2081-2100 compared to the baseline period 1986-2005, in an ensemble of projections. Trends towards drier conditions are shown, indicating that the dry season (summer) is extending in length, particularly in North Africa and the western and southern parts of the Arabian Peninsula.

Figure V. Changes in heavy precipitation days

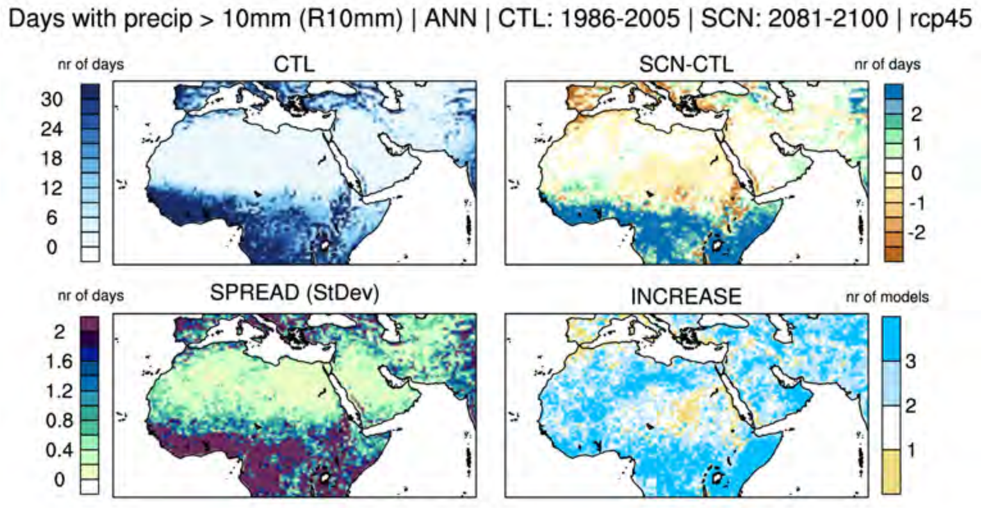

Figure V features the changes in heavy precipitation days (R10mm, annual number of days when precipitation ≥ 10 mm) using RCP4.5, for the period 2081-2100 compared to the baseline period 1986-2005, in an ensemble of projections. Decreasing trends are shown, indicating that that there will be an overall reduction of the number of precipitation days throughout the Arab region.

Figure VI. Changes in wind indices

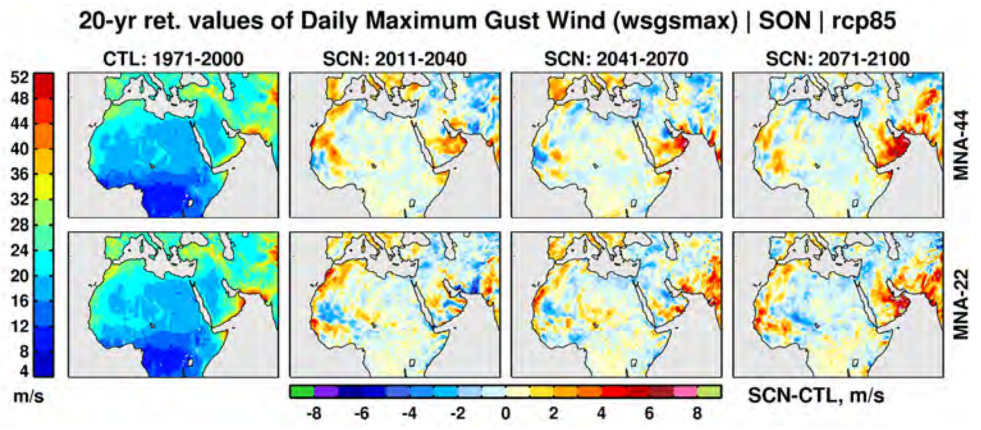

Figure VI features the 20-year return values of daily maximum gust wind (in metres per second), which is an event that occurs once in 20 years.

Values are calculated using the generalized extreme value distribution for three 30-year periods till 2100, compared to the baseline period 1971-2000. An increase in wind extremes in the south-west of the Arab Peninsula was noticed, as well as a large variability in the phenomenon for both 25 kilometre and 50 kilometre grid cell resolutions.

Conclusion

The analysis of the projected extreme climate indices have shown consistent warming trends across the Arab region, with an increasing frequency of warm days and warm nights. The precipitation changes were less significant but dryer conditions and a slight reduction of heavy rainfall on the region were evident.

The occurrence of extreme precipitation reflected stronger spatial variability than temperature extremes. Some additional climate indices should be analysed to reflect the specific characteristics of the climate in the arid and semi-arid Arab region, namely to detect maximum temperatures, heat waves, sandstorms, flash floods and other extreme climate conditions. New regional climate models should be added to the ensemble to reduce the variability of model results, in particular for future changes in precipitation and other related hydrological parameters.

RICCAR Partners

United Nations ESCWA, UNEP, WMO, ACSAD, LAS, SMHI, UNESCO Cairo Office, giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, UNISDR, FAO, United Nations University UNU-INWEH

Research Institutes supporting Climate Ensemble

- Center of Excellence for Climate Change Research / King Abdulaziz University (CECCR / KAU) – Saudi Arabia
- King Abdullah University of Science and Technology (KAUST) – Saudi Arabia
- Climate Services Center (CSC) – Germany

Donors

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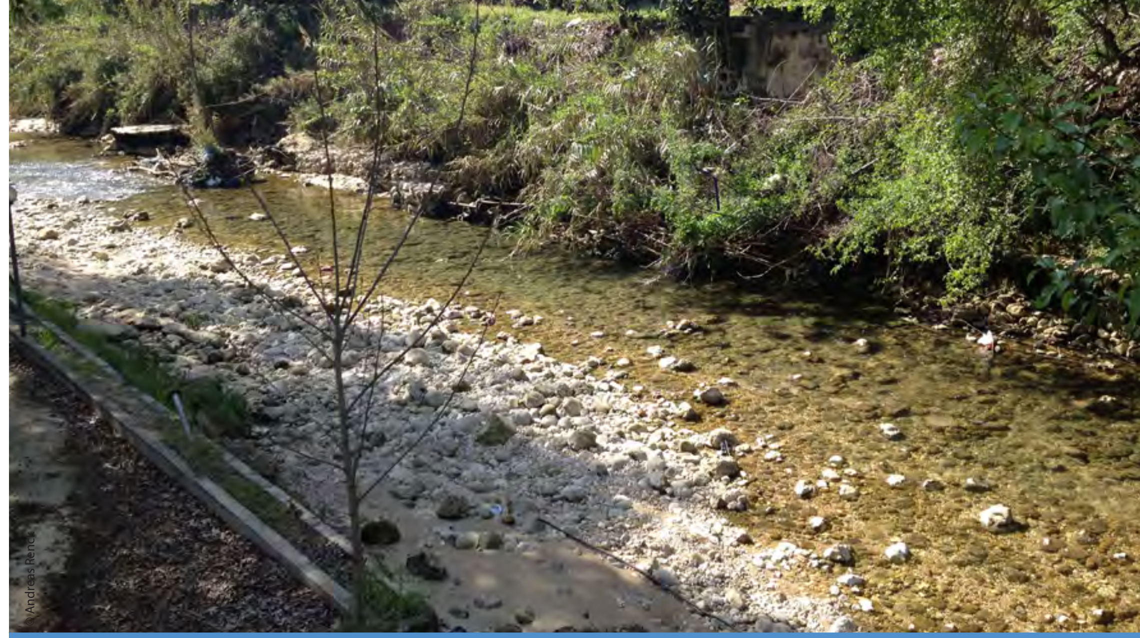


Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR)

Projected Extreme Climate Indices for the Arab Region

LAS

UNITED NATIONS

Introduction

The Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-economic Vulnerability in the Arab Region (RICCAR) is a collaborative initiative by the United Nations and the League of Arab States, implemented jointly by 11 regional and international partners. RICCAR aims to measure the impact of climate change on freshwater resources through an integrated assessment, in order to identify the related underlying causes of socioeconomic and environmental vulnerability in the Arab region. To conduct the impact assessment, an ensemble of regional climate models (RCMs) was developed over the newly established Arab domain, using dynamic downscaling climate projections. RCMs were then linked to regional hydrological models to analyse climate change impacts on water. More information on RICCAR can be found on www.escwa.un.org/RICCAR.

Extreme weather events have a severe impact on many key aspects of our lives, such as health, economy and infrastructure. It is thus necessary to develop modeling tools to predict the patterns of future extreme events, using various climate scenarios, with a view to building the resilience of Arab countries. The region is indeed, as research has shown, one of the world's most vulnerable to climate change.

Methodology

Within the framework of RICCAR, the Swedish Meteorological and Hydrological Institute (SMHI) has conducted analyses using the standard extreme climate temperature and precipitation indicators and indices set by the World Meteorological Organization (WMO) to the year 2100 (see table), in order to detect changes in comparison to historical observations. An ensemble of three regional climate projections was derived over the Arab domain, using the latest modeling version RCA4 and the representative concentration pathways RCP4.5 and RCP8.5. The projected extreme climate indices for temperature and precipitation, as presented by SMHI, are shown in figures I to V. In addition, the 20-year return period of extreme gust wind was detected and analysed through projections (figure VI).

Related Regional Strategies and Action Plans

The analysis of extreme climate events is a key component of RICCAR modeling activities, which aim to inform the strategies and action plans devised for the Arab region. These include:

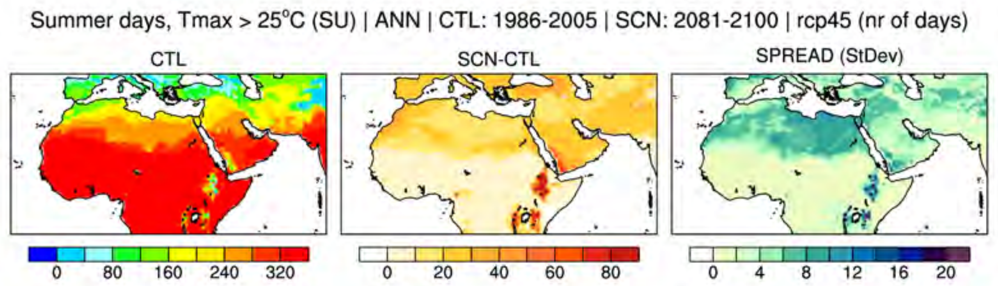
- The Arab Framework Action Plan on Climate Change, adopted by the Council of Arab Ministers Responsible for the Environment (CAMRE) in 2012;
- The Arab Strategy for Water Security in the Arab Region to Meet the Challenges and Future Needs for Sustainable Development 2010-2030, adopted by the Arab Ministerial Water Council in 2011;
- The Arab Strategy for Disaster Risk Reduction 2020, adopted by CAMRE in 2010.

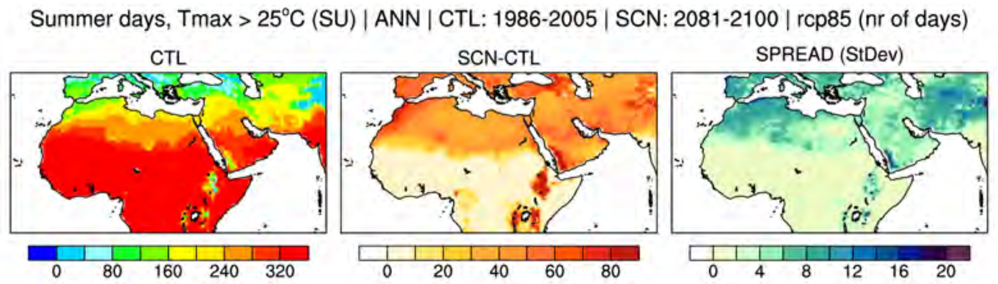
WMO extreme climate index used in RICCAR

Index		Definition	Unit
SU	Summer days	Annual number of days when maximum temperature (Tmax) > 25°C	days
TR	Tropical nights	Annual number of days when minimum temperature (Tmin) < 20°C	days
CSDI	Cold spell duration indicator	Annual number of days with at least 6 consecutive days when Tmin < 10th percentile	days
WSDI	Warm spell duration indicator	Annual number of days with at least 6 consecutive days when Tmax > 90th percentile	days
CWD	Maximum length of wet spell	Maximum annual number of consecutive wet days (when precipitation ≥ 1.0 mm)	days
CDD	Maximum length of dry spell	Maximum annual number of consecutive dry days (when precipitation < 1.0 mm)	days
R10mm	Heavy precipitation days	Annual number of days when precipitation ≥ 10 mm)	days

Long-term Changes in Extreme Climate Indices

Figure I. Changes in temperature indices





Note: The following abbreviations are used in all figures: CTL, control period; SCN, scenario output.

Figure I features the changes in the number of summer days (SU, Tmax > 25°C) in ensembles of three projections using both RCP4.5 and RCP 8.5, for the period 2081-2100 compared to the base period 1986-2005. The projections show significant warming trends and an increase in summer days by the end of the century throughout the Arab region.

Figure II. Changes in tropical nights

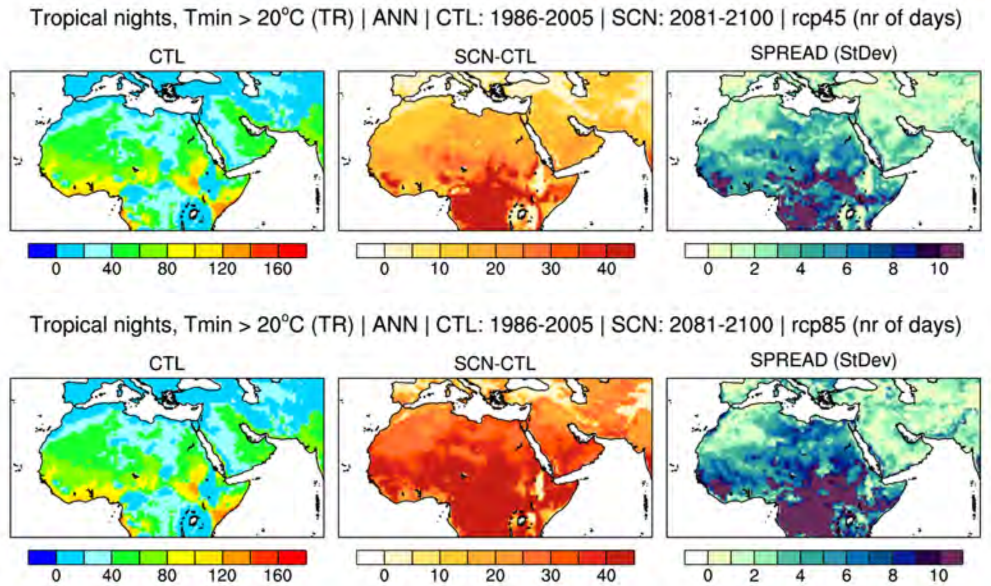


Figure II features the changes in the number of tropical nights (TR, Tmin > 20°C) in ensembles of three projections using both RCP4.5 and RCP 8.5, for the period 2081-2100 compared to the base period 1986-2005. The projections show significant warming trends and an increase in tropical nights, with stronger signals for RCP8.5.

Figure III. Changes in the cold spell duration index

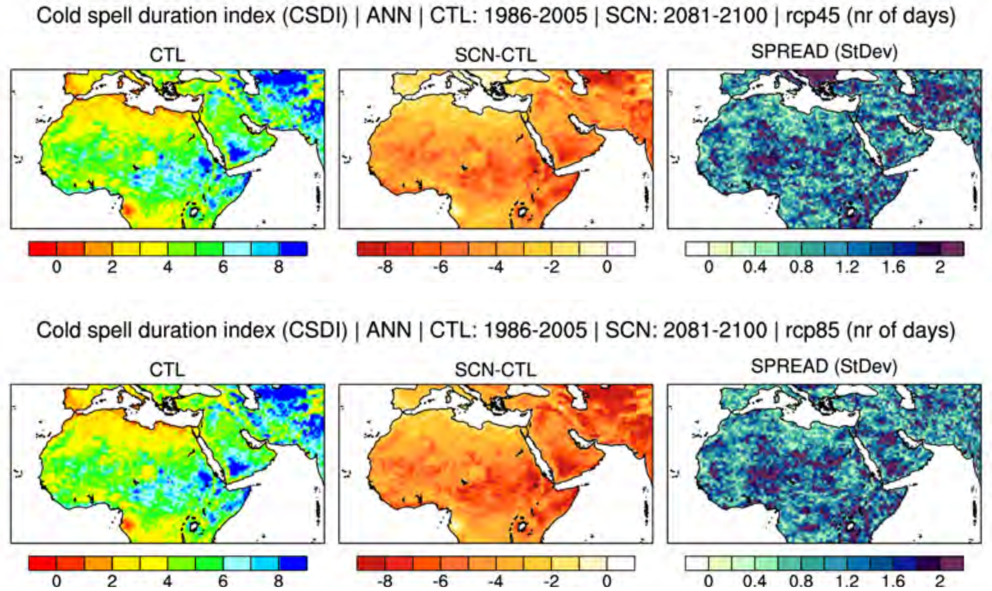


Figure III features the changes in the cold spell duration index (CSDI, at least six consecutive days when Tmin < 10th percentile) for the period 2081-2100 compared to the baseline period 1986-2005, using both RCP 4.5 and RCP 8.5 in ensembles of three projections. Strong decreases in CSDI are found in the entire Arab region.

Changes in Precipitation Indices

Figure IV. Changes in the maximum length of dry spell

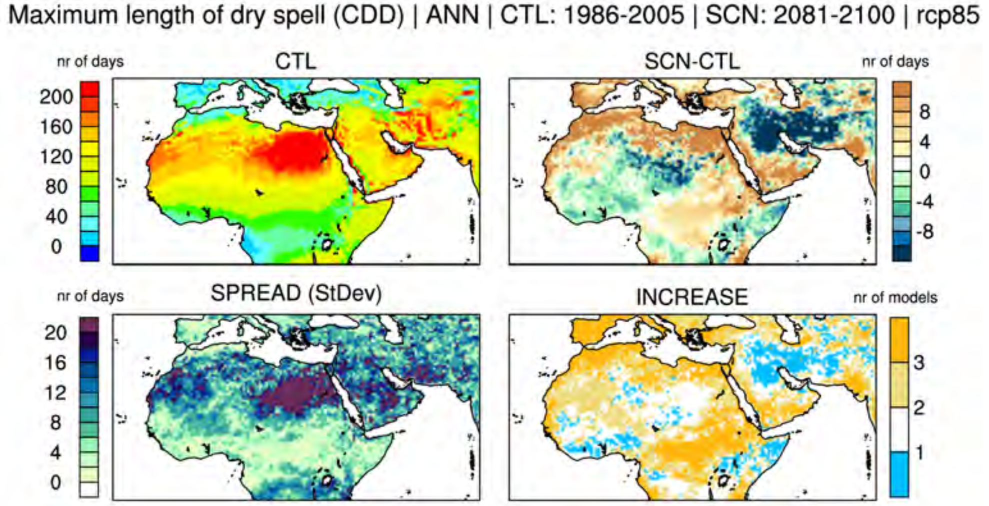


Figure IV features the changes in the maximum length of dry spell (CDD, consecutive days with precipitation < 1 mm) using RCP8.5, for the period