



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

Integrated Assessment



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Sustainable Development Policies Division
UN Economic & Social Commission for Western Asia

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

Arab Ministerial
Council of for
Meteorology & Climate

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, 2017

ESCWA
25th Ministerial
Session
Resolutions on
Climate Change,
Rio+20 follow-up
2008, 2012,
2014

**10 Year Anniversary of Formalized Action on
Climate Change at the Arab Regional Level
2007 - 2017**

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

ACSAD
Board of
Directors
Resolution
2013

Environment

Foreign Affairs &
Planning

Water

Met

Agriculture

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 &
Reducing Risk

Negotiations

RICCAR Partnerships



Cairo Office



UNITED NATIONS
UNIVERSITY
UNU-INWEH



Implemented by

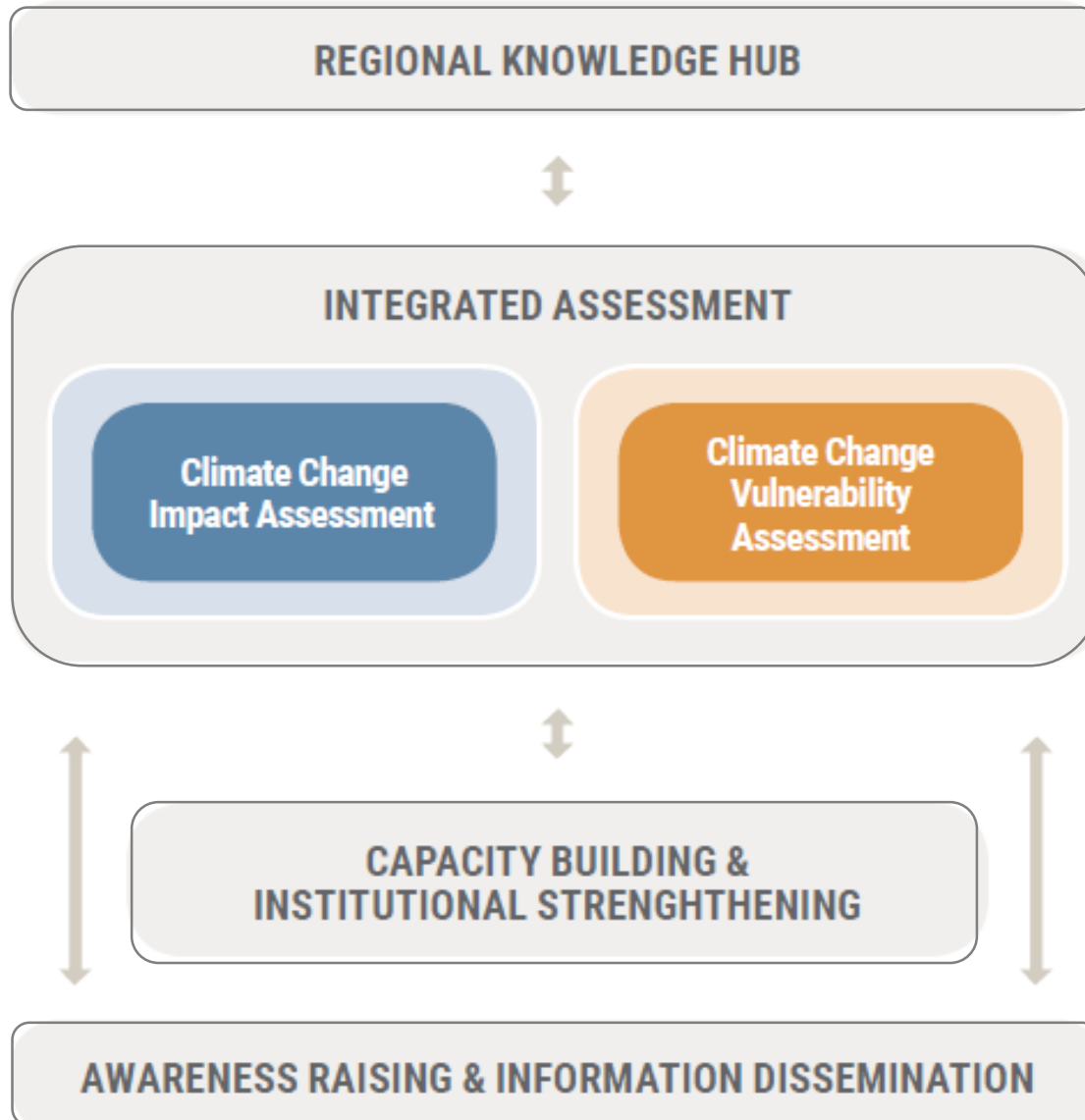


SWEDISH INTERNATIONAL DEVELOPMENT
COOPERATION AGENCY

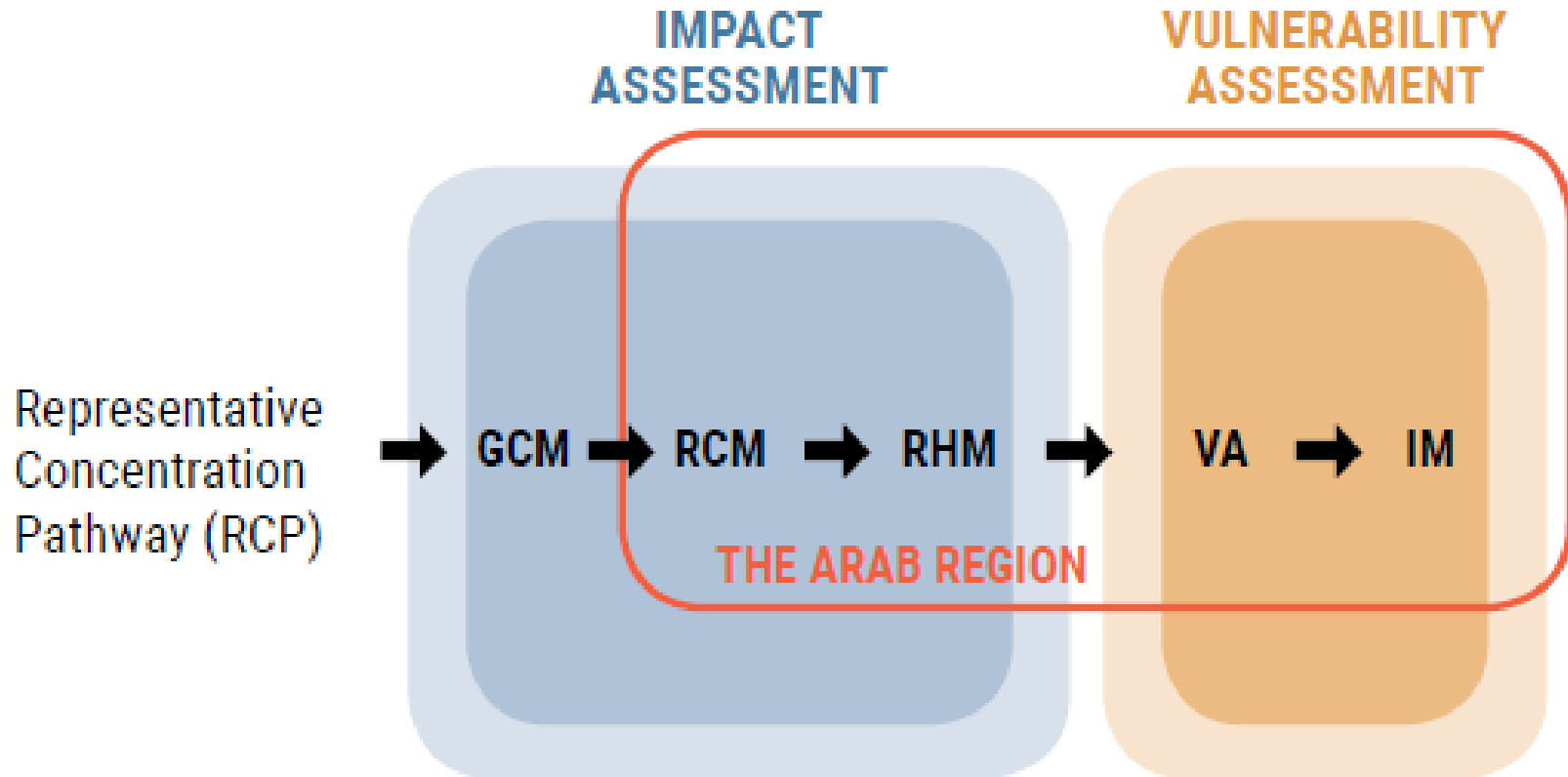
ACCWaM

*CORDEX MENA/Arab Domain
housed at The Cyprus Institute*

Pillars of Work



Integrated Assessment



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

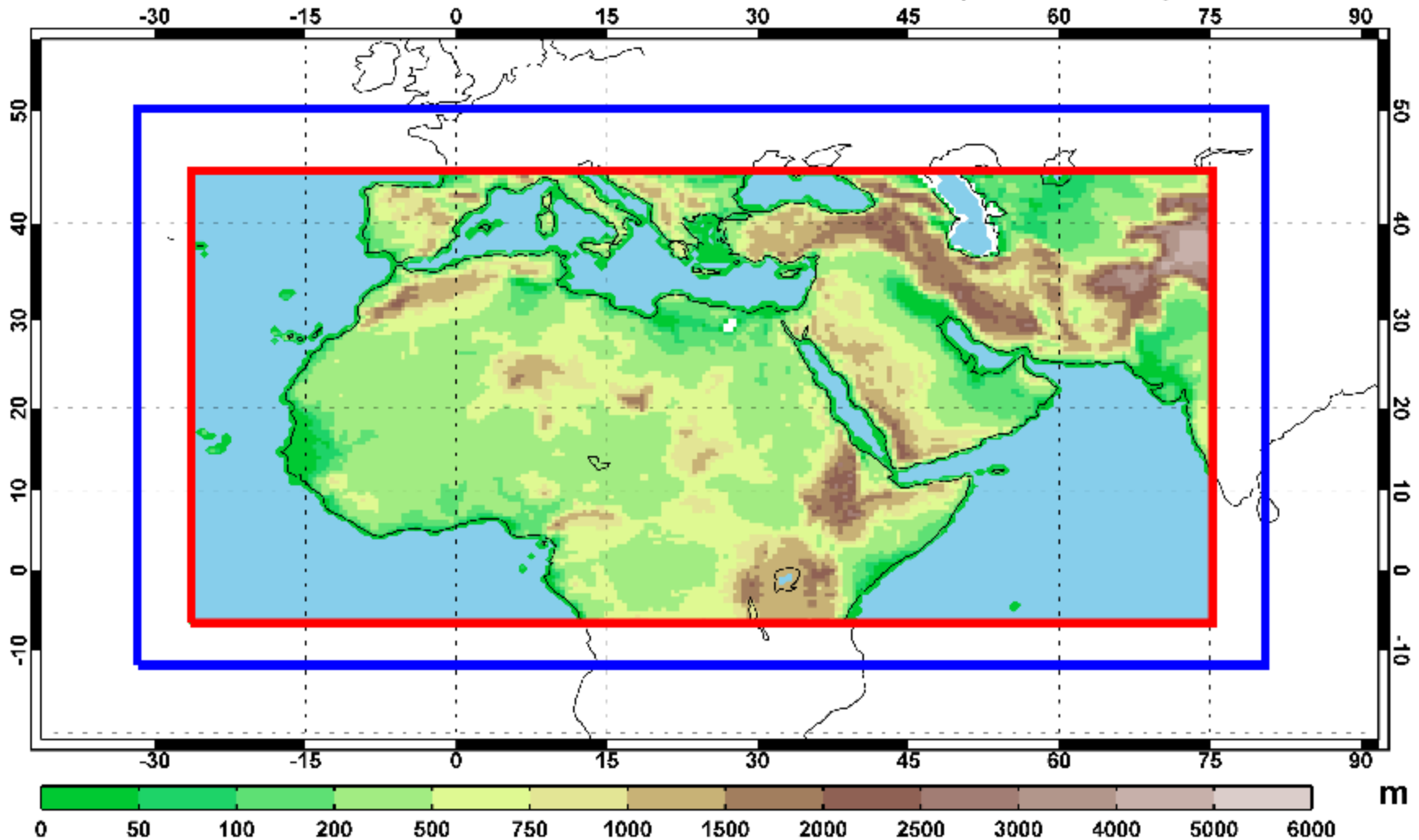
VA: Vulnerability Assessment
IM: Integrated Mapping

Arab Domain

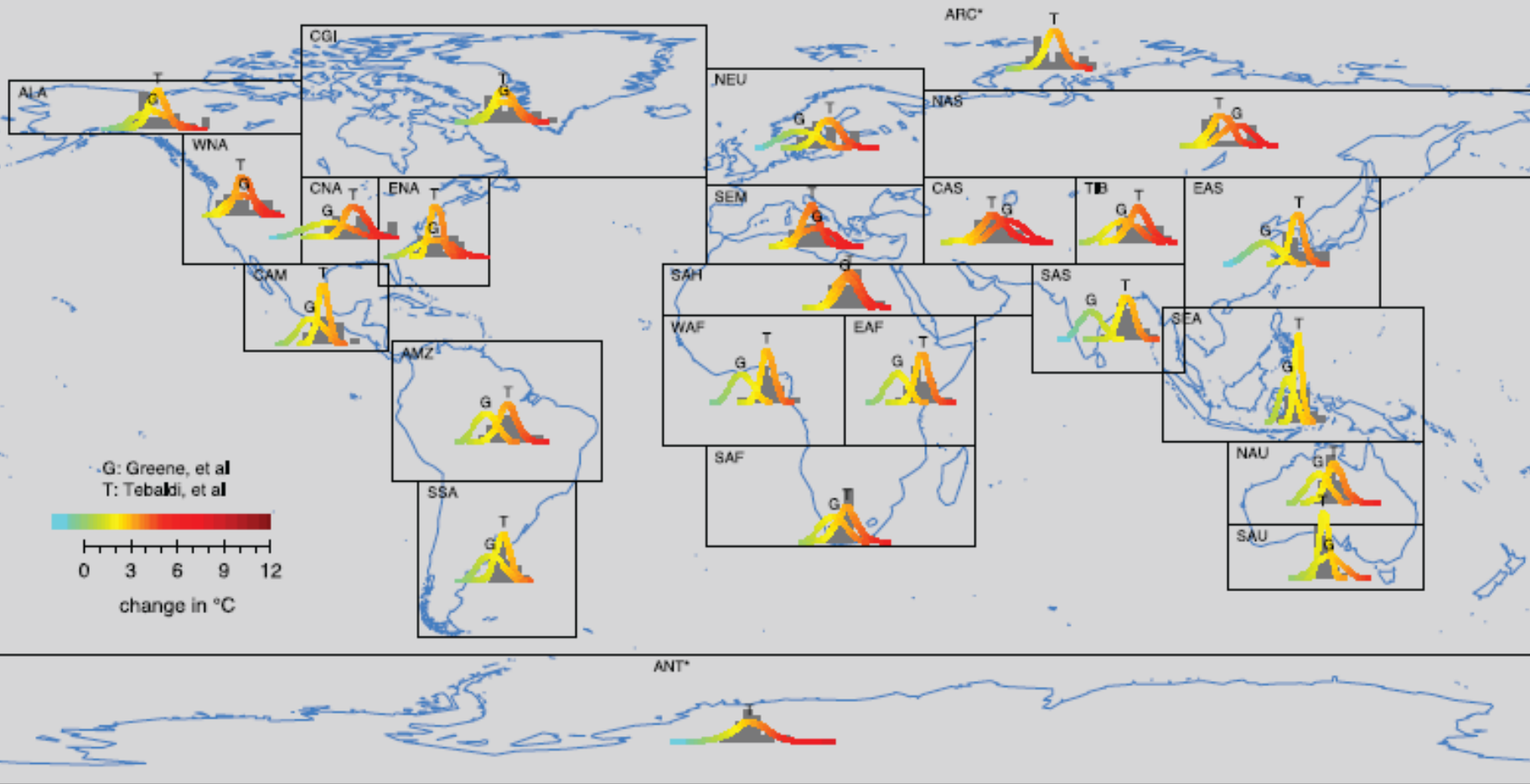
CORDEX-MENA/Arab Domain | 0.44° (50 km)

— Active Domain

— Full Domain (SMHI-RCA4)



Intergovernmental Panel on Climate Change (IPCC) Regional Domains



IPCC Regional Domains (AR5)

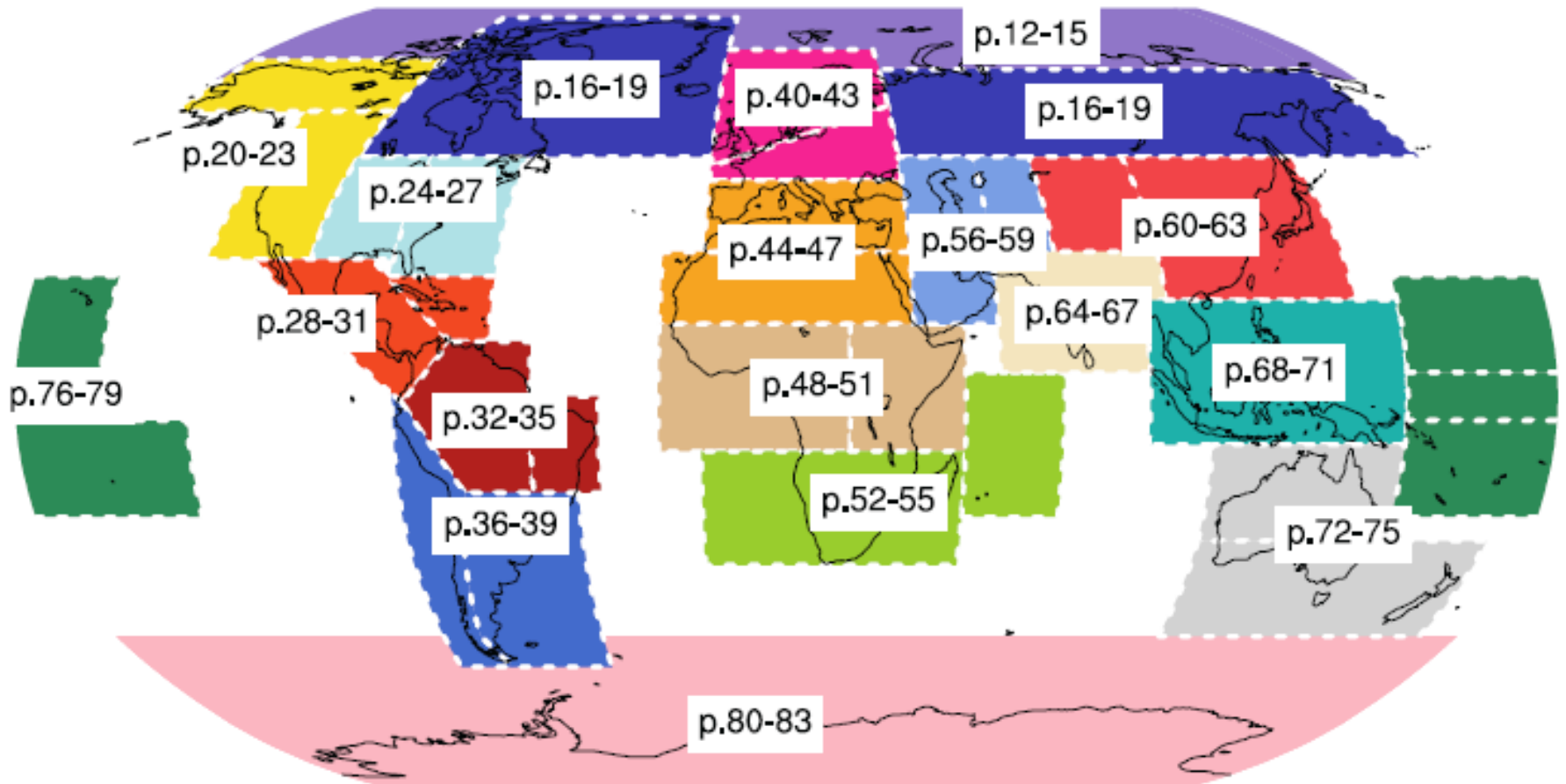


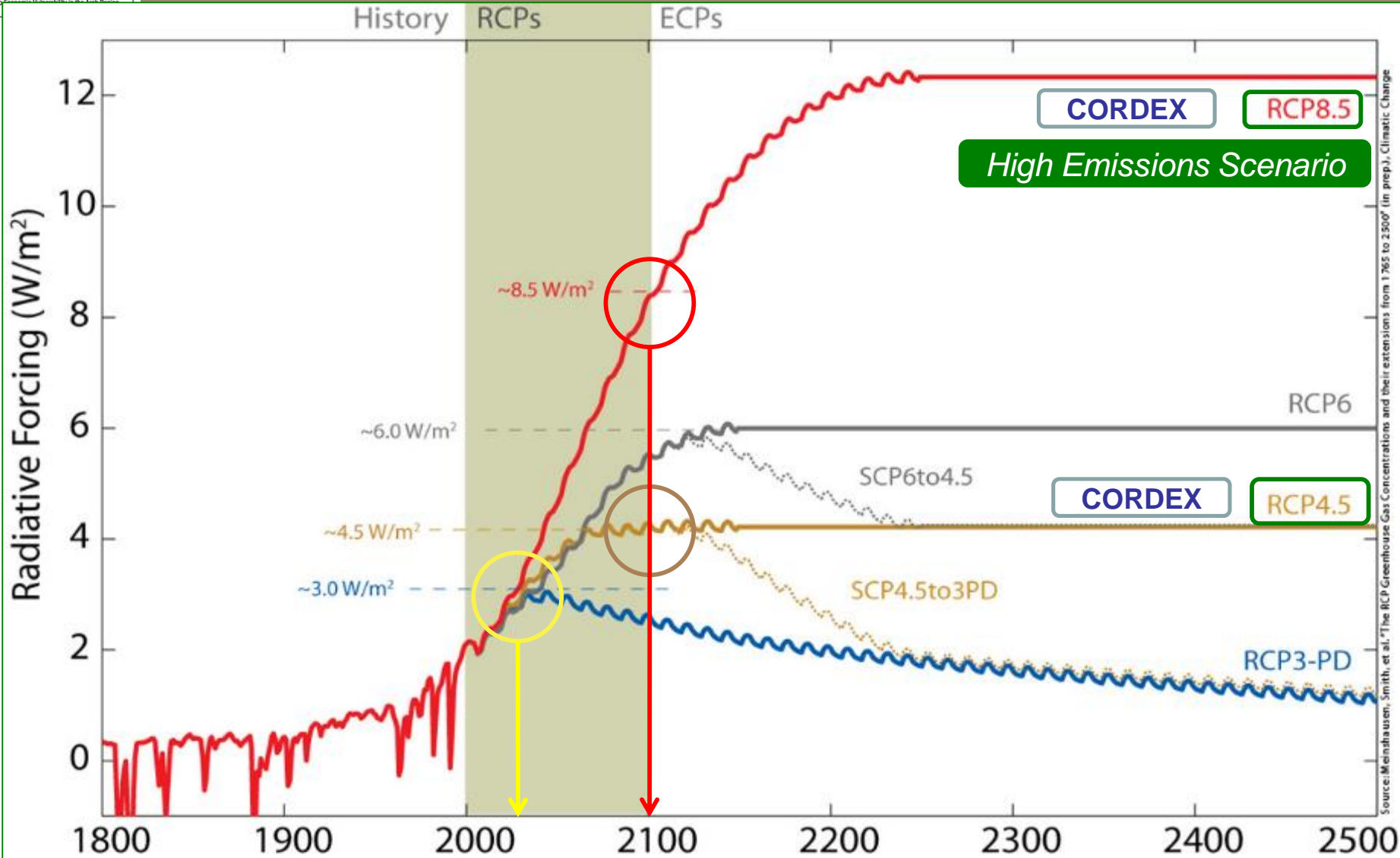
Figure AI.3: Overview of the SREX, ocean and polar regions used.

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*

Representative Concentration Pathways (RCPs)

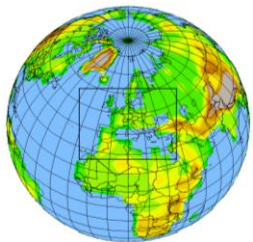
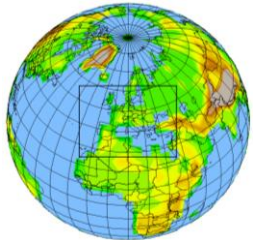
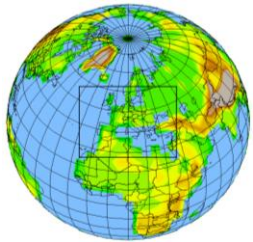
As first represented in IPCC AR5 Projections



Graph adapted from: Meinshausen et al., 2010

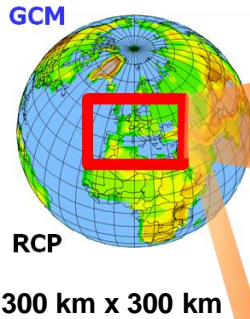
RCMs & RHMs

Different GCMs



For Same RCP

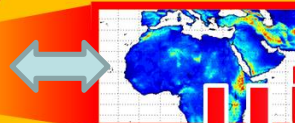
General Circulation Model GCM



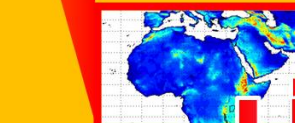
Ensembles used to reduce uncertainty at level of RCMs & RHMs

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

Regional Climate Model (RCM)

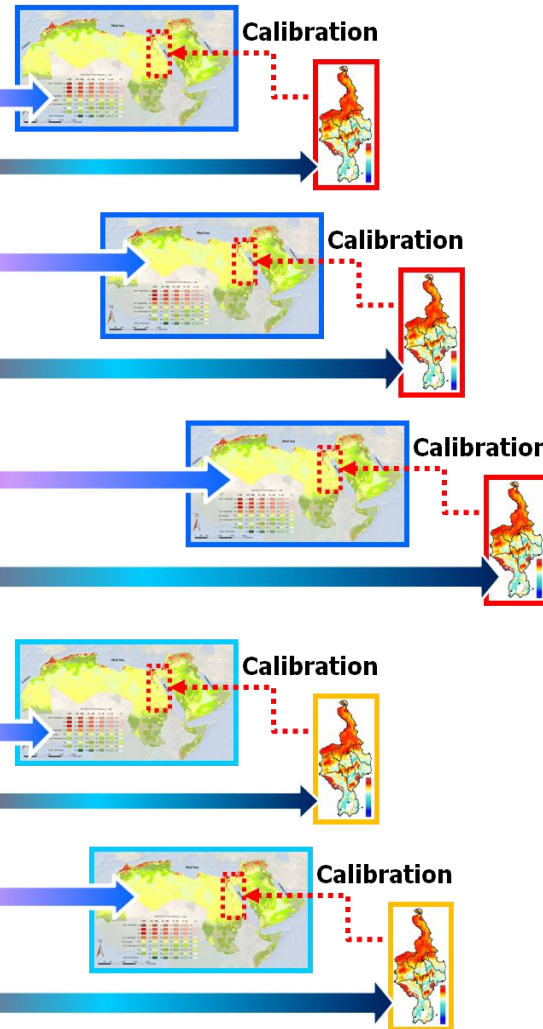


50km x 50km



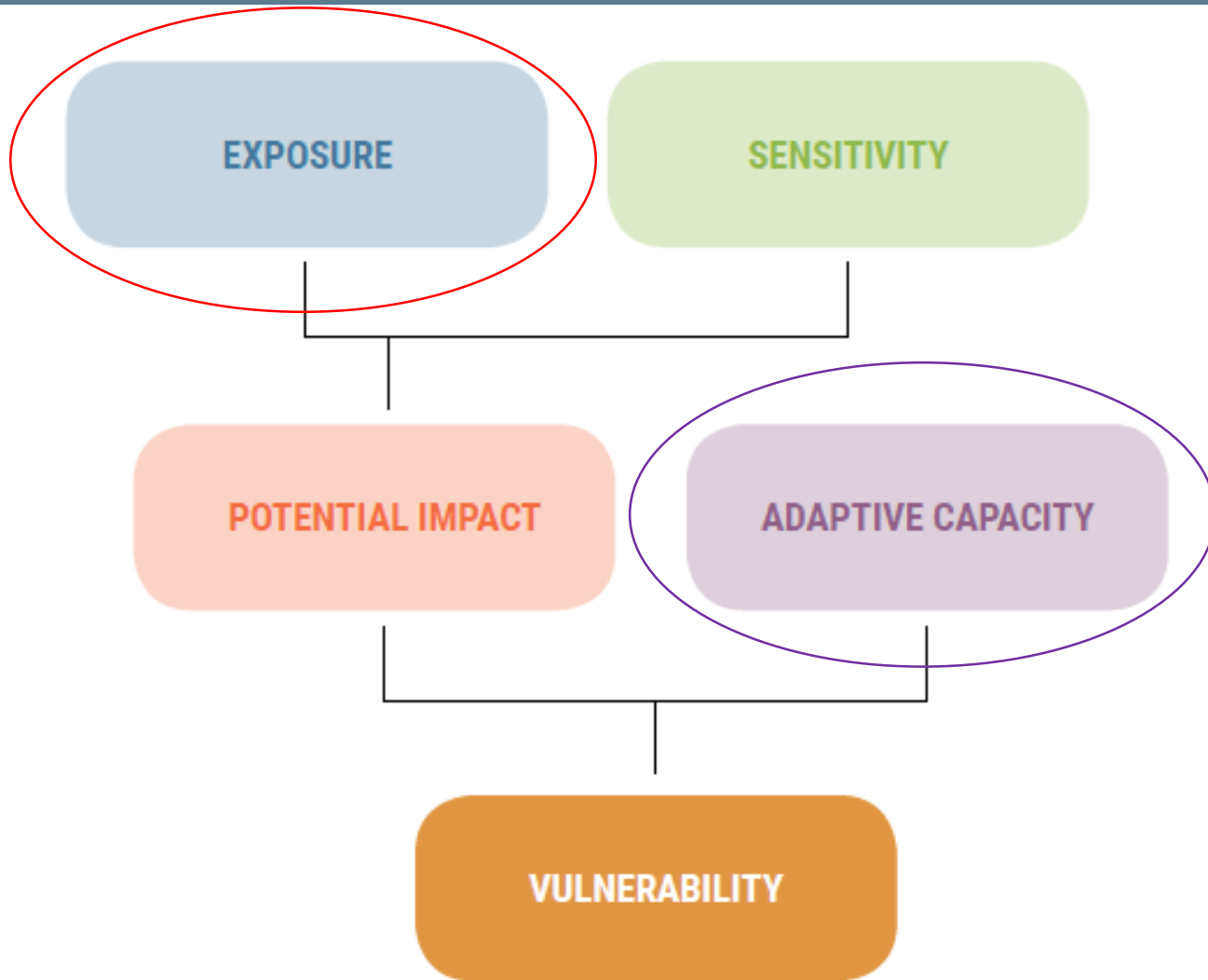
25km x 25km

Regional Hydrological Model (RHM)



Extreme climate events

Vulnerability Assessment



Source: Based on IPCC, 2007

Consultations & Capacity Building

INTEGRATED ASSESSMENT

IMPACT ASSESSMENT

Regional Climate
Modelling

Regional Hydrological
Modelling



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 to 2015)
Regional Knowledge Hub Working Group (2013 to 2014)

National Hydrological Focal Points (2013, 2014, 2015)

Vulnerability Assessment Sensitivity Task Force (2014)
Vulnerability Assessment Adaptive Capacity Task Force (2014)

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

Expert Peer Review Meetings (April and December 2016)

Institutional Strengthening

- **Increasing** data availability through **Climate Data Rescue**
- **Fostering** an **Arab Climate Outlook Forum**
- **Developing** **Disaster Loss Databases**
- **Establishing** a **Regional Knowledge Hub** for informing action through **RICCAR Publication Series & Data Portal**

Main Report



Technical Notes



Training Manuals



Technical Reports



Peer Reviewed Journal Articles for IPCC use



Regional Knowledge Hub



**Arab Ministerial
Water Council
Technical Committee**



**Regional
Knowledge Hub**

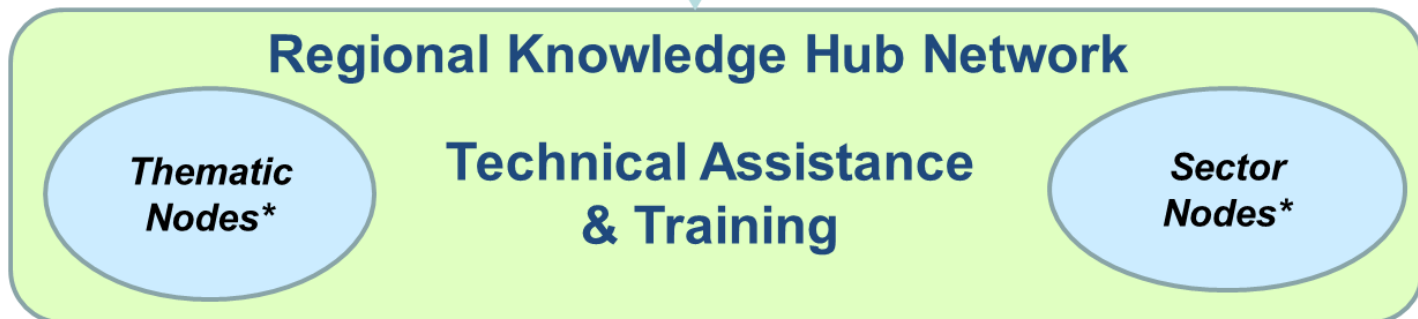
**Link to
ArabCOF**

LAS

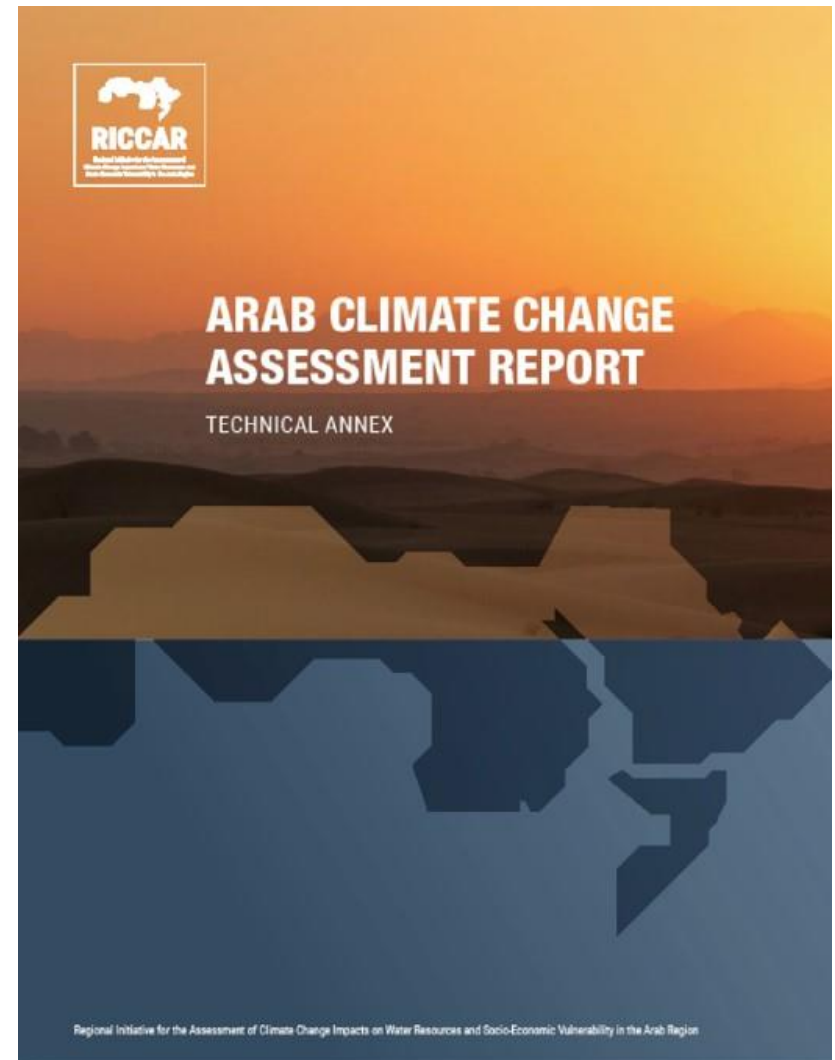
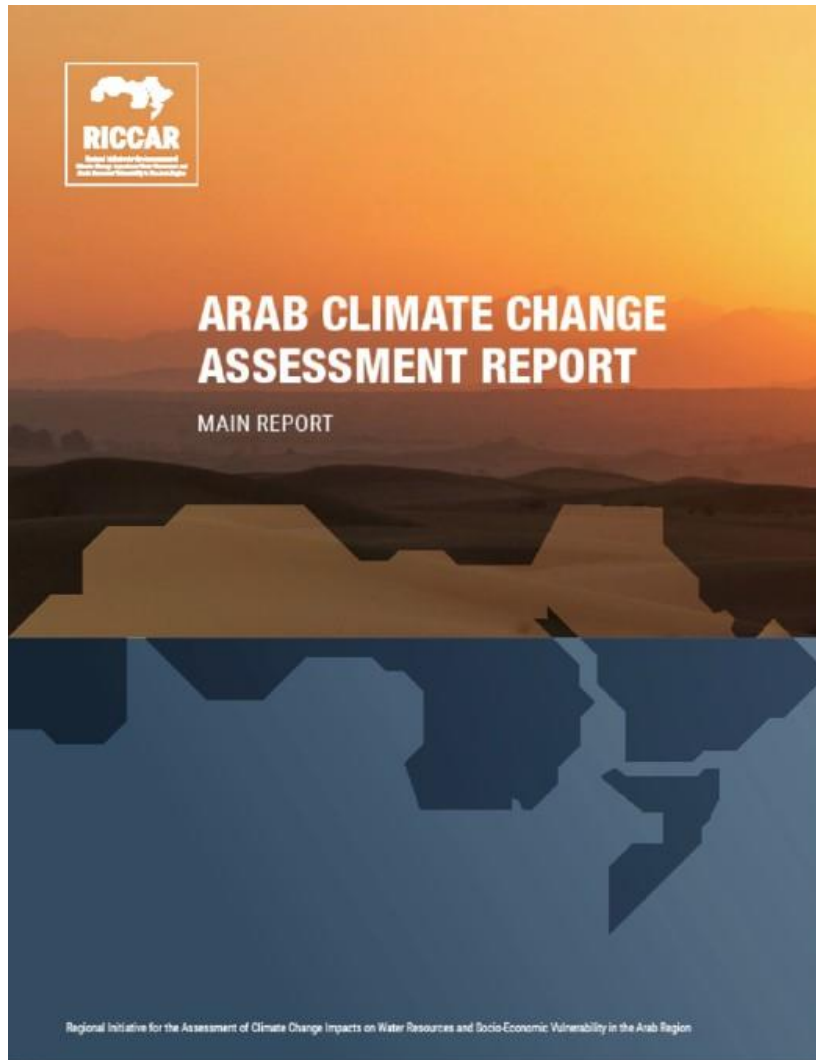
**ACSAD-ESCWA
Coordinating Secretariat**

FAO Data Portal

**RICCAR
Partners**



Reports – launched Sept 2017



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ARAB DOMAIN AND SELECTED SUBDOMAINS



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THE ARAB REGION AND SELECTED SUBDOMAINS



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FINDINGS FOR SELECTED SHARED WATER BASINS
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SECTOR – VULNERABILITY



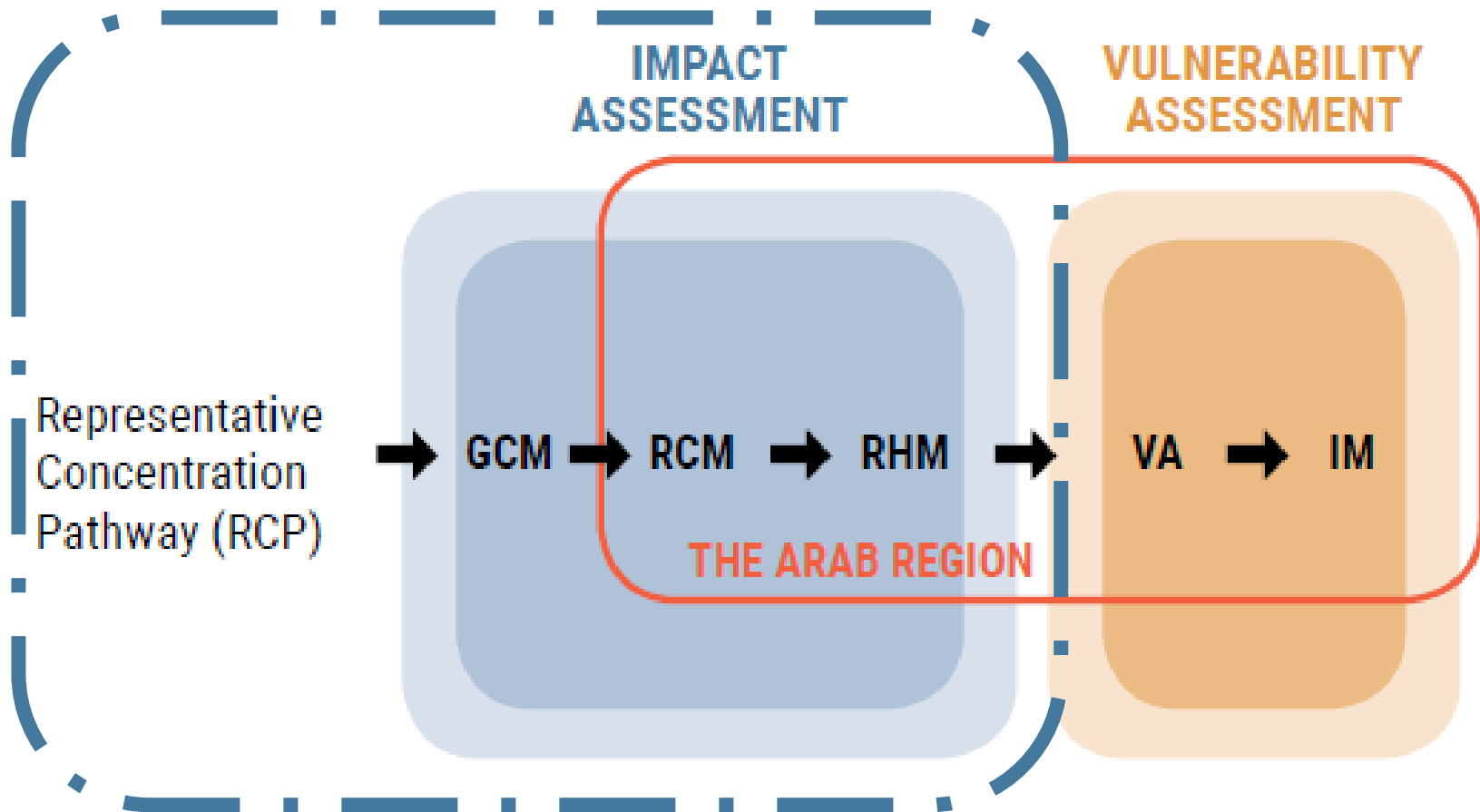
CHAPTER 13
PEOPLE SECTOR – VULNERABILITY

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Technical Annex

Integrated Assessment



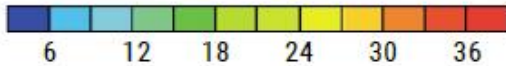
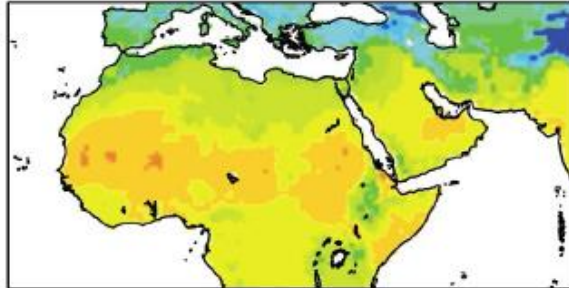
GCM: Global Climate Modelling
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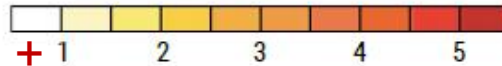
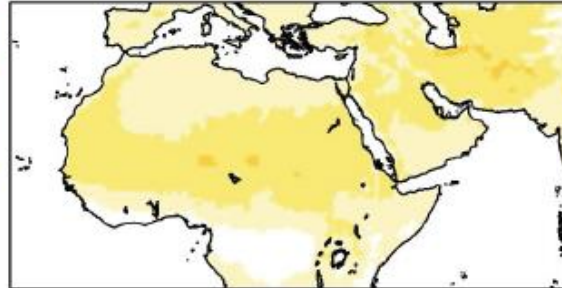
Mean change in temperature

RCP 4.5

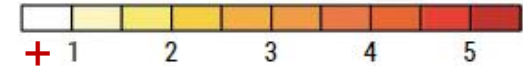
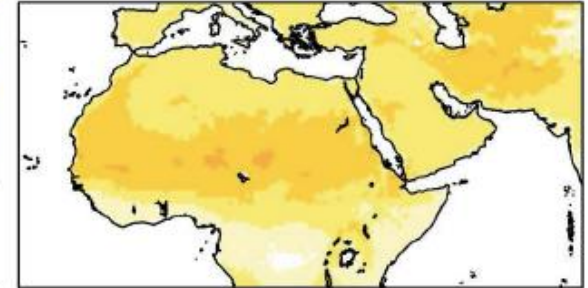
1986-2005



2046-2065



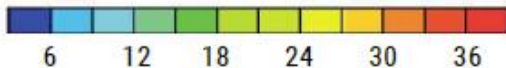
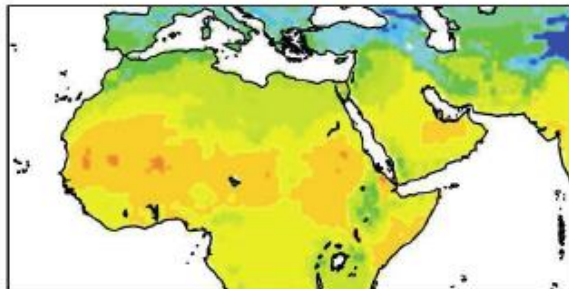
2081-2100



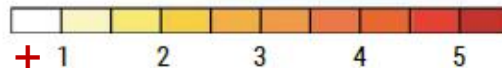
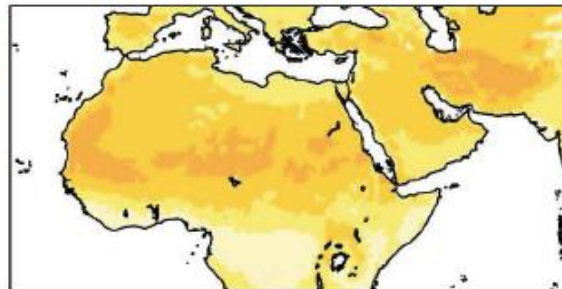
Temperature (°C)

RCP 8.5

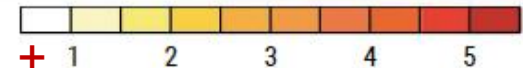
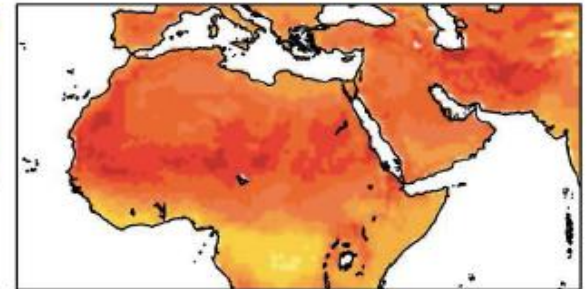
1986-2005



2046-2065



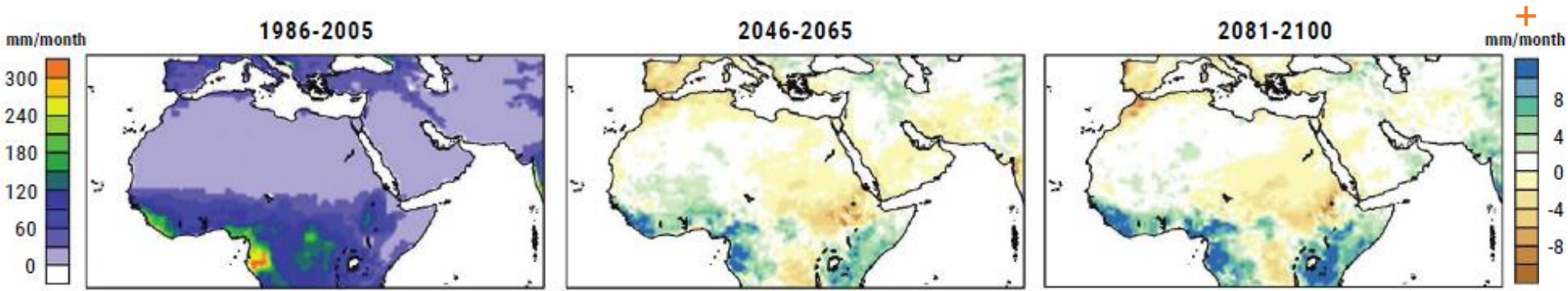
2081-2100



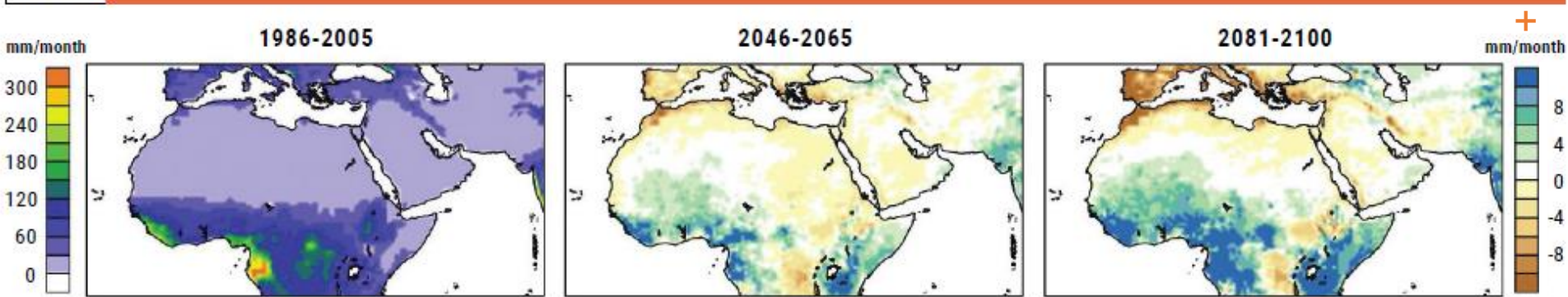
Temperature (°C)

Mean change in precipitation

RCP 4.5



RCP 8.5

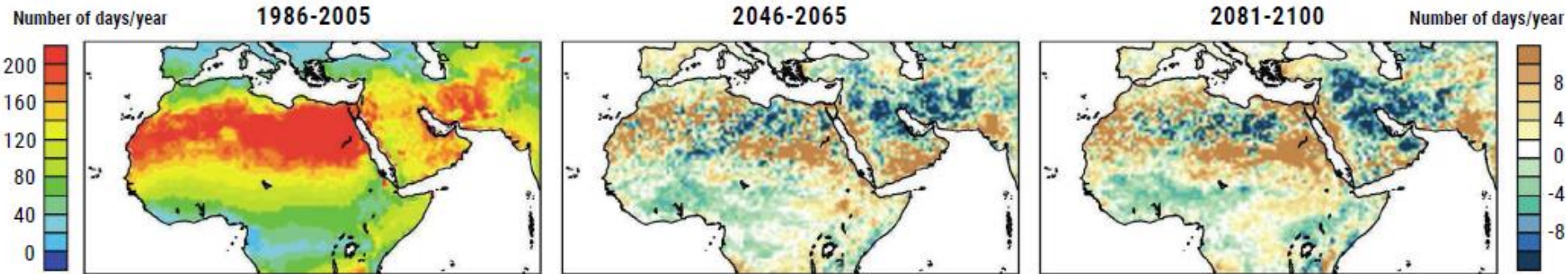


Extreme events indices

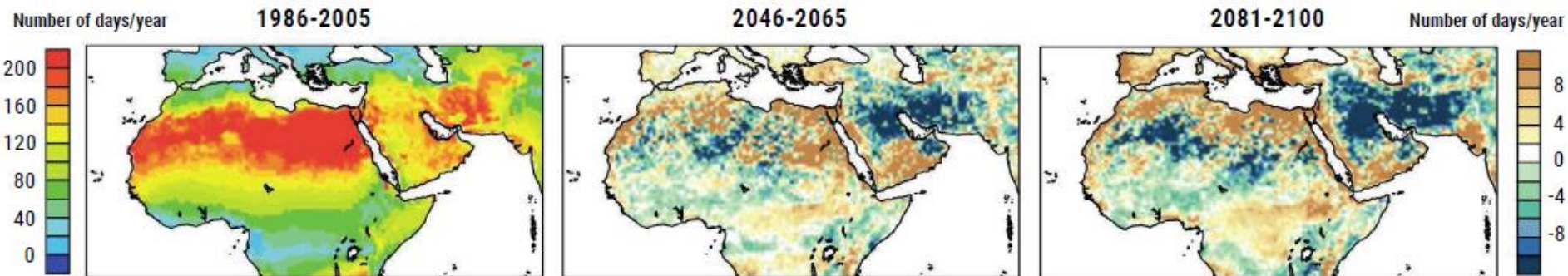
Extreme temperature indices		Extreme precipitation indices	
Index	Full name	Index	Full name
SU	Number of summer days	CDD	Maximum length of dry spell
SU35	Number of hot days	CWD	Maximum length of wet spell
SU40	Number of very hot days	R10	Annual count of 10 mm precipitation days
TR	Number of tropical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

Maximum length of dry spell (CDD)

RCP 4.5



RCP 8.5



Regional Hydrological Modeling

INTEGRATED ASSESSMENT

IMPACT ASSESSMENT

Regional Climate
Modelling

Regional Hydrological
Modelling



VULNERABILITY
ASSESSMENT

GCM and RCM outputs
need to be **Bias Corrected**
to be usable for
Hydrological Modeling &
as inputs for
Agricultural Models,
Drought & Flood Analysis



Case Studies draw on RHM outputs



Health



Green Sectors



Extreme Events

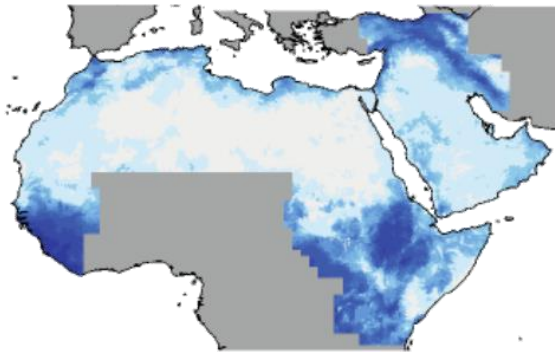
Mean change in annual runoff

RCP 4.5

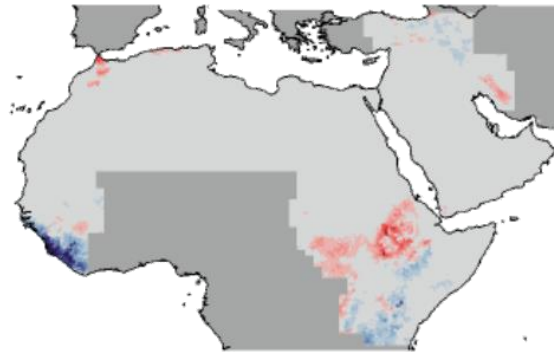
2 Models; RCP 4.5

HYPE MODEL

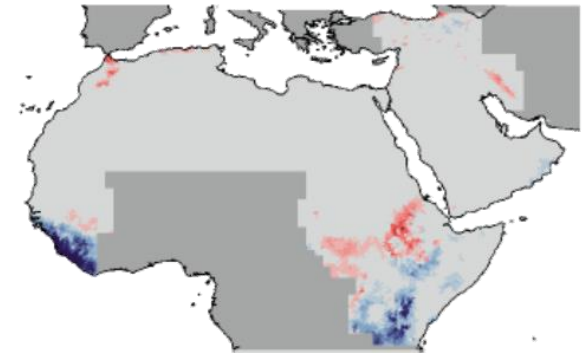
1986-2005



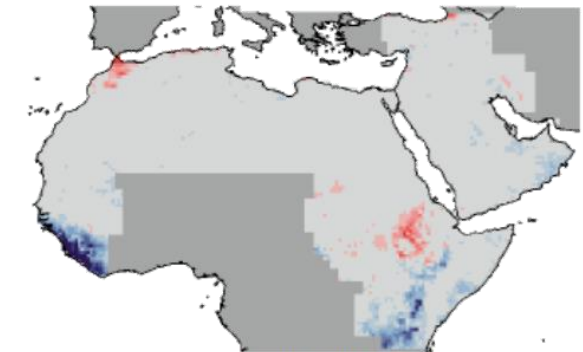
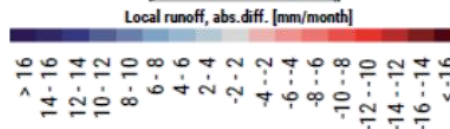
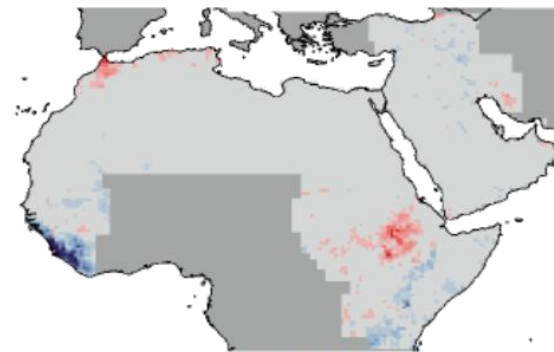
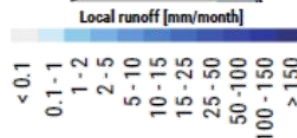
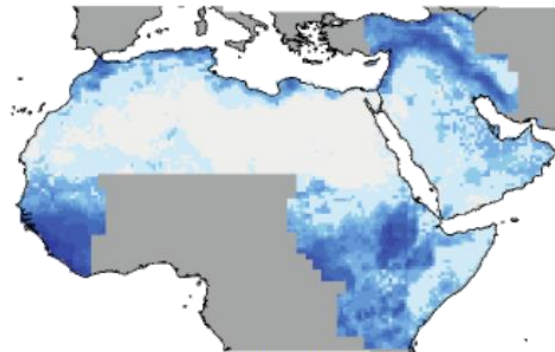
2046-2065



2081-2100



VIC MODEL



Comparison between 2 hydrological models: Hydrological Predictions for the Environment (HYPE) and Variable Infiltration Capacity (VIC)

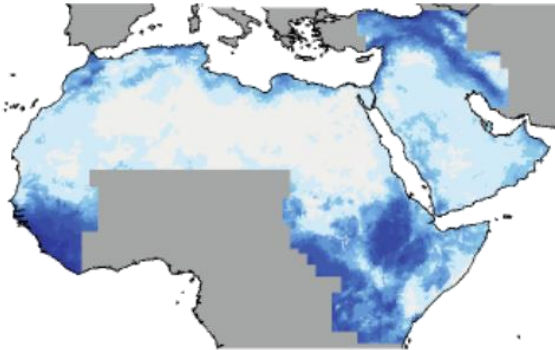
Mean change in annual runoff

RCP 8.5

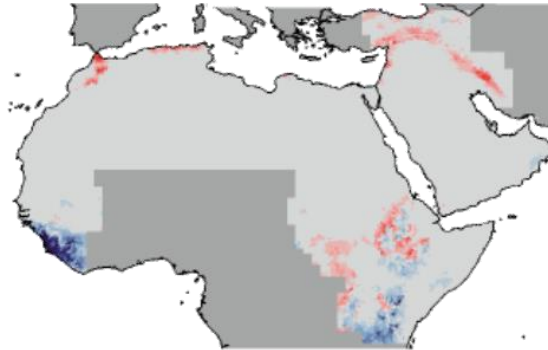
2 Models; RCP 8.5

HYPE MODEL

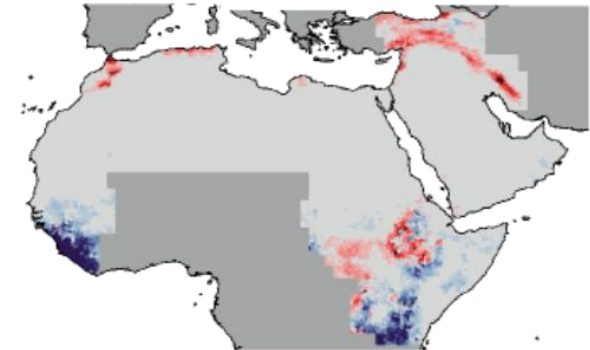
1986-2005



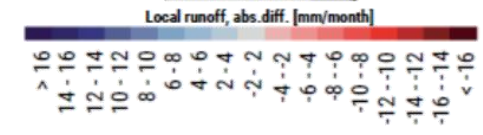
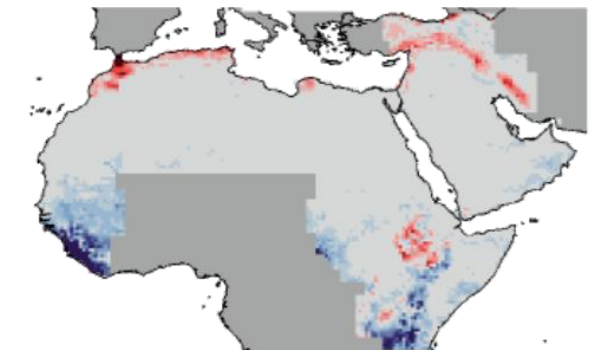
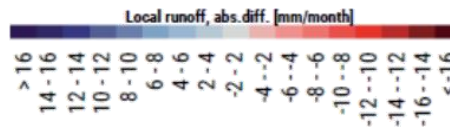
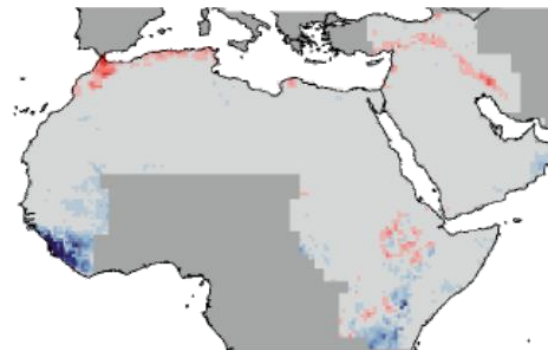
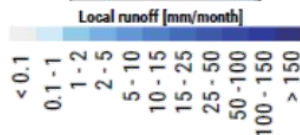
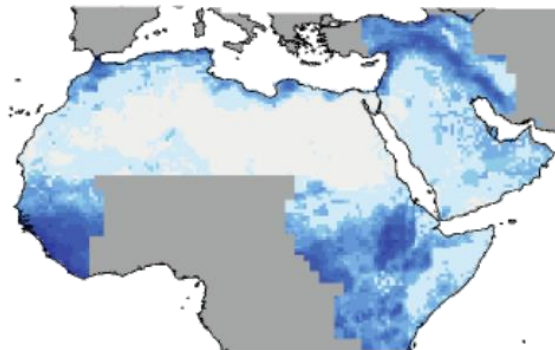
2046-2065



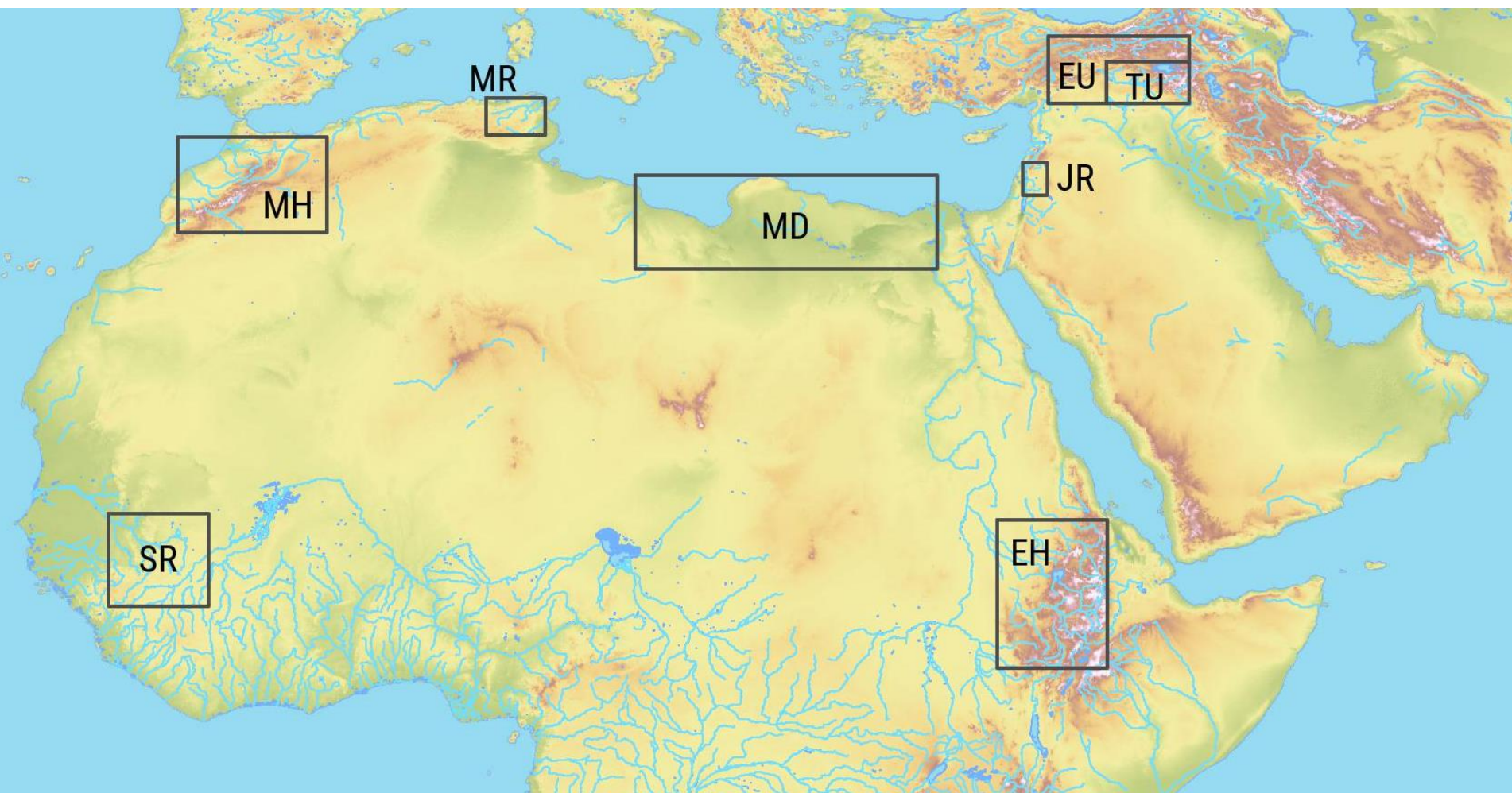
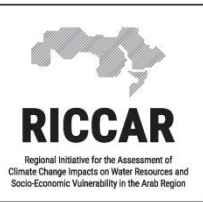
2081-2100



VIC MODEL



Locations of subdomains for hydrological analysis



Mean change in runoff and evapotranspiration

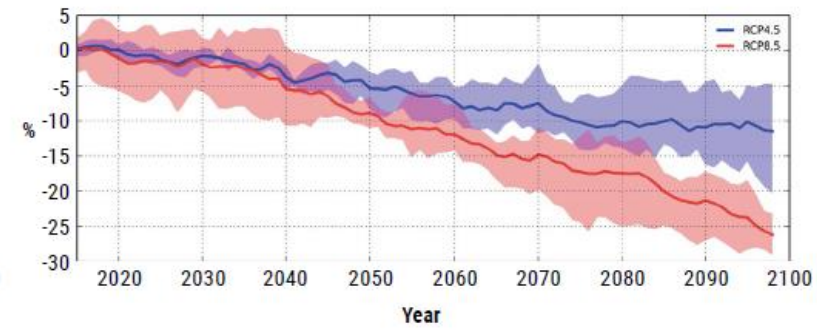
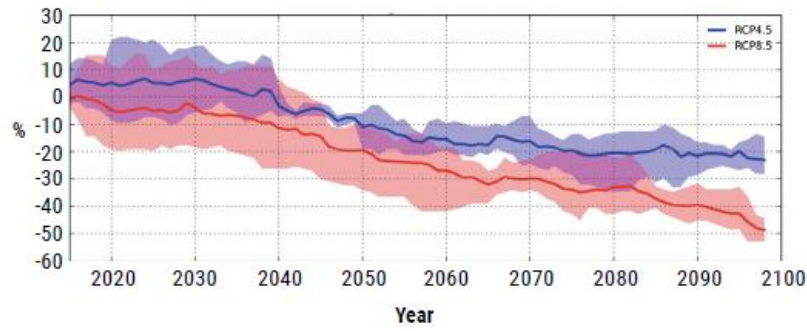
Moroccan Highlands (MH)

RUNOFF

EVAPOTRANSPIRATION

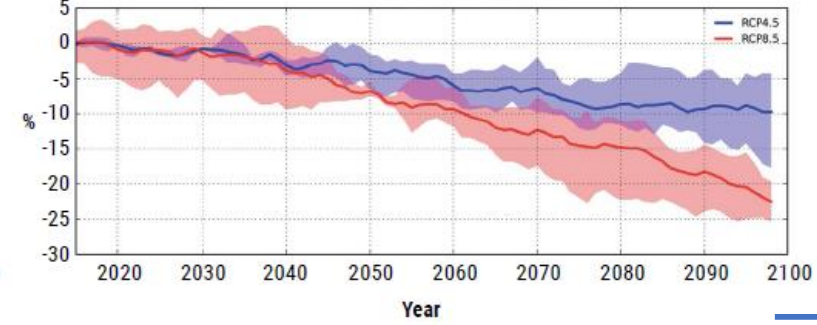
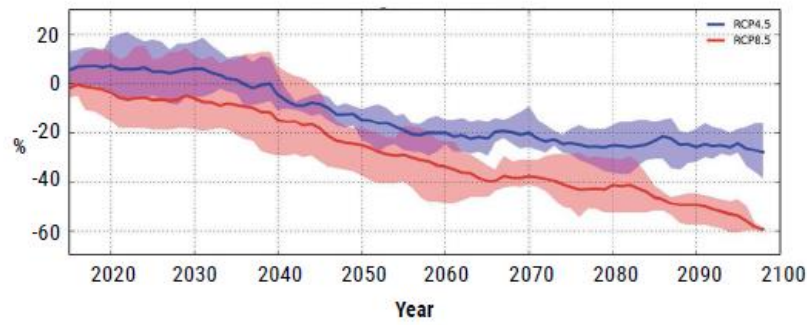
HYPE MODEL

HYPE MODEL



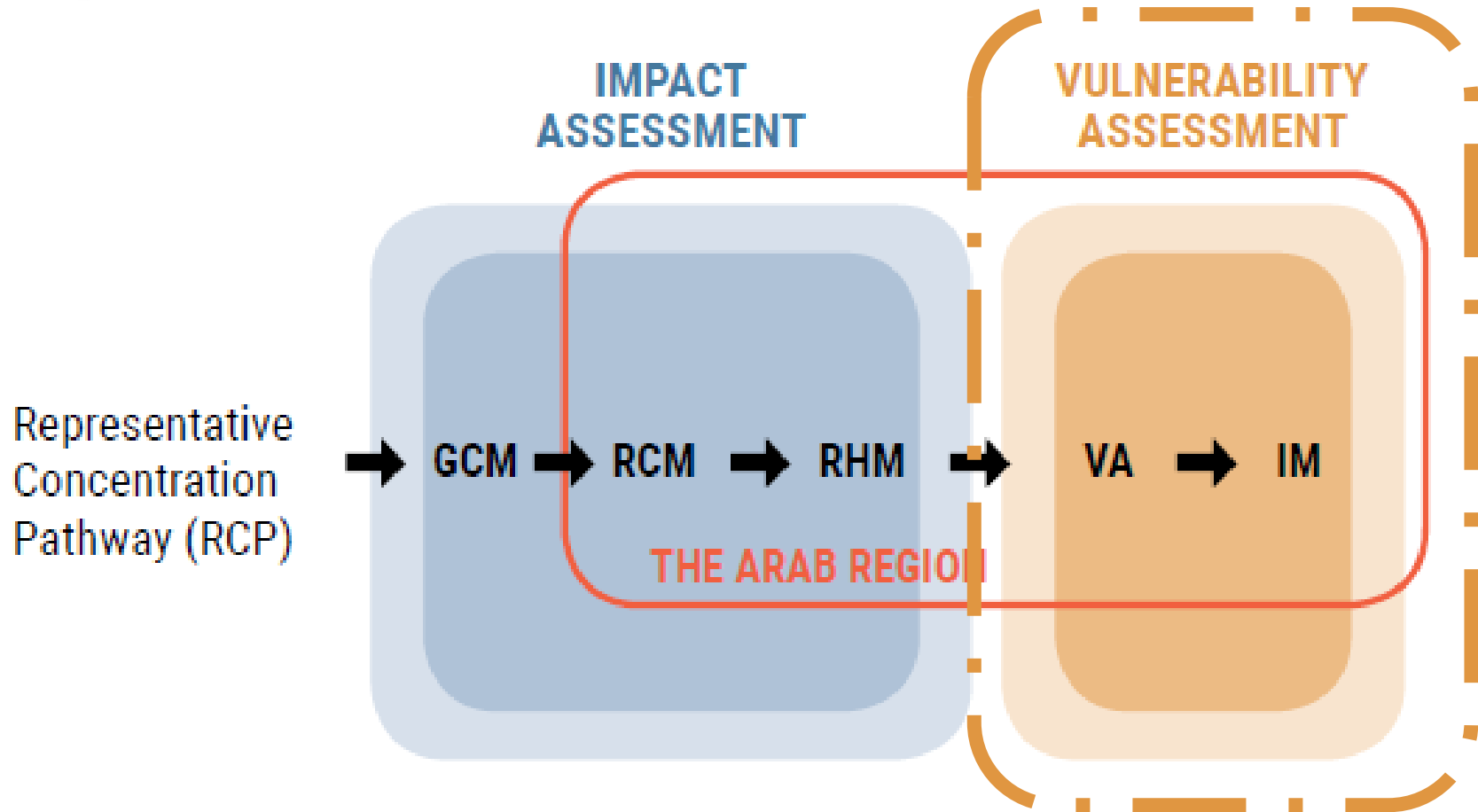
VIC MODEL

VIC MODEL



— RCP4.5
— RCP8.5

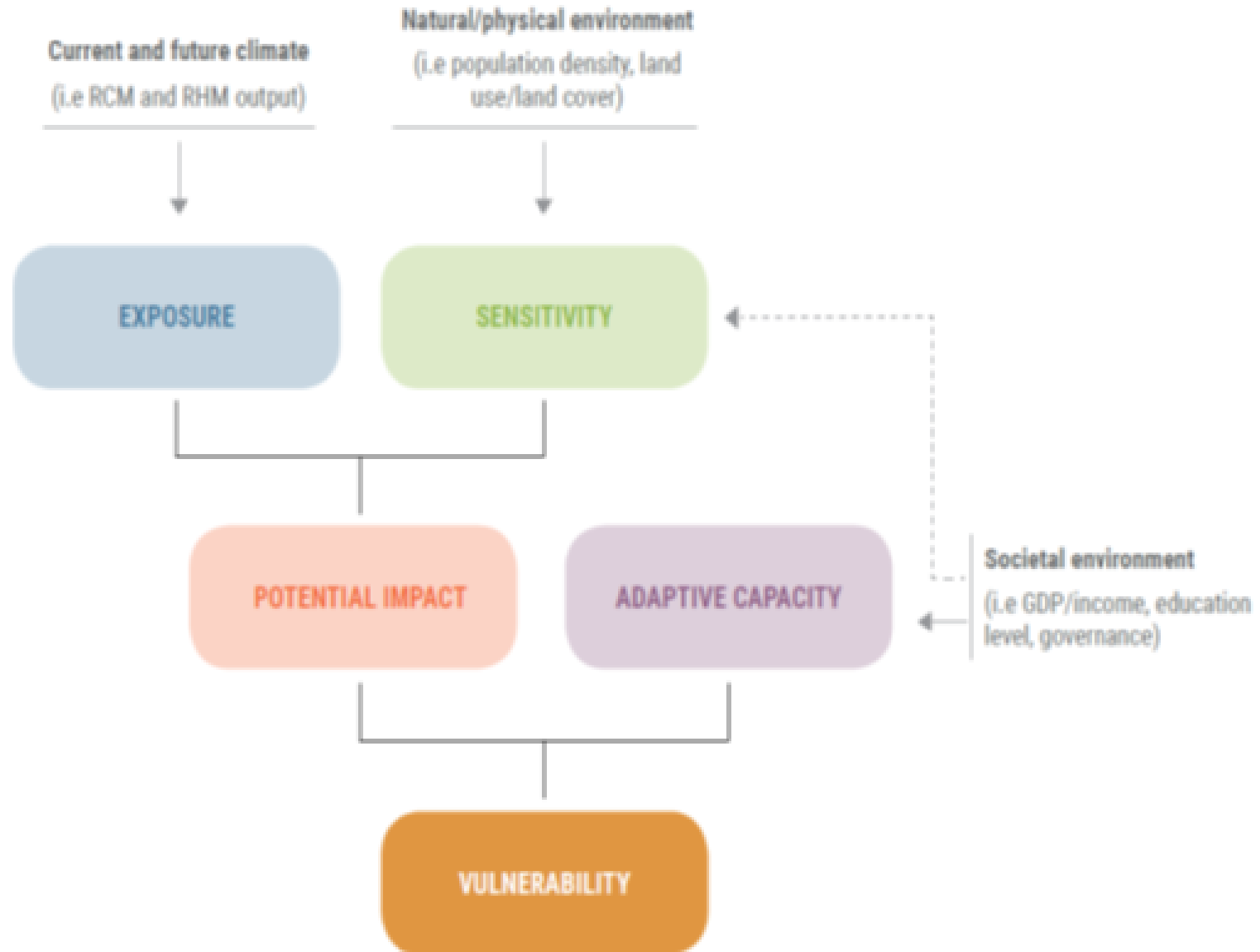
Integrated Assessment








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

VA: Vulnerability Assessment
IM: Integrated Mapping

Vulnerability Assessment



Vulnerability Assessment

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



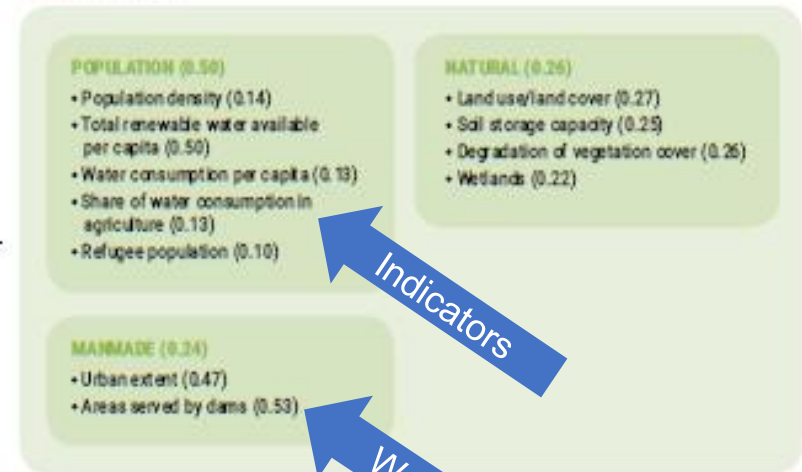
VA Methodological Note

VA: Water Availability Impact Chain

EXPOSURE (0.50)



SENSITIVITY (0.50)

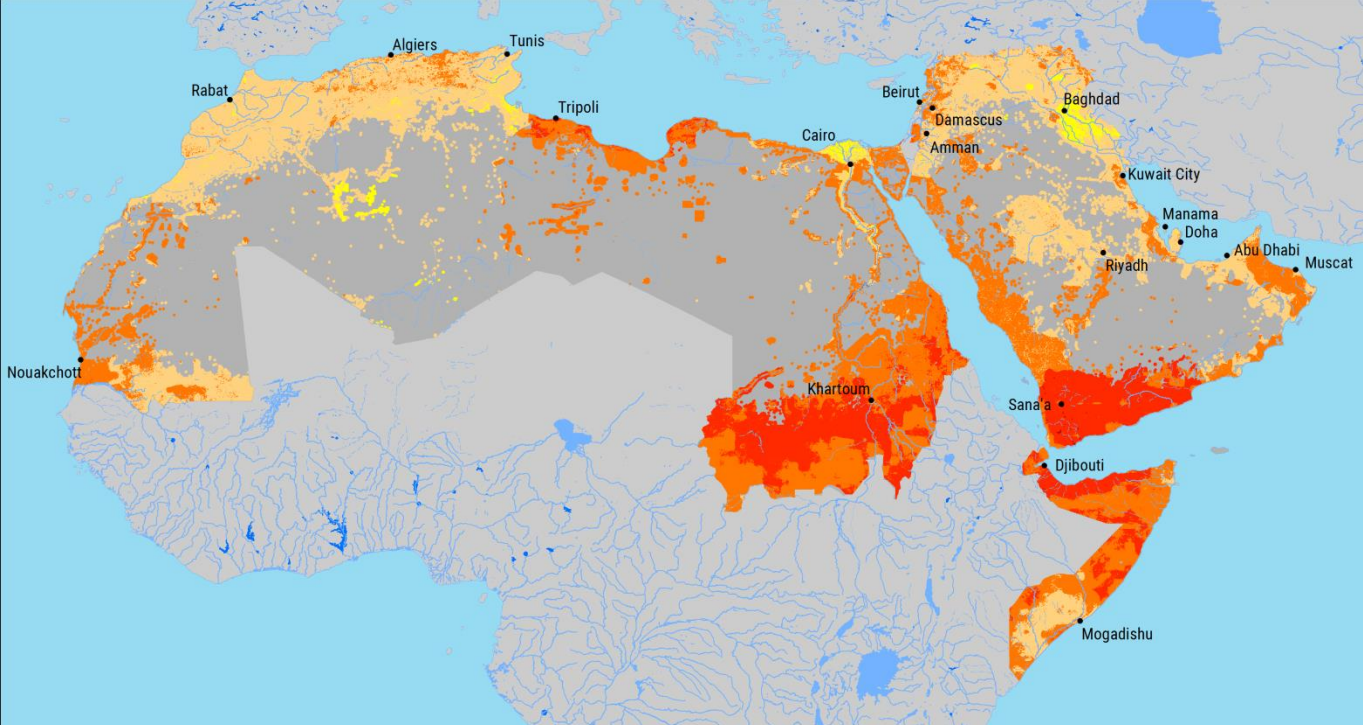


POTENTIAL IMPACT (0.50)

VULNERABILITY ASSESSMENT

ADAPTIVE CAPACITY (0.50)





Areas with highest vulnerability:

- Upper Nile Valley
- SW Arabian Peninsula
- Northern Horn of Africa

Areas with lowest vulnerability:

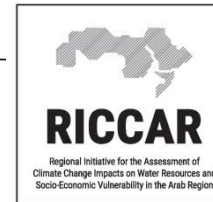
- Tigris-Euphrates Basin
- Lower Nile Valley and Delta

WATER: WATER AVAILABILITY

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

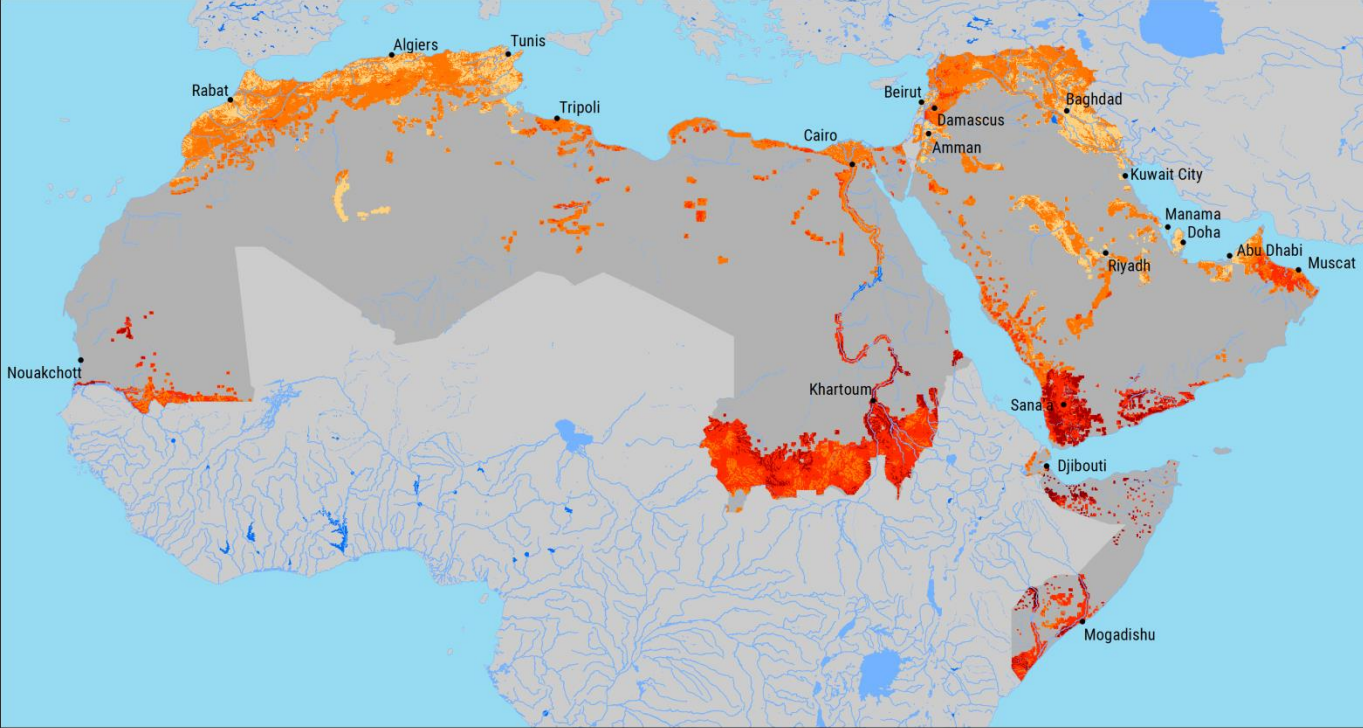
Legend

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



Scenario	Vulnerability (% of study area)		
	Low	Moderate	High
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%

**Water Availability
Vulnerability
(RCP8.5 End-century)**



Areas with highest vulnerability:

- Sub-Saharan Africa
- Horn of Africa
- SW Arabian Peninsula

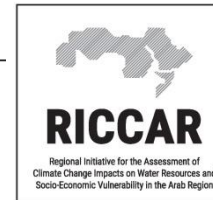
Areas with lowest vulnerability:

- Mediterranean coast of the Magreb
- Selected areas Levant
- Tigris-Euphrates basin
- Central eastern Arabian Desert

AGRICULTURE: WATER AVAILABLE FOR CROPS
VULNERABILITY: RCP8.5 END-CENTURY (2081-2100)

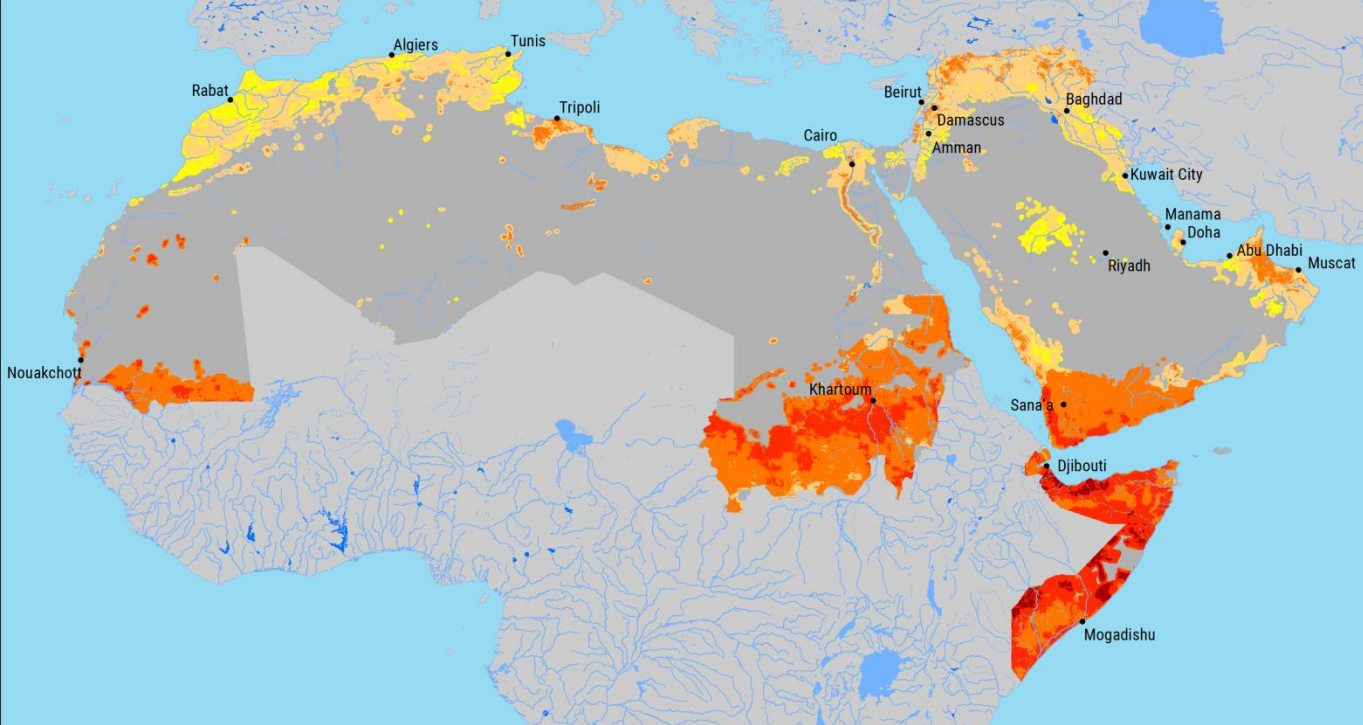
Legend

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



Scenario	Vulnerability (% of study area)		
	Low	Moderate	High
RCP 4.5 Mid-century	0%	50%	50%
RCP 8.5 Mid-century	0%	33%	67%
RCP 4.5 End-century	0%	43%	57%
RCP 8.5 End-century	0%	16%	84%

Water Available for Crops Vulnerability
(RCP8.5 End-century)



Areas with highest vulnerability:

- Sub-Saharan Africa
- Levant
- Upper Tigris-Euphrates Basin
- Al Hajar Mountains
- Horn of Africa
- SW Arabian Peninsula

Areas with lowest vulnerability:

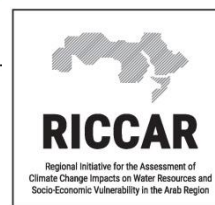
- Atlas Mountains and Plains
- Central Arabian Desert

AGRICULTURE: WATER AVAILABLE FOR LIVESTOCK

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

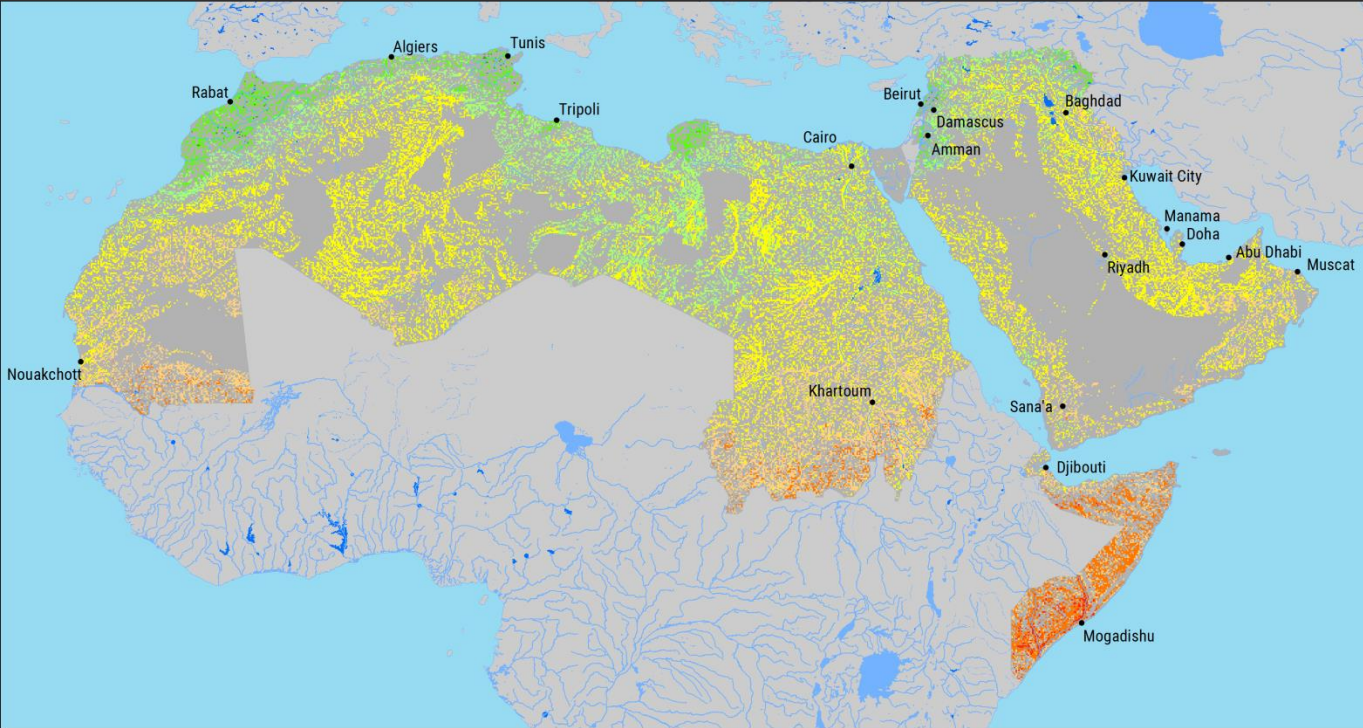
Legend

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



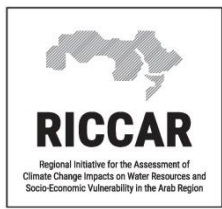
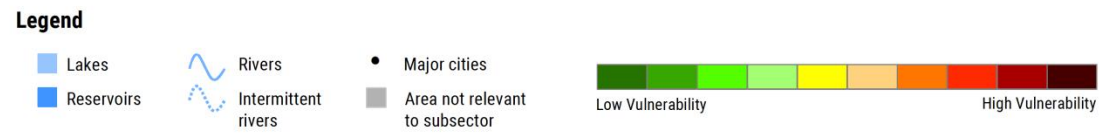
Scenario	Vulnerability (% of study area)		
	Low	Moderate	High
RCP 4.5 Mid-century	0%	67%	33%
RCP 8.5 Mid-century	0%	55%	45%
RCP 4.5 End-century	0%	58%	42%
RCP 8.5 End-century	0%	46%	54%

Water Available for Livestock Vulnerability (RCP8.5 End-century)



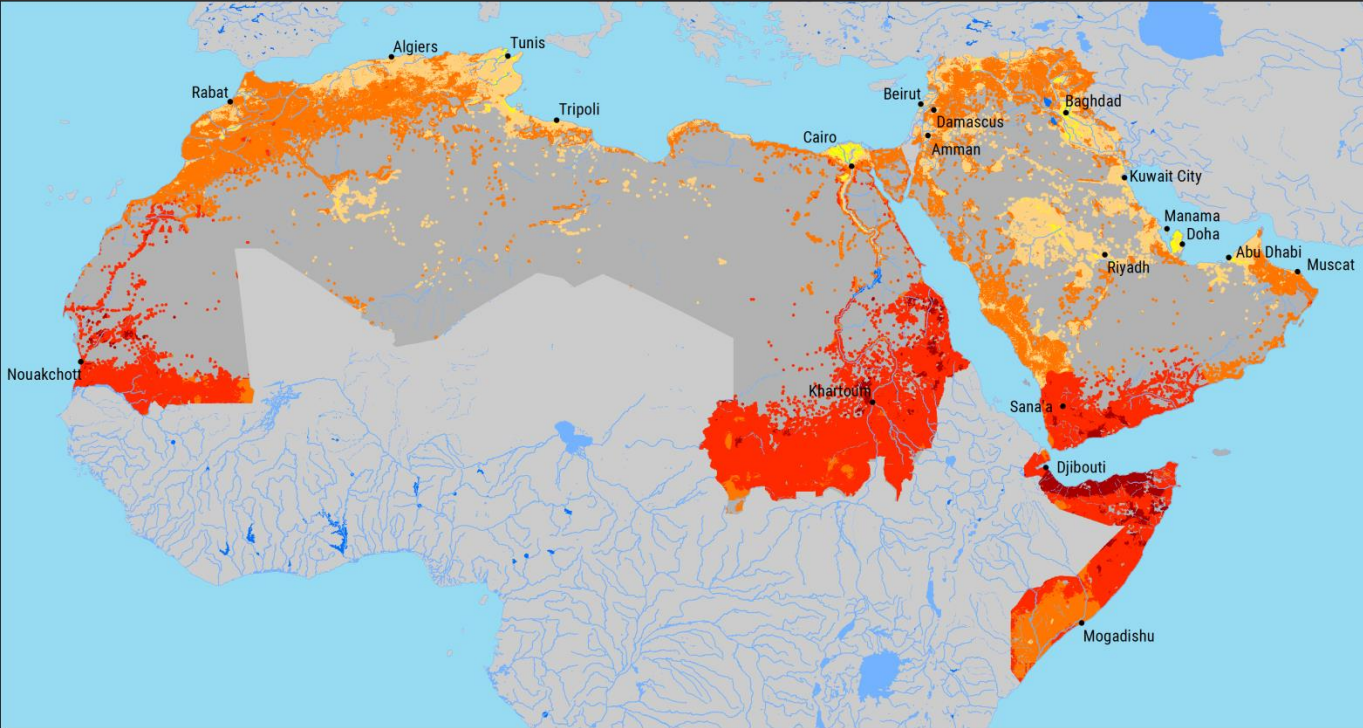
- Areas with highest vulnerability:**
- All coastal areas
- Areas with lowest vulnerability:**
- Sub-Saharan Africa

INFRASTRUCTURE AND HUMAN SETTLEMENTS: INLAND FLOODING AREA
VULNERABILITY: RCP8.5 END-CENTURY (2081-2100)



Scenario	Vulnerability (% of study area)		
	Low	Moderate	High
RCP 4.5 Mid-century	2%	94%	4%
RCP 8.5 Mid-century	3%	93%	4%
RCP 4.5 End-century	2%	94%	4%
RCP 8.5 End-century	4%	89%	7%

Inland Flooding Area Vulnerability (RCP8.5 End-century)



Areas with highest vulnerability:

- Selected areas near Gulf of Aden
- Central eastern Red Sea

Areas with lowest vulnerability:

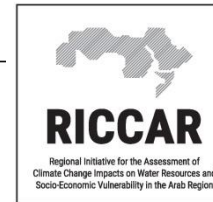
- Lower Nile Valley

PEOPLE: EMPLOYMENT RATE FOR THE AGRICULTURAL SECTOR

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

Legend

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



Scenario	Vulnerability (% of study area)		
	Low	Moderate	High
RCP 4.5 Mid-century	0%	39%	61%
RCP 8.5 Mid-century	0%	28%	72%
RCP 4.5 End-century	0%	36%	65%
RCP 8.5 End-century	0%	23%	77%

**Employment Rate
for the
Agricultural Sector
Vulnerability
(RCP8.5 End-century)**

Main Findings and Conclusions

- 1** The temperature in the Arab region is increasing and is expected to continue to increase until the end of the century.
- 2** Precipitation trends are largely decreasing across the Arab region until the end of the century, though limited areas expected to exhibit an increase in the intensity and volume of precipitation.
- 3** Extreme climate indices and seasonal projections provide valuable insights into climate change impacts, particularly at smaller scales of analysis.
- 4** Analysis of climate change impacts on shared water resources can benefit from regional and basin-level assessments.
- 5** Sector case studies enhance understanding of climate change implications.
- 6** Predicted vulnerability is largely moderate to high and exhibits a generally increasing gradient from north to south across the Arab region.
- 7** Both components of potential impact are important to consider when conducting vulnerability assessments.
- 8** Of the three components of the VA, adaptive capacity is most likely to influence vulnerability, suggesting that the ability of mankind to influence the future is stronger than that of climate change and environmental stressors.
- 9** Areas with the highest vulnerability, which have been defined as hotspots, generally occur in the Horn of Africa, the Sahel and the south-western Arabian Peninsula, irrespective of sector, subsector or projected climate scenario.

Main Findings and Conclusions

- 10** Despite declining precipitation, areas with the lowest vulnerability relative to the region include the western Mediterranean, coastal Maghreb, and the coastal Levant due to higher adaptive capacity in this area compared to other parts of the region.
- 11** Even though the central Mediterranean coast and Green Mountains are subject to particularly strong warming, the area is indicative of moderate vulnerability due to relatively higher adaptive capacity, as compared to other parts of the region.
- 12** Despite precarious environmental, economic and social conditions within the lower Nile River Basin, the area demonstrates projected moderate vulnerability due to high adaptive capacity relative to other parts of the region.
- 13** Although the Euphrates and Tigris rivers face challenges due to demographic pressures, hydro-infrastructure developments and water quality degradation, socioeconomic vulnerability to climate change is found to be moderate relative to other parts of the region.
- 14** Despite remaining among the hottest areas in the Arab region, and signalling increasing temperatures, the Arabian Gulf generally projects moderate vulnerability to climate change.
- 15** Region-specific integrated vulnerability assessments can be drawn upon to inform regional cooperation, as well as basin level, country level and sector level analysis to advance understanding and collective action on climate change.



Thank You

RICCAR Main Report & Technical Annex:

www.unescwa.org/climate-change-water-resources-arab-region-riccar

RICCAR High Level Meeting Documentation

<https://www.unescwa.org/events/riccar-climate-change-assessment-arab-region>

www.riccar.org