HIGH-RESOLUTION CLIMATE PROJECTIONS TO SUPPORT ADAPTATION PLANNING IN THE MASHREQ REGION

Grigory Nikulin[1], Phil Graham[1], Marlene Ann Tomaszkiewicz[2], Carol Chouchani Cherfane[2], Peter Berg[1], Thomas Bosshard[1], Wei Yang[1] and Aitor Aldama Campino[1].
[1]Swedish Meteorological and Hydrological Institute (SMHI), Norrköping, Sweden
[2]United Nations Economic and Social Commission for Western Asia (ESCWA), Beirut, Lebanon

SUMMARY

Climate change information at regional and local scale is highly demanded by a wide range of stakeholders worldwide for impact modelling and adaptation planning. However, high-resolution climate projections that are the basis for regional climate information are still missing or not easily accessible in many regions. We present an integrated approach to provide high resolution (10km) regional climate projections and related datasets in order to inform science-based assessments and analysis of climate impacts on water and agriculture in the Mashreq region. This initiative was developed within the Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR, www.riccar.org). The 10km regional climate projections for the Mashreq region provide a useful package of high-resolution climate data that has already been used for climate change vulnerability and impact assessments in the region.

REGIONAL CLIMATE MODEL AND DOMAIN

The HCLIM-ALADIN Regional Climate Model was used over the Mashreq Domain at 10 km horizontal resolution. HCLIM-ALADIN is part of the HCLIM38 system for regional climate modelling developed by a consortium of national meteorological institutes in Europe. A specific aim is to establish a comprehensive modelling system with appropriate configurations that can be applied across different scales to provide good results without additional region-specific tuning (*Belušić et al. 2020*).

RICCAR Mashreq Domain | 10km | MSH-10
HCLIM-ALADIN (SMHI)
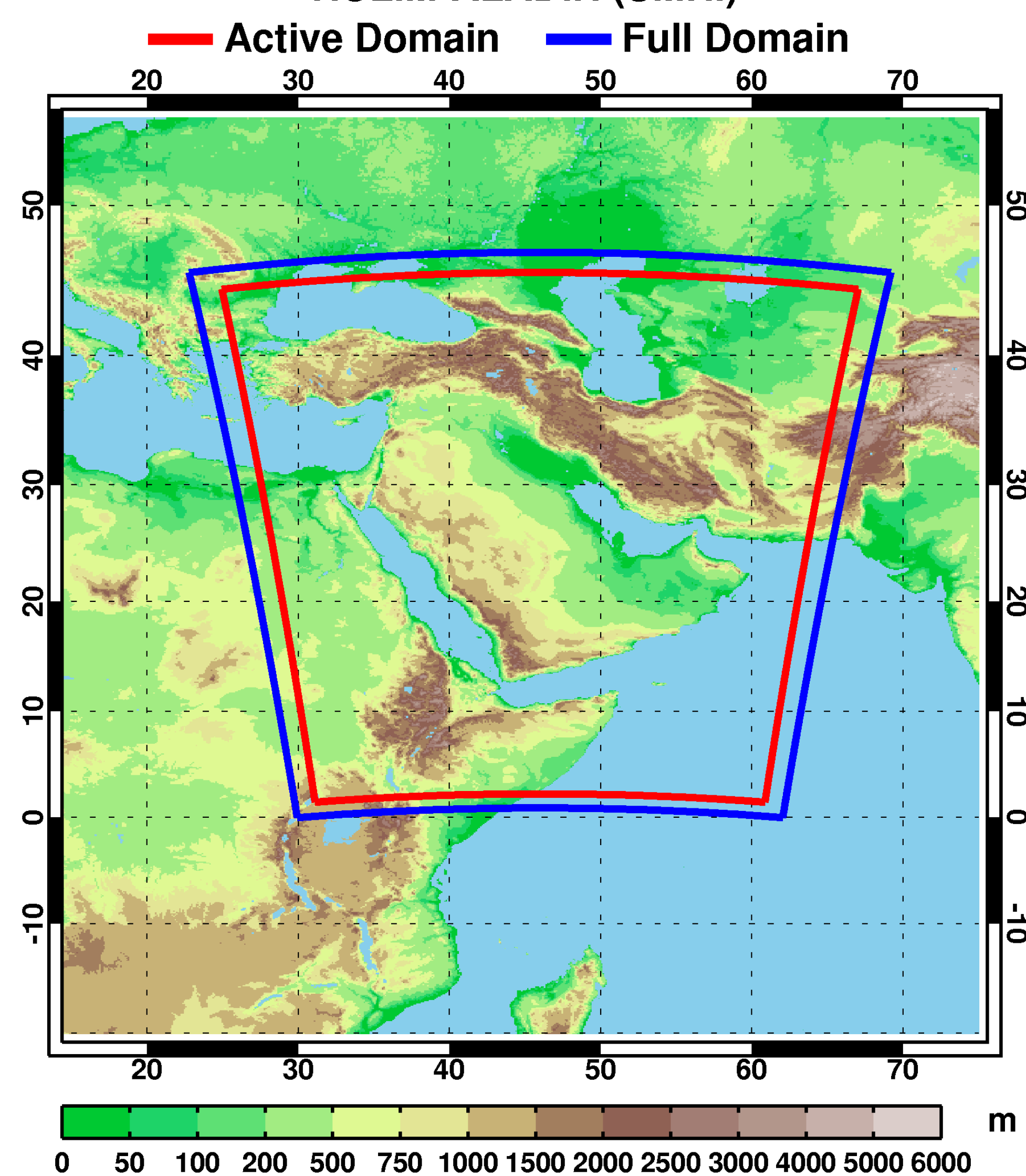
The Mashreq domain covers the eastern Mediterranean coastal countries of Syria, Lebanon, Palestine and north-eastern Egypt, the entire drainage basins of the Tigris and Euphrates Rivers, and the entire Arabian Peninsula.

MASHREQ HCLIM-ALADIN ENSEMBLE

The Mashreq HCLIM-ALADIN ensemble was generated in two phases of the project. The first phase (2020-2021) included downscaling of 6 CMIP6 GCMs under the SSP5-8.5 scenario for the 1961-2070 period. The second phase is ongoing (2022-2023) and extends the SSP5-8.5 ensemble by downscaling the SSP2-4.5 scenario. IPSL-CM6A-LR was downscaled in the 2nd Phase as a replacement for MRI-ESM2-0 which doesn't provide RCM forcing for SSP2-4.5.

CMIP6 GCM	ECS °C	TCR °C	SSP5-8.5 (2020-2021)	SSP2-4.5 (2022-2023)
NorESM2-MM	2.5	1.33	✓	✓
MPI-ESM1-2-LR	3.0	1.84	✓	✓
MRI-ESM2-0	3.1	1.64	✓	no forcing for RCM
CMCC-CM2-SR5	3.5	2.09	✓	✓
EC-Earth3-Veg	4.4	2.60	✓	✓
CNRM-ESM2-1	4.8	1.83	✓	✓
IPSL-CM6A-LR	4.7	2.35	✓	✓

ECS - equilibrium climate sensitivity: TCR - transient climate response

MODEL OUTPUT AND DERIVED DATASETS

Model output includes about 50 variables and in general follows the *CORDEX-CMIP5 variable list* with a number of additional variables (e.g. wind at 50 and 100m). The most common variables with a pronounced diurnal cycle are archived at 1-hourly output frequency instead of 3-hourly output in CORDEX-CMIP5. After postprocessing and quality control daily precipitation and mean/maximum/minimum temperatures were bias-adjusted (see details below). At next step, a number of precipitation- and temperature-based extreme event indices most relevant for the Mashreq region (e.g. number of hot days with different thresholds, maximum length of dry spells etc.) are calculated. In addition to the common set of the indices, tailored datasets can be also provided upon request. For example, proxies for dust emission (e.g. Dust Uplift Potential) are under development in order to fill remaining regional knowledge gaps on how climate change may affect sand and dust storms.

BIAS ADJUSTMENT

Bias adjustment is the collective term for the process of reducing biases (errors) in climate model output in a post processing step. MultI-scale bias AdjuStment (MidAS; *Berg et al. 2021*) and the Hydrological Global Forcing Data (HydroGFD3; *Berg et al. 2021*) at 25km resolution as a reference dataset are used for bias adjustment of the 10km Mashreq ensemble.

- Temperature: cascade bias adjustment (two time scales): one cascade for a 31-day running average and another of daily anomalies from the running average; spatial cascade - the fine scale information of the RCM is retained by performing bias adjustment only on a coarse cascade scale of the reference dataset (25km).
- Precipitation: the number of wet days is adjusted, when too few wet days additional wet days are generated by Singularity Stochastic Removal (*Vrac et al. 2016*).
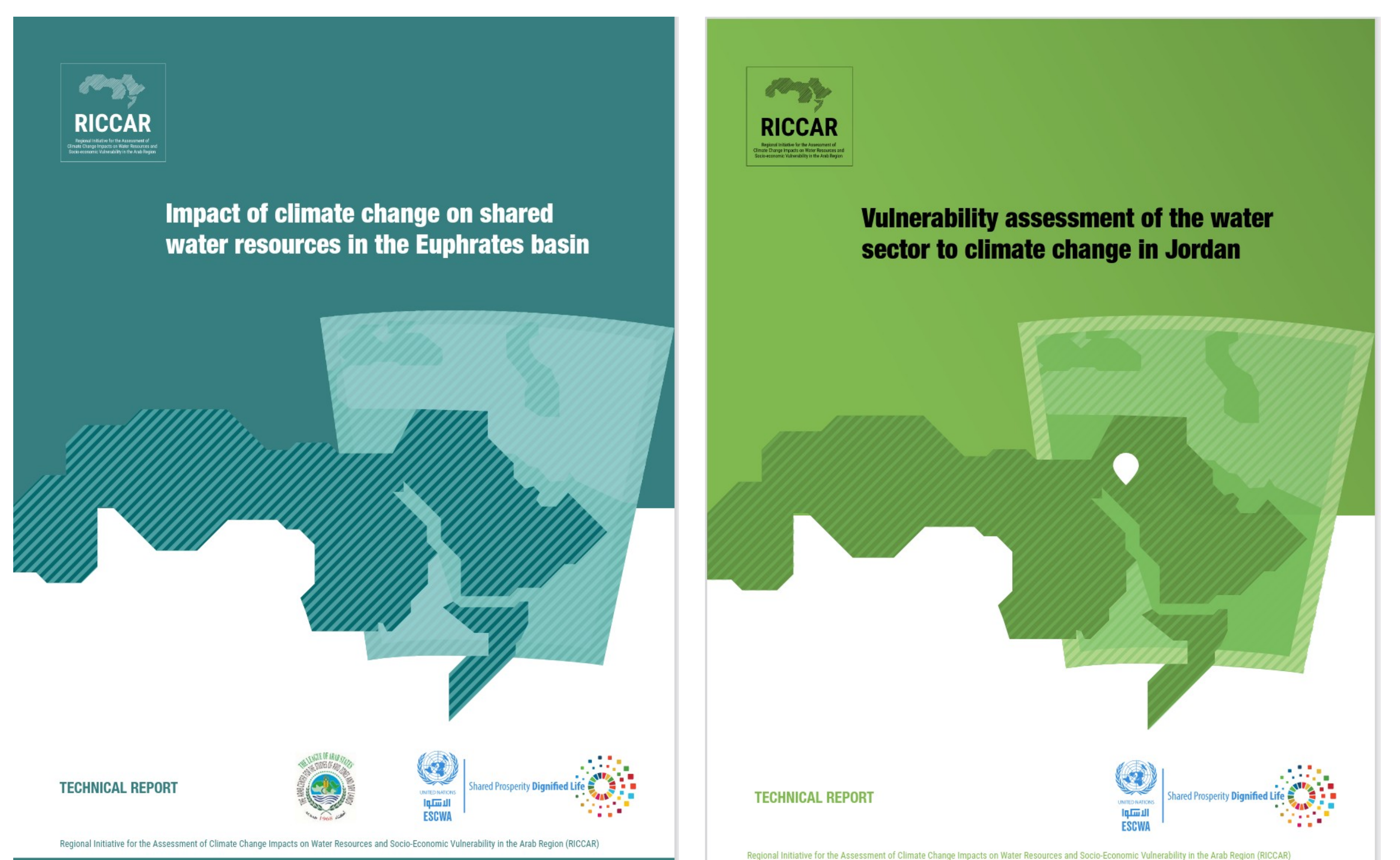
DATA AVAILABILITY

A subset of variables for for the MSH-10 SSP5-8.5 ensemble are available from the RICCAR Regional Knowledge Data Portal and the SSP2-4.5 ensemble will be provided by the end of 2023. It is also planned to make a more complete archive, including sub-daily output, available through the Earth System Grid Federation (ESGF).

Mashreq Domain Data Portals
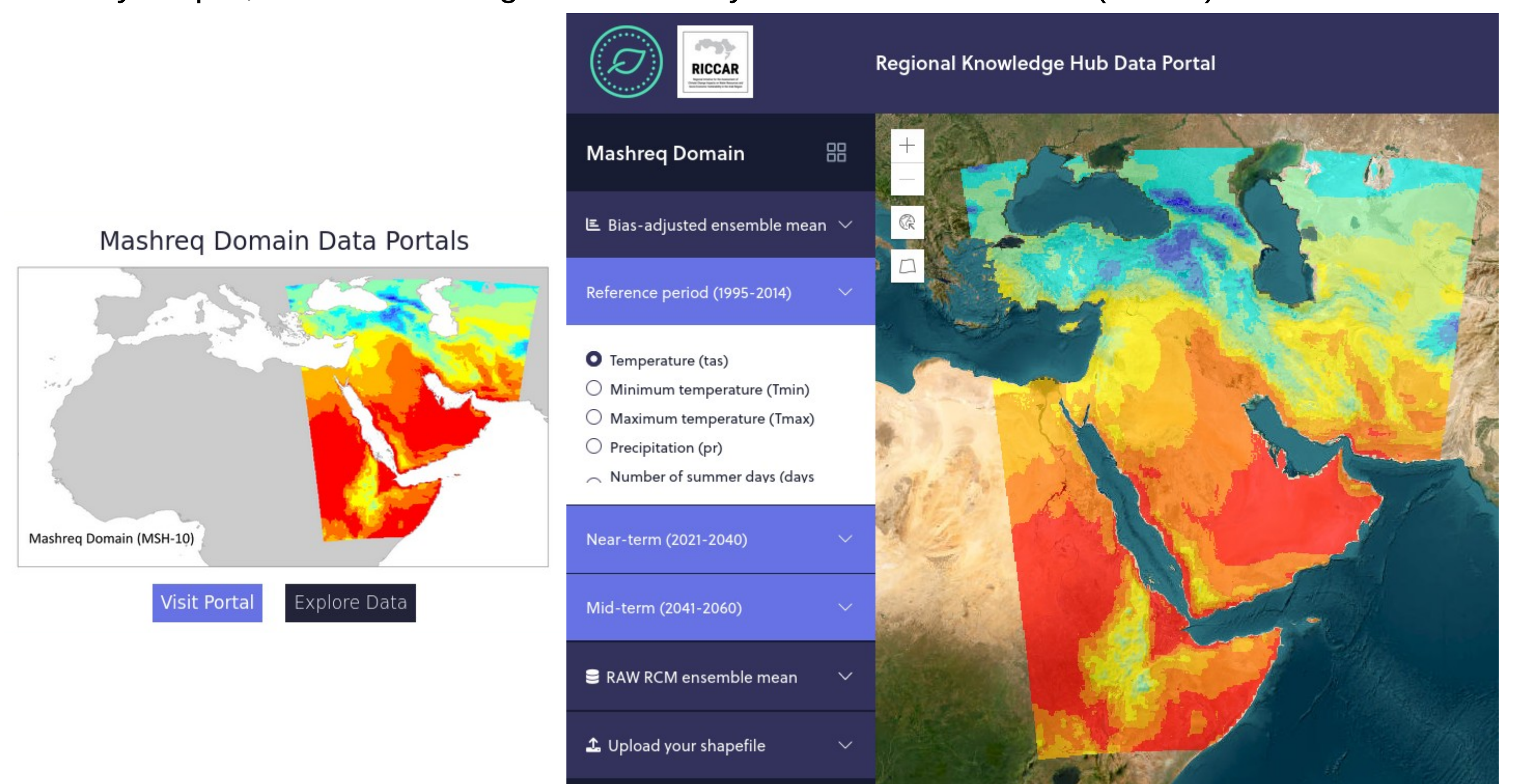
VULNERABILITY AND IMPACT ASSESSMENTS

The Mashreq SSP5-8.5 ensemble has already been used for climate change vulnerability and impact assessments with focus on the water sector and water resources in the Mashreq region. Current work also includes sand and dust storms analysis.