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

Integrated Assessment

Carol Chouchani Cherfane
RICCAR Coordinator
Chief, Water Resources Section
Sustainable Development Policies Division
UN Economic and Social Commission for Western Asia (ESCWA)

Building Capacity for Accessing Disruptive Technologies for Improved Water Resources Management under Climate Change
Beirut, 14-15 January 2020

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

Intergovernmental Mandates calling for & supporting Climate Change Assessment in the Arab Region

Arab Ministerial Declaration on Climate Change
CAMRE 2007

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

Arab Permanent Committee for Meteorology
Resolutions 2012, 2013, 2014, 2015, 2016

APCM is under new **Arab Ministerial Council for Meteorology & Climate**

ESCWA Ministerial Session
Resolutions on Climate Change 2008, 2012, 2014, 2016, 2018

Arab Ministerial Water Council
Resolutions 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017

ACSAD Board of Directors
Resolution 2013

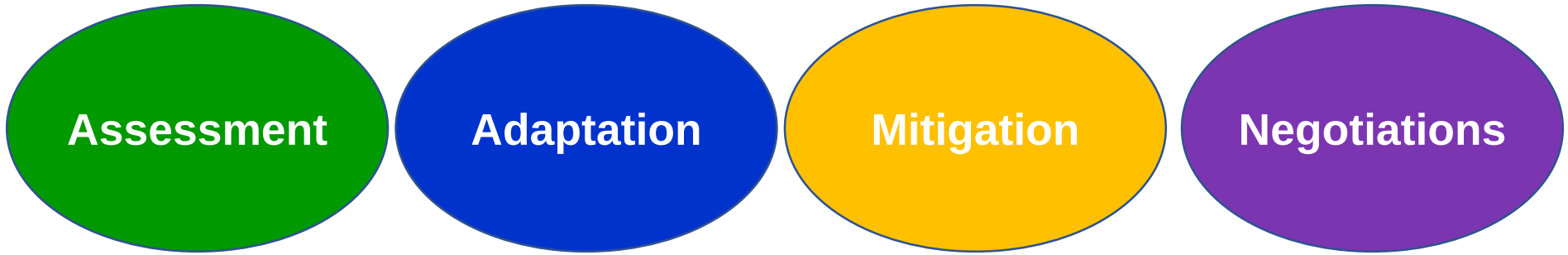
Environment | Foreign Affairs & Planning | Water | Meteorology | Agriculture

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

RICCAR

Objective: To assess the impact of climate change on freshwater resources in the Arab Region through a consultative regional initiative that scientifically identifies the socio-economic and environmental vulnerability caused by climate change impacts on water resources based on regional specificities.

Purpose: 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

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

UNITED NATIONS
ESCWA

UN environment

WMO

ACSAD

LAS

SMHI

United Nations
Educational, Scientific and
Cultural Organization
Cairo Office

UNITED NATIONS
UNIVERSITY
UNU-INWEH

Sweden
Sverige

SWEDISH INTERNATIONAL DEVELOPMENT
COOPERATION AGENCY

german
cooperation

Implemented by
giz

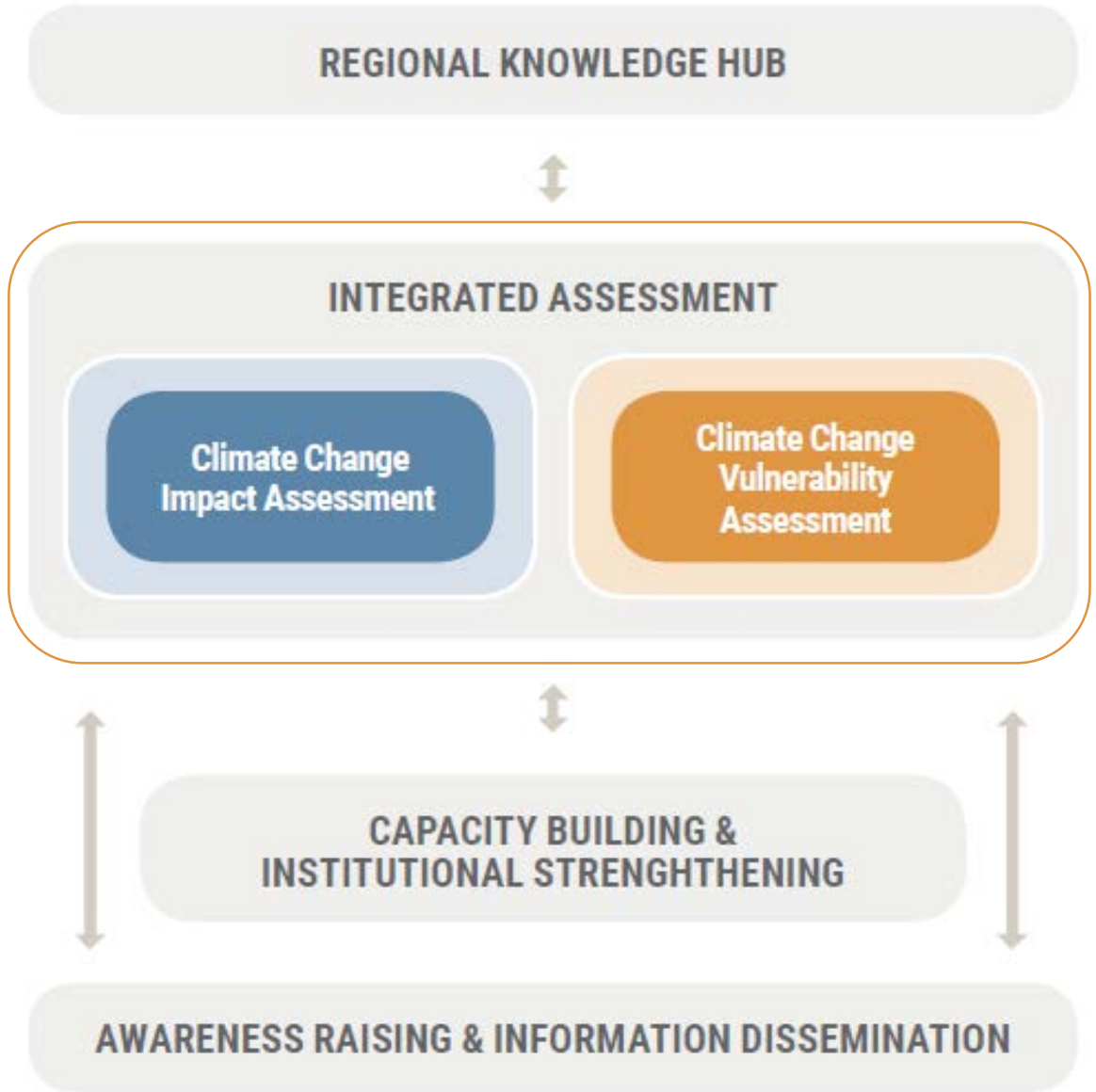
ACCWaM

UNDRR
UN Office for Disaster Risk Reduction

CORDEX/MENA Domain housed at
The Cyprus Institute

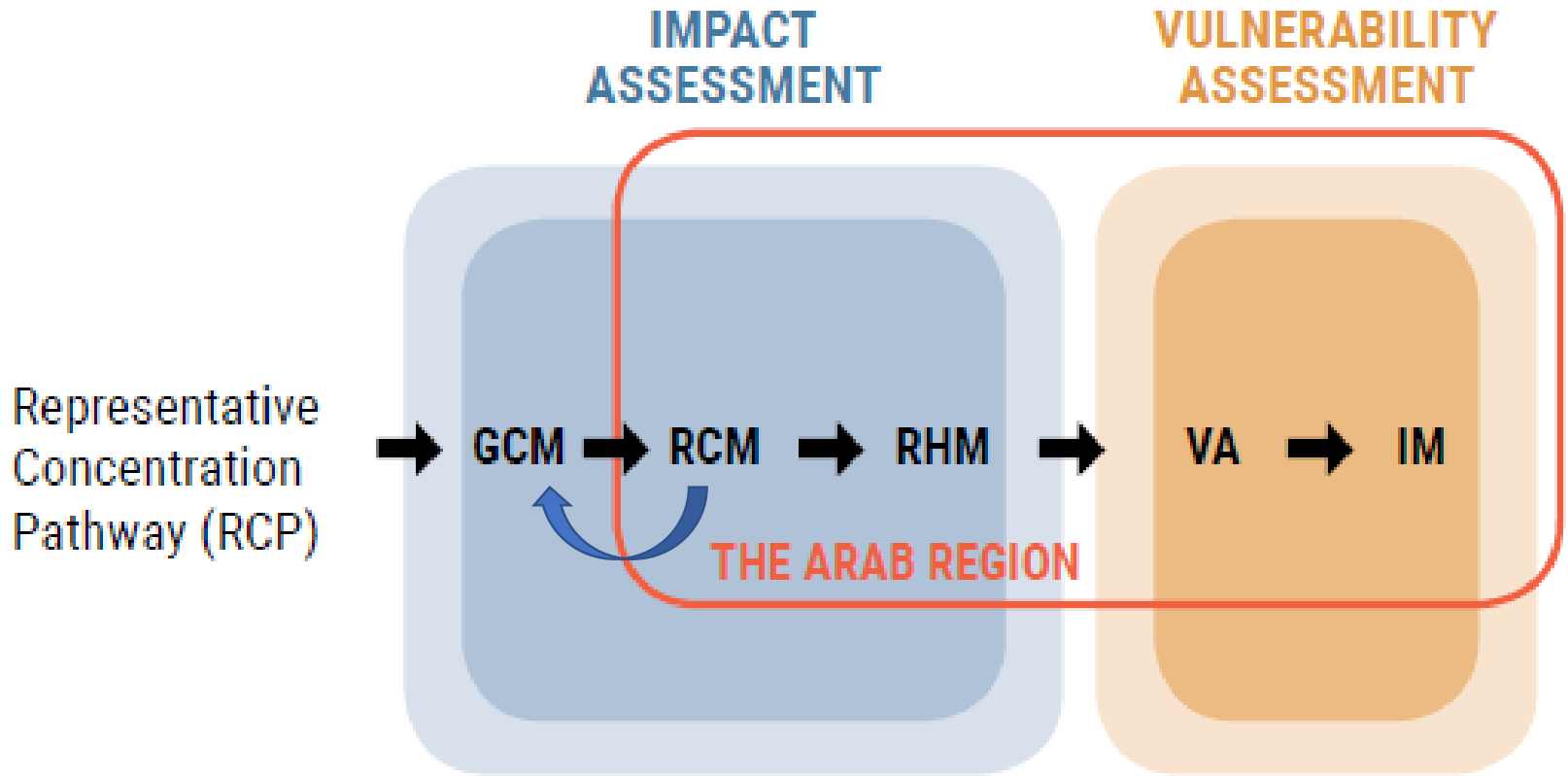
RICCAR
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

Pillars of Work



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

Integrated Assessment



GCM: Global Climate Modelling
RCM: Regional Climate Modelling
RHM: Regional Hydrological Modeling

VA: Vulnerability Assessment
IM: Integrated Mapping

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

Climate Change Impact Assessment: Components to Consider

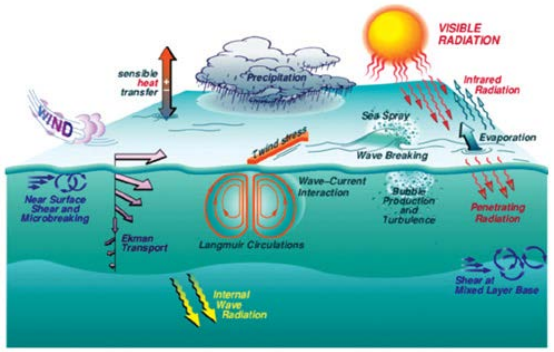
When examining Regional Climate Modelling and Hydrological modelling outputs, consider:

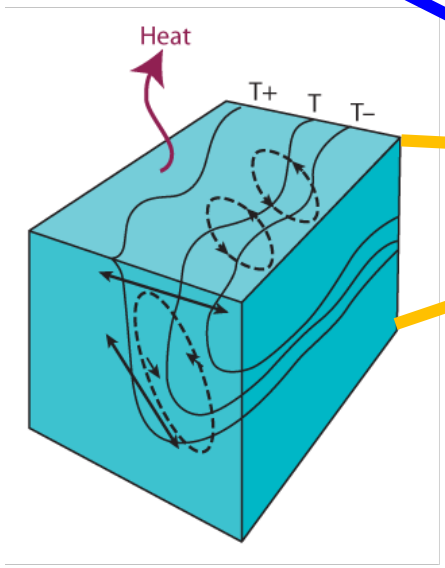
1) What **scale** of outputs do you need?
2) Which **Essential Climate Variables** are you interested in?
3) What **Domain** to use or draw upon for regional climate modelling?
4) Which **Climate Scenario** is of interest to your work?
5) Can you allocate the time needed to consider an **Ensemble** of projections for quantifying the range of uncertainty?
6) What **Time Intervals** do you need? Daily; Monthly; 10-year; 20-year; mid-century; end-century

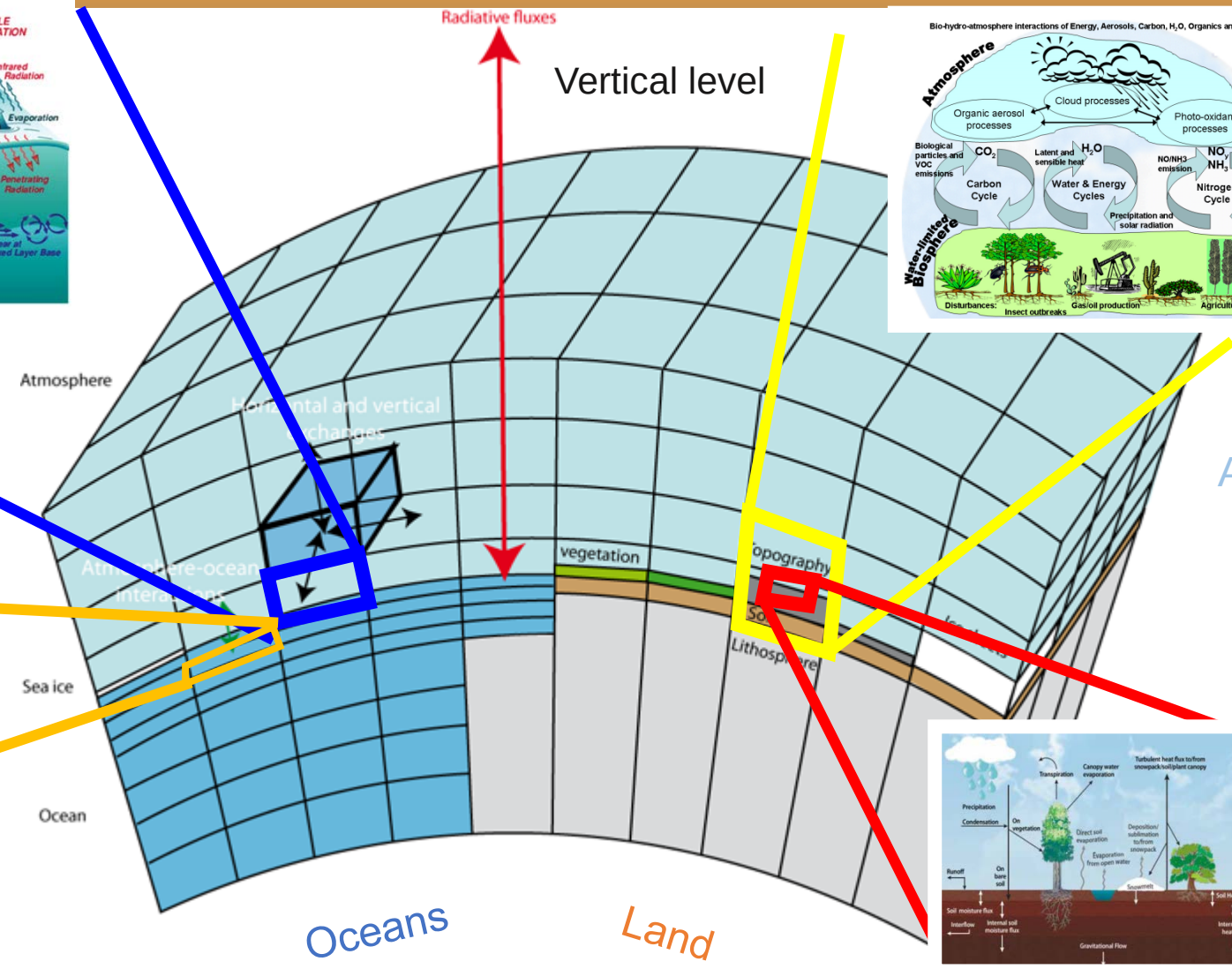
*And ultimately, do you need ready-made **outputs (projections) or inputs (dataset)** for use in other models?*

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

1- Scale: Computing Climate Variables







Atmosphere

REF: http://stratus.astr.ucl.ac.be/textbook/chapter3_node8.html
http://www.nesl.ucar.edu/LAR/2007/strategic-priorities/sp2/index.php

Computing Climate Variables: Scale Improving Over Time

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

IPCC

1990 — FAR — ~500 km (T21)

1995 — SAR — ~250 km (T42)

2001 — TAR — ~180 km (T63)

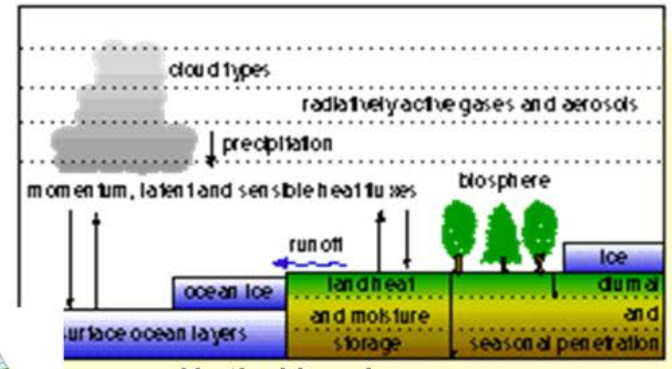
2007 — AR4 — ~110 km (T106)

AR5 in 2014

AR6 in 2021/2022

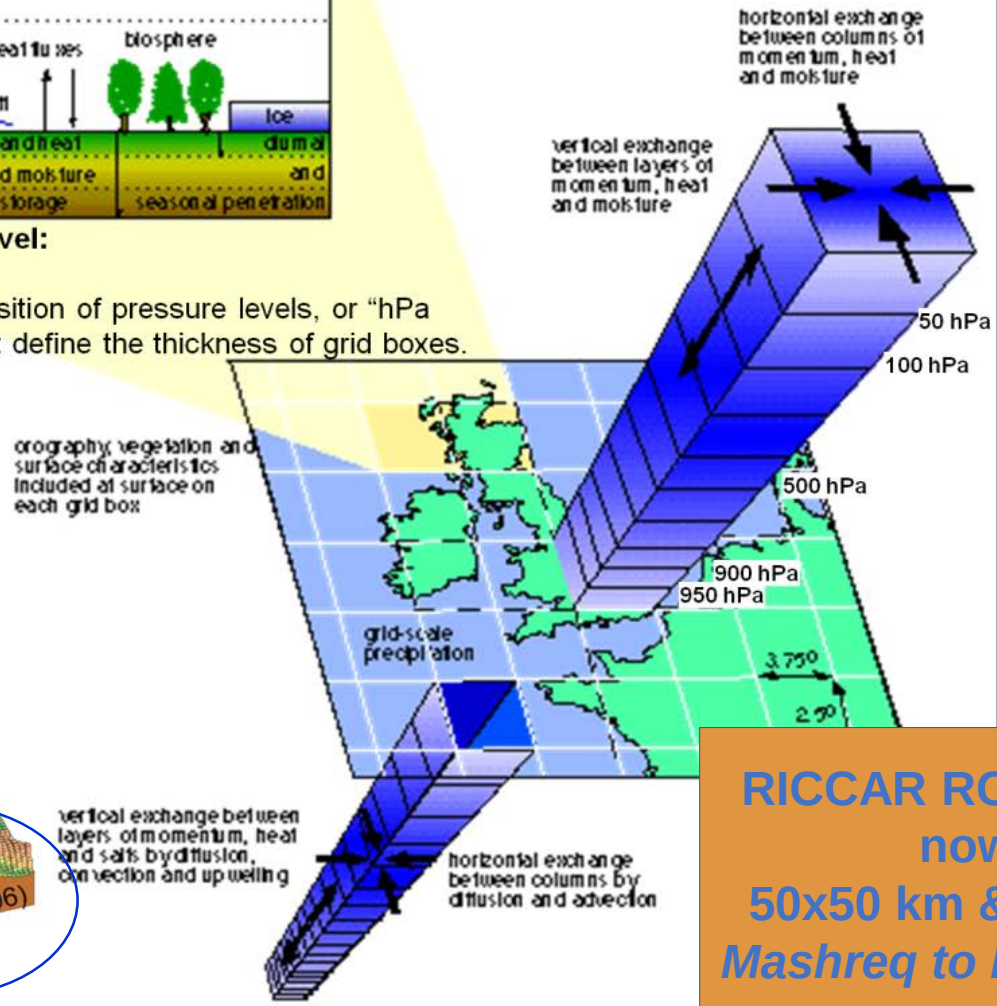
Horizontal Grid:

Evolution of horizontal resolution over the course of the Various IPCC reports



Vertical Level:

Relative position of pressure levels, or "hPa Levels" that define the thickness of grid boxes.



RICCAR RCM Outputs now at 50x50 km & 25x25 km
Mashreq to be at 10 km²

Source: IPCC, 2007; Met Office, 2011

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

2- Essential Climate Variables: Generated per Grid Box

Atmosphere

Surface
- Precipitation
- Pressure
- Radiation budget
- Temperature
- Water vapour
- Wind speed and direction

Upper-air
- Earth radiation budget
- Lightning
- Temperature
- Water vapor
- Wind speed and direction

Atmospheric Composition
- Aerosols
- Carbon dioxide, methane and other greenhouse gases
- Clouds
- Ozone
- Precursors for aerosols and ozone

Land

Hydrosphere
- Groundwater
- Lakes
- River discharge

Cryosphere
- Glaciers
- Ice sheets and ice shelves
- Permafrost
- Snow

Biosphere
- Above-ground biomass
- Albedo
- Evaporation from land
- Fire
- Fraction of absorbed photosynthetically active radiation (FAPAR)
- Land cover
- Land surface temperature
- Leaf area index
- Soil carbon
- Soil moisture

Anthroposphere
- Anthropogenic Greenhouse gas fluxes
- Anthropogenic water use

Ocean

Physical
- Ocean surface heat flux
- Sea ice
- Sea level
- Sea state
- Sea surface currents
- Sea surface salinity
- Sea surface stress
- Sea surface temperature
- Subsurface currents
- Subsurface salinity
- Subsurface temperature

Biogeochemical
- Inorganic carbon
- Nitrous oxide
- Nutrients
- Ocean colour
- Oxygen
- Transient tracers

Biological/ecosystems
- Marine habitats
- Plankton

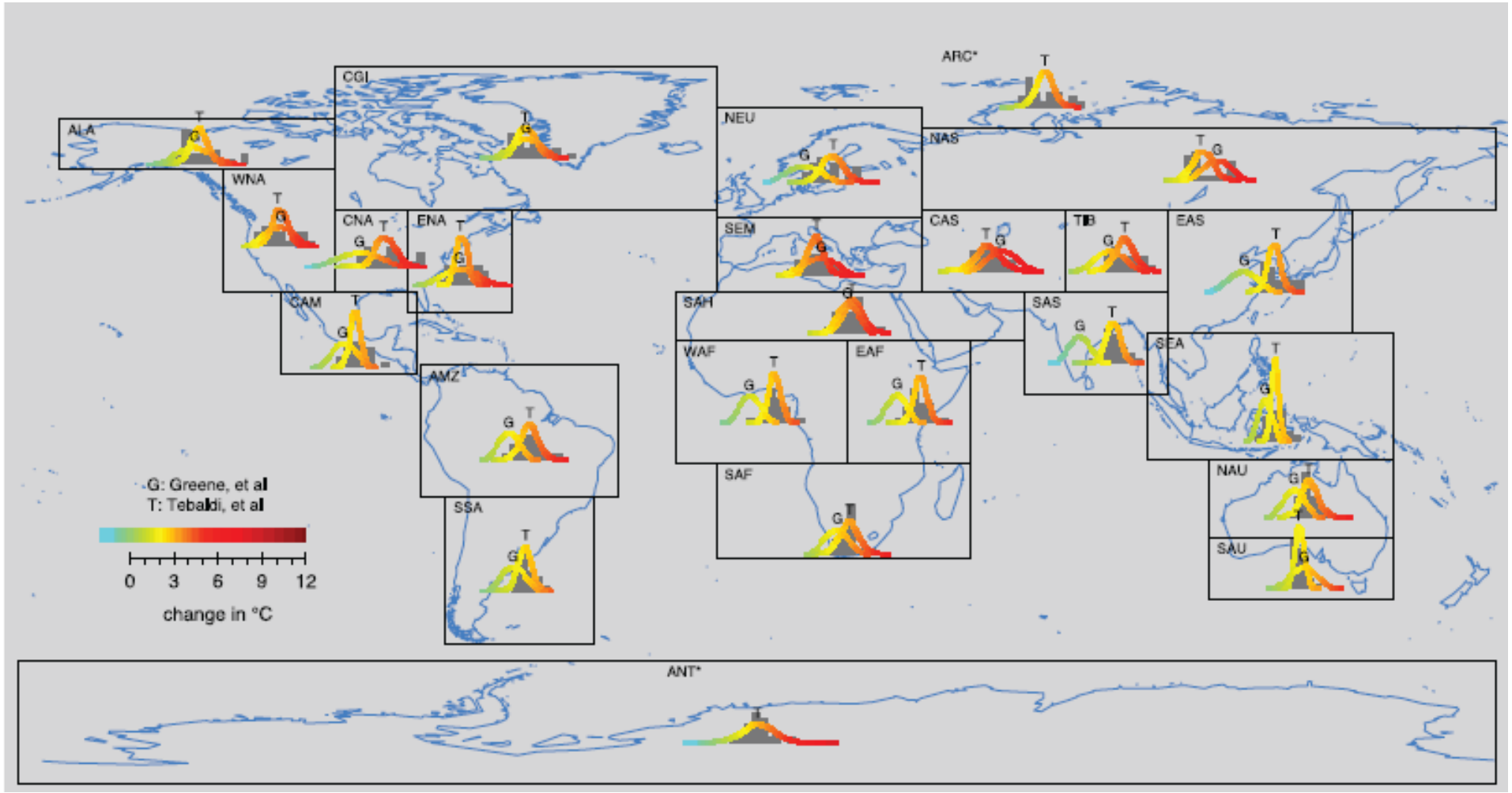
RICCAR RCMs are land-based models and do not generate Oceanic Variables

Essential Climate Variables (ECV) datasets provide the empirical evidence needed to understand and predict the evolution of climate

https://gcos.wmo.int/en/essential-climate-variables/table

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

3-Domain: IPCC Regional Domains (2010)



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

IPCC Regional Domains (2013)

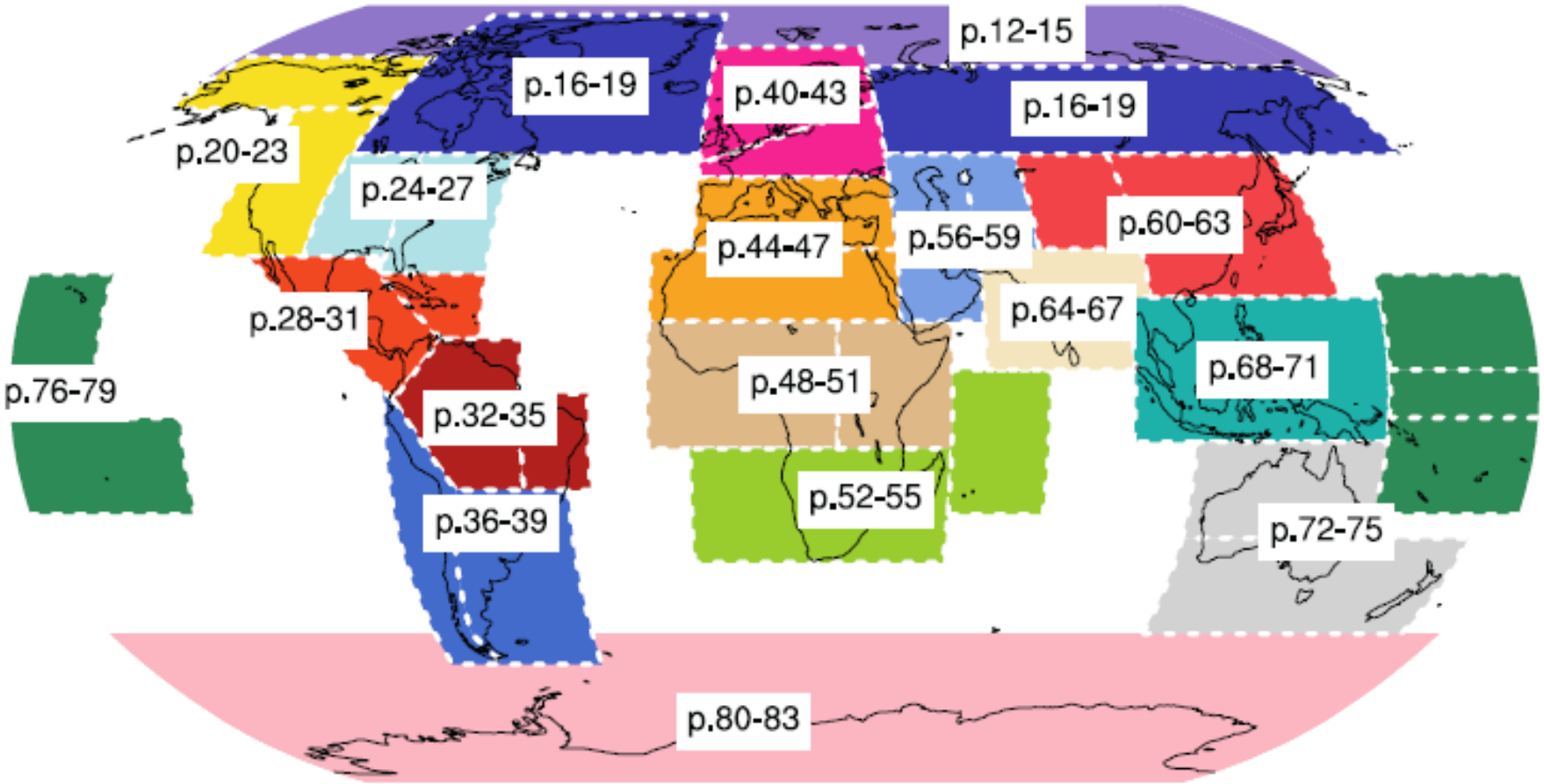


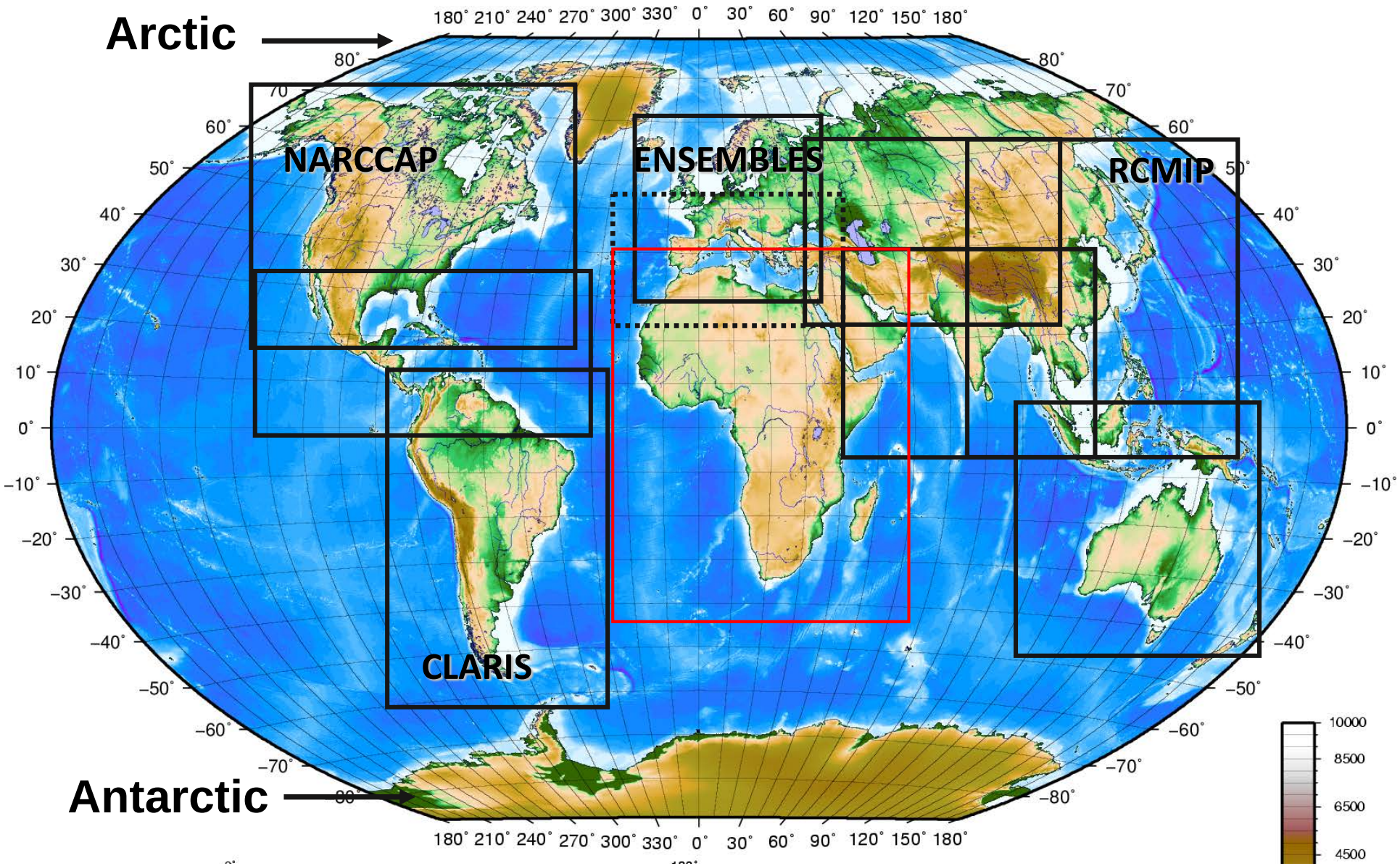
Figure AI.3: Overview of the SREX, ocean and polar regions used.

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 (2012)

Coordinated Regional Climate Downscaling Experiment



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

CORDEX-MENA Working Group

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

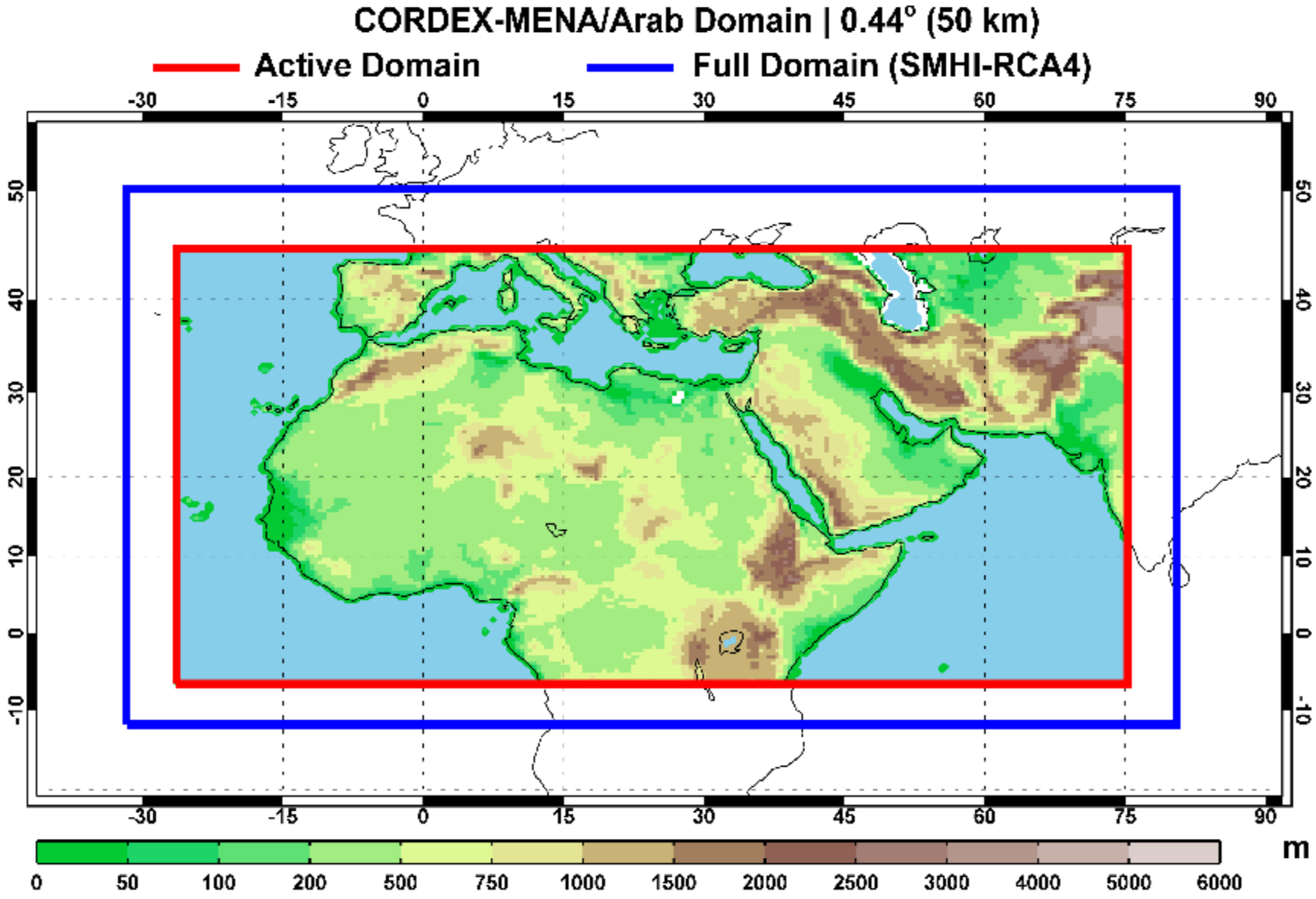
Attending or Interested Centers:

- 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
- The Cyprus Institute
- WMO
- ESCWA

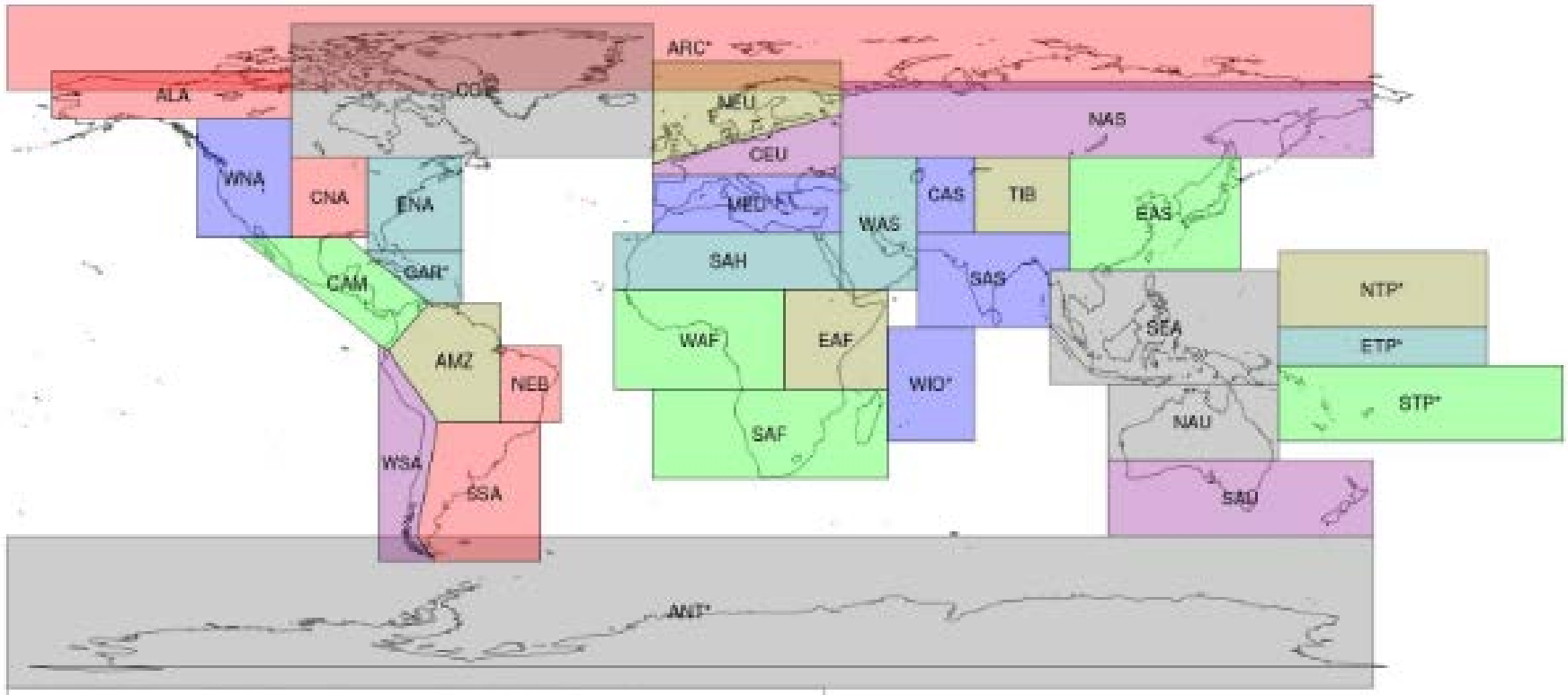
CORDEX is the Coordinated Regional Climate Downscaling Experiment of the World Climate Research Program

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

MENA Domain



IPCC Regional Domains (2014)



ALA : Alaska/N.W. Canada [ALA:1]
AMZ : Amazon [AMZ:7]
CAM : Central America/Mexico [CAM:6]
CAR* : small islands regions Caribbean
CAS : Central Asia [CAS:20]
CEU : Central Europe [CEU:12]
CGI : Canada/Greenland/Iceland [CGI:2]
CNA : Central North America [CNA:4]
EAF : East Africa [EAF:16]
EAS : East Asia [EAS:22]
ENA : East North America [ENA:5]
MED : South Europe/Mediterranean [MED:13]
NAS : North Asia [NAS:18]
NAU : North Australia [NAU:25]
NEB : North-East Brazil [NEB:8]
NEU : North Europe [NEU:11]
SAF : Southern Africa [SAF:17]
SAH : Sahara [SAH:14]
SAS : South Asia [SAS:23]
SAU : South Australia/New Zealand [SAU:26]
SEA : Southeast Asia [SEA:24]
SSA : Southeastern South America [SSA:10]
TIB : Tibetan Plateau [TIB:21]
WAF : West Africa [WAF:15]
WAS : West Asia [WAS:19]
WNA : West North America [WNA:3]
WSA : West Coast South America [WSA:9]
ANT* : Antarctica
ARC* : Arctic
NTP* : Pacific Islands region[2]
STP* : Southern Topical Pacific
ETP* : Pacific Islands region[3]
WIO* : West Indian Ocean

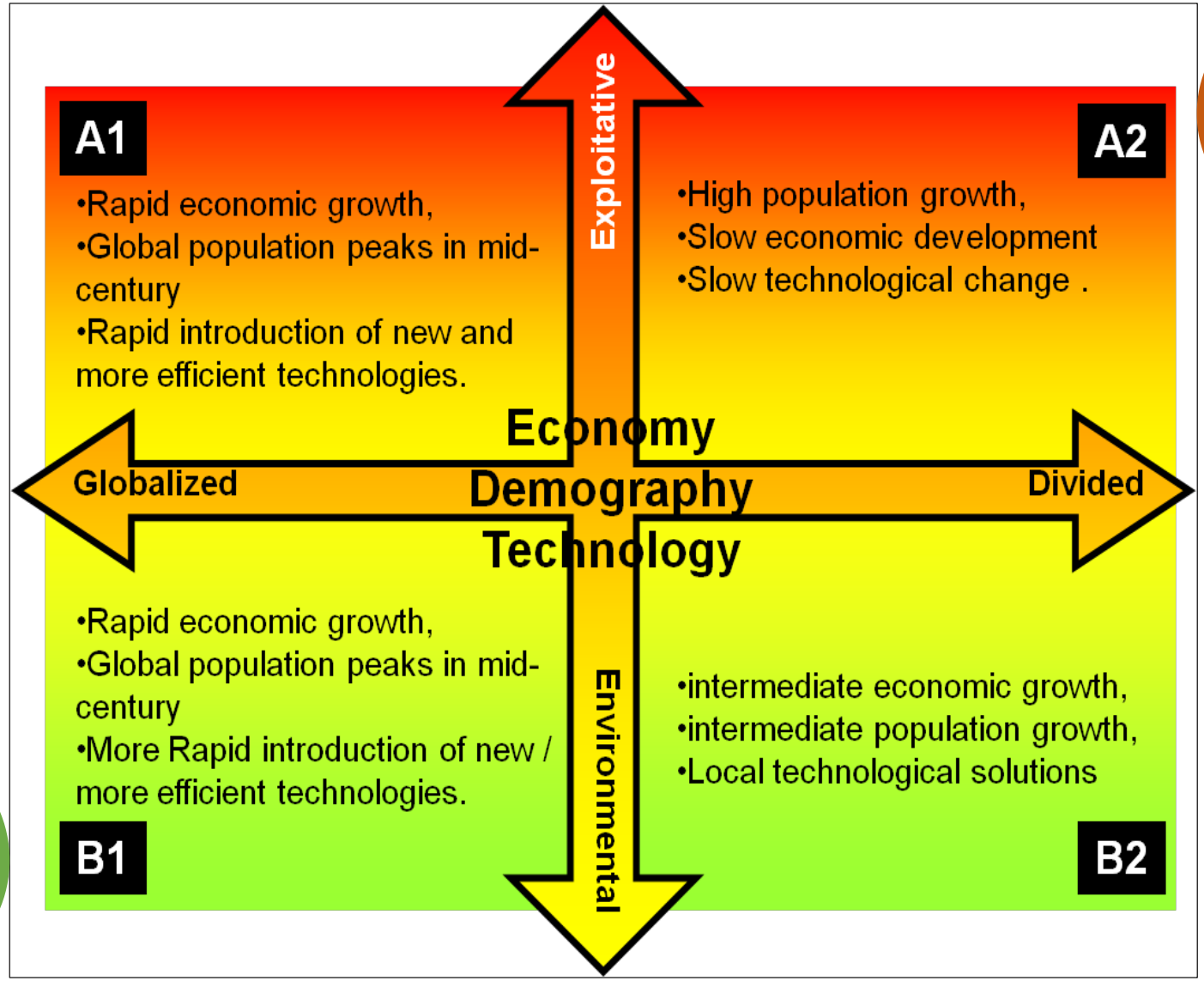
Spatial boundaries of the geographical regions used in the IPCC 5th Assessment Report (AR5) (2014)

http://www.ipcc-data.org/guidelines/pages/ar5_regions.html

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

4- Climate Scenarios

Special Report on Emission Scenarios (SRES) - SRES used in IPCC AR4 (2007)



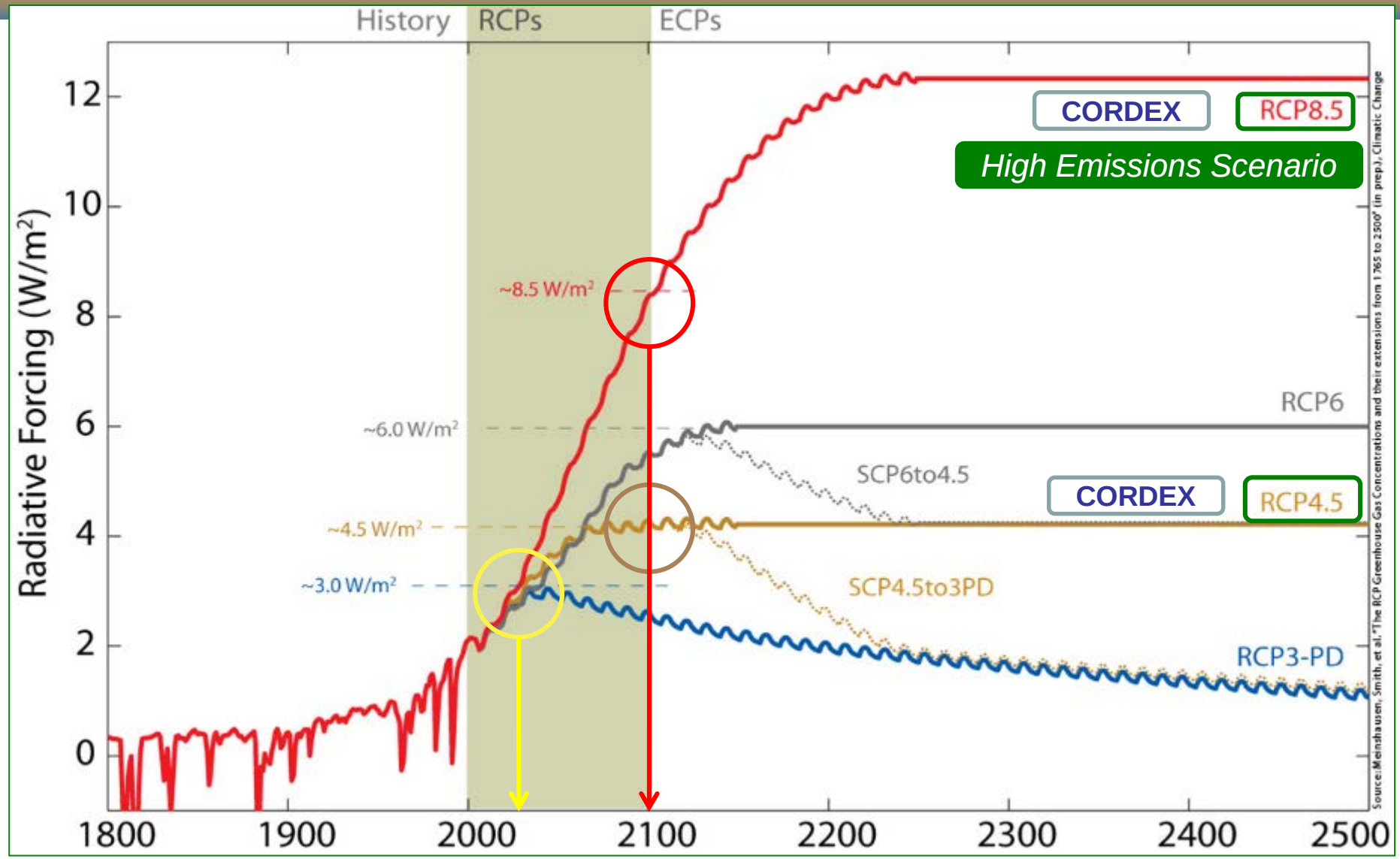
Average 3.4C Temp increase Scenario

Average 1.8 C Temp increase Scenario

Source: ESCWA, 2009

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

Representative Concentration Pathways (RCPs)
Scenarios used in IPCC AR5



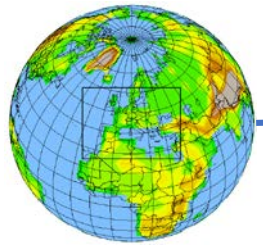
Graph adapted from: Meinshausen et al.,2010

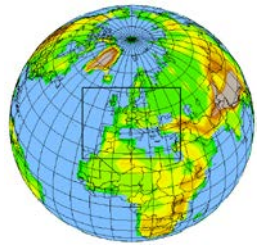
RICCAR
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

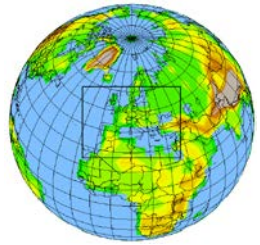
5- Regional Climate Modeling as Core Component

GCM ensembles used by IPCC

Different GCMs

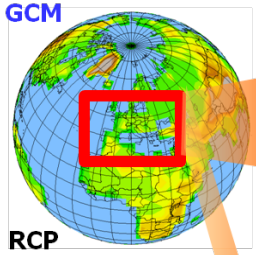






At least 3 projections for the same scenario to generate an Ensemble

General Circulation Model GCM)

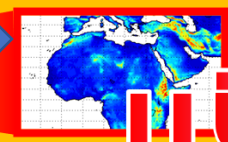


GCMs at 300 km x 300 km

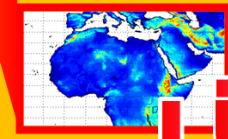
Ensemble Average used to reduce uncertainty at level of RCMs & RHMs

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

Regional Climate Model (RCM)

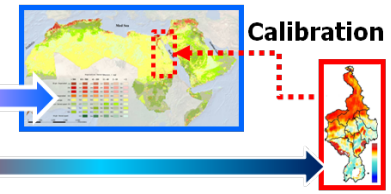


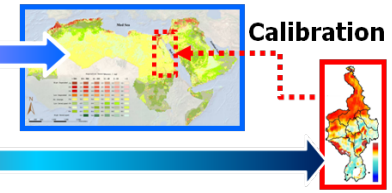
50km x 50km

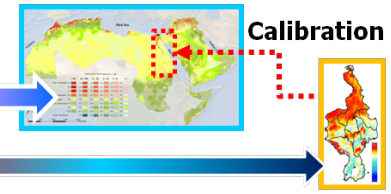


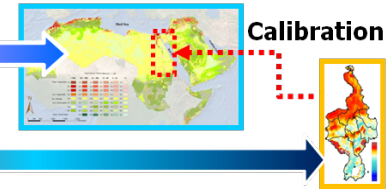
25km x 25km

Regional Hydrological Model (RHM)









Extreme Climate Events from RCM

RICCAR RCM Simulations Generated by SMHI

RCM Ensemble Matrix

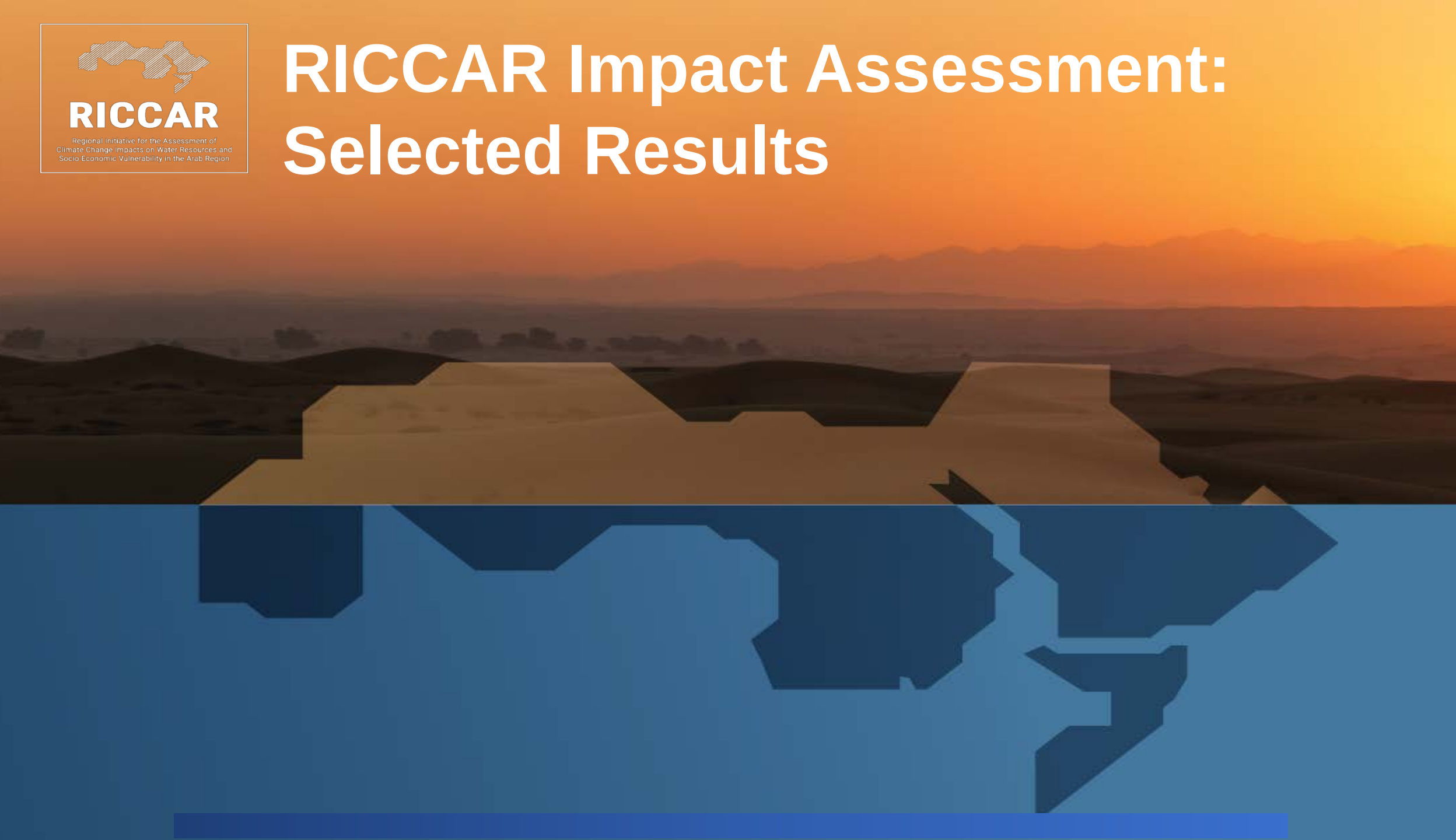
RCM	Driving GCM/ Reanalysis	Evaluation 1979-2010	Historical 1950-2005	RCP 2.6 2006-2100	RCP 4.5 2006-2100	RCP 8.5 2006-2100	RESOLUTION (km)
RCA4	ERA-INTERIM	X					50
RCA4	EC-Earth		X	X	X	X	50
RCA4	EC-Earth		X			X	25
RCA4	CNRM-CM5		X		X	X	50
RCA4	GFDL-ESM2M		X		X	X	50
RCA4	GFDL-ESM2M		X			X	25
HIRAM	GFDL-ESM2M		X				25
REMO	MPI-ESM-LR		X				50

For RICCAR Report (2017), MENA/Arab Domain presented for
Reference period; Mid-Century; End-Century,
but data is available for customized domains & for daily/monthly/customized time periods via
RICCAR Regional Knowlege Hub

RICCAR

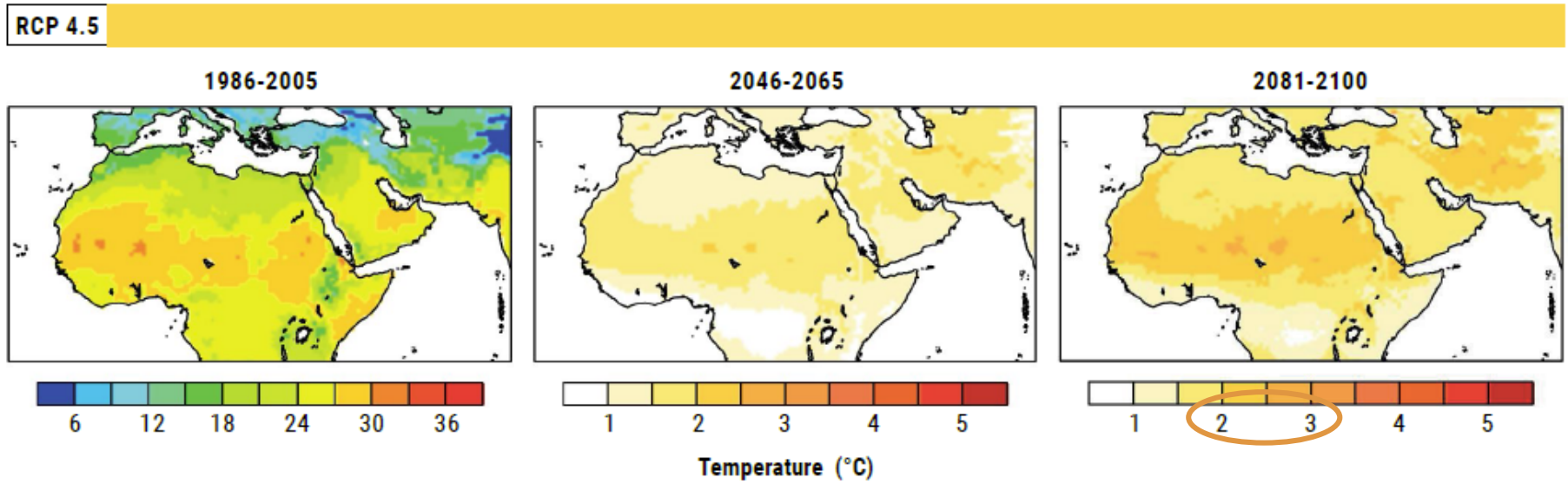
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio Economic Vulnerability in the Arab Region

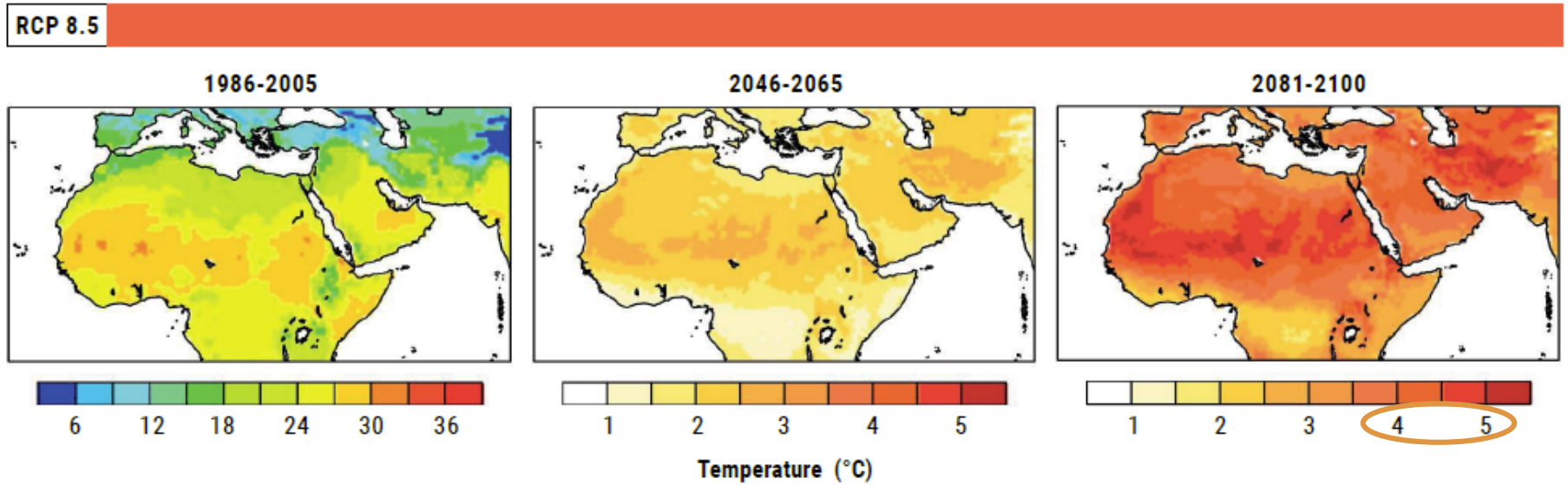
RICCAR Impact Assessment: Selected Results



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

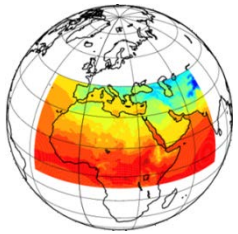
Temperature in the region is increasing and is expected to continue to increase until the end of the century.

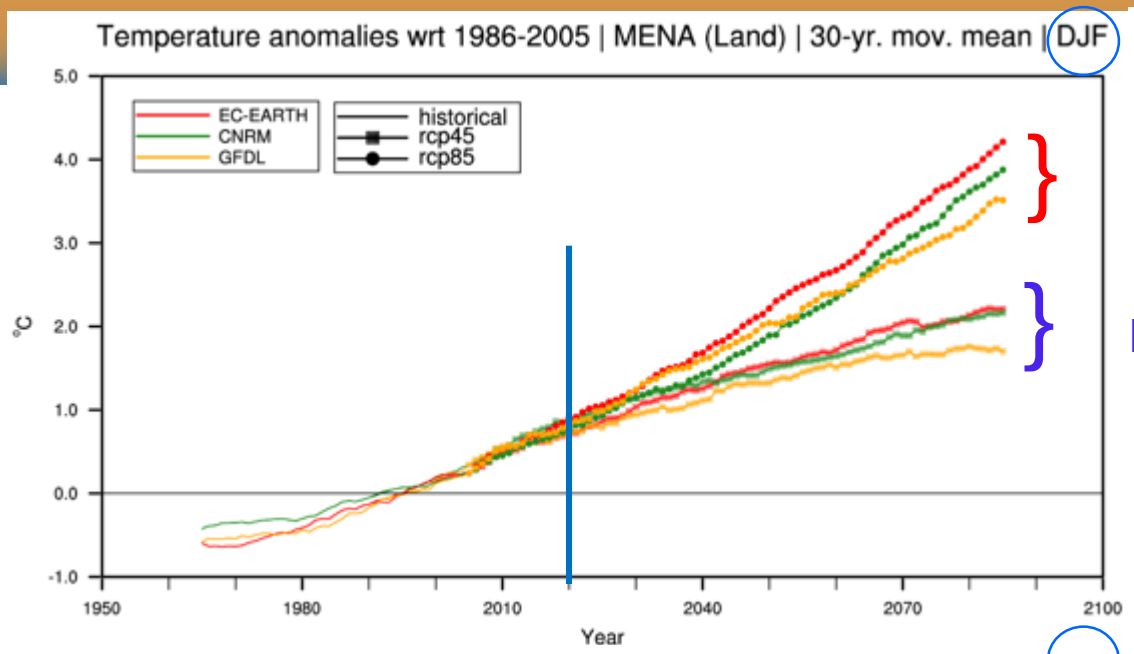




Temperature Ensembles through a Seasonal Lens

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

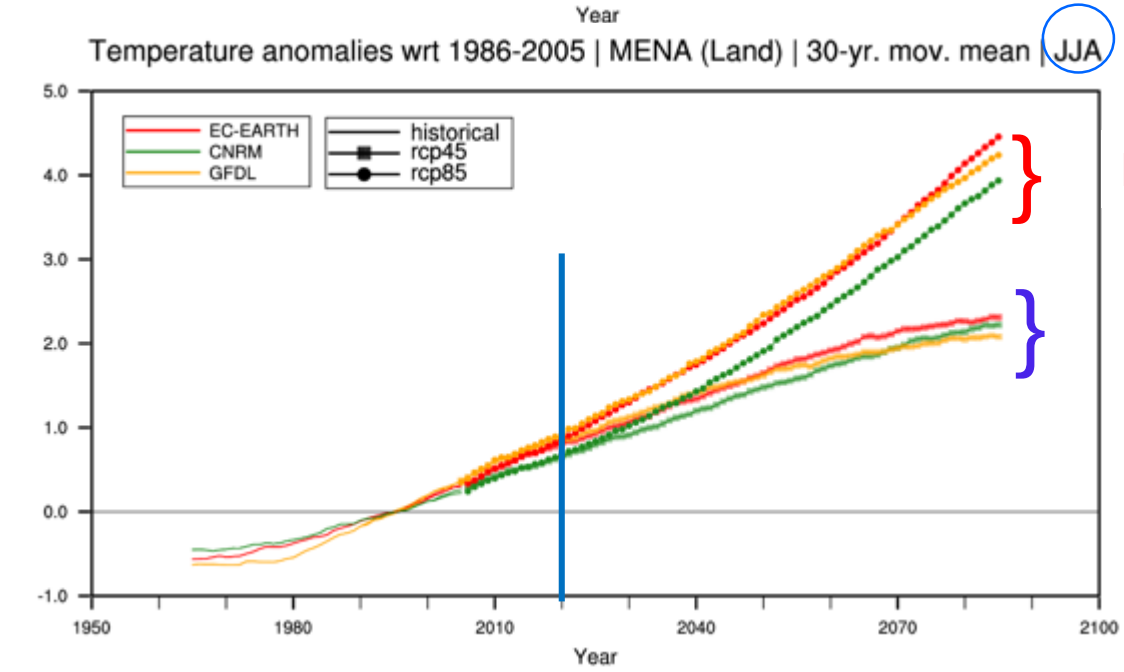




Winter

RCP **8.5 Ensemble**

RCP **4.5 Ensemble**



Summer

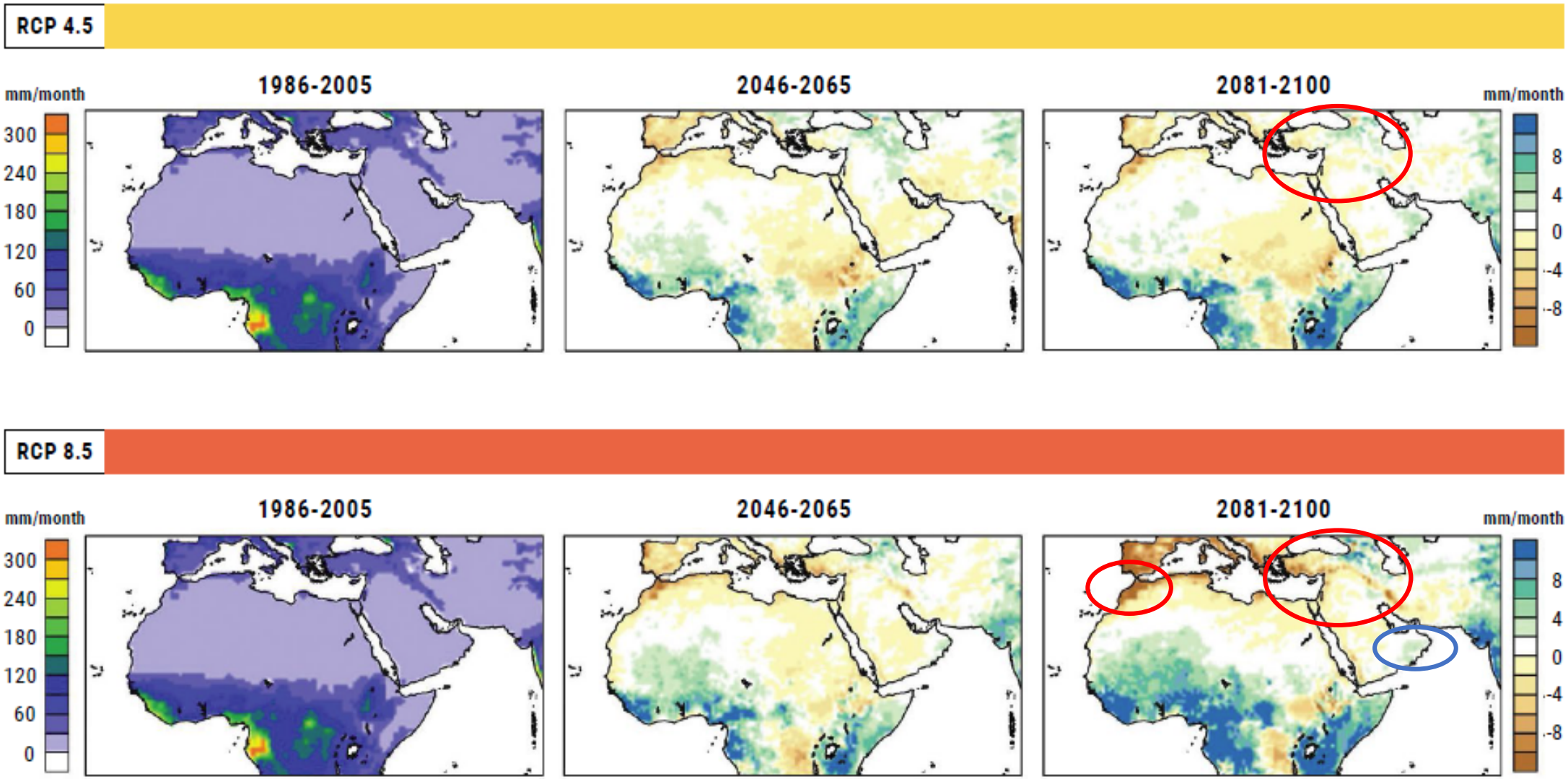
RCP **8.5 Ensemble**

RCP **4.5 Ensemble**

Depends on which future *(which climate scenario)* one plans against

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

Precipitation trends are largely decreasing across the region until the end of the century, though limited areas expected to exhibit an increase in the intensity & volume of precipitation.



From RICCAR RCM ensemble outputs

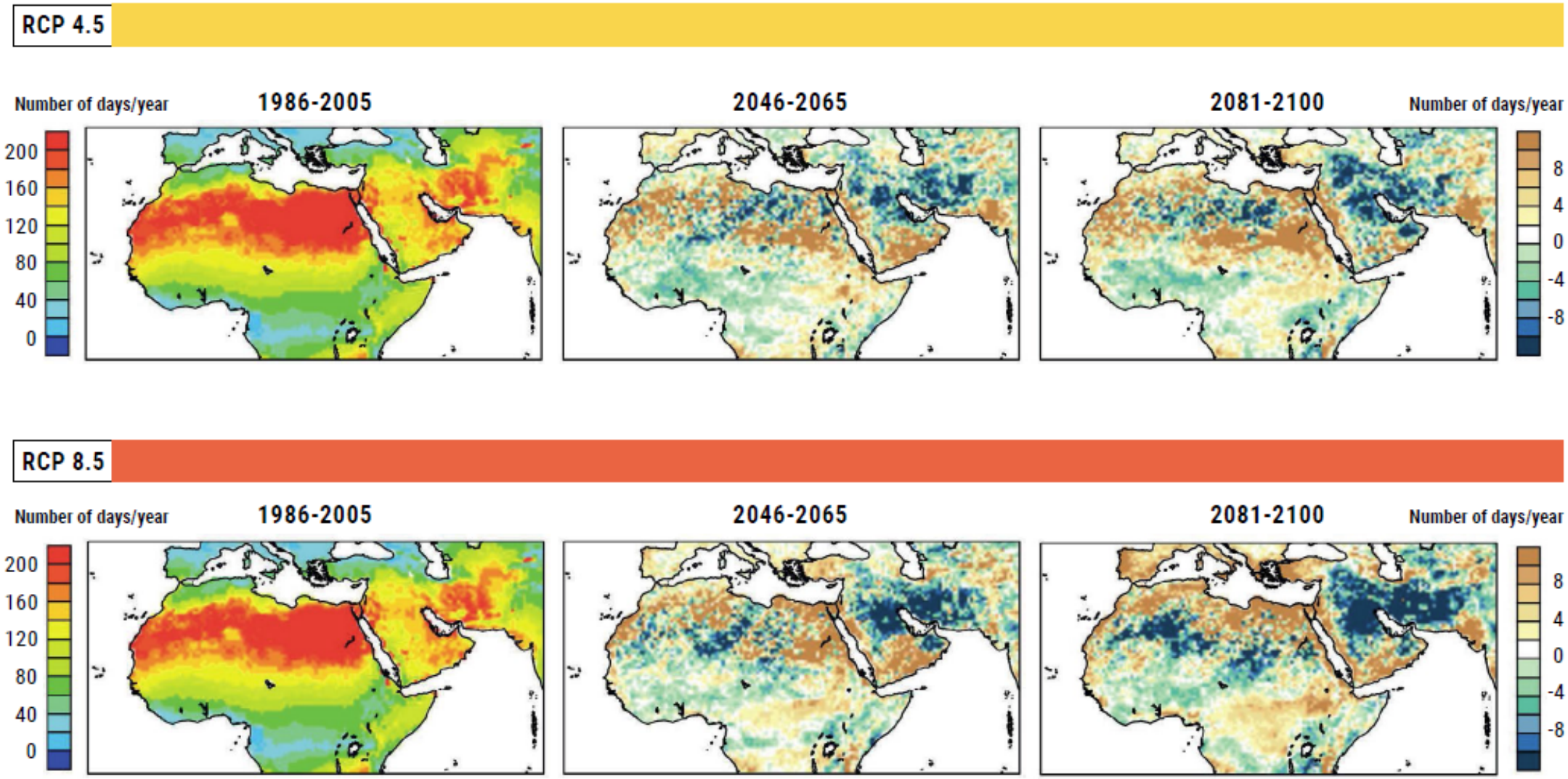
RICCAR
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

Extreme events indices

Extreme temperature indices		Extreme precipitation indices	
Index	**Full name**	**Index**	**Full name**
SU	Number of summer days	CDD	Maximum length of dry spell
SU35	Number of hot days	CWD	Maximum length of wet spell
SU40	Number of very hot days	R10	Annual count of 10 mm precipitation days
TR	Number of tropical nights	R20	Annual count of 20 mm precipitation days
		SDII	Simple precipitation intensity index

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

Maximum length of dry spell (CDD)

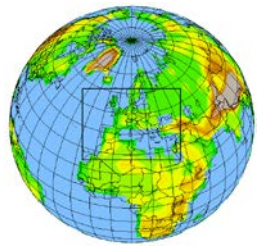


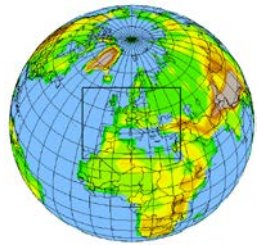
RICCAR
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

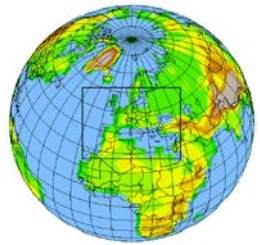
Regional Climate Modeling to Hydrological Modeling

Bias Correction of RCM Projections needed before data can be used for water & agricultural modeling

Different GCMs



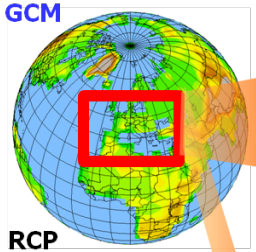




Same RCP

General Circulation Model GCM)

GCM



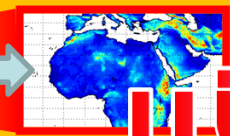
RCP

300 km x 300 km

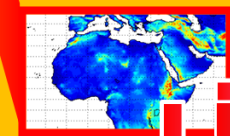
Ensembles *used to reduce uncertainty at level of RCMs & RHMs*

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

Regional Climate Model (RCM)

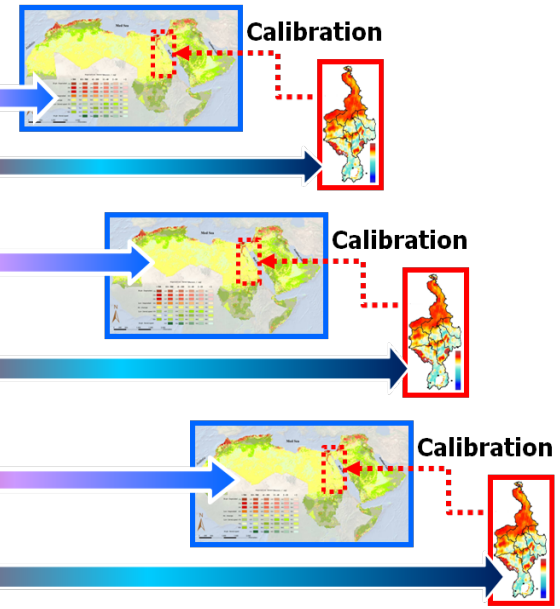


50km x 50km



25km x 25km

Regional Hydrological Model (RHM)



VIC
HYPE
HEC-HMS
Models Used

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

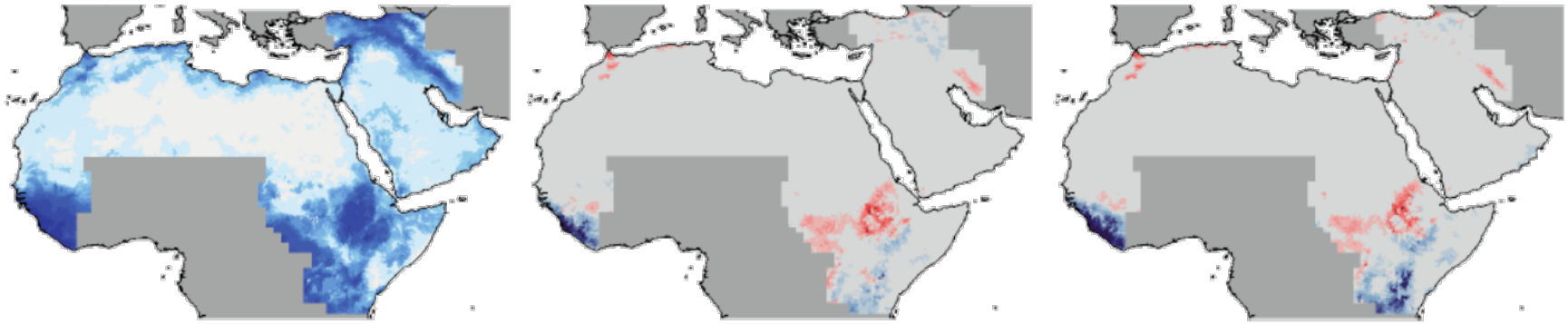
Mean change in Annual Runoff

2 Models; 2 RCPs

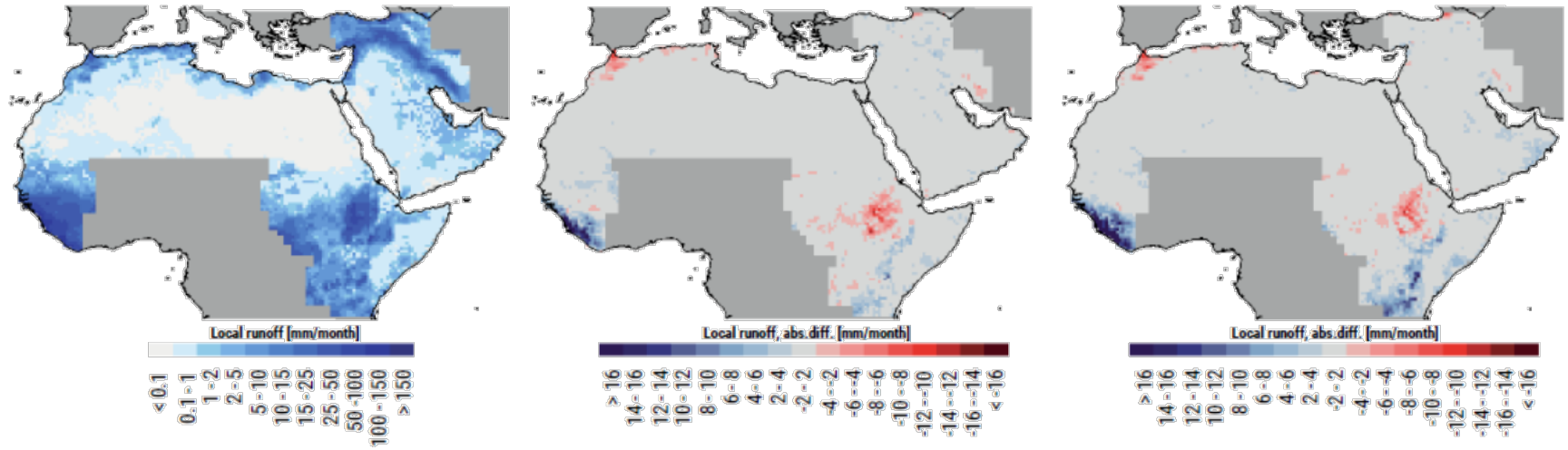
RCP 4.5

HYPE MODEL

1986-2005 | 2046-2065 | 2081-2100



VIC MODEL



Comparison between 2 hydrological models based on SMHI modeling outputs:
Hydrological Predictions for the Environment (HYPE) and Variable Infiltration Capacity (VIC)

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

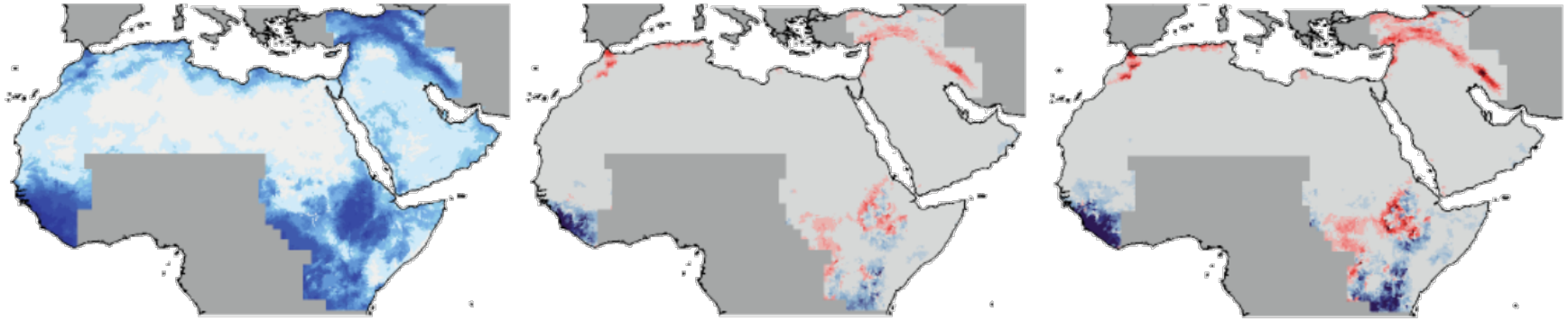
Mean change in Annual Runoff

RCP 8.5

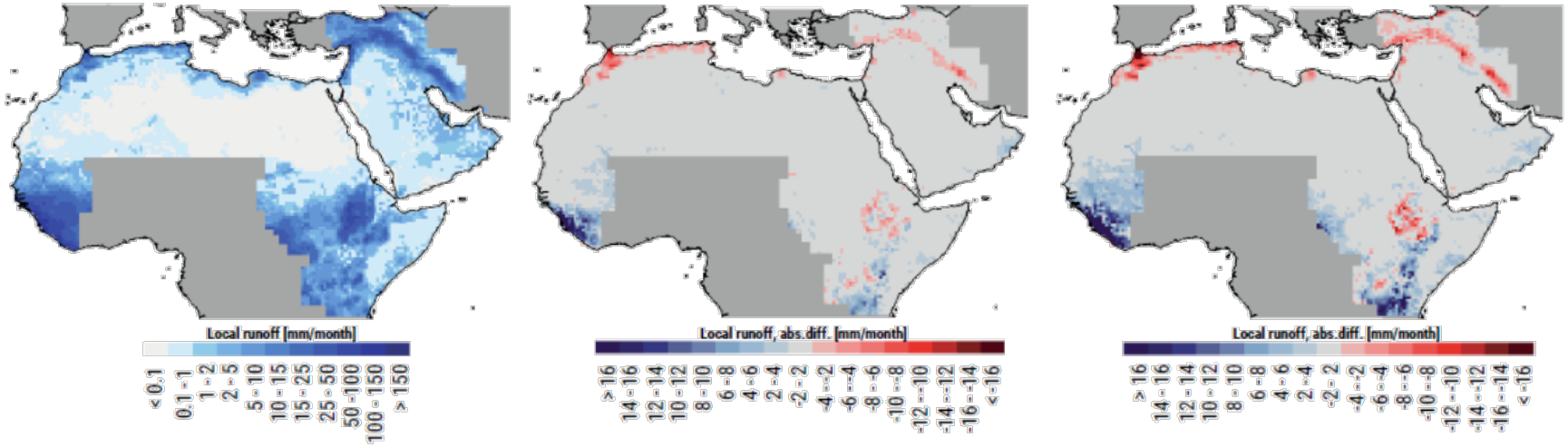
2 Models; 2 RCPs

HYPE MODEL

1986-2005 | 2046-2065 | 2081-2100



VIC MODEL



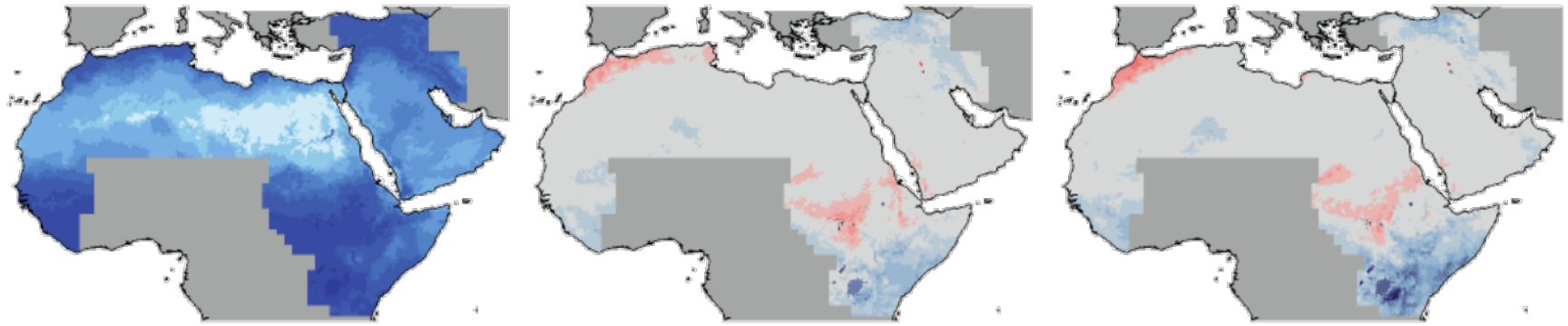
RICCAR
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

Mean change in Annual Evapotranspiration

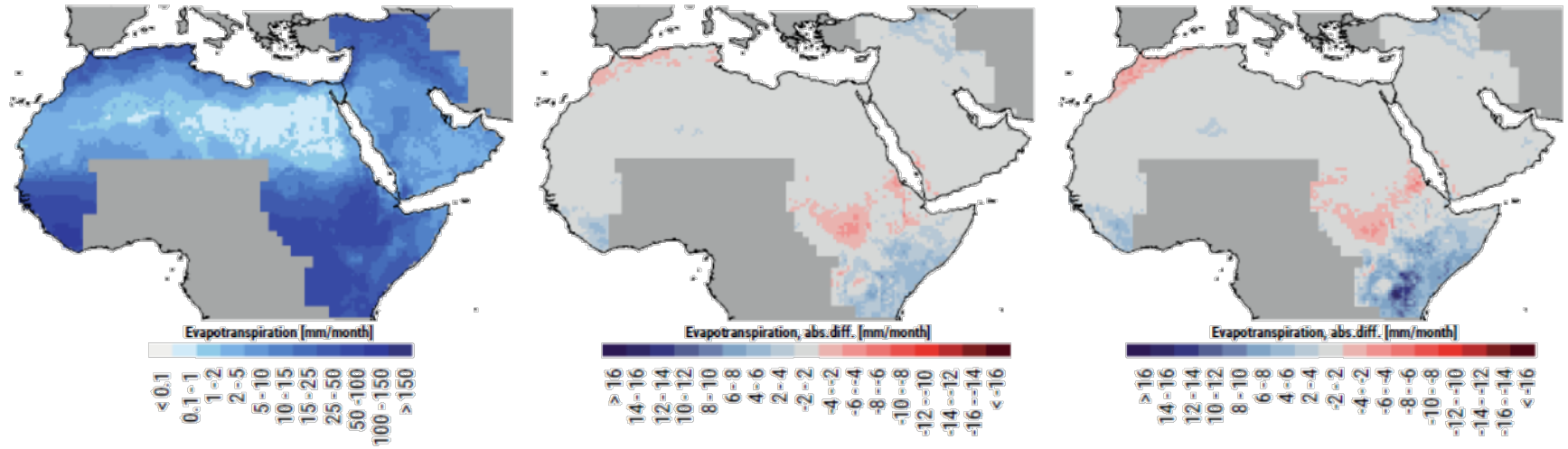
RCP 4.5

HYPE MODEL

1986-2005 | 2046-2065 | 2081-2100



VIC MODEL



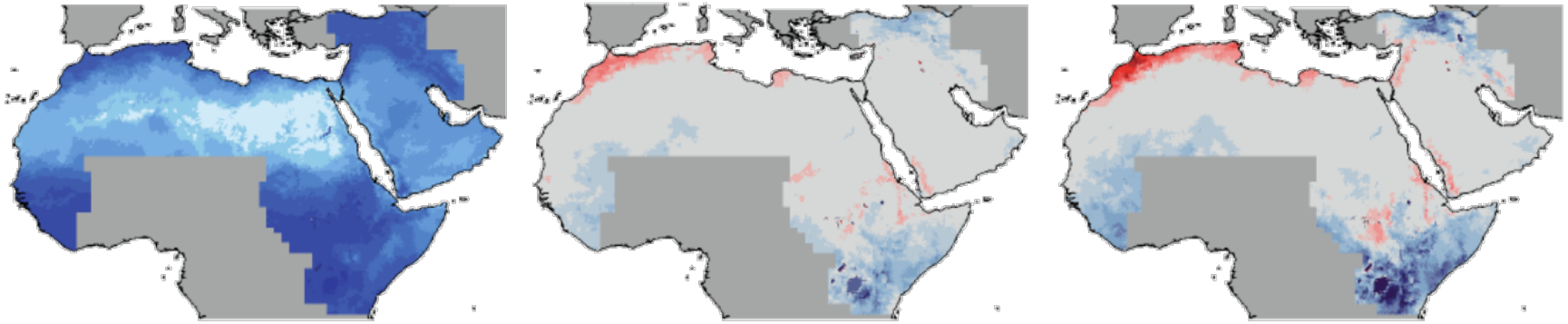
RICCAR
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

Mean change in Annual Evapotranspiration

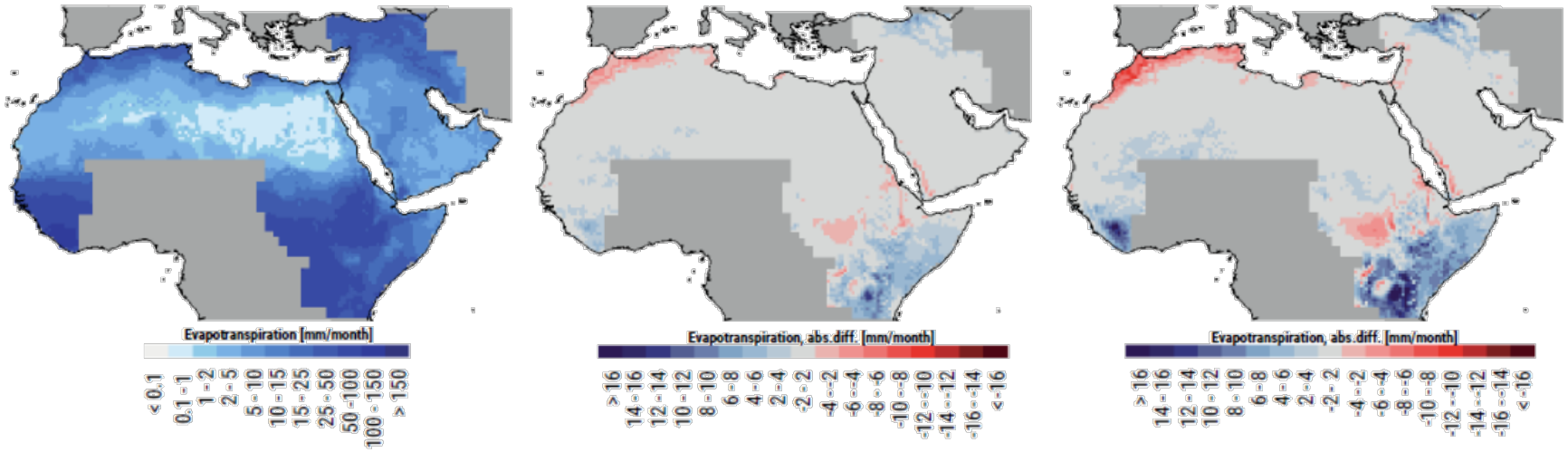
RCP 8.5

HYPE MODEL

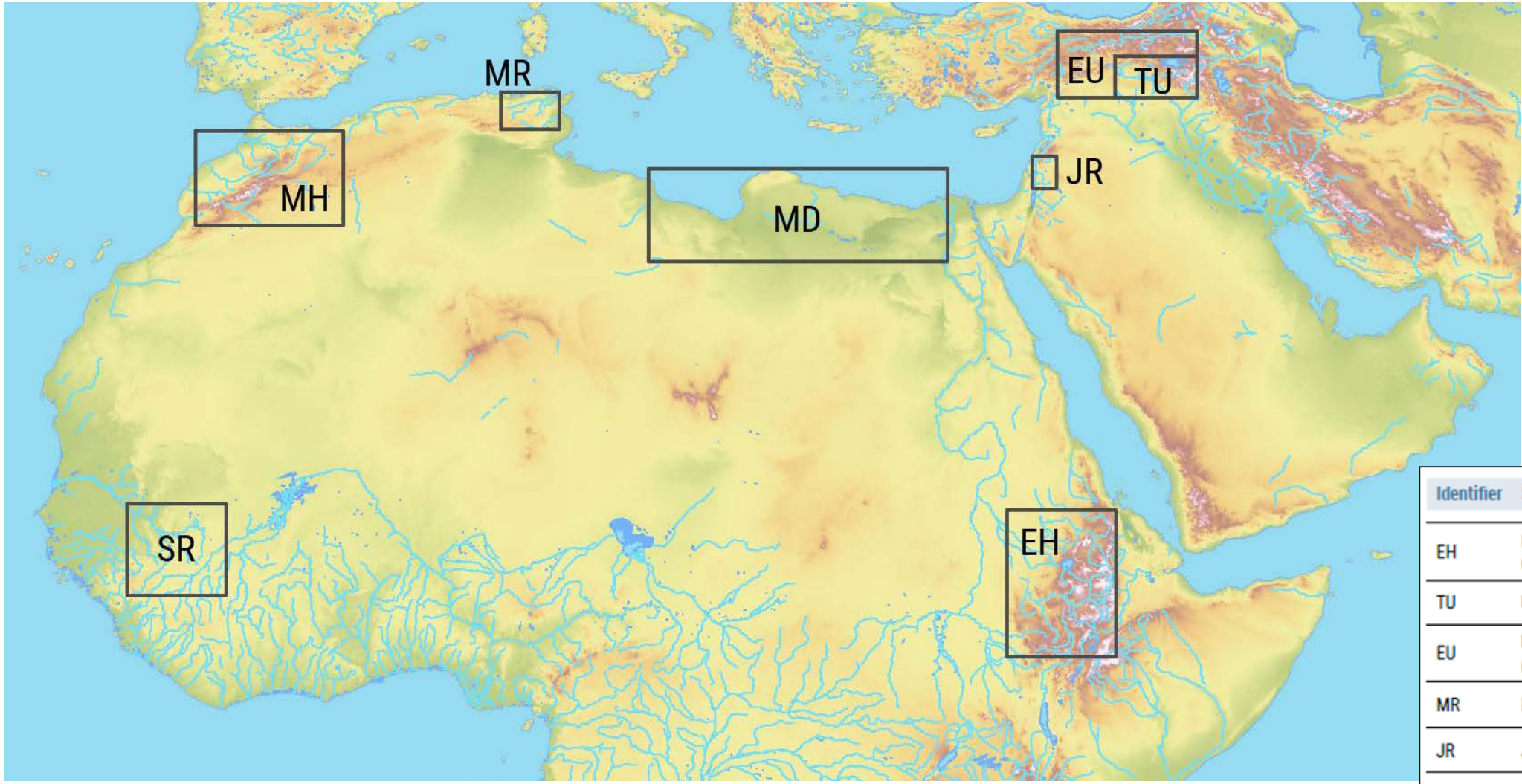
1986-2005 | 2046-2065 | 2081-2100



VIC MODEL



Locations of subdomains identified for hydrological analysis



Most details in the RICCAR Main Report's Technical Annex and RKH

Identifier	Subdomain Name
EH	Ethiopian Highlands (Blue Nile Headwaters)
TU	Upper Tigris (Tigris River Headwaters)
EU	Upper Euphrates (Euphrates River Headwaters)
MR	Medjerda River
JR	Jordan River
SR	Senegal River Headwaters

Climate Impacts on Transboundary Water Resources: Euphrates River

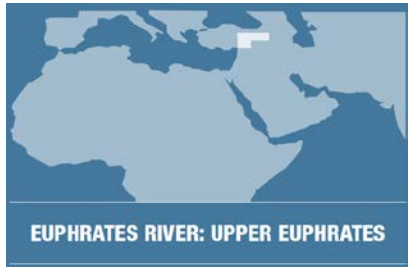


FIGURE 140
Mean change in annual temperature over time for ensemble of three RCP 4.5 and RCP 8.5 projections

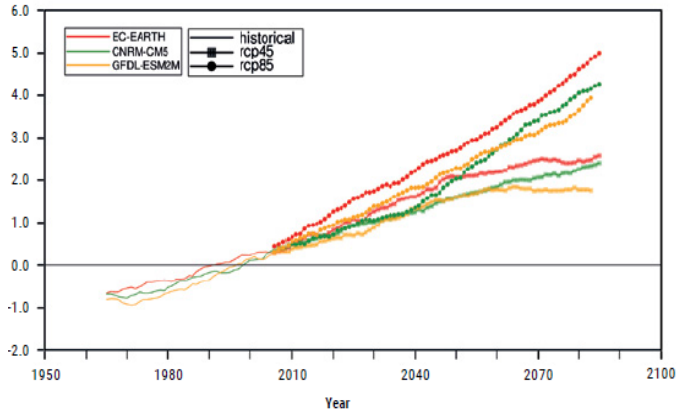
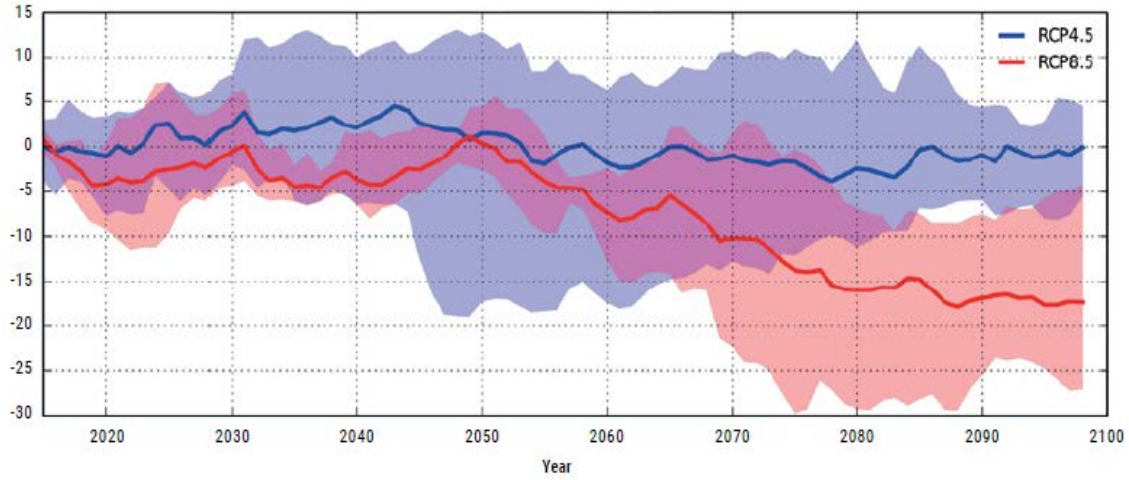
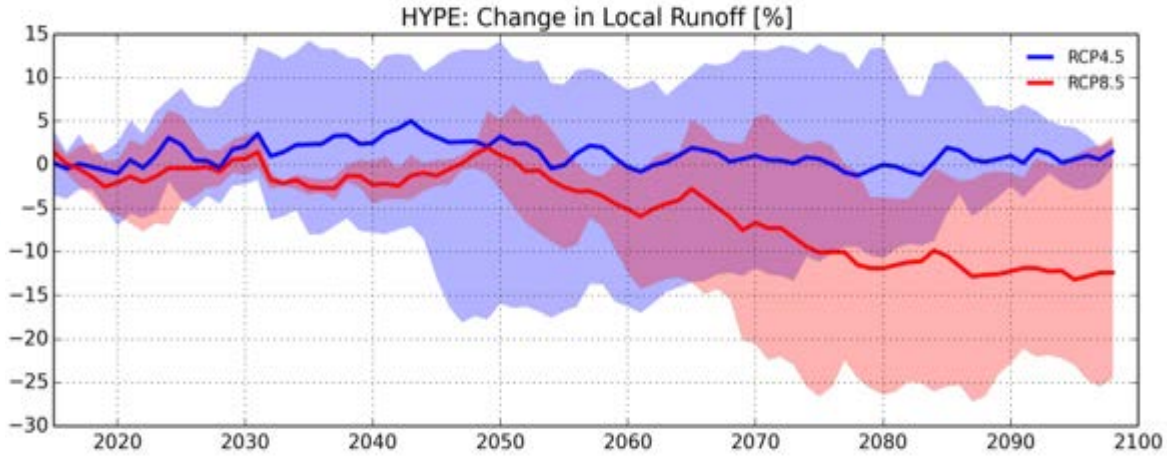


FIGURE 160
Mean change in annual discharge over time for ensemble of three RCP 4.5 and RCP 8.5 projections using HYPE model





Upper Euphrates River

(1986-2005) : (2081-2100)

Variable	RCP4.5	RCP8.5
Temp.	2.3˚C	4.8˚C
Precip.	3%	0%
Runoff	-2%	-12%

Climate Impacts on Transboundary Water Resources: Upper Tigris

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

Upper Tigris River:
Seasonal Temperature
(RCM output)

FIGURE 111
Mean change in seasonal temperature (April-September) over time for ensemble of three RCP 4.5 and RCP 8.5 projections

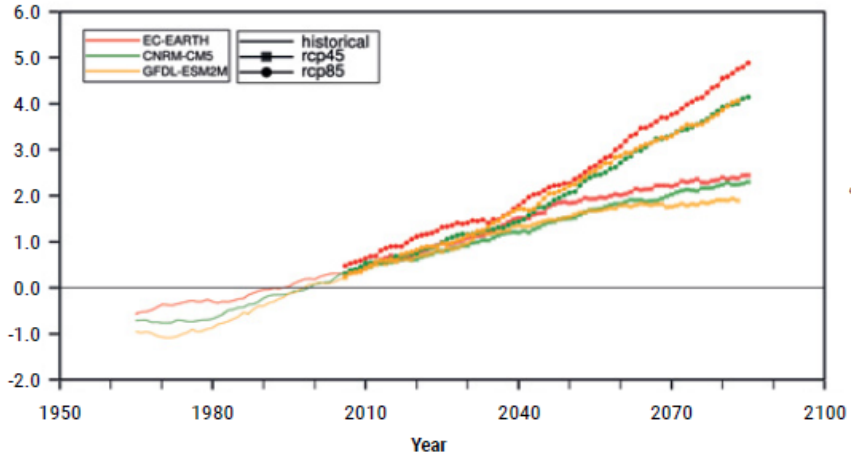
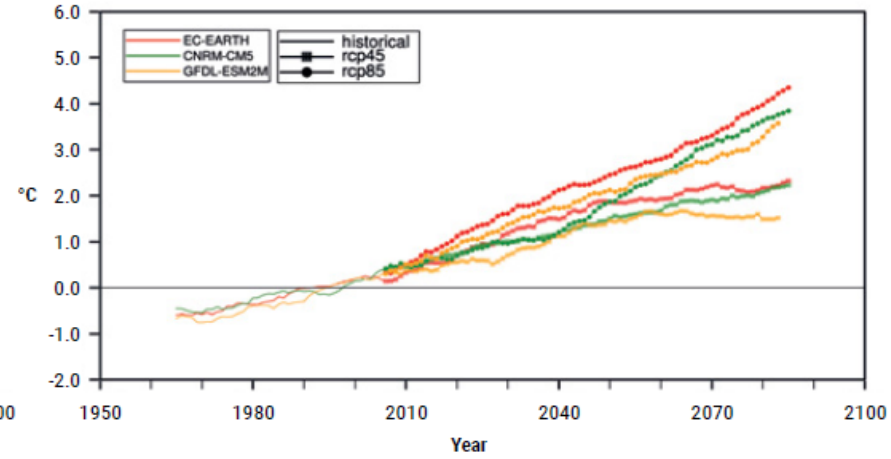


FIGURE 112
Mean change in seasonal temperature (October-March) over time for ensemble of three RCP 4.5 and RCP 8.5 projections



Upper Tigris River:
Extreme Climate Indicators:
Consecutive Dry Days
Consecutive Wet Days
(RCM output)

FIGURE 123
Mean change in CDD over time for ensemble of three RCP 4.5 and RCP 8.5 projections

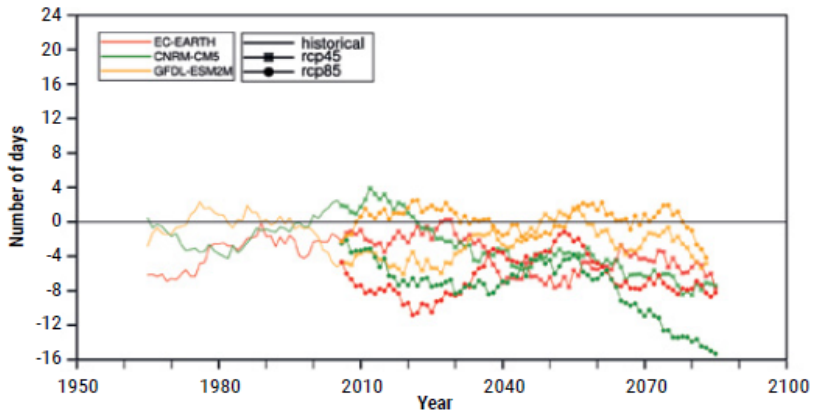
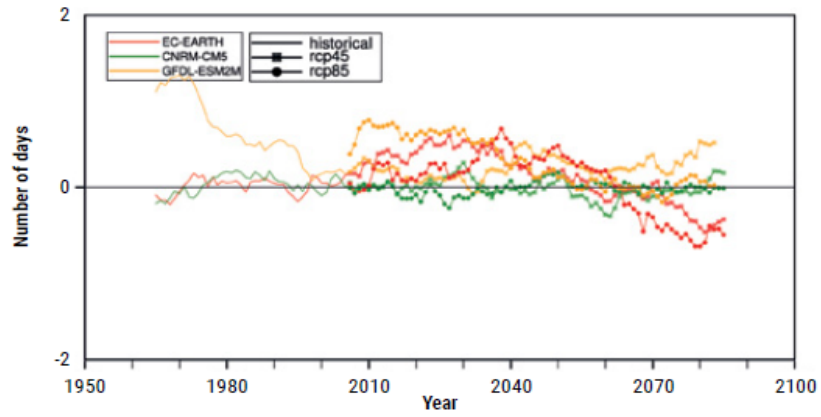


FIGURE 124
Mean change in CWD over time for ensemble of three RCP 4.5 and RCP 8.5 projections



Climate Impacts on Transboundary Water Resources: Upper Tigris

Upper Tigris River: Monthly precipitation (mm/day) for mid-century and end-century (RHM output)

FIGURE 118
Mean change in monthly precipitation for mid-century for ensemble of three RCP 4.5 and RCP 8.5 projections compared to the reference period

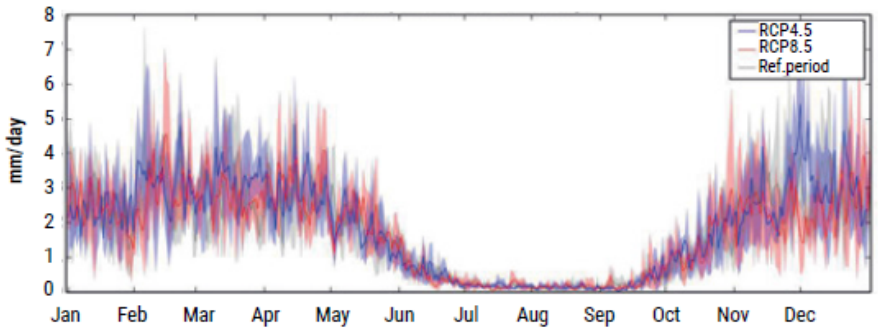
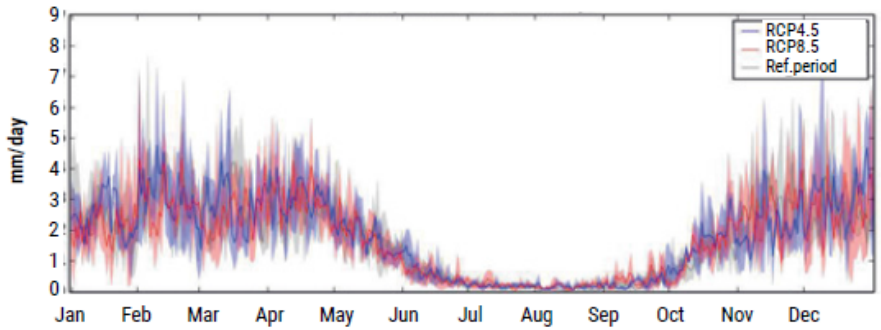
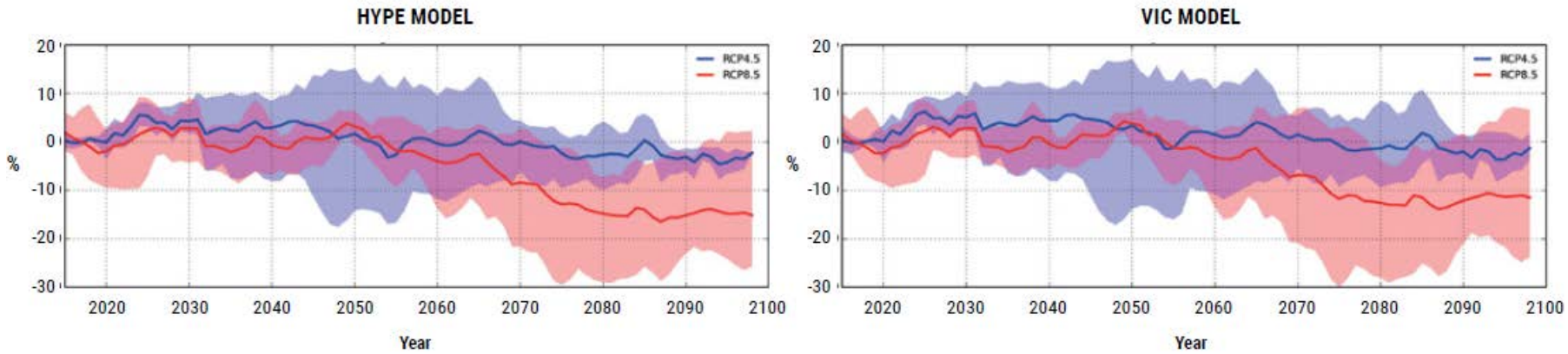


FIGURE 119
Mean change in monthly precipitation for end-century for ensemble of three RCP 4.5 and RCP 8.5 projections compared to the reference period



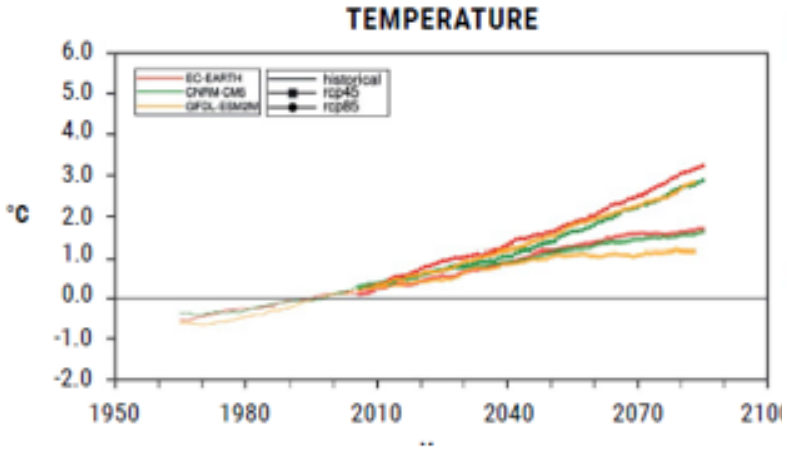
Upper Tigris River: Runoff (RHM output)

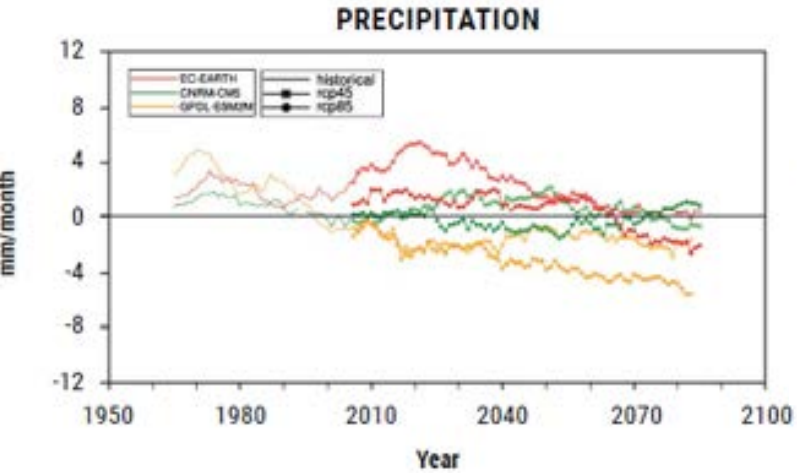
FIGURE 127
Mean change in annual runoff over time for ensemble of three RCP 4.5 and RCP 8.5 projections using two hydrological models



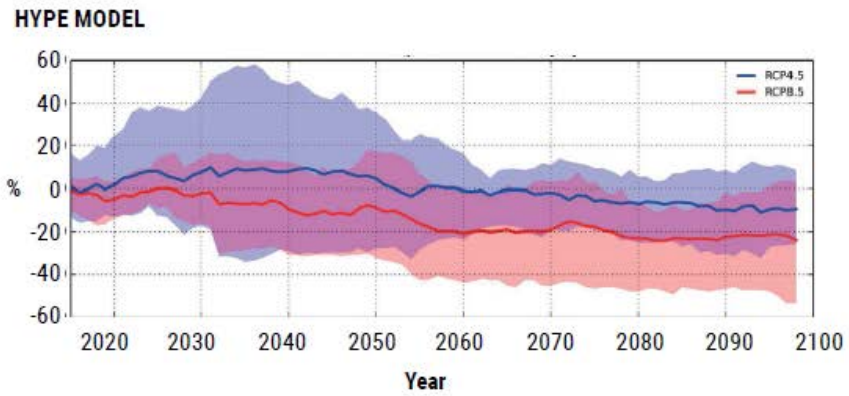
Climate Impacts on Transboundary Water Resources: Jordan River

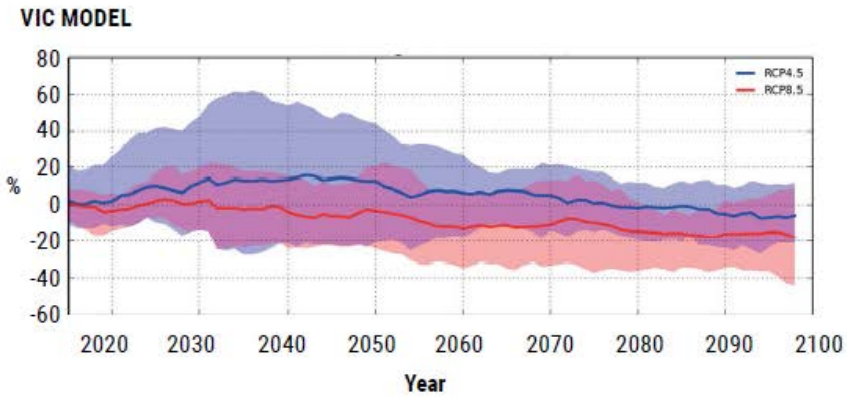
for a three-member ensemble of RCP 4.5 projections and three-member ensemble of RCP 8.5 projections for the Jordan River



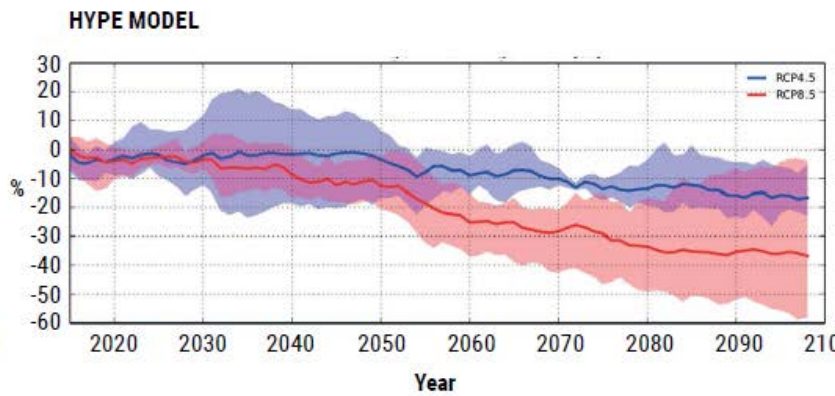


RUNOFF





DISCHARGE

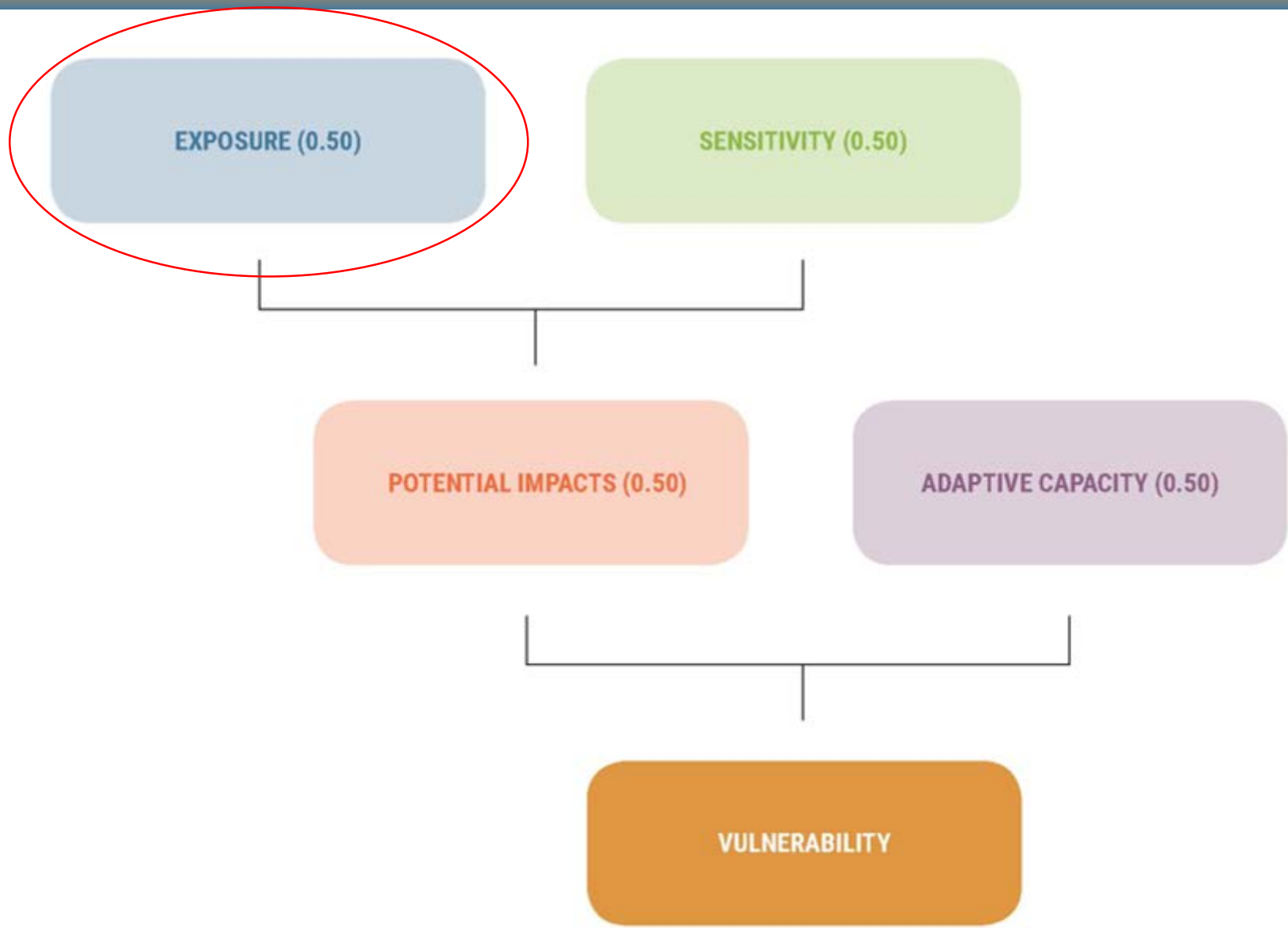


RICCAR

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

Integrated Vulnerability Assessment: Selected Results

RICCAR Vulnerability Assessment Components



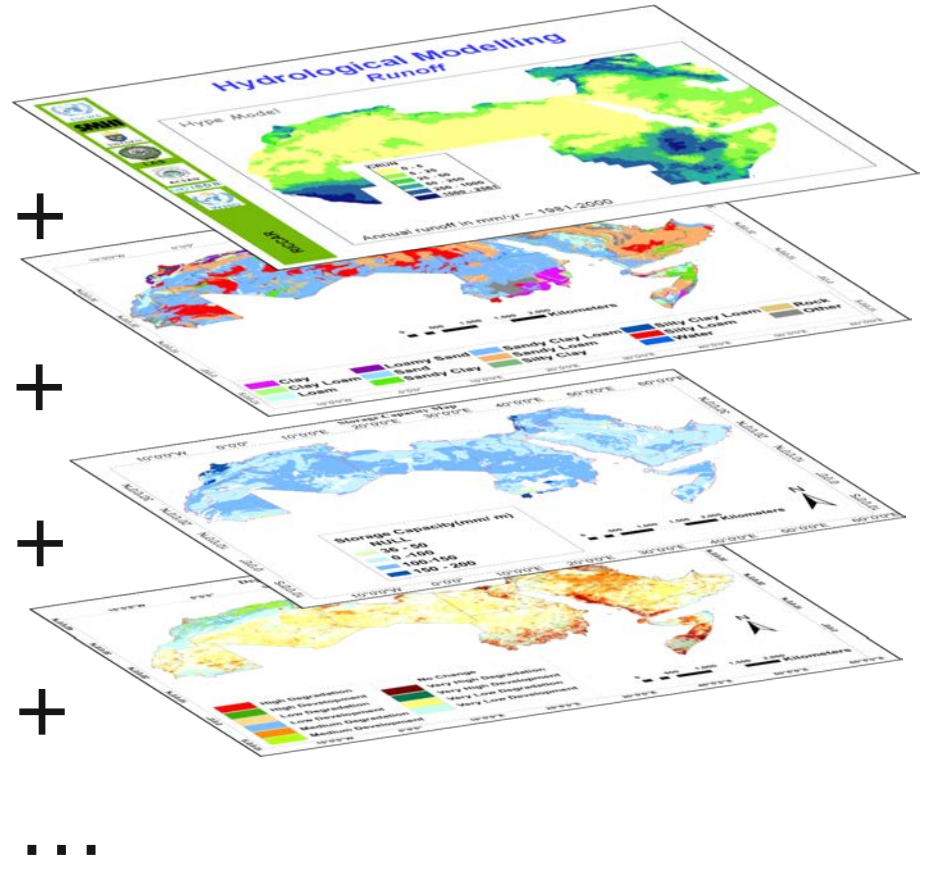
RICCAR, based on IPCC AR4, 2007

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

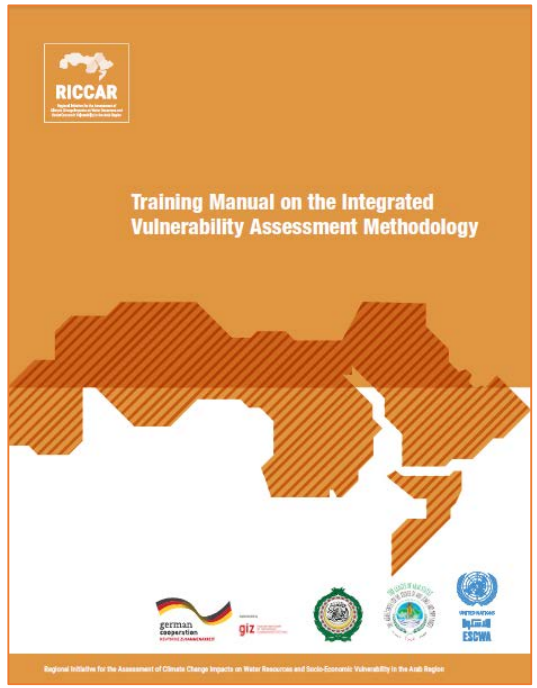
- Overall Vulnerability
  - Aggregates vulnerability of each sector to generate an Overall VA
  - Supports identification of VA Hotspots



Slide graphics: adelphi
Source of maps: ACSAD, SMHI

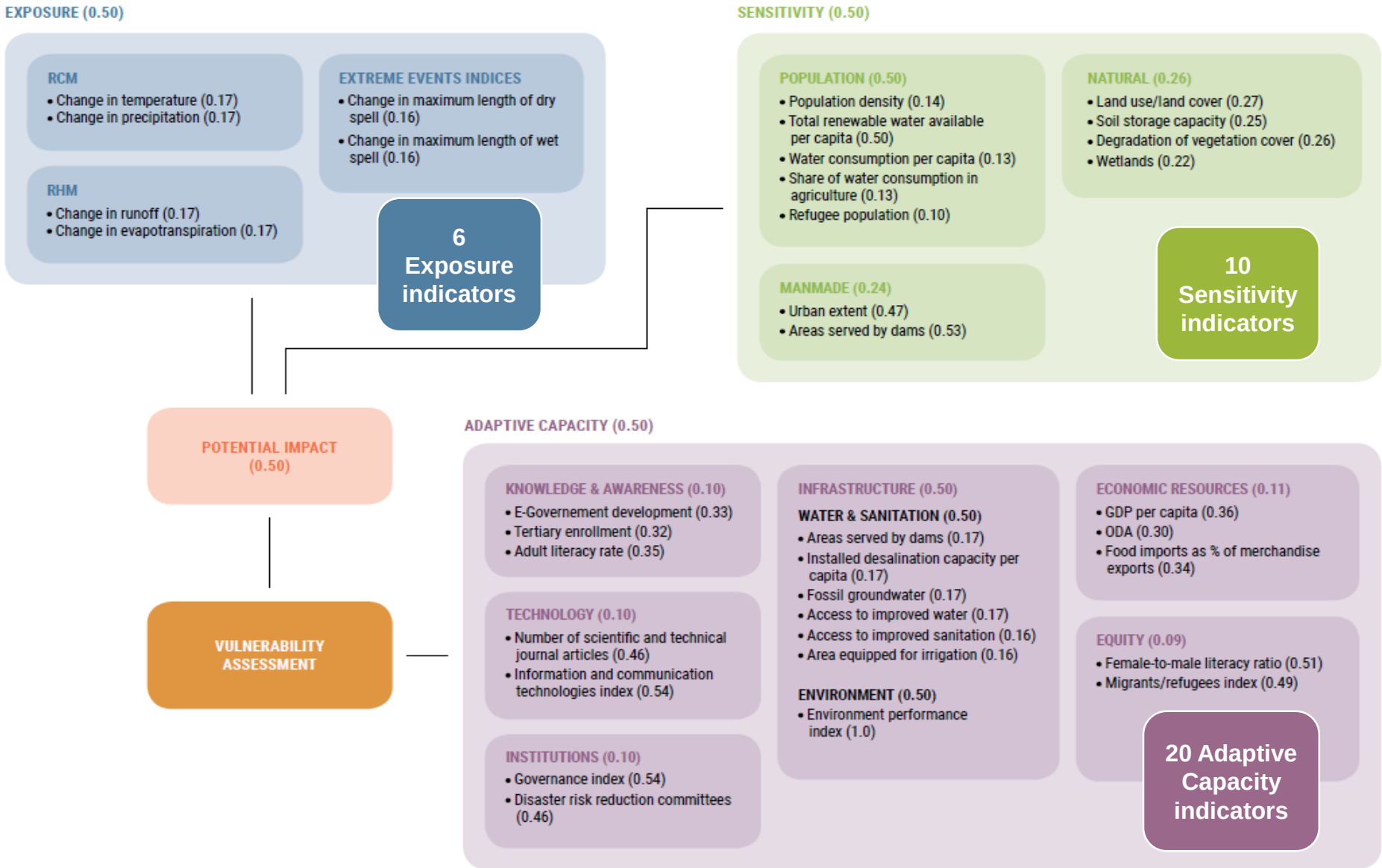
Vulnerability Assessment

SECTORS	SUBSECTORS
Water	Water availability
Biodiversity and Ecosystems	Area covered by forests Area covered by wetlands
Agriculture	Water available for crops Water available for livestock
Infrastructure and Human Settlements	Inland flooding area
People	Water available for drinking Health conditions due to heat stress Employment rate for the agricultural sector



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

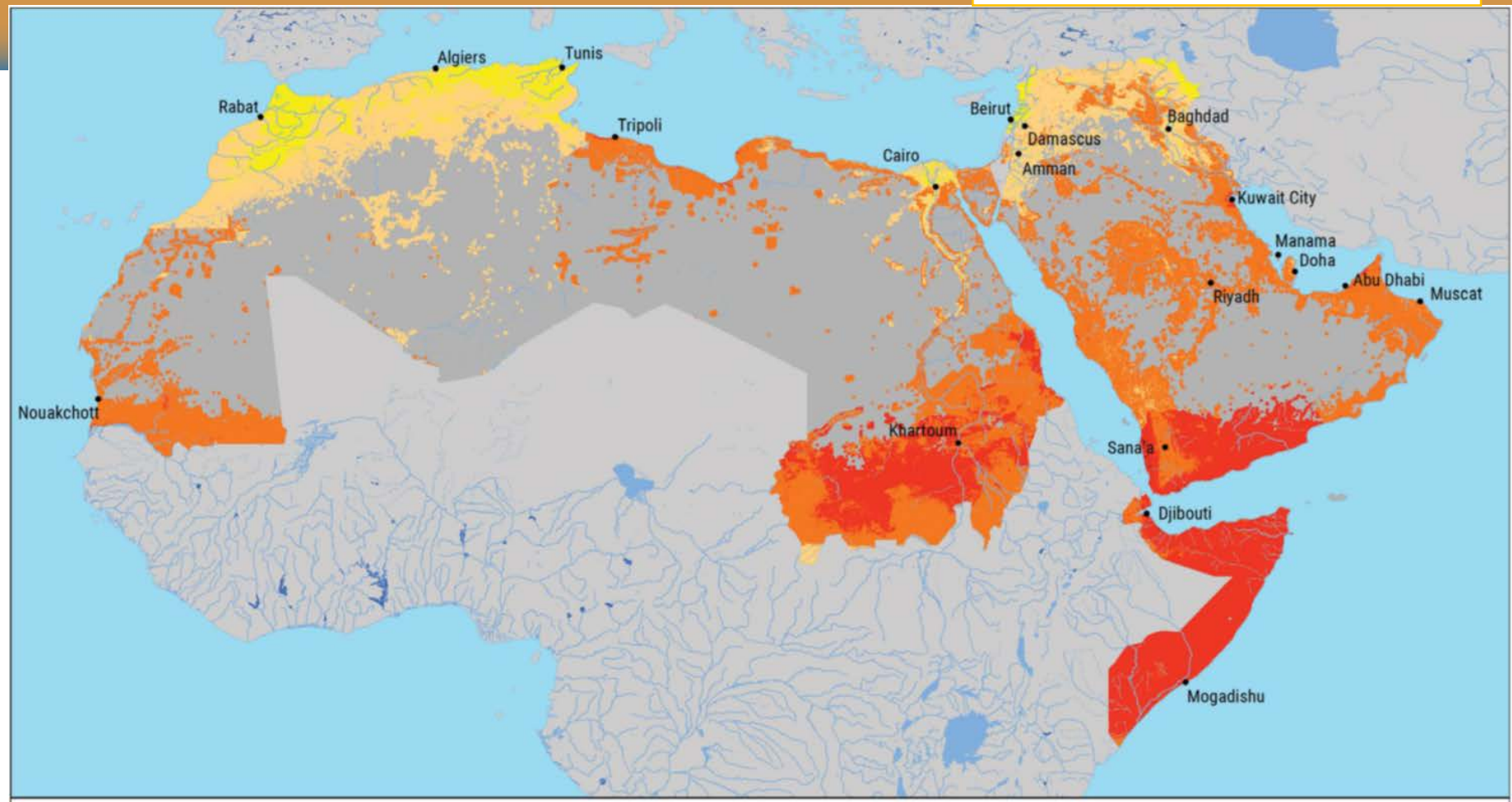
Vulnerability Assessment Impact Chain
Water Availability



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

WATER AVAILABILITY VULNERABILITY

Reference Period
(1986-2005)



WATER: WATER AVAILABILITY

VULNERABILITY: REFERENCE PERIOD

Legend

- Lakes
- Reservoirs
- Rivers
- Intermittent rivers
- Major cities
- Area not relevant to subsector

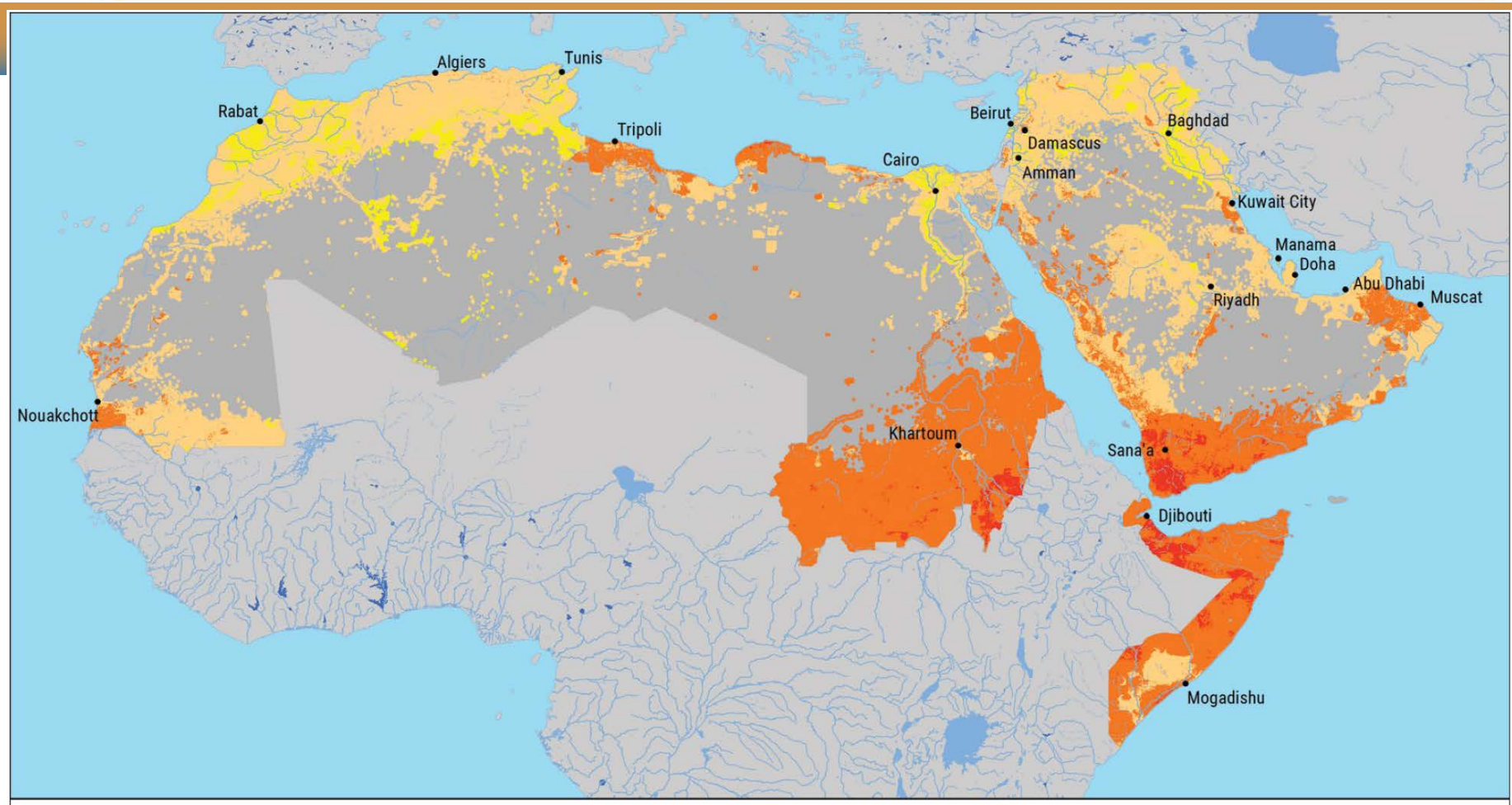
Low Vulnerability — High Vulnerability

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

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

WATER AVAILABILITY VULNERABILITY

Mid-Century RCP 4.5



WATER: WATER AVAILABILITY

VULNERABILITY: RCP4.5 MID-CENTURY (2046-2065)

Legend

- Lakes
- Reservoirs
- Rivers
- Intermittent rivers
- Major cities
- Area not relevant to subsector

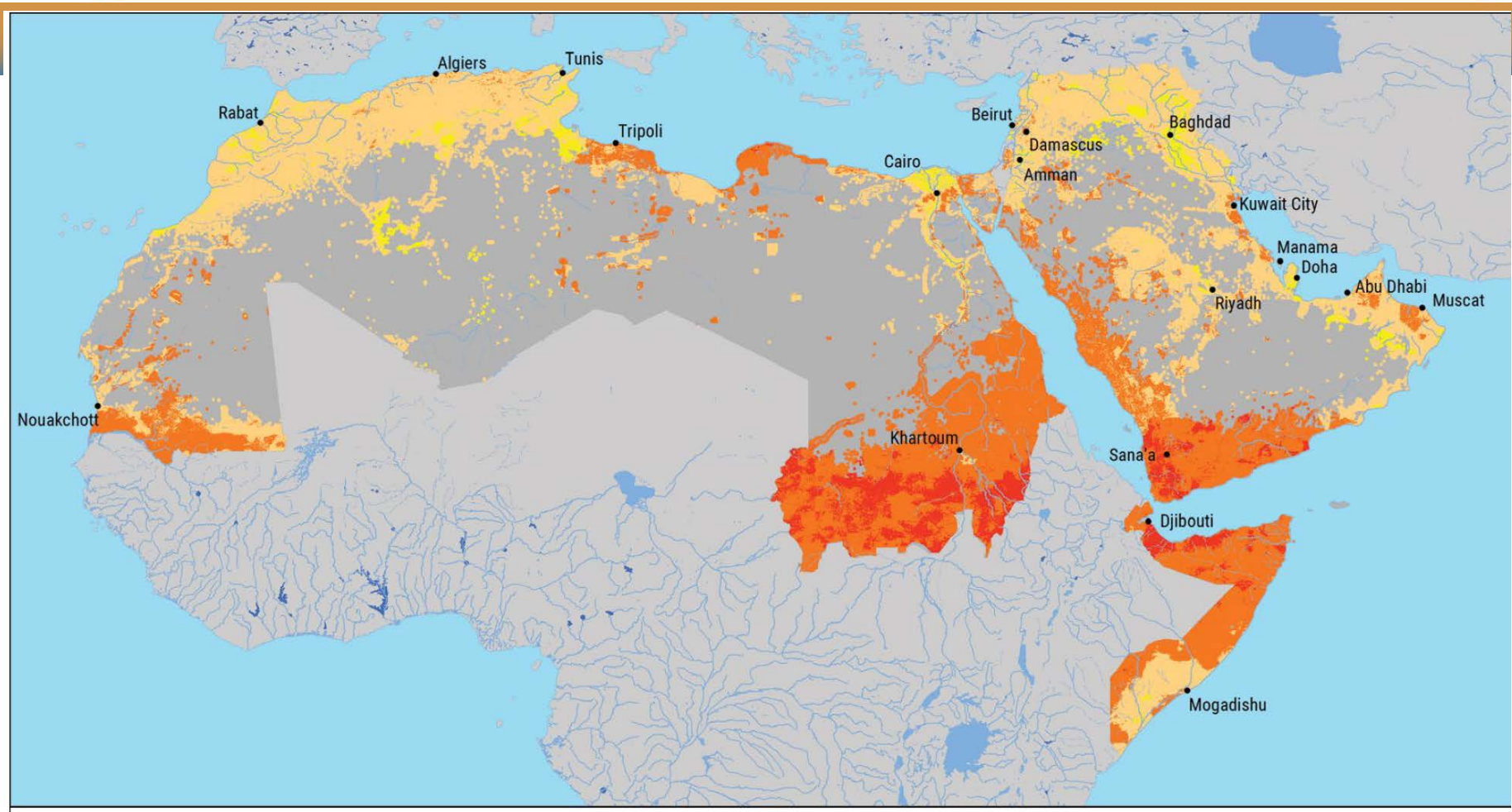
Low Vulnerability — High Vulnerability

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

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

WATER AVAILABILITY VULNERABILITY

End-Century RCP 4.5



WATER: WATER AVAILABILITY

VULNERABILITY: RCP4.5 END-CENTURY (2081-2100)

Legend

- Lakes
- Reservoirs
- Rivers
- Intermittent rivers
- Major cities
- Area not relevant to subsector

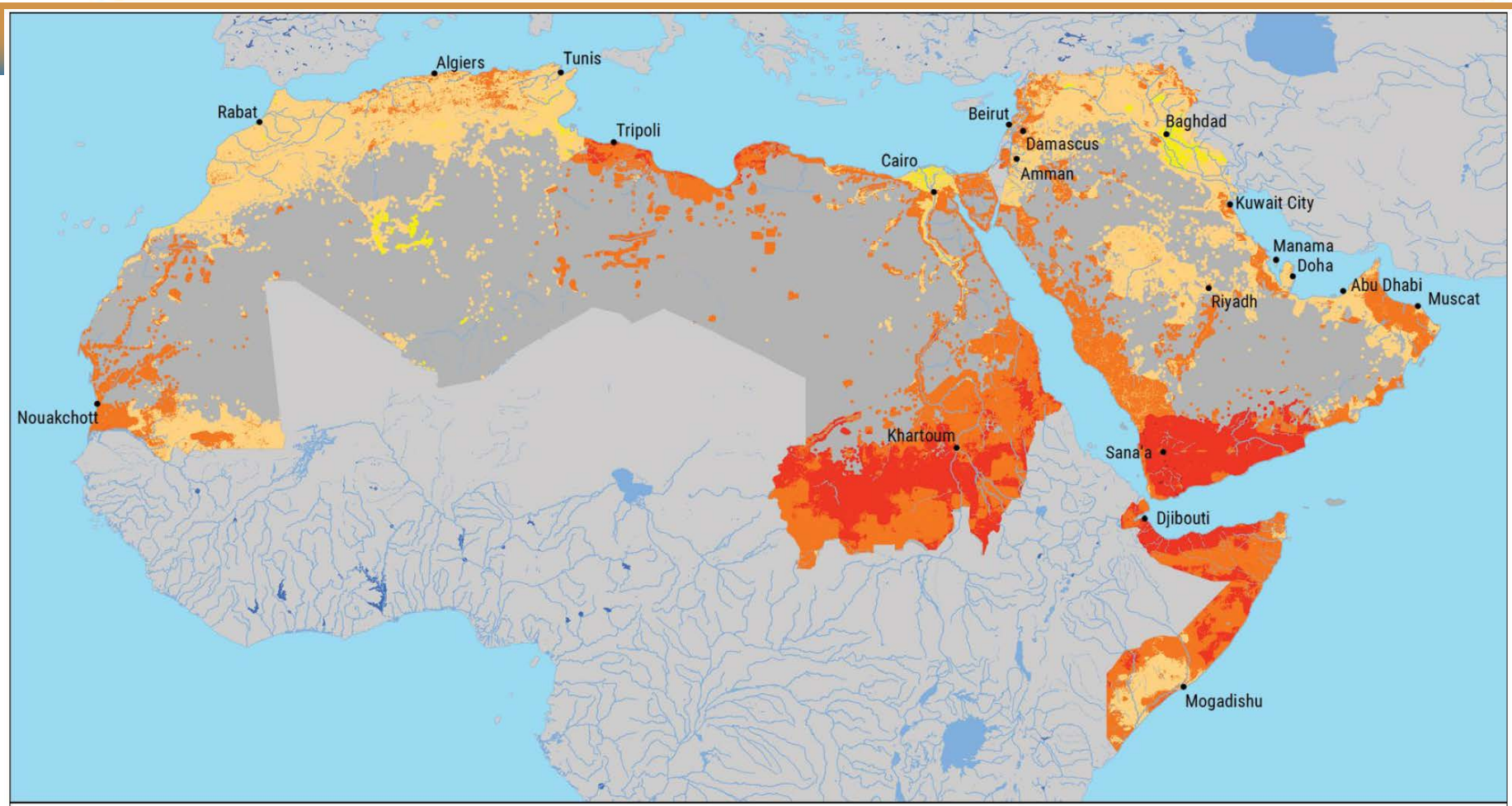
Low Vulnerability — High Vulnerability

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

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

WATER AVAILABILITY VULNERABILITY

End-Century RCP 8.5



WATER: WATER AVAILABILITY

VULNERABILITY: RCP8.5 END-CENTURY (2081-2100)

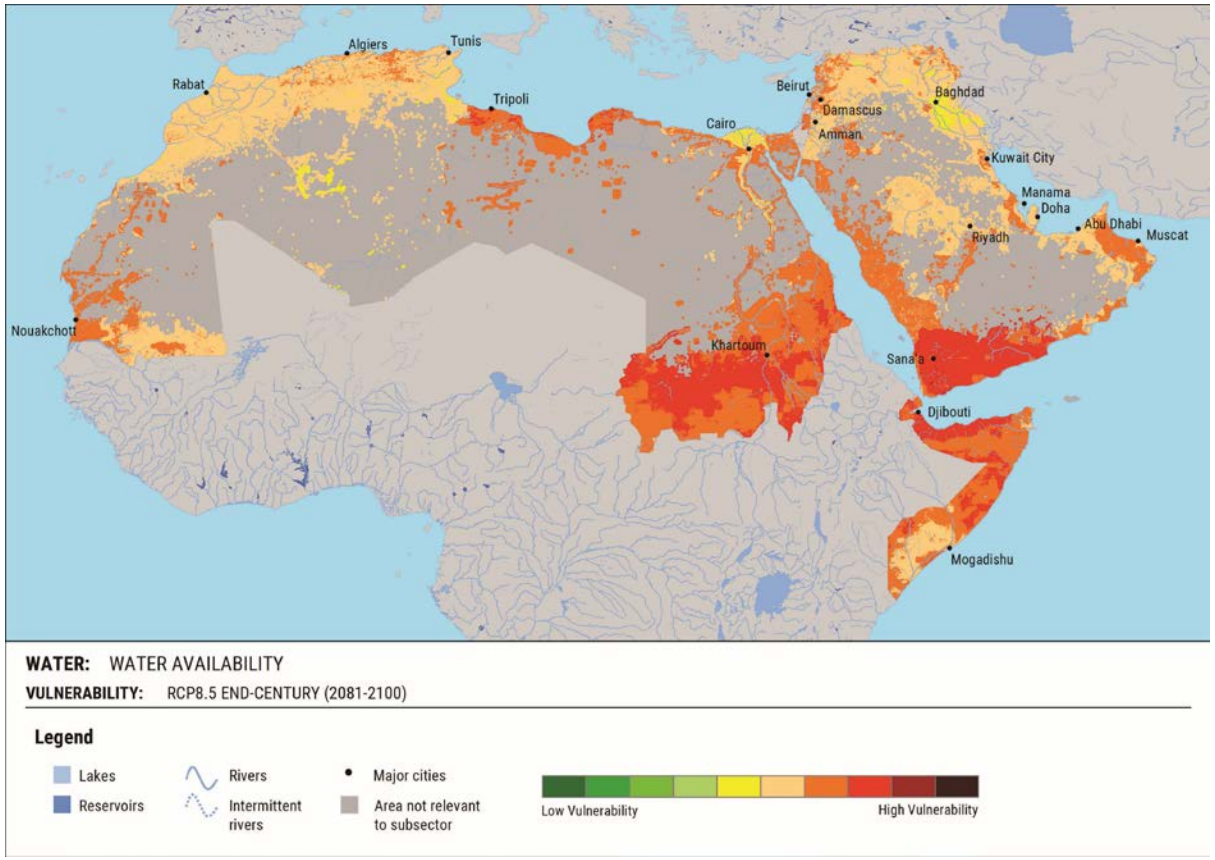
Legend

- Lakes
- Reservoirs
- Rivers
- Intermittent rivers
- Major cities
- Area not relevant to subsector

Low Vulnerability — High Vulnerability

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

Water Availability Vulnerability



Scenario	Percentage of study area		
	Low Vulnerability	Moderate Vulnerability	High Vulnerability
RCP 4.5 Mid-century	0%	57%	43%
RCP 8.5 Mid-century	0%	48%	52%
RCP 4.5 End-century	0%	52%	48%
RCP 8.5 End-century	0%	43%	57%

Lebanese Agricultural Sector Vulnerability Assessment

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

FIGURE 7: Change in temperature compared to the reference period at mid-century for (a) RCP4.5 and (b) RCP8.5 (0.11° grid resolution)

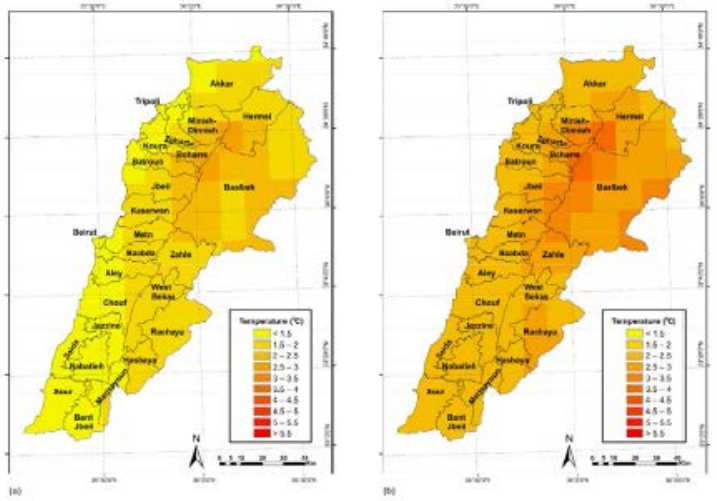


FIGURE 8: Change in temperature compared to the reference period at end-century for (a) RCP4.5 and (b) RCP8.5 (0.11° grid resolution)

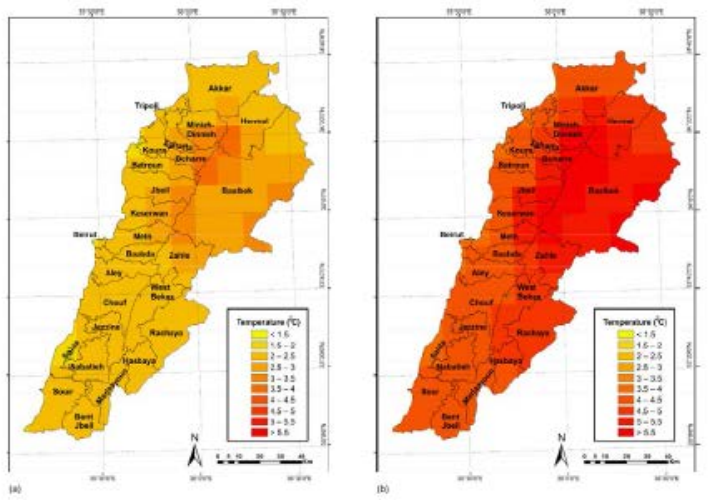


FIGURE 21: Vulnerability at mid-century for (a) RCP4.5 and (b) RCP8.5

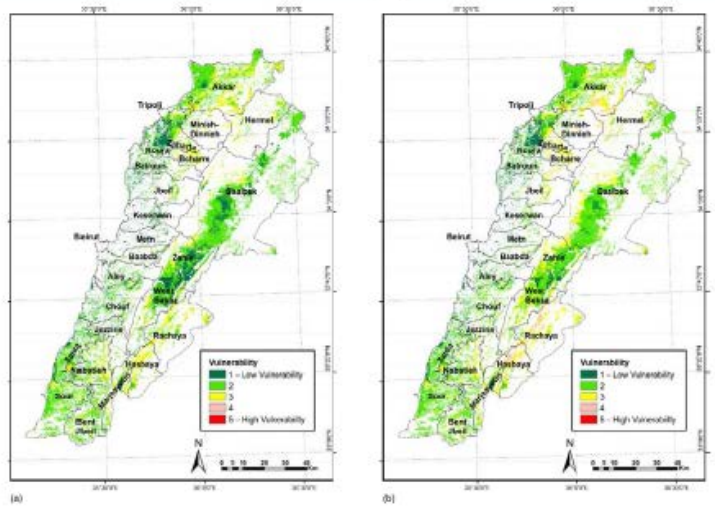


FIGURE 22: Vulnerability at end-century for (a) RCP4.5 and (b) RCP8.5

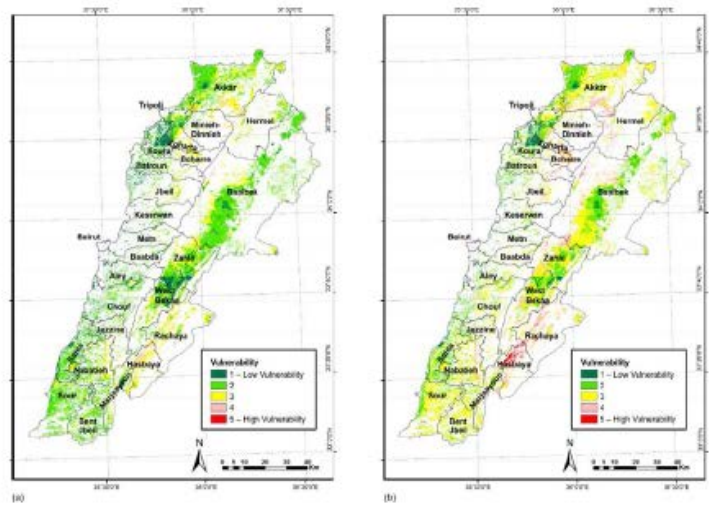


FIGURE 24: Vulnerability hotspots for end-century RCP8.5

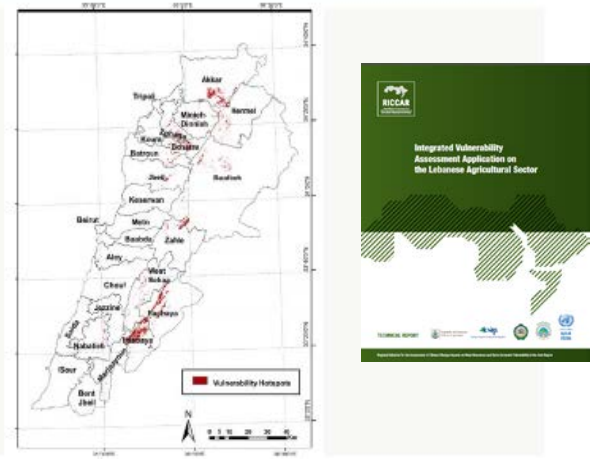
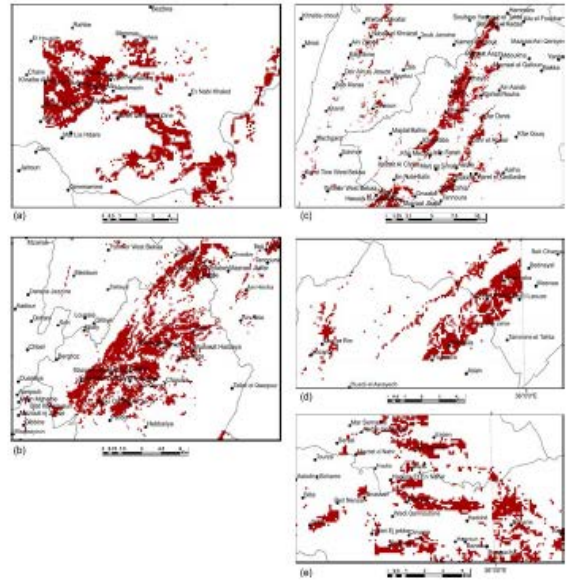
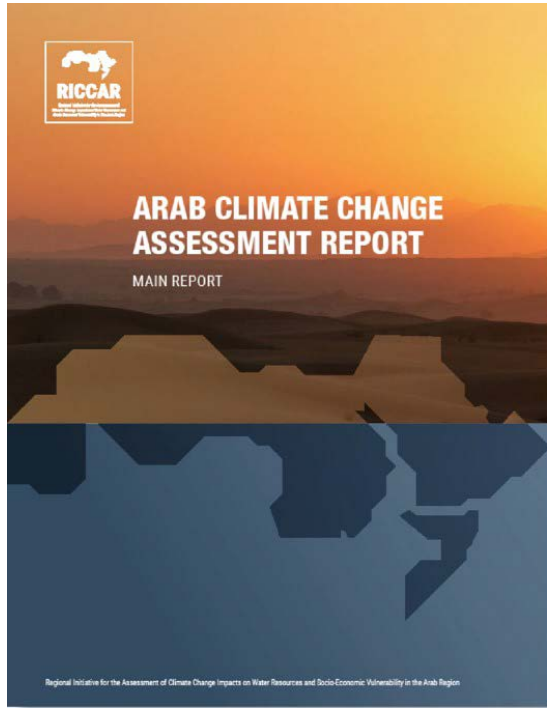
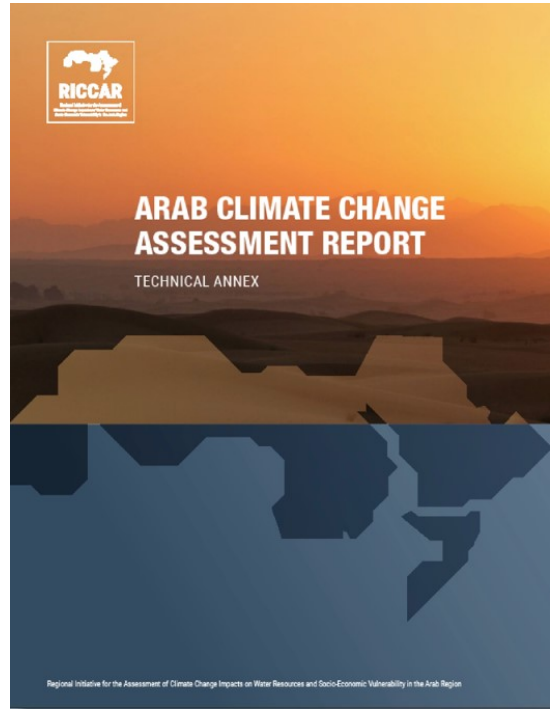


FIGURE 25: Selected vulnerability hotspots for end-century RCP8.5 in (a) Akkar, (b) Hasbaya, (c) Rachaya, (d) Baalbek and Zahle, and (e) Zgharta and Bcharre



Report Launched – September 2017





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

RICCAR Publication Series

ARAB CLIMATE CHANGE ASSESSMENT REPORT

BOOKLET

TECHNICAL NOTES

MANUAL

TECHNICAL REPORTS

RICCAR used to inform other publications

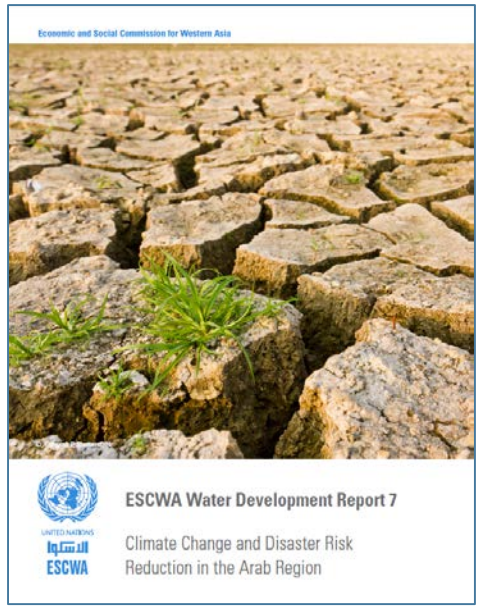
Climate Change Adaptation Manual:

Five sector modules drawing on RICCAR outputs were developed by ESCWA in close cooperation with the following leading organizations:

1. **Environment** module with UNEP/ROWA;
2. **Agriculture** module with ACSAD and GIZ;
3. **Health** module with WHO;
4. **Human settlements** (on water supply/sanitation) with ACWUA;
5. **Economic Development** module by ESCWA

A joint introductory chapter by ESCWA render the 5 modules a manual.

Five workshops were held with stakeholders from each sector to finalize the modules.



RICCAR

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

Thank You

www.riccar.org

www.unescwa.org/our-work/climate-change