



RICCAR



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

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Sustainable Development Policies Division, ESCWA
RICCAR Coordinator*

World Water Week, Stockholm, 25 August 2015



RICCAR Objective

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.

Assessment

Adaptation

Mitigation

Negotiations

Arab Regional Policy Frameworks Addressing Climate Change



League of Arab States

Arab Ministerial Declaration on Climate Change (2007)

Arab Framework Action Plan on Climate Change

Arab Water Security Strategy (& Action Plan)

Arab Strategy on Disaster Risk Reduction (& Action Plan)

Arab Sustainable Development Initiative

Arab Sustainable Consumption and Production Strategy

Arab Green Economy Roadmap

UN & LAS Inter-Governmental Resolutions calling for Climate Change Assessment in the Arab Region

**Arab Ministerial
Declaration
on Climate
Change
CAMRE
2007**

**ESCWA
Ministerial
Session
Resolutions on
Climate Change,
Rio+20 follow-up
2008, 2012,
2014**

**Arab
Economic and
Social Summit
Resolution on
Water & Climate
Change Project
2009**

**Arab
Ministerial
Water Council
Resolutions
2010, 2011,
2012, 2013,
2014, 2015**

**Arab
Permanent
Committee for
Meteorology
Resolutions
2012, 2013,
2014, 2015**

**ACSAD
Agricultural
Board of
Directors
Resolution
2013, 2014,
2015**

Environment

Foreign Affairs
& Planning

Water

Met

Agriculture

DRR

RICCAR Implementation Framework: Four Pillars

Regional Knowledge Hub



Integrated Assessment

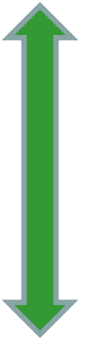
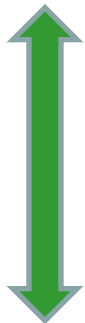
**Climate Change
Impact Assessment**



**Climate Change
Vulnerability Assessment**



Capacity Building & Institutional Strengthening
*for Water Ministries, Meteorological Offices, Agricultural Ministries,
Environmental Agencies, Arab Research Centers*



Awareness Raising & Information Dissemination

RICCAR Partners

Implementing Partners



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SWEDISH INTERNATIONAL DEVELOPMENT
COOPERATION AGENCY

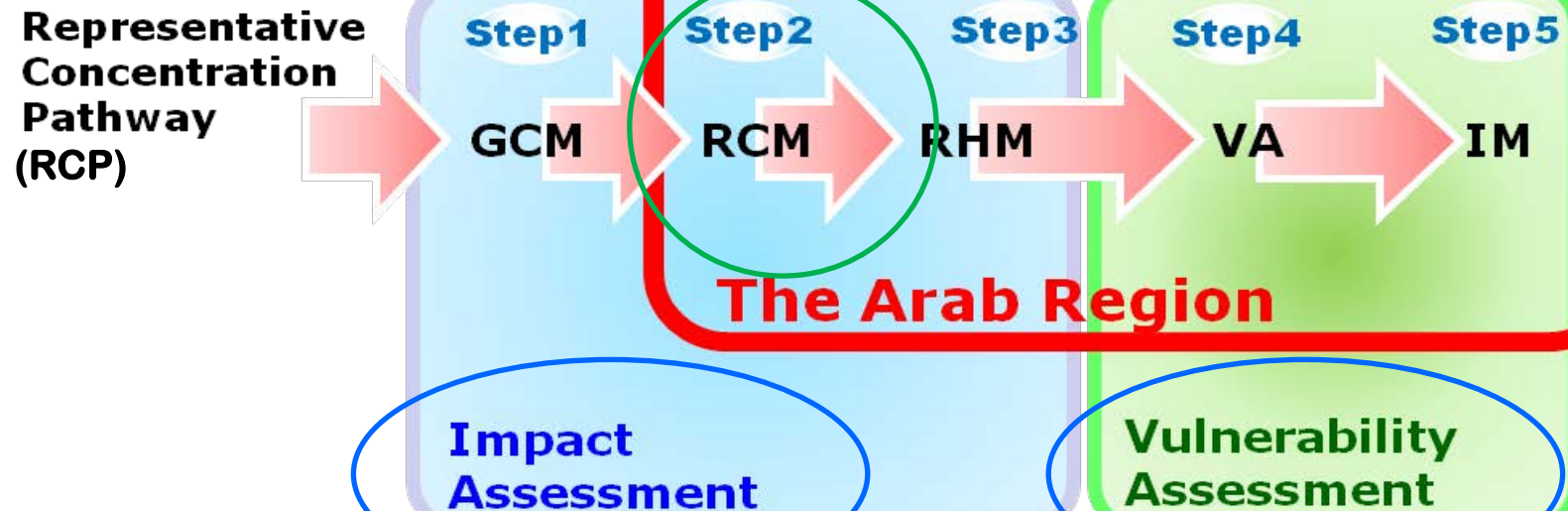


Contributing Research Institutes *supporting Regional Climate Modelling*

- 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 (CSC) - Germany

Integrated Assessment Methodological Framework

The Integrated Assessment Model



Step 1: Global Climate Modeling using General Circulation Model

Step 2: Regional Climate Modeling

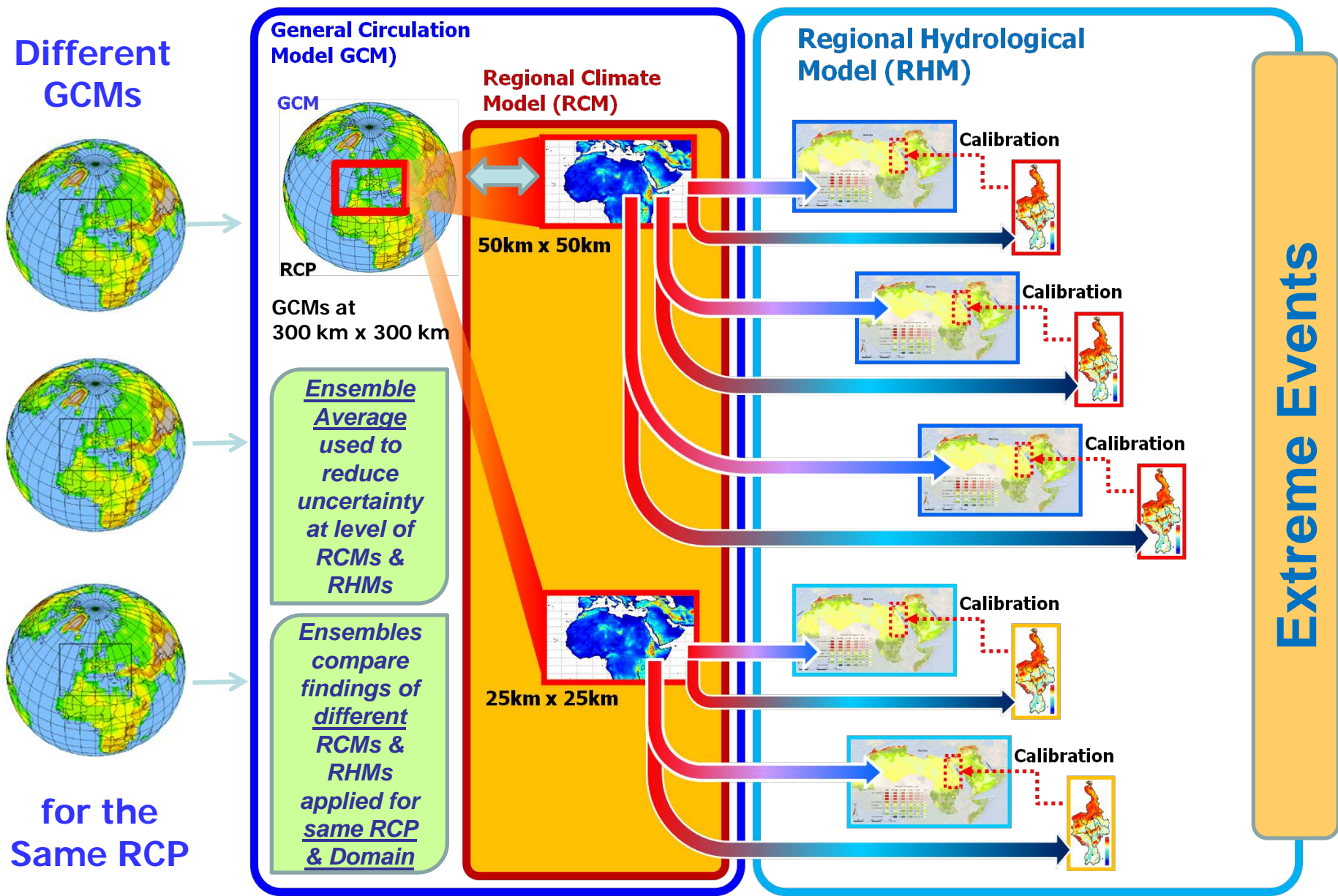
Step 3: Regional Hydrological Modeling

Step 4: Vulnerability Assessment

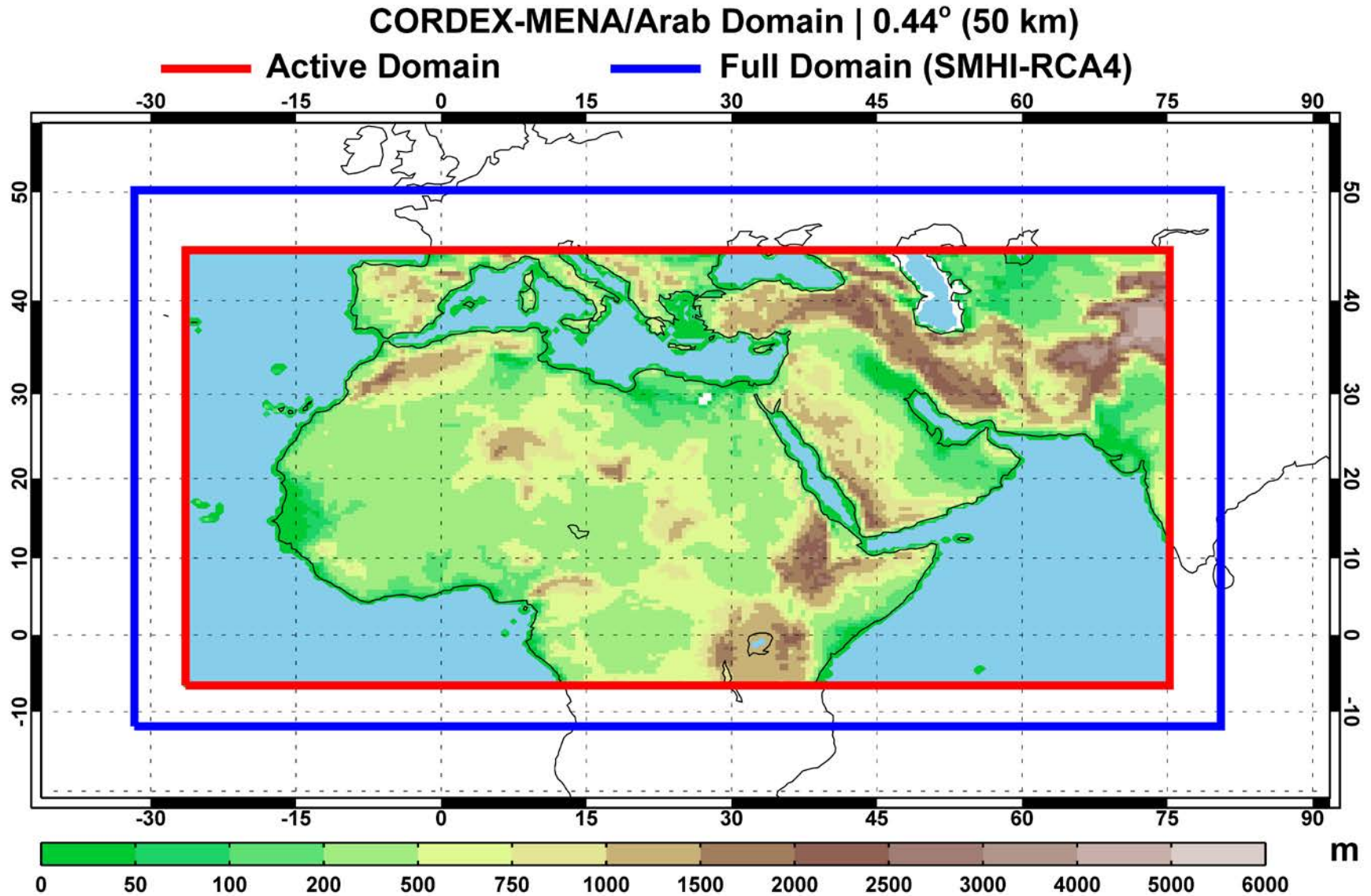
Step 5: Integrated Mapping

Impact Assessment Component:

Pursuing a Coordinated Ensemble for Climate & Hydrological Modeling

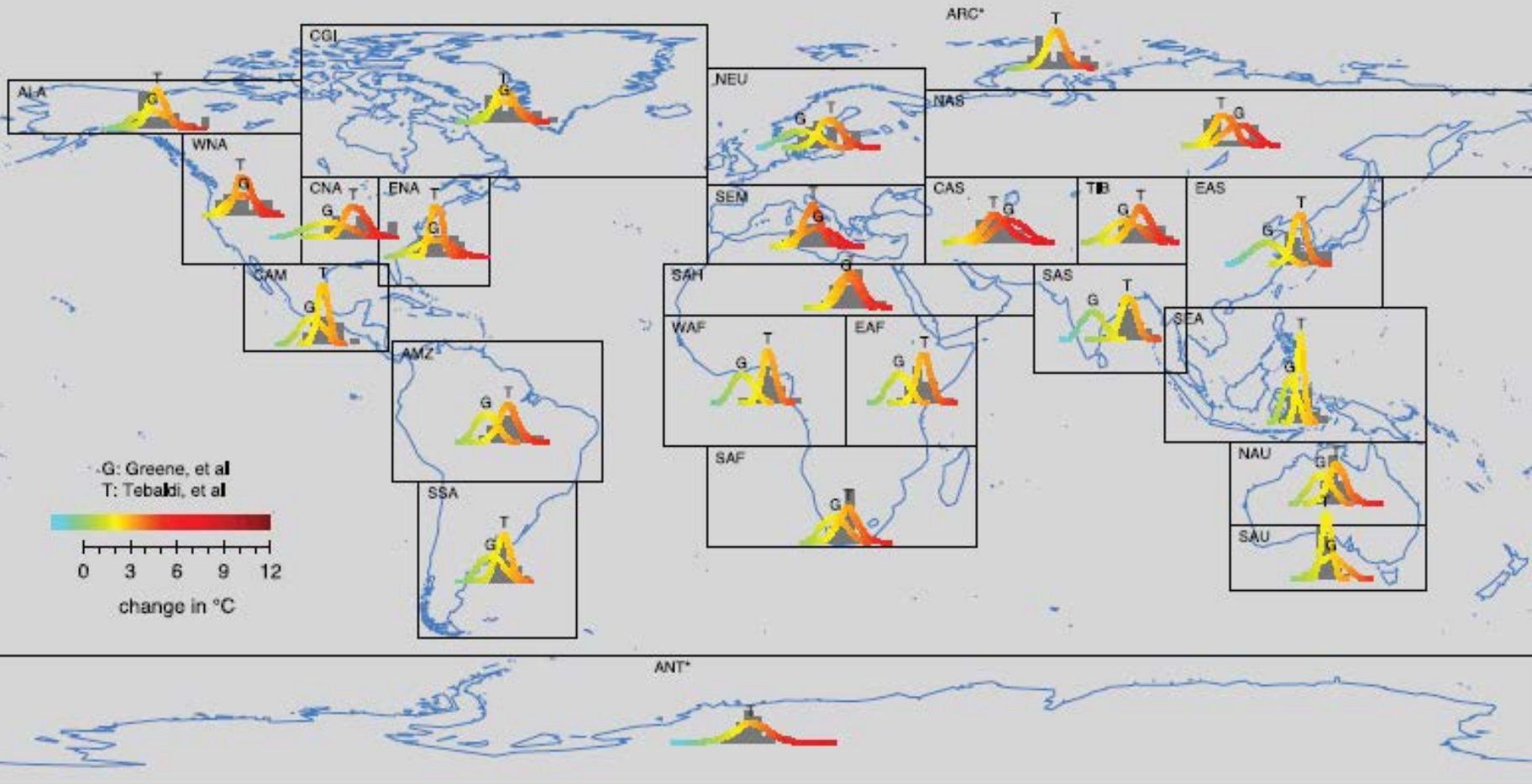


Regional Climate Modeling over the Arab Domain



CORDEX = Coordinated Regional Downscaling Experiment (under the WMO-WCRP)

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



From R.K Kolli, WMO
RICCAR EGM #2 (Beirut, 2010)

Inter-Governmental Panel on Climate Change: Areas considered for regional averages in IPCC AR5

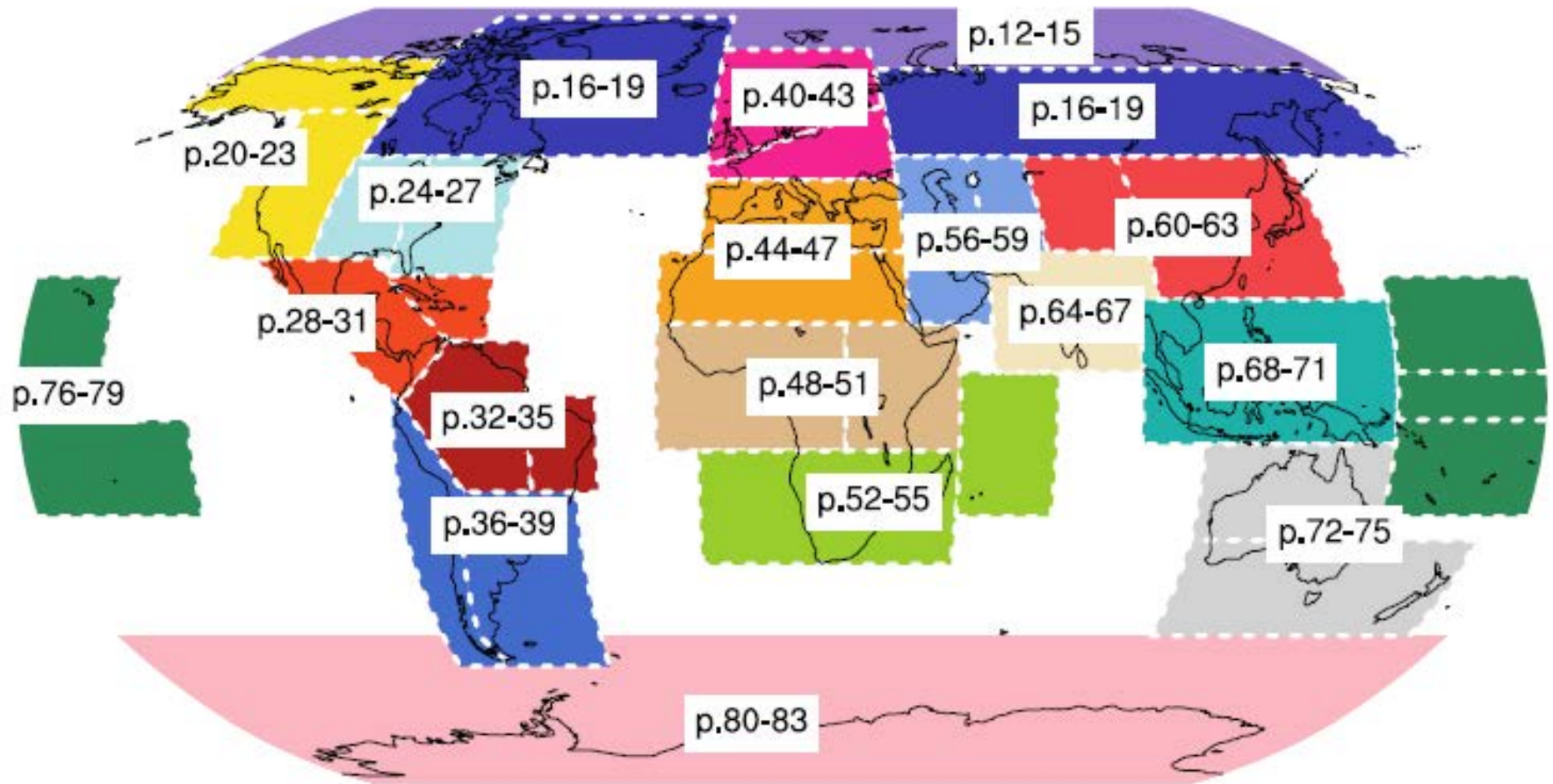


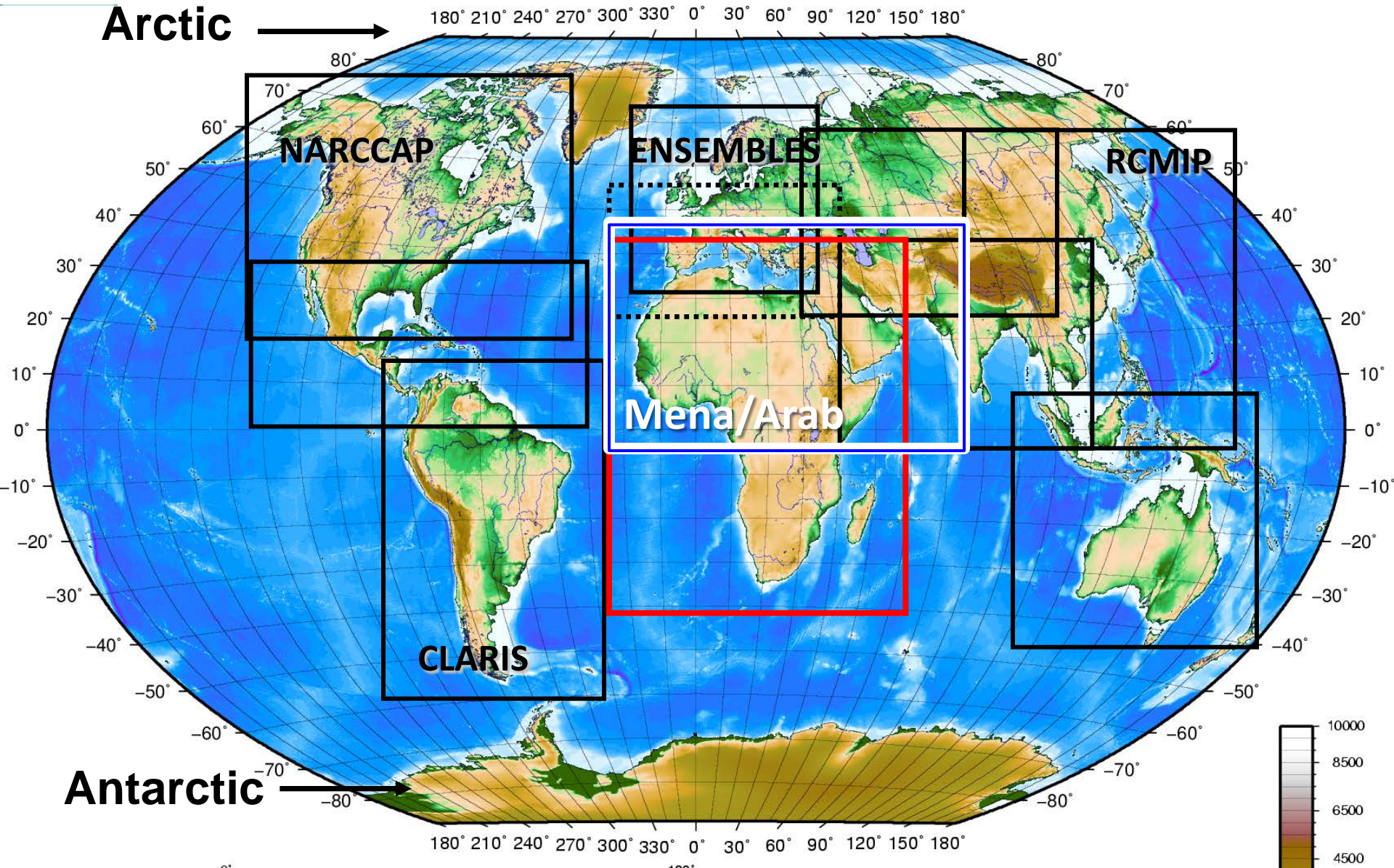
Figure AI.3: Overview of the SREX, ocean and polar regions used.

SREX: Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

*IPCC Assessment Report 5 – WGI: Annex I
Draft: 30 September 2013*

CORDEX Domains

Coordinated Regional Climate Downscaling Experiment



CORDEX MENA Working Group

CORDEX Arab Domain / MENA Domain Working Group

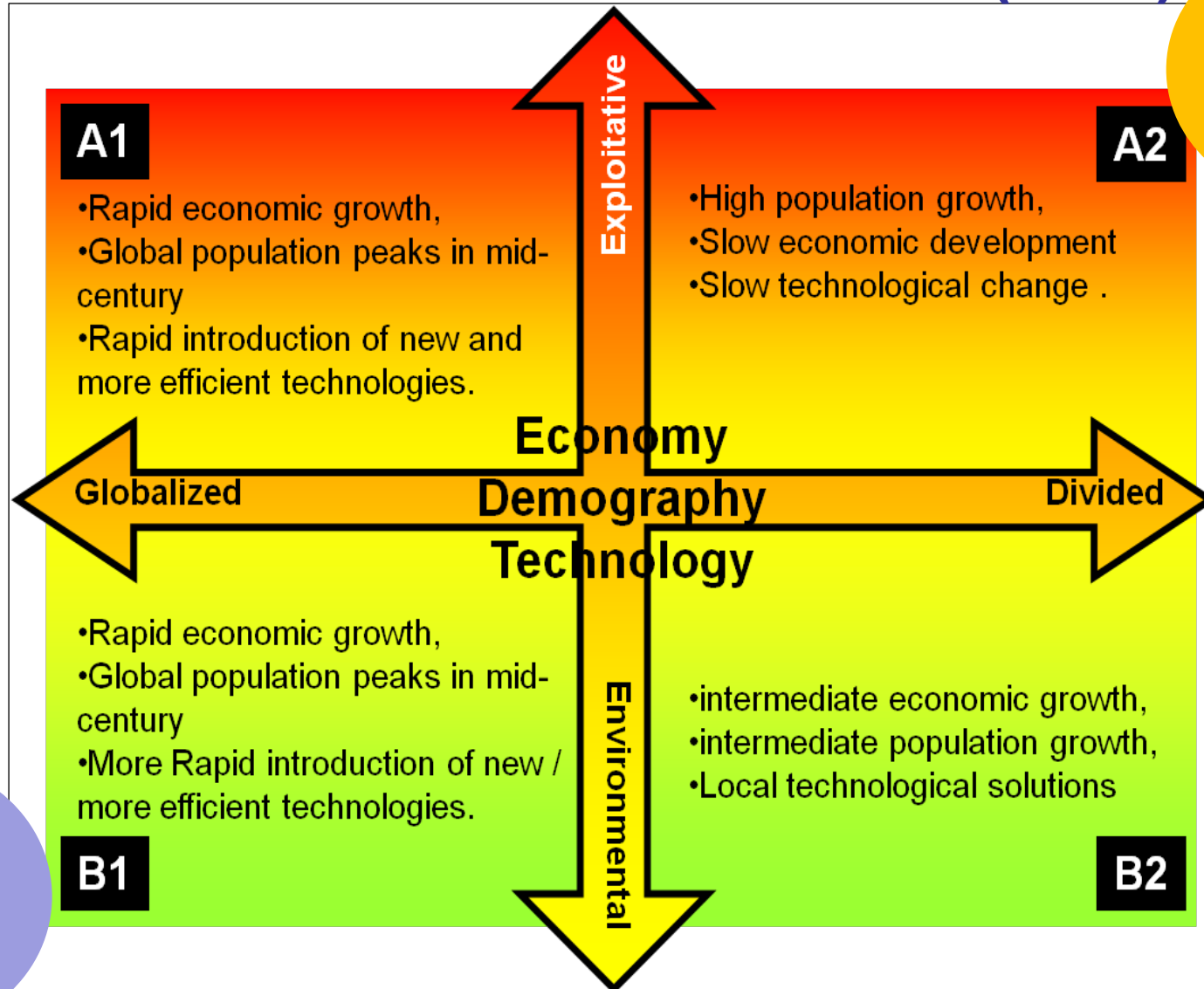
- Preliminary **RCM Ensemble** Meeting led by SMHI (Brussels, 2013)
- First **CORDEX MENA-CA Meeting** (Nicosia, November 2014)
 - Organized by CORDEX (WMO) with SMHI
 - Hosted by The Cyprus Institute

Attending and Interested Centers working on domain:

- King Abdulaziz University (KAU) - KSA
- King Abdullah University of Science and Technology (KAUST) - KSA
- Istanbul Technical University (Turkey)
- Bogazici University (Turkey)
- Cairo University
- Jet Propulsion Laboratory (USA)
- Max Plank Institute for Chemistry (Germany)
- Italian Aerospace Research Center (CIRA)
- Qatar Meteorology Department
- SMHI
- ACSAD
- Maroc Meteo
- Cyprus Institute
- ESCWA
- WMO

Special Report on Emission Scenarios (SRES)

SRES Scenarios used in IPCC AR4 (2007)



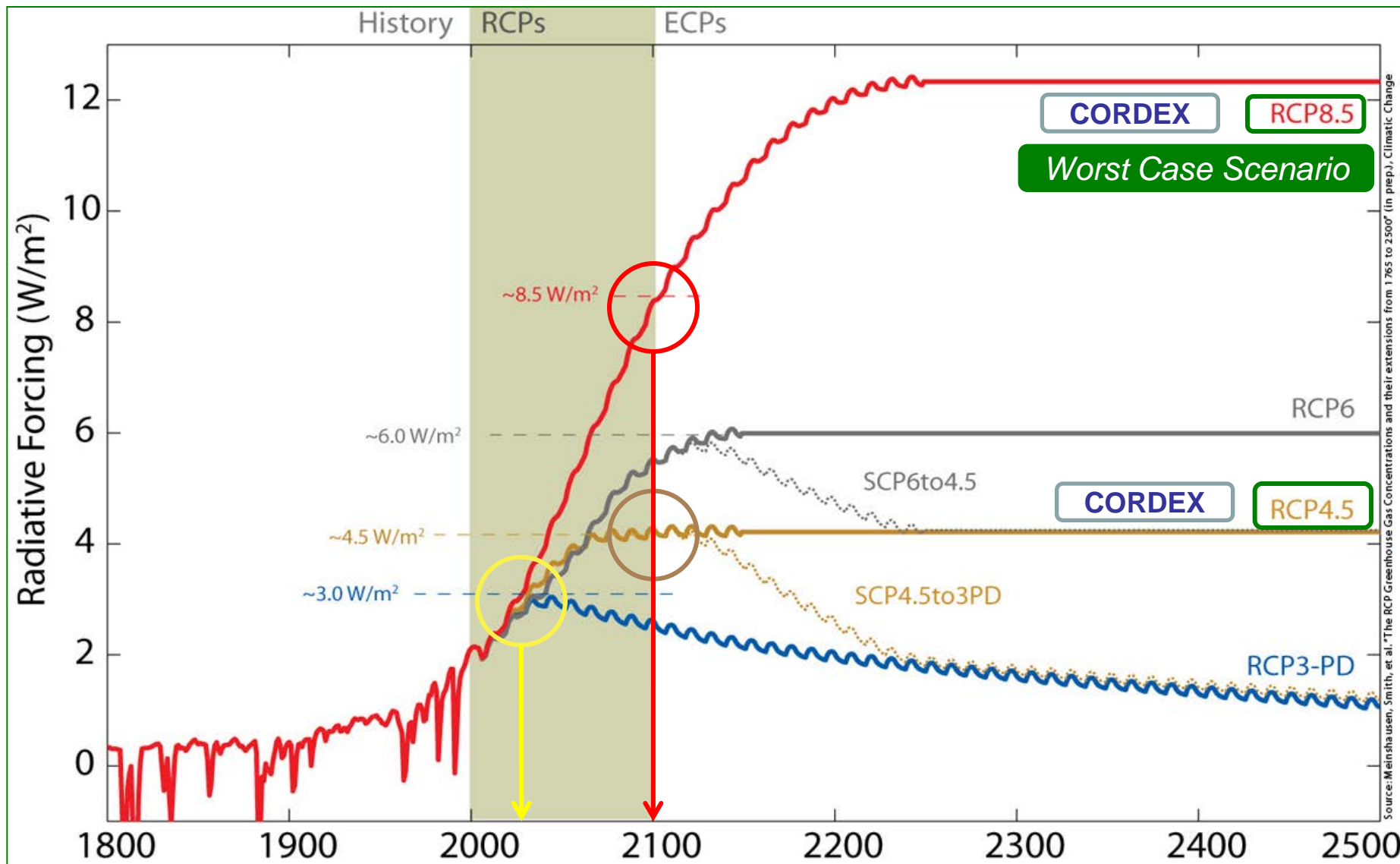
Average
3.4C
Temp
increase
Scenario

Average
1.8 C
Temp
increase
Scenario

Source:
ESCWA,
2009

Representative Concentration Pathways (RCPs)

New basis for Climate Modeling & IPCC Projections for AR5



Graph adapted from: Meinshausen et al., 2010



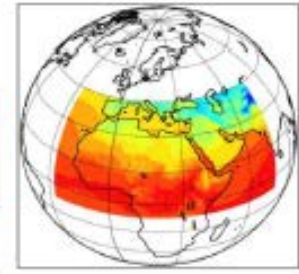
SMHI



RICCAR

CORDEX-MENA/Arab Ensemble Matrix

RCM (Institute)	GCM	Historical 1950-2005	RCP2.6 2006-2100	RCP4.5 2006-2100	RCP8.5 2006-2100
RCA4 (SMHI)	EC-Earth 50km	✓	✓	✓	✓
RCA4 (SMHI)	EC-Earth 25km	✓			✓
RCA4 (SMHI)	CNRM 50km	✓		✓	✓
RCA4 (SMHI)	GFDL-ESM 50km	✓		✓	✓
RCA4 (SMHI)	GFDL-ESM 25km	✓			✓
na (Kaust)	GFDL-ESM-1 25km	✓			✓
na (Kaust)	GFDL-ESM-2 25km	✓			✓
Remo (CSI)	MPI-ESM 50km	✓		✓	✓
RegCM4 (Kau)	HadGEM2 50km	✓		✓	✓
RegCM4 (Kau)	MPI-ESM 50km	✓		✓	✓
RegCM4 (Kau)	GFDL-ESM 50km	✓		✓	✓



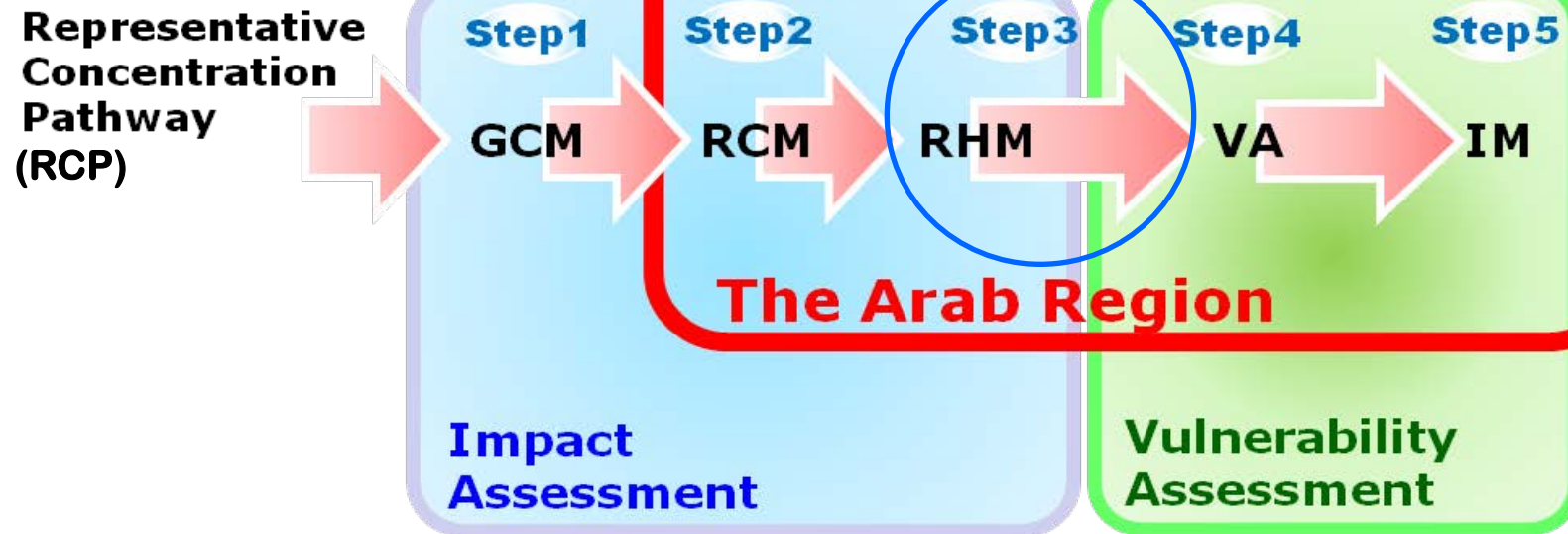
Currently have 13 regional climate projections completed
 9 are available for download

✓ Completed
 ✓ Running
 ✓ Planned

Source: P. Graham, SMHI, RICCAR EGM 6 (Cairo, Dec 2014)

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

Hydrological Modeling Set-Up

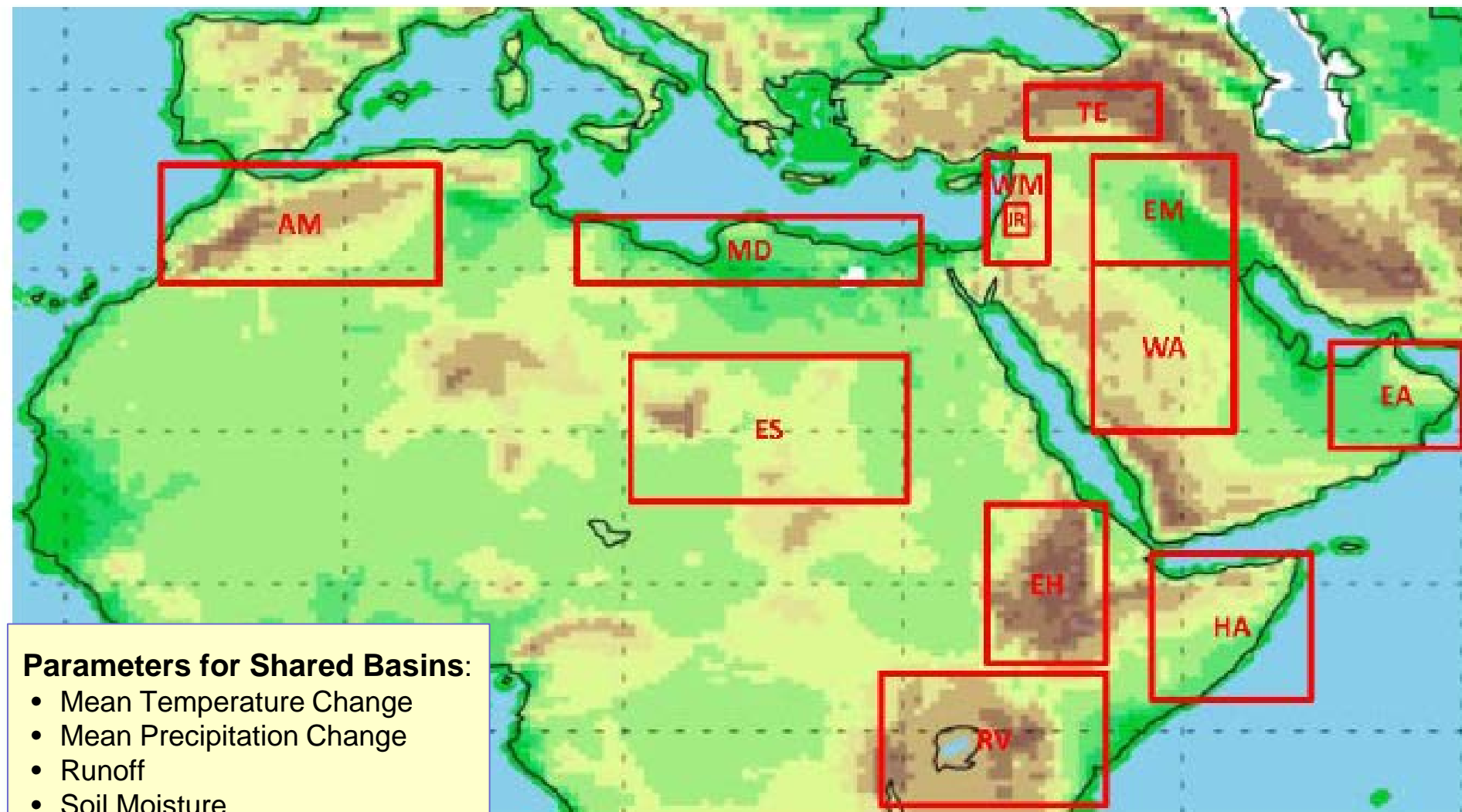
ACSAD & SMHI selected 3 models to simulate hydrological process over the Arab region:

- **HYPE model**
(*HYdrological Predictions for the Environment*)
- **VIC model**
- **HEC-HMS (basin-level)**

Test basins of varied size selected from different areas of Arab region to evaluate and calibrate the models:

- **Mejerda Watershed (Tunisia/Algeria)**
- **Wadi Dayqah (Oman)**
- **Nahr el Kabir Al-Junoubi (Syria)**
- **Nile River**
- **Euphrates River**

Sub-Domains for Hydrological Modeling



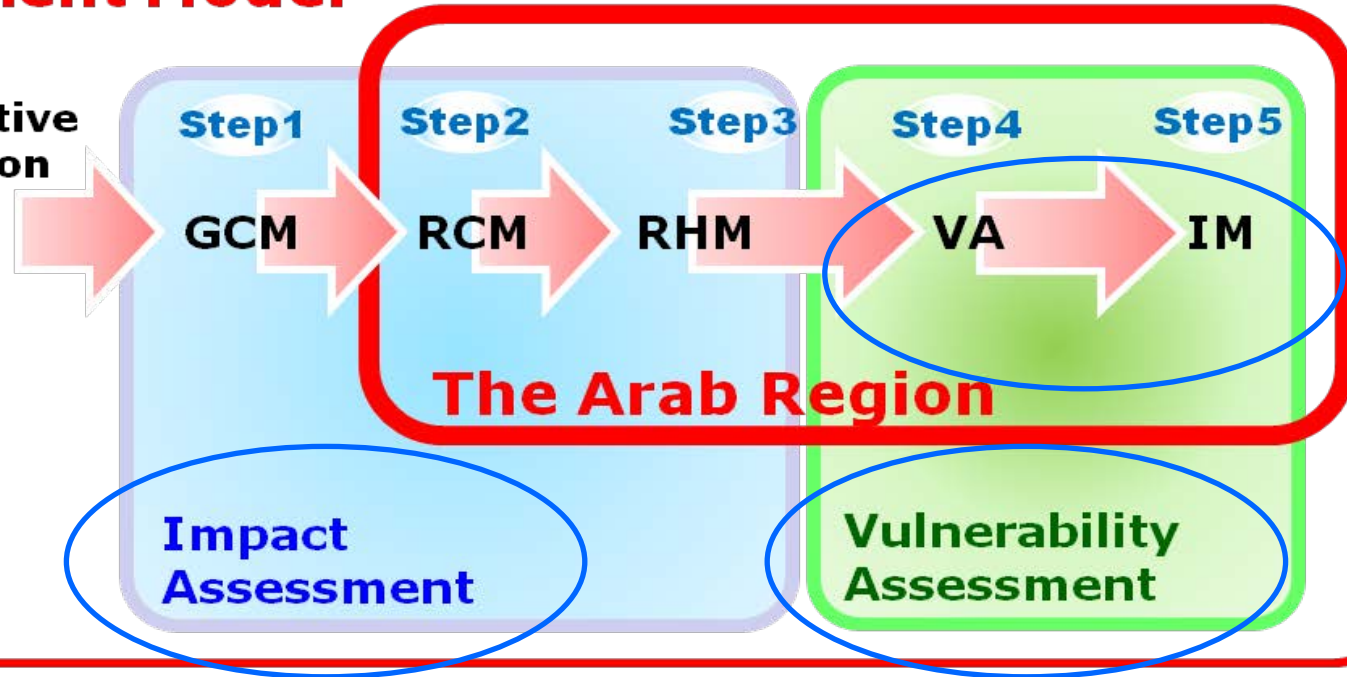
Parameters for Shared Basins:

- Mean Temperature Change
- Mean Precipitation Change
- Runoff
- Soil Moisture
- Evapotranspiration
- Groundwater interaction with surface water

Integrated Assessment Methodological Framework

The Integrated Assessment Model

Representative Concentration Pathway (RCP)



Step 1: Global Climate Modeling using General Circulation Model

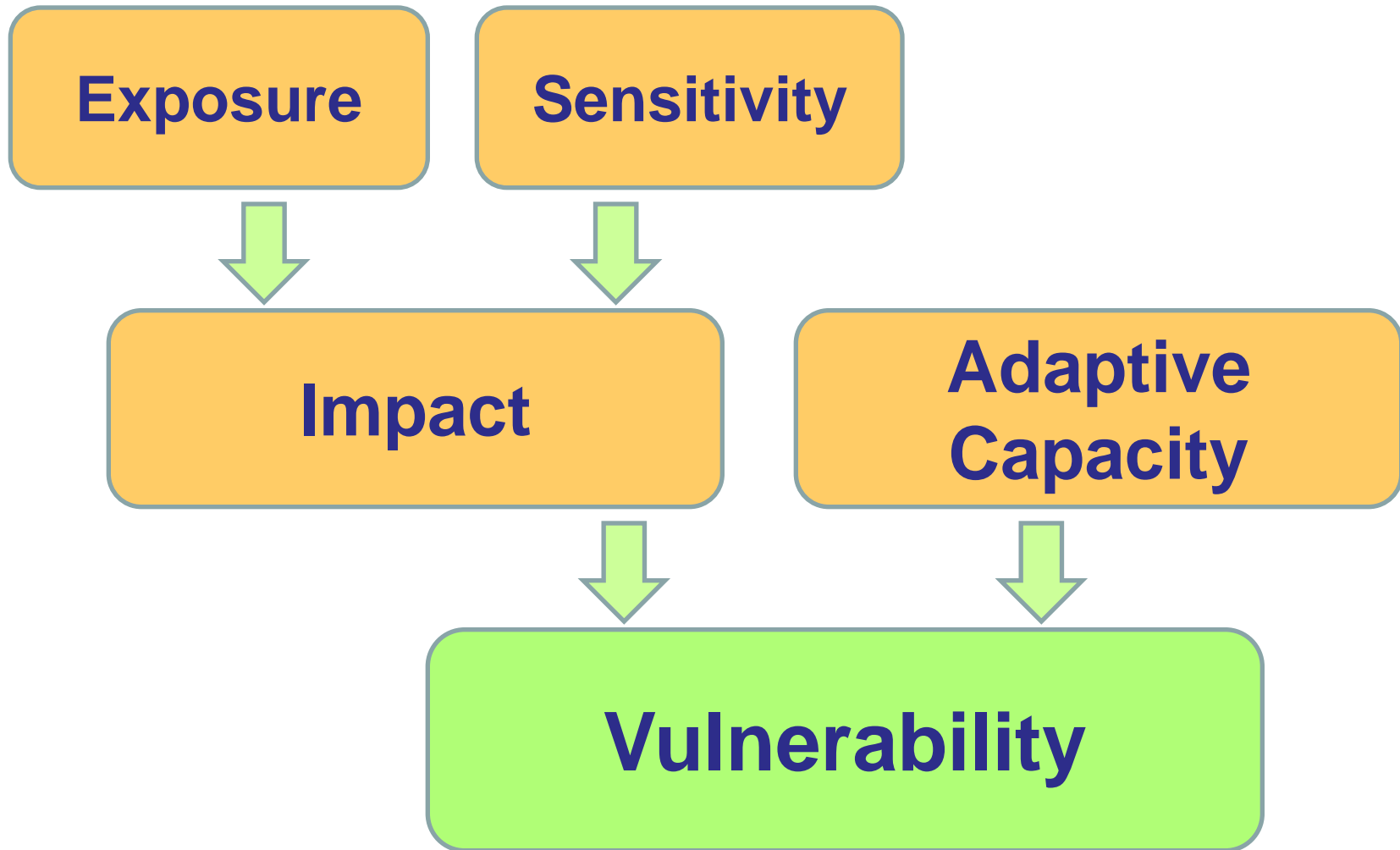
Step 2: Regional Climate Modeling

Step 3: Regional Hydrological Modeling

Step 4: Vulnerability Assessment

Step 5: Integrated Mapping

Vulnerability Assessment Components



Based on IPCC AR4 conceptual framework

Vulnerability Assessment Working Group

Objective: To support the preparation of the methodology and contribute to the preparation of the vulnerability assessment.

Tasks:

- Define the objectives, scope and deliverables of the socio-economic and environmental vulnerability assessment;
- Agree on the most suitable methodology and tools to be used;
- Contribute to the collection of data and information to support the assessment;
- Assist with the identification of expertise to provide input to the assessment;
- Provide expert review of the assessment products as they become available.

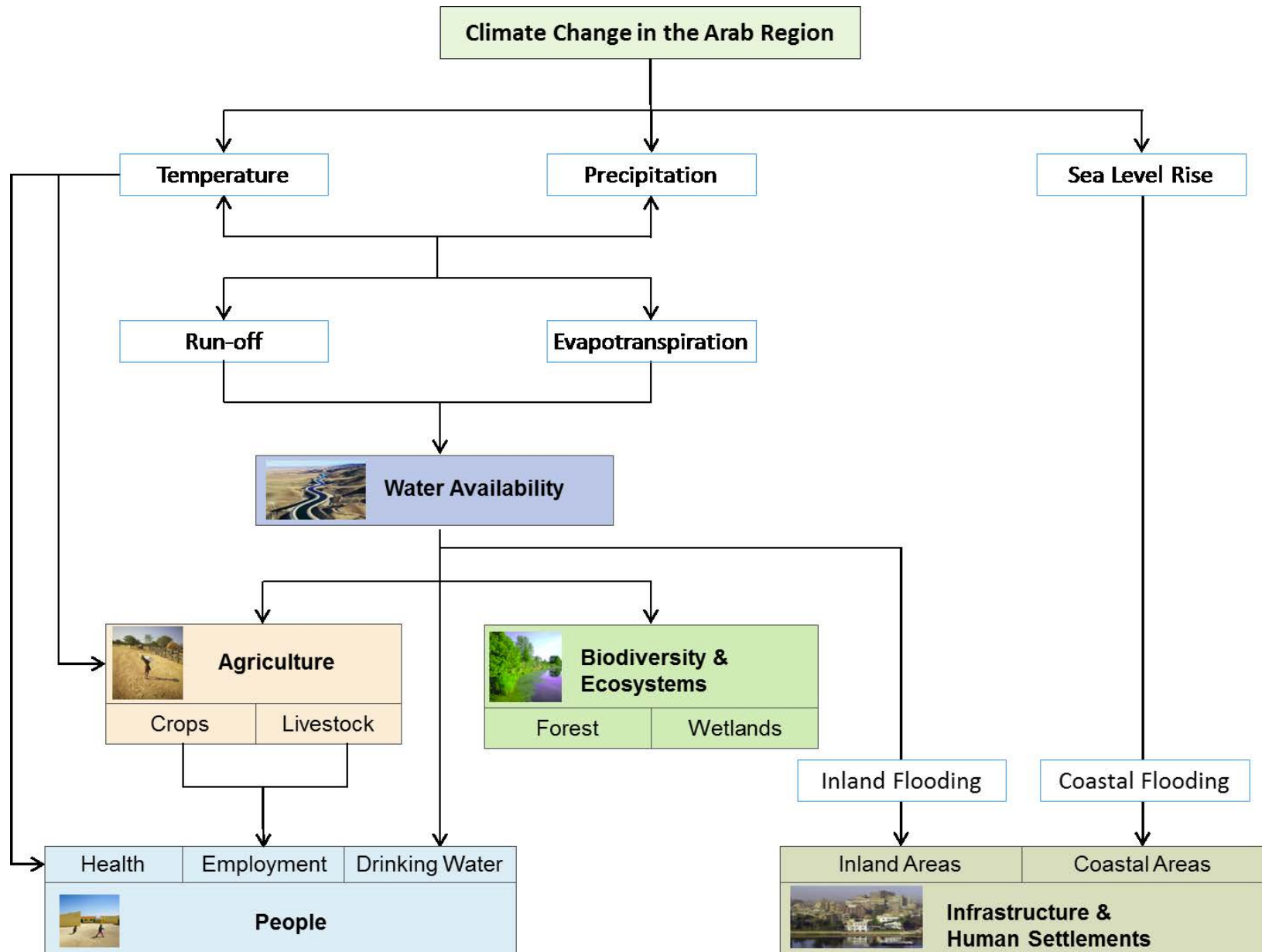
Composition (15 members):

- 4 Arab Governments (Egypt, Libya, Palestine, Tunisia)
- 4 Arab Organizations (ACSAD, AGU, AUB, LAS)
- 4 UN Organizations (ESCWA, UNEP, UNESCO, WHO)
- 3 Expert Organizations (GIZ, ICBA, University of Alexandria)

Duration: January 2013 – September 2014

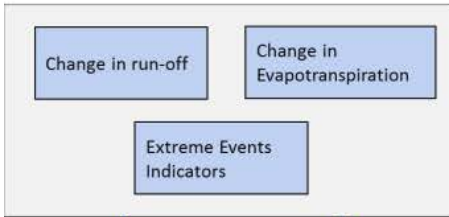
Meeting 1: January 2013; **Meeting 2:** May 2013; **Meeting 3:** November 2013

Impact Chain

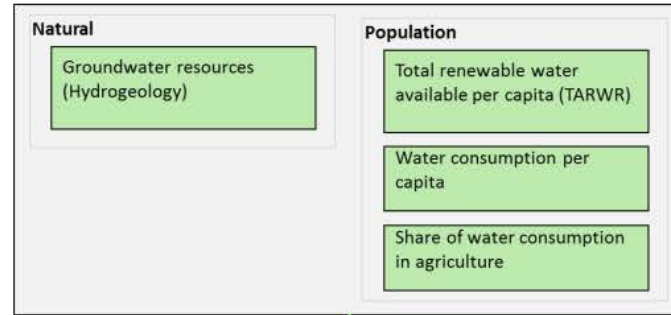


Impact Chain for Water Availability

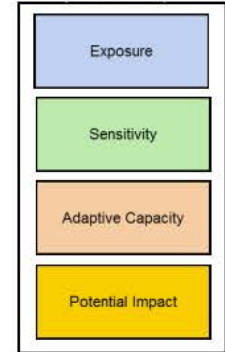
Exposure



Sensitivity



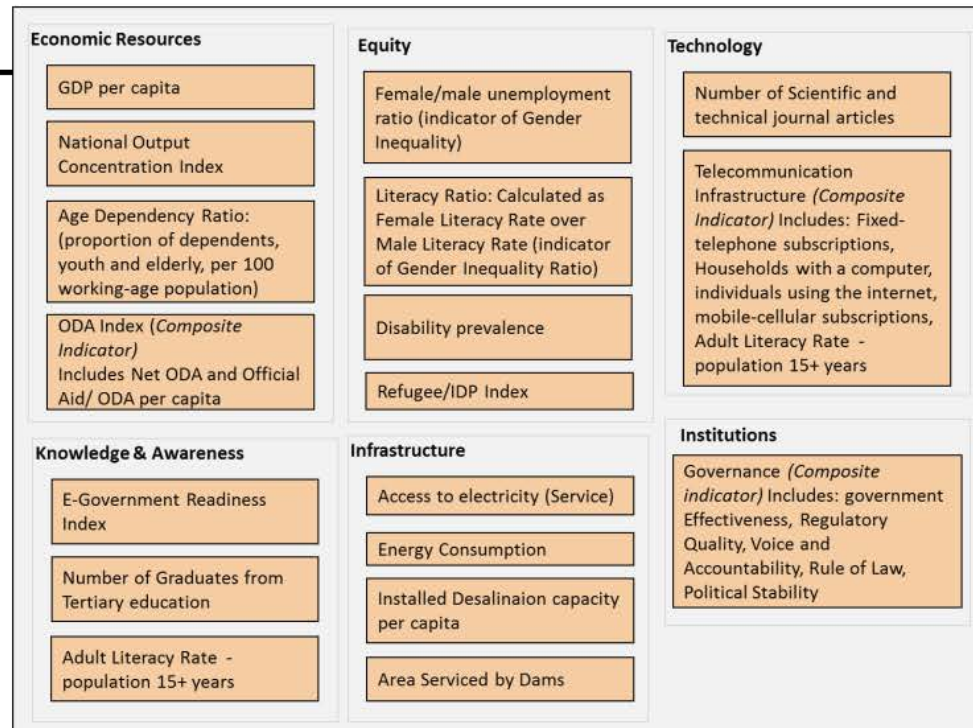
Legend



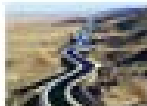


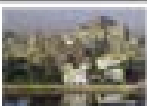

Water availability

Vulnerability

Adaptive Capacity



Sector & Impacts Selected for Arab Region VA

Sectors	Impacts
 Water	Change in water availability
 Biodiversity & Ecosystems	Change in area covered by forests
 Agriculture	Change of water available for crops
 Infrastructure & Human Settlements	Change in inland flooding area
 People	Change of water available for drinking
	Change in health due to heat stress
	Change of employment rate in the agricultural sector

Overall Vulnerability

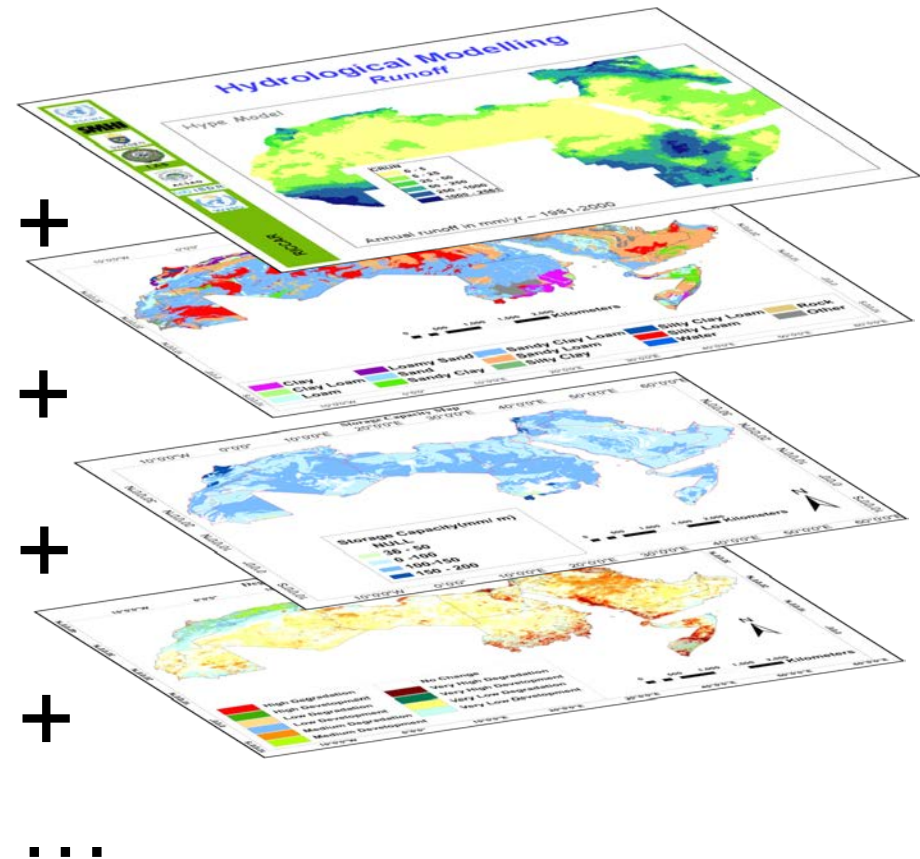
Preparation of a Vulnerability Index:

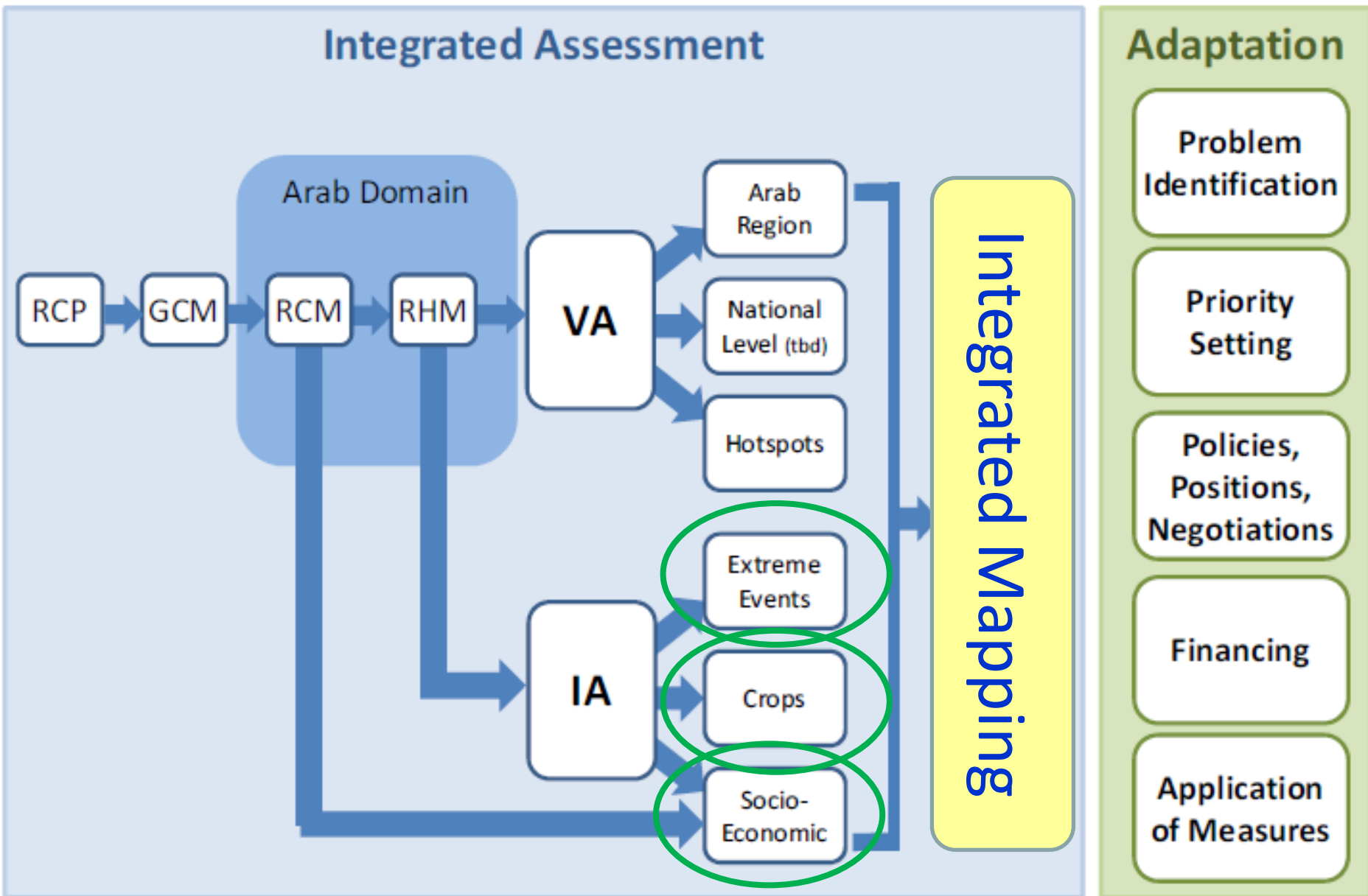
➤ Per Sector

- Contains all indicators identified to assess a given sectors
- 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 in Arab Region





RCP: Representative Concentration Pathway; **GCM:** Global Climate Model; **RCM:** Regional Climate Model; **RHM:** Regional Hydrological Model; **VA:** Vulnerability Assessment; **IA:** Impact Assessment; **IM:** Integrated Mapping

Sector Impact Assessments

Agriculture

- FAO, ACSAD, GIZ
- Forests
- In-land Fisheries
- Selected Crops
- Selected Hot Spots

Health

- UNU/INWEH under Sida Project, in consultation with WHO
- Disease Vectors
- Rodent-Borne Infectious Diseases
- North Africa



UNITED NATIONS
UNIVERSITY

UNU-INWEH



SWEDEN



UNITED NATIONS
الشرق الأوسط
ESCWA

RICCAR Implemented through Inter-Governmental and Inter-Agency Cooperative Mechanisms

Integrated Assessment

Impact Assessment

Regional
Climate
Modeling

Regional
Hydrological
Modeling

VA

Vulnerability
Assessment

Annual
Expert Group Meetings

2009, 2010, 2011, 2012, 2013, 2014

Technical Training Workshops

2011, 2012, 2013, 2014, 2015

**Vulnerability Assessment
Working Group** (2013-2015)

Regional Knowledge Hub
Working Group (2013-2014)

**National Hydrological
Focal Points** (2013, 2014, 2015)

VA Sensitivity Task Force (2014)
VA Adaptive Capacity Task Force

RCM Ensemble Task Force (2011);
CORDEX Working Group (2014)

Capacity Building & Institutional Strengthening

Workshops

Expert Group Meetings

Projection/ Prediction and Extreme Events Indices	Arab Met Offices	March 2012 Casablanca	EGM 1: Launching	Water, Environ	2009 Beirut
Applications & Analysis of Regional Climate Models	Water Ministries	July 2012 Beirut	EGM 2: Arab Domain	Water Environ	2010 Beirut
National Workshops for Disaster Losses Inventories (Tunisia, Morocco, Yemen, Jordan, Palestine)	Inter-ministerial	September 2012-April 2014	EGM 3: RCMs	Water Environ	2011 Beirut
Climate Data Rescue Sub-regional Workshop (Palestine, Jordan, KSA, Yemen)	Met Services	June 2013 Amman	EGM 4: Climate Ensemble & Working Groups	Water Ministries Environ Agencies	2012 Beirut
Linking Regional Climate Models to Hydrological Models	Arab Water Ministries`	June 2013 Beirut	EGM 5: Preliminary RCM Findings for Arab Domain & VA Methodology	Water Ministries	2013 Amman
Technical Workshop on the Vulnerability Assessment Methodology Application	Research Centers	May 2014 Beirut	EGM 6: Review of RCM & RHM Findings & VA Sectors	Water, Ag & Environ Ministries	2014 Cairo
Scoping Meeting for Establishing an Arab Climate Outlook Forum (ArabCOF)	Met Services	Oct 2014, Amman			
Moving from Impact Assessment to Socio-Economic Vulnerability Assessment	Water & Agriculture Ministries	June 2015 Beirut			

RICCAR Partners

Implementing Partners



LAS



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Cairo Office



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COOPERATION AGENCY



Contributing Research Institutes *supporting Regional Climate Modelling*


- 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 (CSC) - Germany

Thank you!

www.escwa.un.org/RICCAR

ASSESSING THE IMPACT OF CLIMATE CHANGE ON WATER RESOURCES AND SOCIO-ECONOMIC VULNERABILITY IN THE ESCWA REGION:

A Methodological Framework for Pursuing an Integrated Assessment



United Nations Economic and Social Commission for Western Asia

ESCWA

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RMetS
Royal Meteorological Society

Changes in extreme temperature and precipitation in the Arab region: long-term trends and variability related to ENSO and NAO

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⁶Center for Excellence for Climate Change Research, Department of Meteorology, King Abdulaziz University, Jeddah, Saudi Arabia
⁷World Meteorological Organization, Geneva, Switzerland
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⁹Department of Statistics, University of Jordan, Amman, Jordan
¹⁰Ministry of Civil Aviation, Cairo, Egypt
¹¹Climate Unit, Ministry of Transport, Beirut, Lebanon
¹²Ministry of Civil Aviation, Cairo, Egypt
¹³Asian Meteorological Department, Amman, Jordan
¹⁴Department of Meteorology, MOCC, Sana'a, Yemen
¹⁵Ministry of Public Health and Emergency Services, Lebanon
¹⁶United Nations Meteorological Centre, Tripoli, Libya
¹⁷Office National de la Météorologie, Nouadhibou, Mauritania
¹⁸Directorate de la Météorologie Nationale, Conakry, Guinea
¹⁹Palestinian Meteorological Office, Ramallah, Palestine
²⁰President's Office for Meteorology and Environment, Jeddah, Saudi Arabia
²¹Saudi Meteorological Authority (SMA), Dhahran, Saudi Arabia
²²National Weather Institute, Tunis, Tunisia
²³UAE Authority for Air Defense, Fuairah, UAE
²⁴National Center of Meteorology and Seismology, Abu Dhabi, UAE

ABSTRACT: A workshop was held in Cuernavaca, Mexico, 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 seasonal 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 middle of the 20th 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 trends seem to be particularly strong since the early 1970s. Changes in precipitation are generally less consistent and characterized 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 less significance. We also find some relationships between climate extremes in the Arab region and certain patterns 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 (close to the Atlantic Ocean). The relationships with ENSO are found to be more significant towards the eastern part of the area of study. Copyright © 2013 Royal Meteorological Society

KEY WORDS climate extremes; climate change; observations; temperature; precipitation; ENSO; NAO

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

Adaptation to Climate Change in the Water Sector in the MENA Region (ACCWetM) project

Training Manual on the Integrated Vulnerability Assessment Methodology