RICCAR REGIONAL KNOWLEDGE HUB DATA PORTAL:

Climate information to bridge data gaps in water and agriculture sectors

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Introduction

To better understand the impact of climate change on water resources and agriculture in the Arab region, the ESCWA Arab Centre for Climate Change Policies (ACCCP)[1] has been coordinating the Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) since 2009. This initiative provides a scientific basis for informing climate change policy and priority setting through a region-specific geospatial integrated assessment methodology.

Data and assessments are provided on the RICCAR Regional Knowledge Hub Data Portal[2], that serves as a common platform for assessing and addressing regional climate change challenges. This platform supports dialogue, priority-setting, policy formulation, and responses to climate change at the Arab regional level, ensuring that decision-makers are equipped with reliable data and analyses to shape more effective climate strategies. For example, RICCAR has provided assessments on how changes in temperature and precipitation patterns are expected to affect socio-economic resilience in river basins in Algeria and Lebanon, exacerbating water scarcity and affecting agriculture, tourism, and water supply. Additionally, RICCAR has developed climate models that project increased drought frequency in North African countries, highlighting vulnerabilities for water-dependent sectors such as agriculture and livestock.

RICCAR Regional Knowledge Hub data portal

RICCAR employs scientific methods and consultative processes to enhance access to knowledge, build capacity, and strengthen institutions for climate change assessment in the Arab region. Through its Regional Knowledge Hub (RKH) several climatological datasets exist for hydrological and agricultural analyses.

Regional climate modeling (RCM) is particularly useful for climate change analysis as it projects future climate by considering different greenhouse gas scenarios, leading to non-linear changes in temperature and precipitation. However, RCM outputs, based on global climate models, carry uncertainties and biases due to factors like spatial resolution and simplified climate processes. These biases are reduced by using multiple model outputs and bias-adjusted RCM data. Over long periods (10-30 years), RCM data aligns with observed climatological statistics despite some differences.

The RKH includes RCM outputs for the **Arab Domain** (which includes all Arab States except Comoros) which in turn can be used to inform dialogue, priority setting, policy formulation and responses to climate change across the region. This data is available at **50 km resolution** and includes three downscaled models and two climate scenarios (RCP4.5 and RCP8.5[3]) and covers the period from 1951-2100.

In response to the need for more detailed climate data, the **Mashreq Domain** was established. This data is available at **10 km resolution**, includes six downscaled models and two climate scenarios: SSP2-4.5 and SSP5-8.5[4], which are updated RCP scenarios that factor in differing potential shared socioeconomic pathways. The Mashreq Domain is available from 1961-2070.

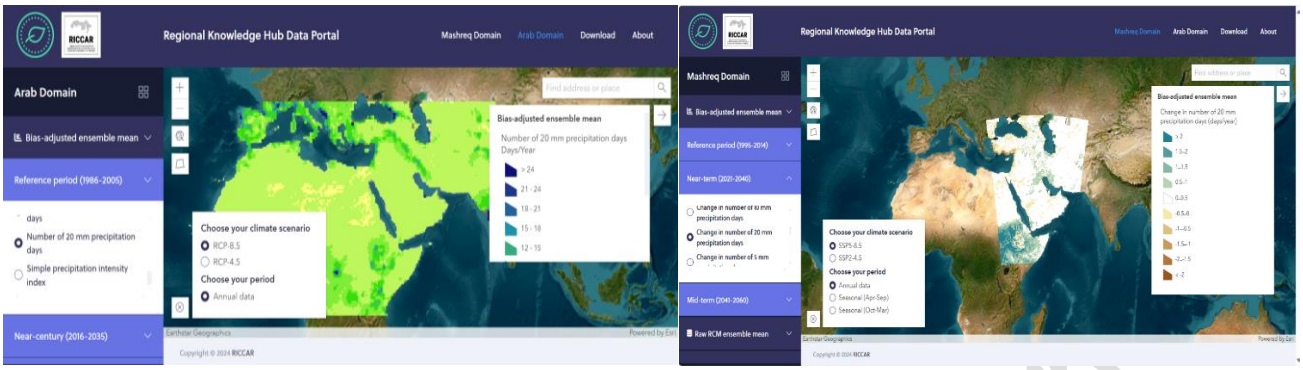
[1] More information on ACCCP is available at https://www.unescwa.org/acccp

[2] RKH can be accessed at: https://www.unescwa.org/portal/riccar-data

[3] Representative Concentration Pathways (RCPs) describe potential future greenhouse gas concentration trajectories and were proposed by the IPCC Fifth Assessment Report (AR5) for use in CMIP5 models

[4] Shared Socioeconomic Pathways (SSPs) refer to five potential socioeconomic development scenarios for global or regional societies. They pair with the RCPs to represent a wider range of climate futures and were proposed in the IPCC Sixth Assessment Report (AR6) for used in CMIP6 models.

Figure 1. RICCAR Regional Knowledge Hub data portal (Arab and Mashreq Domains)



Furthermore, the Arab Centre for Climate Change also utilizes data from the **European Domain** evaluated under the Coordinated Regional Climate Downscaling Experiment (Euro-CORDEX). This domain extends into North Africa. Downscaling CMIP6 models (based on the latest generation SSPs) is in process. However, data from the downscaled CMIP5 models (based on the RCPs) is still acceptable and widely used. Currently available data represents a **12.5 km spatial resolution**, includes three scenarios (RCP2.6, RCP4.5 and RCP8.5) and is available from 1970-2100.

Table 1. Bias-adjusted Regional Climate Modelling (RCM) outputs developed as part of RICCAR (except for Euro-CORDEX) and endorsed by the Arab Centre for Climate Change Policies

Domain	Spatial resolution	Climate scenarios	Time period	Domain extent
Arab Domain (CORDEX-MENA)	0.44 ° (~50 km)	RCP4.5 and RCP8.5	1951-2100	27W-76E, 7S-45N
Mashreq Domain	0.10 ° (~10 km)	SSP2-4.5 and SSP5-8.5	1961-2070	24E-69E, 1N-46N
Euro-CORDEX	0.11 ° (~12.5 km)	RCP2.6, RCP4.5 and RCP8.5	1971-2100	44W-65E, 22N-73N

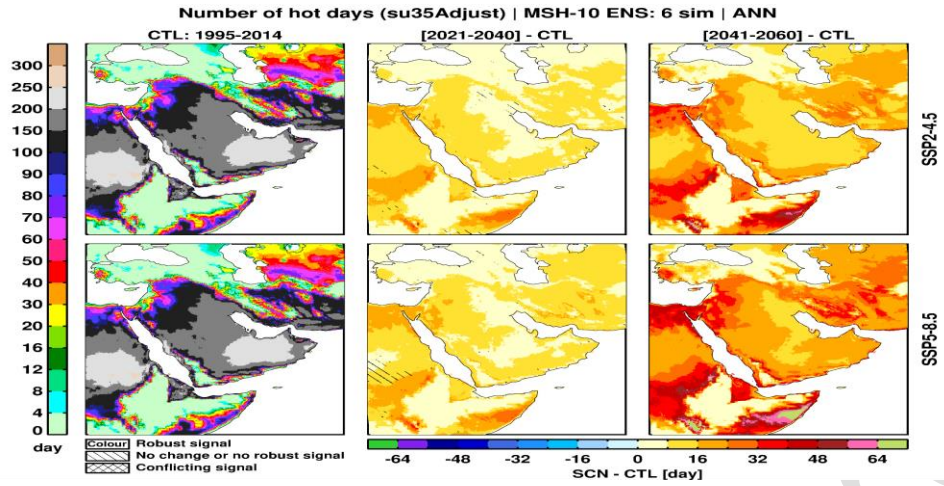
RICCAR's climate datasets:

RICCAR assesses the impacts of climate change on freshwater resources and examines the implications of these impacts for socio-economic and environmental vulnerability based on the region's characteristics. Climate models generate various atmospheric data, both near the Earth's surface and higher up in the atmosphere. They also provide land surface and water body information depending on the model used.

The most common and recent variables used in RICCAR climate modeling include:

- Temperature
- Precipitation
- Total Runoff
- Evaporation (including transpiration)
- Total Soil Moisture
- Dust Uplift Potential (DUP), (based on 10-meter wind data)

FIGURE 2: Annual projected change in the number of "hot days" (SU35, Tmax > 35°C) in 2021-2041 and 2041-2060 for the ensemble mean of the six regional Mashreq projections under the SSP2-4.5 and SSP5-8.5 scenarios compared to the baseline period 1995-2014. Source (SMHI, 2024)



Available datasets thus include bias-adjusted precipitation and temperature as well as extreme event indices. Extreme events are of great importance to develop adaptation strategies as they better represent the local processes related to weather/climate extremes (Table 2). In addition, several raw (not bias-adjusted) RCM outputs are available for analysis including evaporation, total runoff, total soil moisture content and wind speed.

Table 2. Extreme events indices based on bias-adjusted precipitation and temperature data

Index	Long name	Definition	Units
SU	Number of summer days	Frequency of daily maximum temperature > 25 °C	days
SU35	Number of hot days	Frequency of daily maximum temperature > 35 °C	days
SU40	Number of very hot days	Frequency of daily maximum temperature > 40 °C	days
TR	Number of tropical nights	Frequency of daily minimum temperature > 20 °C	days
FD	Number of frost days	Frequency of daily minimum temperature > 20 °C	days
CDD	Consecutive dry days	Maximum number of consecutive days when precipitation < 1 mm	days
CWD	Consecutive wet days	Maximum number of consecutive days when precipitation ≥1 mm	days
R10	Heavy precipitation days	Frequency of precipitation ≥ 10 mm	days
R20	Very heavy precipitation days	Frequency of precipitation ≥ 20 mm	days
SDII	Simple precipitation intensity index	Ratio of total annual precipitation to the number of wet days (≥1 mm)	mm

Use of RICCAR Datasets

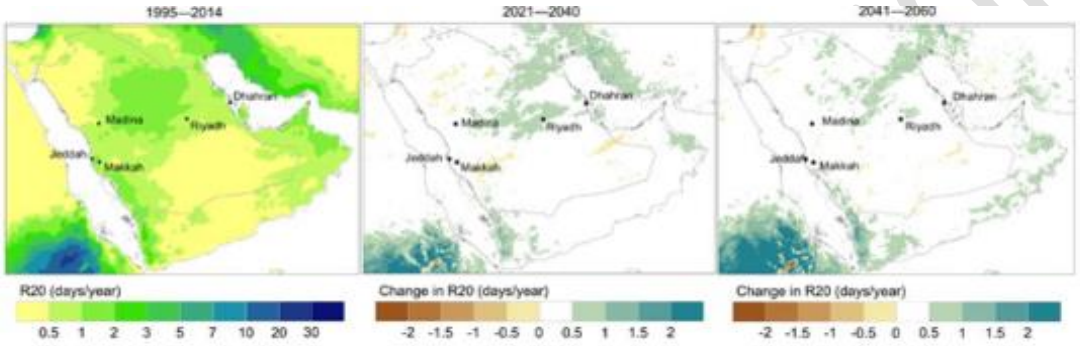
Both the Arab Domain and Mashreq Domain datasets are open-source and are available from the RICCAR Regional Knowledge Hub (www.riccar.org). Available data includes both the RCM ensemble geospatial datasets as well as the full data catalogue for more detailed analysis (netCDF format). Tailored datasets are complimentary and can be obtained with a formal data request. Moreover, technical assistance is available to help simplify usage of climate model data.

To date, RICCAR climate datasets have been used for multiple hydrological and agricultural analyses whereby technical reports for each of these studies are available from the RICCAR Regional Knowledge Hub.

Some examples are listed below:

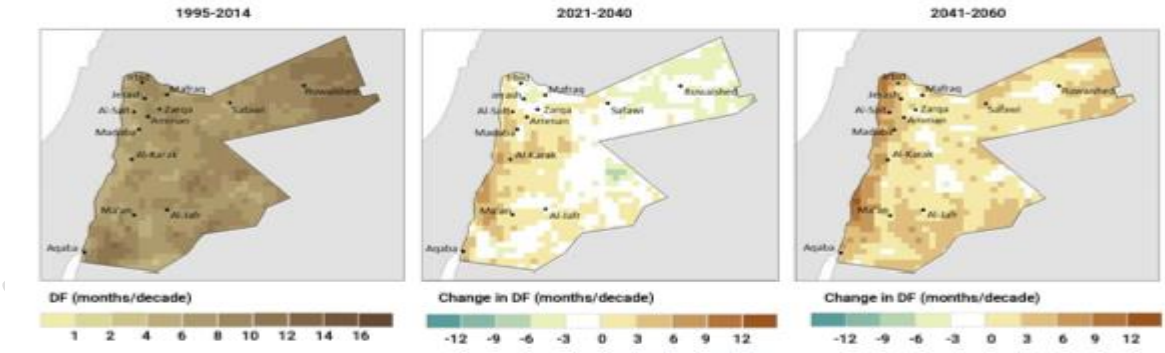
- Assessment of climate change impacts on groundwater resources in the Ben-Amir aquifer (Tadla complex, Morocco), the Eocene Aquifer System in Palestine and the Dibdibba Aquifer System in Iraq
- Climate change impacts on selected crops for watershed management design and resilience (Nahr el Kalb and Nahr el Kabir in Lebanon and Algérois Basin in Algeria)
- Regional climate modelling outputs for Saudi Arabia: Key findings

Figure 3: Mean annual change in very heavy rain days (days when precipitation ≥ 20 mm; R20) for the near term (2021–2040) and the midterm (2041–2060) compared to the reference period (1995–2014) based on the bias-corrected Mashreq Domain RCM outputs, SSP5-8.5[5]



- Vulnerability assessment of the water sector to climate change in Jordan.

Figure 3: Change in drought frequency compared to the reference period based on six bias-corrected models from the Mashreq Domain, SSP5-8.5[6]



- Impact of climate change on shared water resources in the Euphrates basin that includes an analysis of localized impacts of climate change on wheat yields and a discussion of climate change impacts on GDP in the Basin.
- Bias-adjusted RCM outputs are currently being used for several groundwater aquifer analyses in Iraq, Palestine, Tunisia and Morocco.
- In addition, a drought assessment based on the Standardized Precipitation Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI) is in progress to evaluate projected changes in drought frequency, intensity and severity.

[5] ESCWA. 2023. Regional climate modelling outputs for Saudi Arabia: Key findings. RICCAR technical report, Beirut, E/ESCWA/CL1.CCS/2023/RICCAR/TECHNICAL REPORT.18.

[6] ESCWA. 2022. Vulnerability assessment of the water sector to climate change in Jordan. RICCAR technical report, Beirut, E/ESCWA/CL1.CCS/2022/RICCAR/Technical Report.16.

Conclusion

The RICCAR regional climate modeling (RCM) projections for the moderate emissions scenario (SSP2-4.5) were completed for the Mashreq Domain, with a report on the outputs under preparation. These projections, comparing the six-member ensemble outputs for SSP2-4.5 and SSP5-8.5, are being used to support climate analysis (namely Sand and Dust storm, drought, etc) and team at the ACCCP providing technical assistance to countries for their national and sub-national policy planning.

The RICCAR Regional Knowledge Hub (RKH) Mashreq Data Portal has been updated to include these new projections, featuring a GIS-based data portal and a comprehensive data catalogue for user download and analysis. ESCWA continues to enhance user accessibility, with over 14,865 visits and 18,897 data downloads recorded between January and June 2024. Tailored maps and datasets were provided upon request to several government institutions and researchers, accompanied by technical assistance to refine and meet specific data needs.

Arab Countries are thus invited to benefit from the available climate change data and capacity building activities available under the RICCAR initiative hosted by ACCCP for informing water and agriculture policies.