCM Codes
- Links to other Knowledge Tools

Data and/or Services?
Land Surface Stations:
Monthly Air Temperature Dataset (GHCN, HadCRUTEMP4):
Total of 227 stations of which 77 stations with incomplete records (red colors) thus not used in IPCC AR4

Compiled by ACSAD.
ACSAD SIDA-ESCWA Project Progress Report March 2012 (pg.6)

Distributed climate observing stations in the Arab/MENA Domain – Compiled by ACSAD
ACSAD SIDA-ESCWA Project Progress Report / March 2013 (pg.5)
Pillar 2: Integrated Assessment
Methodological Framework

The Integrated Assessment Model

Step 1: Global Climate Modeling using General Circulation Model
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
Different GCMs

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

RCP

GCMs at 300 km x 300 km

50km x 50km

25km x 25km

Calibration

Extreme Events now also included
Special Report on Emission Scenarios (SRES)

SRES Scenarios used in IPCC AR4 (2007)

A1
- Rapid economic growth,
- Global population peaks in mid-century
- Rapid introduction of new and more efficient technologies.

A2
- High population growth,
- Slow economic development
- Slow technological change.

B1
- Rapid economic growth,
- Global population peaks in mid-century
- More rapid introduction of new / more efficient technologies.

B2
- Intermediate economic growth,
- Intermediate population growth,
- Local technological solutions.

Average 3.4C Temp increase Scenario

Source:
ESCWA, 2009
Inter-Governmental Panel on Climate Change: Areas considered for regional averages in IPCC AR4

From Dr. Rupa Kumar Kolli, WMO Presentation to RICCAR EGM #2 (Beirut, 2010)
Regional Climate Modeling: Establishing an Arab/MENA-CORDEX Domain

CORDEX: COordinated Regional climate Downscaling Experiment

- Arab/MENA-COREX Domain sets the limiting boundary conditions for regional climate modelling
- Domain approved by CORDEX in June 2012.
- SMHI conducted Sensitivity Analysis & set up Domain in consultation with ACSAD, UNESCO, KAU, KAUST, ESCWA
- Domain covers headwaters of Nile & Indian Ocean effects
- Comoros may be covered in own map.

*Arab Domain shown here only for illustrative & comparative purposes; domain is larger

Illustration adapted from Giorgi et al., 2009, p.178, as drawn from collective CORDEX effort displayed at: http://www.meteo.unican.es/en/projects/CORDEX.
## CORDEX Regional Climate Model Output Fields

<table>
<thead>
<tr>
<th>Domain</th>
<th>Essential Climate Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Atmospheric (over land, sea and ice)</strong></td>
<td><strong>Surface</strong></td>
</tr>
<tr>
<td></td>
<td>Air temperature</td>
</tr>
<tr>
<td></td>
<td>• Surface skin temperature</td>
</tr>
<tr>
<td></td>
<td>• Near-surface (2 m): air temp, daily-max daily-min</td>
</tr>
<tr>
<td></td>
<td>Wind speed and direction</td>
</tr>
<tr>
<td></td>
<td>• Eastward winds &amp; Westward winds</td>
</tr>
<tr>
<td></td>
<td>• Near-surface winds (10 m)</td>
</tr>
<tr>
<td></td>
<td>Water vapour/ Precipitation</td>
</tr>
<tr>
<td></td>
<td>• Water evaporation flux from canopy, humidity</td>
</tr>
<tr>
<td></td>
<td>• Precipitation &amp; Convective precipitation</td>
</tr>
<tr>
<td></td>
<td>• Snowfall &amp; Atmospheric water vapour content</td>
</tr>
<tr>
<td></td>
<td>Pressure</td>
</tr>
<tr>
<td></td>
<td>• Air pressure on the ground surface &amp; sea level</td>
</tr>
<tr>
<td></td>
<td>• Surface downward stresses due to wind</td>
</tr>
<tr>
<td></td>
<td>Radiation budget</td>
</tr>
<tr>
<td></td>
<td>• Sensible &amp; Latent Heat Flux</td>
</tr>
<tr>
<td></td>
<td>• Upward/Downwelling heat fluxes</td>
</tr>
<tr>
<td></td>
<td>• Heat flux corrections &amp; Prescribed heat flux</td>
</tr>
<tr>
<td><strong>Upper-air:</strong> (Up to the stratopause)</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>Atmospheric boundary layer thickness (meters)</td>
</tr>
<tr>
<td></td>
<td>Air temperature</td>
</tr>
<tr>
<td></td>
<td>• For each specified pressure elevation</td>
</tr>
<tr>
<td></td>
<td>Wind speed and direction</td>
</tr>
<tr>
<td></td>
<td>• For each specified pressure elevation:</td>
</tr>
<tr>
<td></td>
<td>Eastward and Westward winds, geopotential height</td>
</tr>
<tr>
<td></td>
<td>Water vapour/ Precipitation</td>
</tr>
<tr>
<td></td>
<td>• For each pressure elevation:</td>
</tr>
<tr>
<td></td>
<td>cloud parameters (area fraction, ice content, water content)</td>
</tr>
<tr>
<td></td>
<td>Radiation budget</td>
</tr>
<tr>
<td></td>
<td>• Heat fluxes incoming and outgoing (long wave and shortwave)</td>
</tr>
<tr>
<td>Composition</td>
<td>• Mole fraction of ozone in air</td>
</tr>
<tr>
<td></td>
<td>• Concentration of sulphate aerosols (NOx, SOx)</td>
</tr>
<tr>
<td>Terrestrials</td>
<td>Surface runoff, snow (area fraction, amount, melt flux)</td>
</tr>
<tr>
<td></td>
<td>Glaciers (land ice area fraction)</td>
</tr>
<tr>
<td></td>
<td>Permafrost (soil frozen water content)</td>
</tr>
<tr>
<td></td>
<td>Soil moisture (content, content at field capacity, content of soil layer, root depth)</td>
</tr>
</tbody>
</table>

**Sources:** ESCWA (20) based on GCOS (2011), IPCC (2009) and WCRP (2004)
Regional Hydrological Modeling (RHM): For enhanced understanding of water-related impacts

Feeding RCM outputs into Hydro Models (HM)

CORDEX Regional Climate Model Outputs

Atmospheric (Surface & Upper Air) + Terrestrial

RHM Incorporates:
- RCM Outputs
- Elevation Data (DEM)
- Land Parameters
- Hydrological data on surface water
- Hydrological data on groundwater

Regional Hydrological Model (RHM)

Hydrologic Stations: Air Temperature and pressure at Surface, Surface Evapotranspiration, Precipitation (rain & snow)

Surface: Runoff, Flow (into/out of), Snow amount, snow Melt, Soil Moisture Content


Calibration

Two Options:
RCM to Regional HM or RCM to Basin HM

Basin-Centered Hydrological Model (BHM)

Groundwater: water table, Change in Groundwater Level, Groundwater Infiltration Rate, aquifer safe yield, Seawater Intrusion, Salinization

Surface: soil moisture, runoff, Crop Water Demand, Agricultural Productivity
Vulnerability Assessment
Vulnerability Assessment Framework

Adopts IPCC Approach to VA using RCMs for Impact Component

Different from DRR Approach to VA based on Hazard & Risk Analysis
**Incorporating Extreme Events**

**Flooding**
- Coastal flooding
- Wadi flooding
- Urban flooding/stormwater drainage

**Droughts**
- Regional/sub-regional
- Cyclical
- Duration
- Displacement

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> “In Ar Raqqah (Syria), many displaced farmers talk about wells running dry, and turning polluted.”

> “My uncle’s well used to be 70 meters deep, now it’s 130 meters and now the water became salty, so we closed it down,” said Khalaf Ayed Tajim, a stocky sheep herder and farmer who heads a local collective for displaced northerners. He left his native village 60 miles from here when half of his herd died off and his fields dried up, and now lives in a concrete bunker with his 17 children, two wives, and his mother.” – “The Earth is Parched where Syrian Farms Thrived”, NYT, 13 Oct 2010

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*Tropical Cyclone Gonu: Oman (2007)*

Credit: H.M. Fritz et al. / *Estuarine, Coastal and Shelf Science* 86 (2010) 102–106
### Pillar 3: Capacity Building & Institutional Strengthening

<table>
<thead>
<tr>
<th>Regional Workshops / EGMs</th>
<th>Participants</th>
<th>Leads</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RICCAR Expert Group Meeting #3:</strong> Set-up of Regional Climate Modeling Approach</td>
<td>RICCAR Partners &amp; Arab Water Ministries (senior staff)</td>
<td>ESCWA, UNEP, LAS</td>
<td>6-7 July 2011 Beirut</td>
</tr>
<tr>
<td>Workshop on Projection/Prediction and Extreme Events Indices in the Arab Region</td>
<td>Arab Met Offices</td>
<td>WMO</td>
<td>13-16 March 2012 DMN, Casablanca</td>
</tr>
<tr>
<td>Regional Workshop on Applications and Analysis of Regional Climate Models</td>
<td>Arab Water Ministries (technical staff)</td>
<td>SMHI, ACSAD</td>
<td>2-4 July 2012 Beirut</td>
</tr>
<tr>
<td><strong>RICCAR Expert Group Meeting #4:</strong> Set-up of Regional Modeling Ensemble &amp; Working Groups</td>
<td>RICCAR Partners &amp; Arab Water Ministries (senior staff)</td>
<td>ESCWA, UNEP, LAS</td>
<td>5-6 July 2012 Beirut</td>
</tr>
<tr>
<td>National Workshops for Disaster Losses Inventories (Tunisia, Morocco, Yemen, Jordan)</td>
<td>Inter-ministerial (planning, interior, env)</td>
<td>UNISDR</td>
<td>September 2012 – April 2013</td>
</tr>
<tr>
<td>Sub-Regional Training Workshop on Climate Date Rescue &amp; Digitization</td>
<td>Jordan, Palestine, Yemen, KSA Met Offices</td>
<td>WMO</td>
<td>11-13 June 2013 JMD, Amman</td>
</tr>
<tr>
<td>Regional Workshop on Linking Regional Climate Model Projections to Hydrological Models</td>
<td>Arab Water Ministries (technical staff)</td>
<td>SMIH, ACSAD</td>
<td>26-28 June 2013 Beirut</td>
</tr>
<tr>
<td><strong>RICCAR Expert Group Meeting #5:</strong> Preliminary Findings of the Regional Climate Models covering the Arab Domain</td>
<td>Arab Water Ministries (senior staff)</td>
<td>ESCWA, UNEP, LAS, SMHI, WMO, ACSAD, UNISDR</td>
<td>December 2013 (tbc)</td>
</tr>
</tbody>
</table>
Changes in extreme temperature and precipitation in the Arab region: long-term trends and variability related to ENSO and NAO

M. G. Donat,a,b C. T. Peterson,b, A. D. King,b M. Almazroui,c R. K. Kolli,c Djamel Bouchet,a,2 Arwar Younis Al-Mulla,a Abdoahman Youssouf Noir,c Ahmed Attia Aly,2 Tamer Ali Ali Nada,2 Muhammad M. Senawil,1 Hassan Abdullah Al Dashi,1 Tarek G. Sallab,1 Khalid I. El Fadil,3 Mohamad K. Mustah,3 Sidah Dab Eida,1 Waefae Hadi,1 Fatima Driouch,3 Khalid El Baha,3 Mohammed J. Y. Abubaker,1 Ayman S. Ghandam,1 Amani Sahnoura Ebrah,1 Maher Ben Mansour,1 Waleed O. Alaloulou,3 Jenine Saleem Al Dahhan,1 and Majed N. Al Shehri,1

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2Center for Climate Change, Department of Geography, Universitat Rovira i Virgili, Tarragona, Spain
3Climatic Research Unit, School of Environmental Sciences, University of East Anglia, Norwich, UK
4Center of Excellence for Climate Change Research/Department of Meteorology, King Abdullah University, Jeddah, Saudi Arabia
5World Meteorological Organization, Geneva, Switzerland
6National Climatological Center, Algiers, Algeria
7Transport/Civil Aviation Affairs, Monaco, Monaco
8Climatic Task, Ministry of Transport, Djibouti, Djibouti
9Ministry of Civil Aviation, Cairo, Egypt
10Department of Meteorology, DGCA, Jeddah, Saudi Arabia
11Ministry of Public Works and Transport, Beirut, Lebanon
12Libyan National Meteorological Center, Tripoli, Libya
13Office National de la Meteorologie, Fes, Morocco
14Direction de la Météorologie Nationale, Casablanca, Morocco
15Palestinian Meteorological Office, Ramallah, Palestine
16Paradise of Meteorology and Environment, Jeddah, Saudi Arabia
17Islamic Meteorological Authority (IMAA), Khartoum, Sudan
18National Weather Institute, Tian, Tianjin
19UAE Airforce and Air Defence, Fujairah, UAE
20National Center of Meteorology and Geophysical, Abu Dhabi, UAE

ABSTRACT: A workshop was held in Casablanca, Morocco, in March 2012, to enhance knowledge of climate extremes and their changes in the Arab region. This workshop initiated intensive data compilation activities of daily observational weather station data from the Arab region. After conducting careful control processes to ensure the quality and homogeneity of the data, climate indices for extreme temperatures and precipitation were calculated. This study examines the temporal changes in climate extremes in the Arab region with regard to long-term trends and natural variability related to ENSO and NAO. We find consistent warming trends since the mid-19th Century across the region. This is evident in the increased frequencies of warm days and warm nights, higher extreme temperature values, fewer cold days and cold nights and shorter cold spell durations. The warming trend seems to be particularly strong since the early 1970s. Changes in precipitation are generally less consistent and characterised by a higher spatial and temporal variability: the trends are generally less significant. However, in the western part of the Arab region, there is a tendency towards wetter conditions. In contrast, in the eastern part, there are more drying trends, although these are of low significance. We also find some relationships between climate extremes in the Arab region and certain prominent modes of variability, in particular El Niño-Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO). The relationships of the climate extremes with NAO are stronger, in general, than those with ENSO, and are particularly strong in the western part of the Arab region (closer to the Atlantic Ocean). The relationships with ENSO are found to be more significant towards the eastern part of the area of study.

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(ENSO) ENSO; NAO North Atlantic Oscillation; WMO World Meteorological Organization; ETCCDI European Centre for Medium-Range Weather Forecasts' Climate Data Initiative; WMO ETCCDI Approach; Int’l Journal of Climatology Int’l Journal of Climatology on climate indices in Arab region (WMO ETCCDI Approach)
## Pillar 4: Awareness Raising & Information Dissemination

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Activities Completed</th>
<th>Activities in Progress</th>
</tr>
</thead>
</table>
| ✓ Raise public awareness on climate change phenomenon and encourage the participation of local civil society to face it. | ✓ Brochure  
❑ National Disaster Inventories  
❑ Technical Docs/Policy Briefs  
❑ Integrated Mapping Tool |

### Linkages to Regional Projects:
- GIZ: ACCWaM
- UNDA Project: Strengthening National Capacities of Conflict-Affected Countries to Manage Water Scarcity and Drought
- UNDA Project: Developing the capacities of the Arab countries for climate change adaptation by applying IWRM tools
- FAO Water Scarcity Initiative
- WMO Global Climate Services
Research Institutes supporting RCM Ensemble

- Center of Excellence for Climate Change Research / King Abdullah University (KSA)
- King Abdullah University of Science and Technology (KAUST) (KSA)
- Climate Services Center (CSC) - Germany
Thank you!

Additional information on the Regional Initiative is available at:

www.escwa.un.org/RICCAR