Modelling Climate Change Impacts on Agricultural Productivity: Selected Findings

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The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)

Promoting Food and Water Security through Cooperation and Capacity Development in the Arab Region:

Strengthening Capacity to Assess Impacts of Changing Water Availability on Agricultural Production

Objectives

1 - Contribute to enhancing food and water security in the Arab region

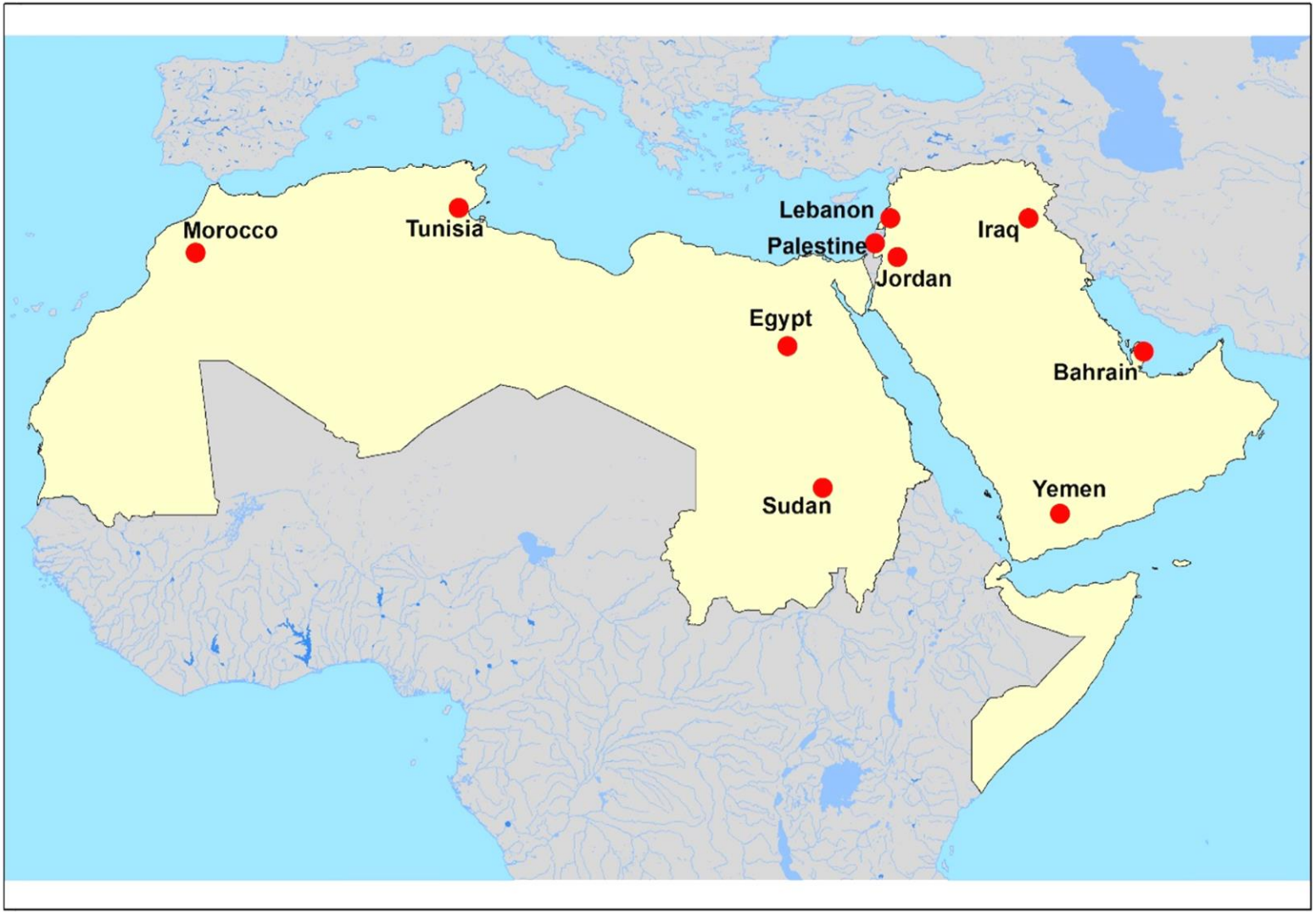
2 - Contribute to strengthening the national and regional knowledge base, capacity development and greater intraregional cooperation

3 - Contribute to promoting sustainable development and strengthening capacity to assess impacts of changing water availability (climate change) on agricultural production in the Arab countries

Project partners

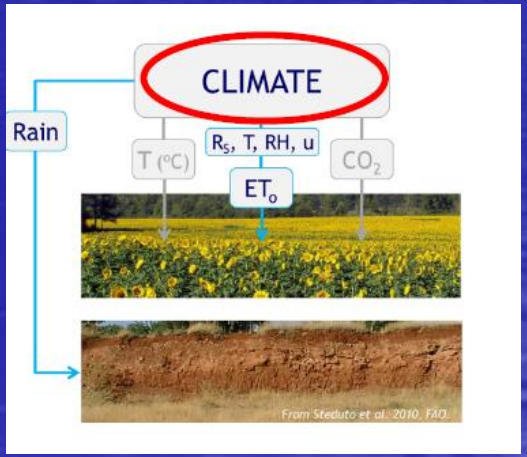
- The project is implemented as a partnership among the FAO, ACSAD, and ESCWA and funded by Sida

Target countries

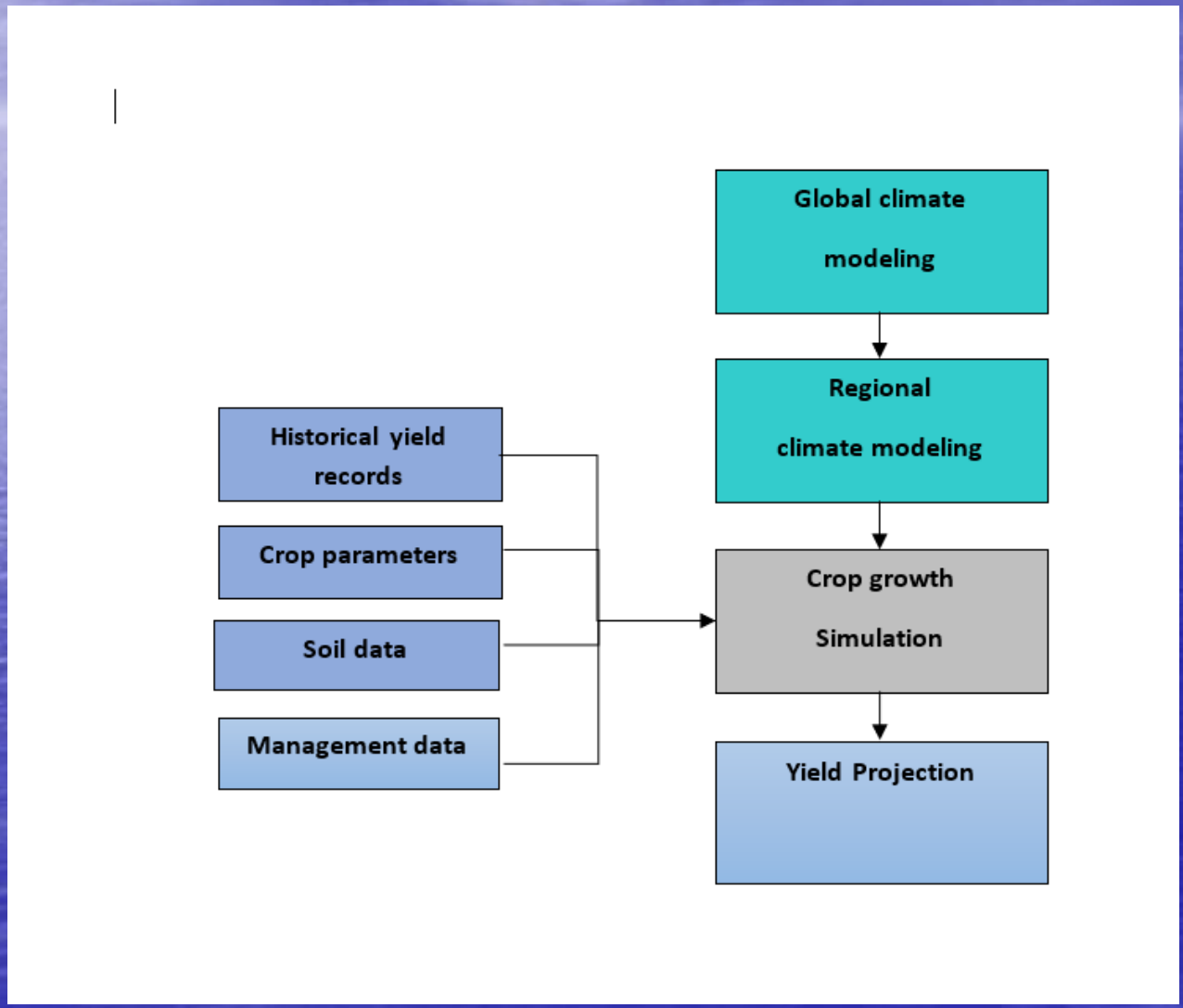


Introduction

- Climate change may affect agriculture due to changes in temperature, precipitation, soil moisture, an increase in the probability of extreme events such as droughts, extreme heat waves, heavy rainfall, cyclones, flooding of the coastal areas, erosion etc.



Methodology



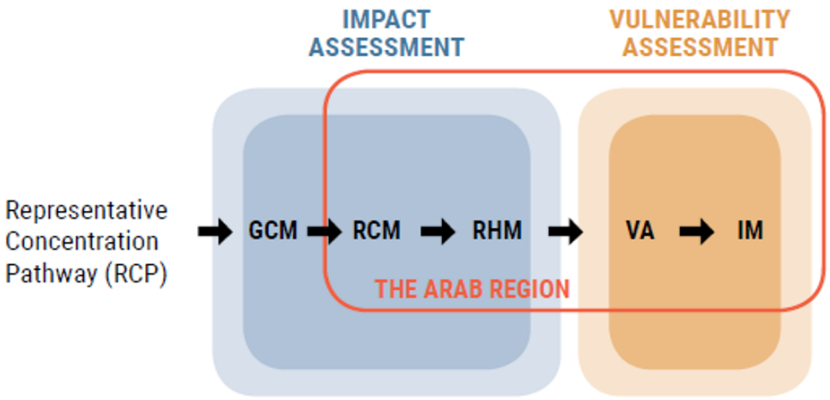
Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR)

RICCAR Partnerships

UNITED NATIONS ESCWA · UN environment · WMO · ACSAD · LAS · SMHI · UNESCO Cairo Office · UNITED NATIONS UNIVERSITY UNU-INWEH Institute for Water, Environment and Health · FAO FIAT PANIS · Sweden Sverige SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY · german cooperation · giz · UNDRR UN Office for Disaster Risk Reduction · ACCWaM

CORDEX-MENA Domain hosted by The Cyprus Institute

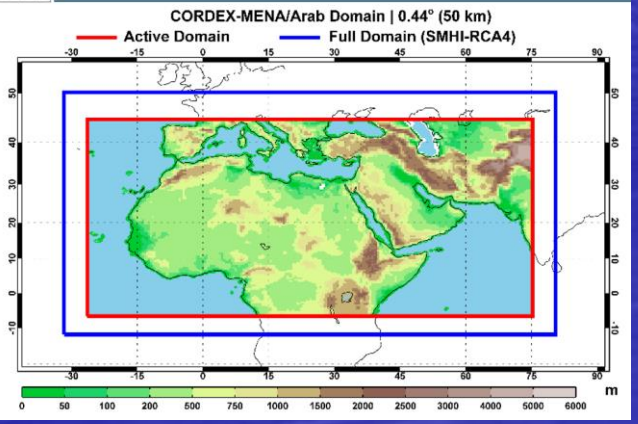
Integrated Assessment

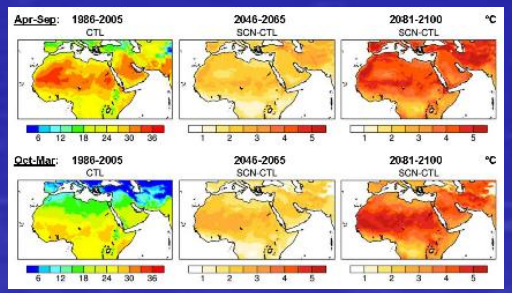


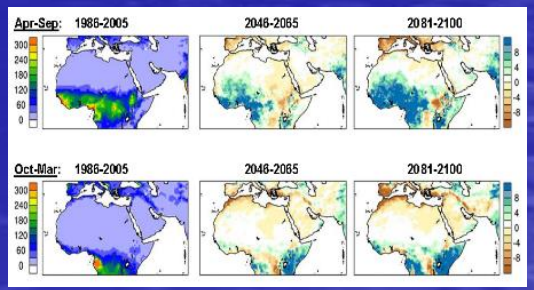
GCM: Global Climate Modelling
RCM: Regional Climate Modelling
RHM: Regional Hydrological Modelling

VA: Vulnerability Assessment
IM: Integrated Mapping

MENA/Arab Domain





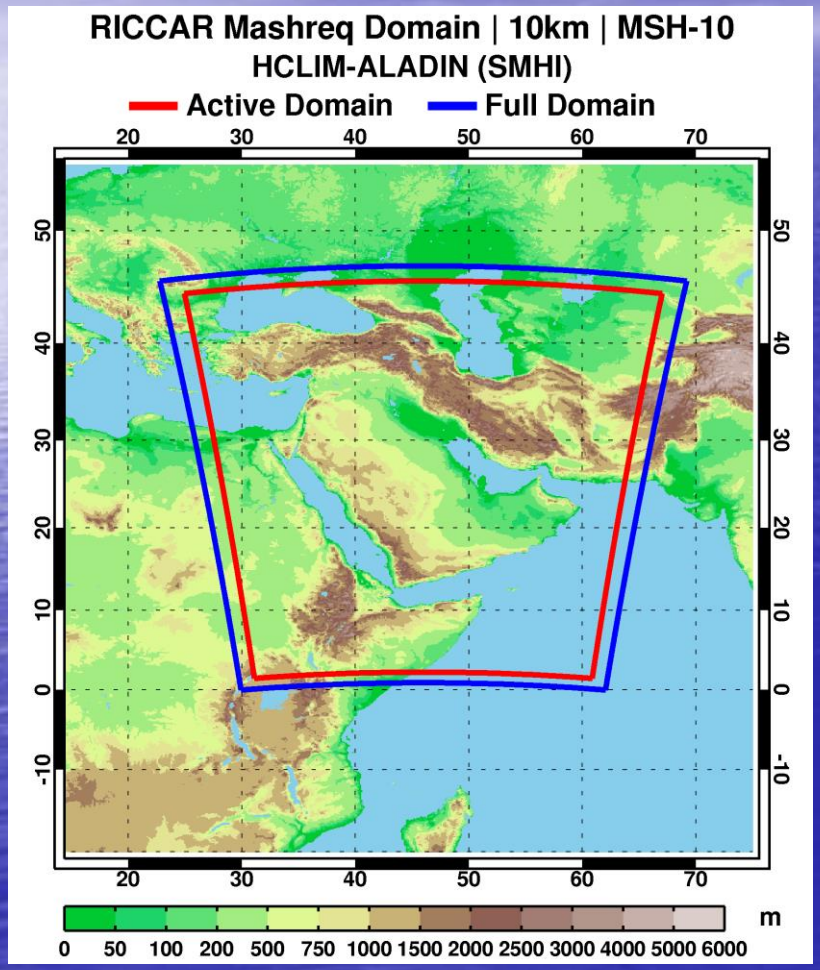


RICCAR
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

Advantages of RICCAR Datasets

- Regional climate modeling performed for the Arab/MENA Domain
- Climate change data (rainfall and temperature) available on daily basis
- Climate change data available for the whole Arab/MENA region with resolution of 50 km2
- Climate change data available for RCP 4.5 and RCP8.5 scenarios
- Climate change data is bias corrected for use in water and agricultural modeling

Mashreq Domain



NEW

- Mashreq projections available in April 2021
- 10 km^2 scale
- RCP 8.5
- ALADIN RCM nested in 6 CMIP6 GCMs
- Historical conditions1961-2014
- Future climate 2015-2070
- Raw and bias-corrected outputs and ensembles will be openly available via www.riccar.org

SMHI

UNITED NATIONS
الاسكوا
ESCWA

Sweden
Sverige

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

Using NetCDF Files

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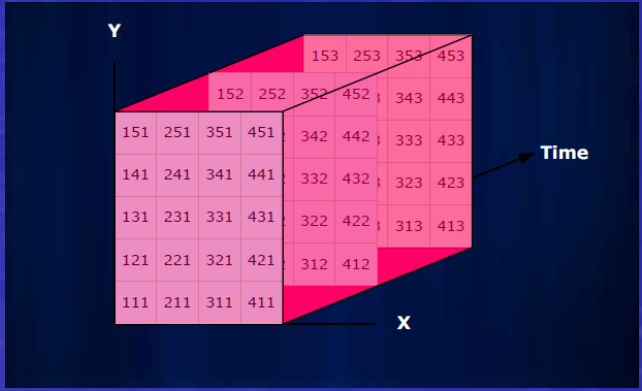
What is NetCDF?

- NetCDF (network Common Data Form)

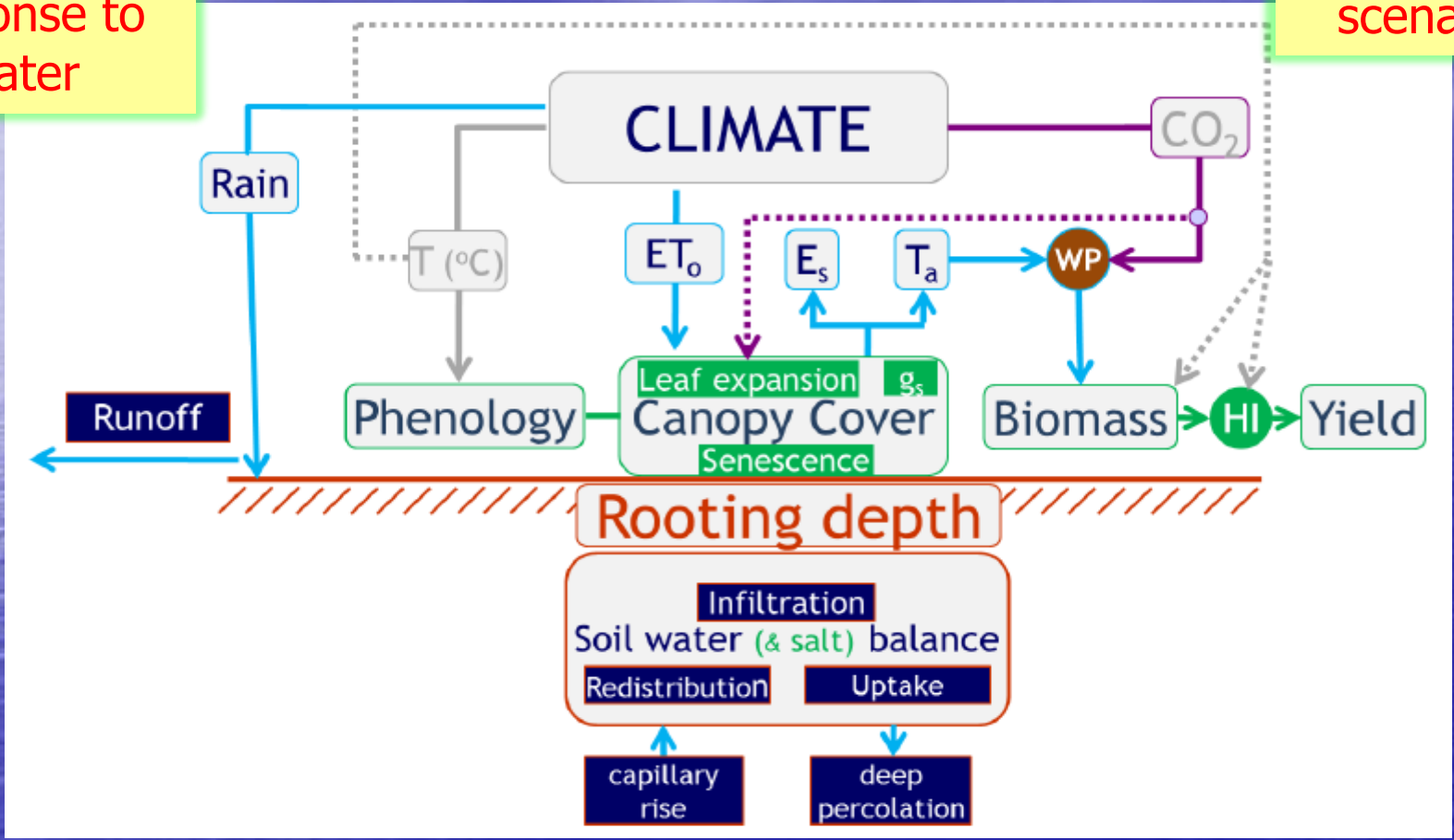
A platform independent format for representing multi-dimensional array-orientated scientific data.



AquaCrop model simulates yield response to water

AquaCrop model

AquaCrop predicts yield under climate change scenarios



Developed by FAO

Dirk RAES, Pasquale STEDUTO, Theodore C. HSIAO, and Elias FERERES

AquaCrop model

AquaCrop was selected because it has:

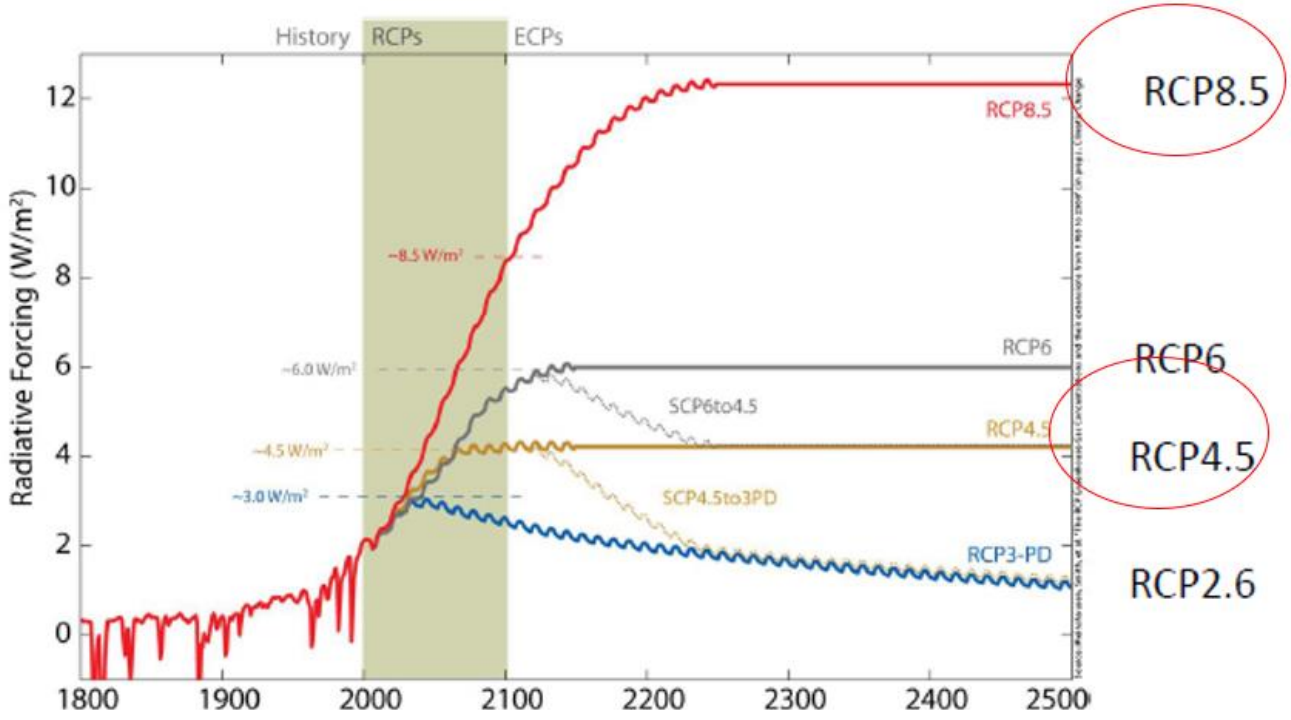
- Public domain accessibility,
- Limited data requirements,
- User-friendly interface enabling non-specialists to develop scenarios,
- Focus on climate change, CO2, water and crop yields,
- Developed and supported by FAO, which is a RICCAR partner thus allowing for model to be adapted to use regional climate modeling data

Climate change scenarios (RCP)

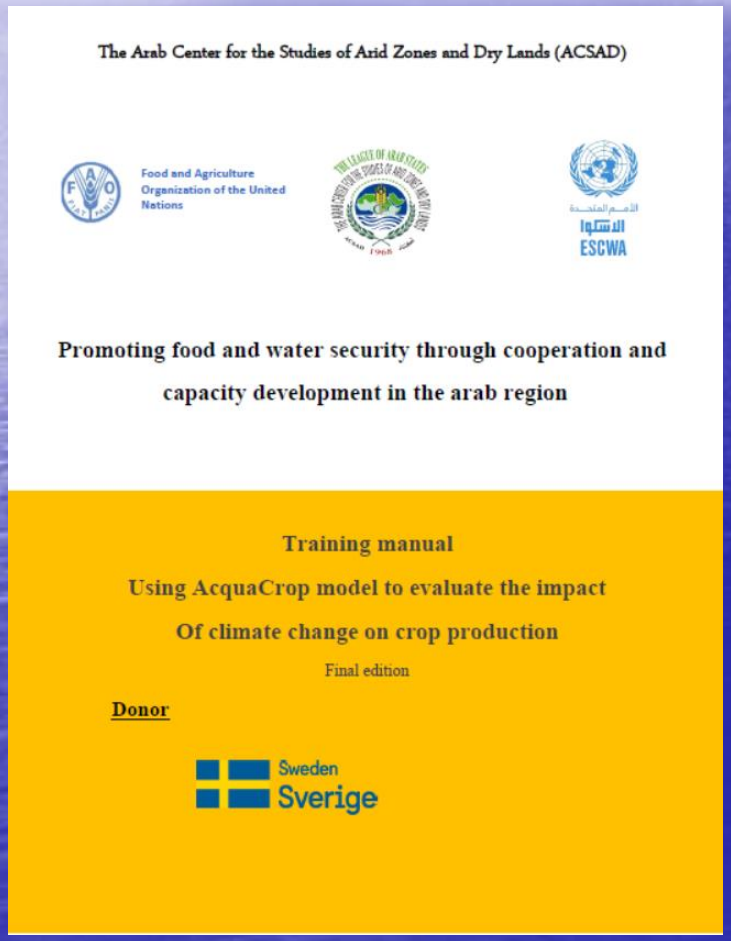
Representative Concentration Pathways (2007) - **RCP scenarios** used in IPCC Fifth Assessment Report - AR5 and CMIP5

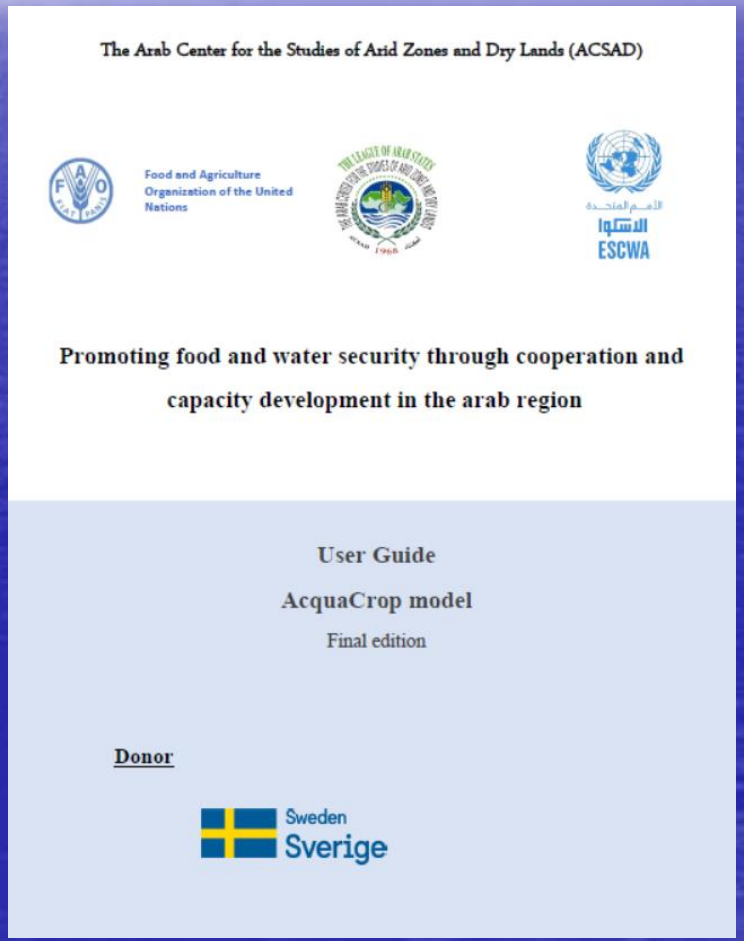
RCP assume radiative forcings of magnitude ***N*** (W/m-2) to the wide range of circumstances that might result in such forcings

4 RCPs: RCP 8.5, RCP 6.0, RCP 4.5, and RCP 2.6 corresponding to that amount of radiative forcing in W/m-2 in 2100 (CO2 equivalent: 1370, 850, 650 and 490 ppmv)



Training manuals





Training activities

6 sub-regional and 7 national training workshops for 10 countries

Ten different crops

Country - Area		Crop
Jordan	Mafrak	Tomato- Irrigated
	Madaba	Wheat-Rainfed
Lebanon	Beqaa	Wheat-Sup Irrigation
Iraq	Swereh	Tomato- Irrigated
	Swereh	Wheat-Irrigated
Palestine	Jenin	Wheat-Rainfed
	Jenin	Potato-Irrigated
Yemen	Sanaa	Wheat-Irrigated
	Sanaa	sorghum-Sup Irrigation
	Dhamar	Wheat-Irrigated
	Dhamar	sorghum-Rainfed
	Alkod	Maize-Irragated
	Alkod	Sesame-Irragated
Tunis	Shbeka	Wheat-Irrigated
	Koudiat	Wheat-Rainfed
Morocco	Marchouch	Wheat-Rainfed
	Zamamreh	Wheat-Irrigated
	Zamamreh	Sugar beet-irrigated
Sudan	Wad Madany	Wheat-Irrigated
	Gedaref	sorghum-Rainfed
Egypt	Sakha	Wheat-Irrigated
	Sakha	Maize-Irragated
	Nubareih	Tomato- Irrigated







Results

Assessment reports

Rainfed Wheat - Morocco

Scenario RCP8.5

الجدول 20. متوسط إنتاجية القمح في مرشوش والتغير المتوقع في الانتاجيه من اجل السيناريو RCP8.5 لحالة ثبات تركيز غاز ثاني أكسيد الكربون

	متوسط التغير خلال الفترة (2020-2030)	متوسط التغير خلال الفترة (2040-2050)
الإنتاج في سنة الأساس (طن/هكتار)	4.01	
التغير المطلق (طن/هكتار)	-0.36	-1.03
التغير النسبي (%)	-9 %	-26 %

الجدول 21. متوسط طول موسم النمو خلال فترة الأساس 1986-2005 وخلال الفترات 2020-2030 و2040-2050 من اجل السيناريو RCP8.5 لحالة ثبات تركيز غاز ثاني أكسيد الكربون

	خلال فترة الأساس 1986-2005	خلال الفترة 2020-2030	خلال الفترة 2040-2050
طول موسم النمو(يوم)	150	142	131

Rainfed wheat yield is projected to decrease between 9 and 26 %

Growth cycle of wheat is projected to decrease between 8 and 19 days

Rainfed Sorghum - Sudan

جدول رقم (8-أ): متوسط انتاجية الذرة الرفيعة(طن/هكتار) للفترة الأساسية (1985-2005) والتغيرات المتوقعة في الفترات 2020-2030 و2040-2050، بمنطقة القضارف، السيناريو RCP 4.5 و RCP 8.5 في حالة ثبات ثانى أكسيد الكربون

	السيناريو 4.5		السيناريو 8.5	
	2030-2020	2050-2040	2030-2020	2050-2040
الإنتاجية في فترة الأساس (طن/هكتار)	2.73		2.64	
التغيير (طن/هكتار)	0.02-	0.2-	0.19-	0.29-
التغيير النسبى (%)	0.7-	7-	7-	11-

جدول رقم (11): متوسط دورة نمو محصول الذرة الرفيعة للفترة الأساسية (1985-2005) والفترات 2020-2030 و2040-2050، بمنطقة القضارف، السيناريو RCP 4.5 و RCP 8.5 في حالة ثبات ثانى أكسيد الكربون

الفترة	الأساسية 1985-2005		2030-2020		2050-2040	
تركيز ثانى أكسيد الكربون	ثابت	متغير	ثابت	متغير	ثابت	متغير
دورة النمو (السناريو 4.5)	103	103.1	102	102.3	99	99.3
دورة النمو (السيناريو 8.5)	103	103.2	101	101.4	98	98.2

Rainfed Sorghum yield is projected to decrease between 7 and 11%

Growth cycle of Sorghum is projected to decrease between 2 and 5 days

Irrigated Wheat - Yemen

	متوسط التغير خلال الفترة (2030-2020)	متوسط التغير خلال الفترة (2050-2040)
الإنتاج في فترة الأساس(طن/هكتار)	2.39	
التغير المطلق (طن/هكتار)	-0.09	-0.18
التغير النسبي (%)	-3.81	-7.62

	خلال فترة الأساس 2005-1986	خلال الفترة 2030-2020	خلال الفترة 2050-2040
طول موسم النمو (يوم)	96.24	93.79	91.73

Irrigated wheat yield is projected to decrease between 4 and 7%

Growth cycle of is projected to decrease between 3 and 5 days

Irrigated Potato - Palestine

متوسط التغير خلال الفترة 2050-2040	متوسط التغير خلال الفترة 2030-2020	
6.62		الإنتاج في سنة الأساس (طن/هكتار)
-0.20	-0.22	التغير المطلق (طن/هكتار)
-3.01	-3.38	التغير النسبي (%)

خلال الفترة 2050-2040	خلال الفترة 2030 - 2020	خلال فترة الأساس 2005 - 1985	
94	92	95	طول موسم النمو(يوم)

Irrigated potato yield is projected to decrease about 3%

Irrigated Tomato - Iraq

	متوسط التغير خلال الفترة (2030-2020)	متوسط التغير خلال الفترة (2050-2040)
الإنتاج في فترة الأساس (طن/هكتار)	2.43	
التغير المطلق (طن/هكتار)	-0.15	-0.17
التغير النسبي (%)	-6.17	-7

	خلال فترة الأساس 2005-1986	خلال الفترة 2030-2020	خلال الفترة 2050-2040
طول موسم النمو	92.6	91.4	90.8

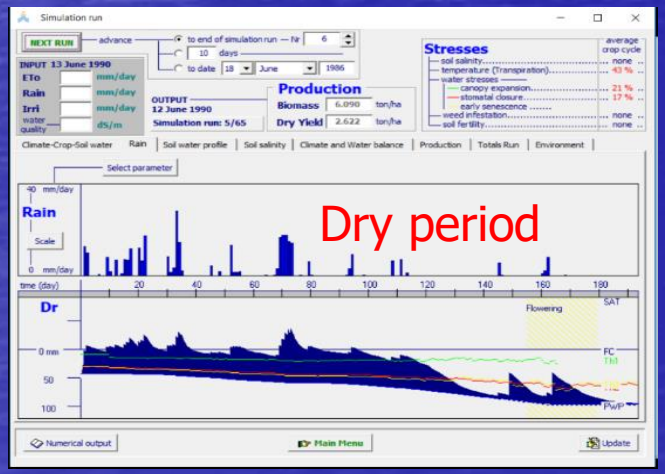
Potato yield is projected to decrease about 7%

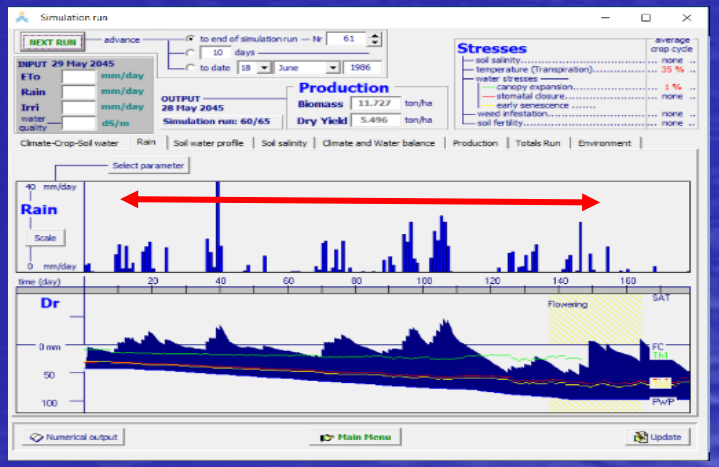
Supplementary Irrigated Wheat – Lebanon

متوسط التغير خلال الفترة (2050-2040)	متوسط التغير خلال الفترة (2030-2020)	
4.19		الإنتاج في سنة الأساس (طن/هكتار)
17% 0.73 ↑	4% ↑ 0.43	التغير المطلق

خلال الفترة 2050-2040	خلال الفترة 2030-2020	خلال فترة الأساس 2005-1986	
173 ↓	↓ 176	181	طول موسم النمو

Supplementary irrigated wheat yield is projected to increase between 4 and 17%





Summary

- The results show that climate change will have several impacts on crops

Crop yields will decline, food production could be affected significantly,

Crop growth cycle will decrease

The shortage of the growing-season length could have a negative impacts on grain yield in terms of quantities and quality.

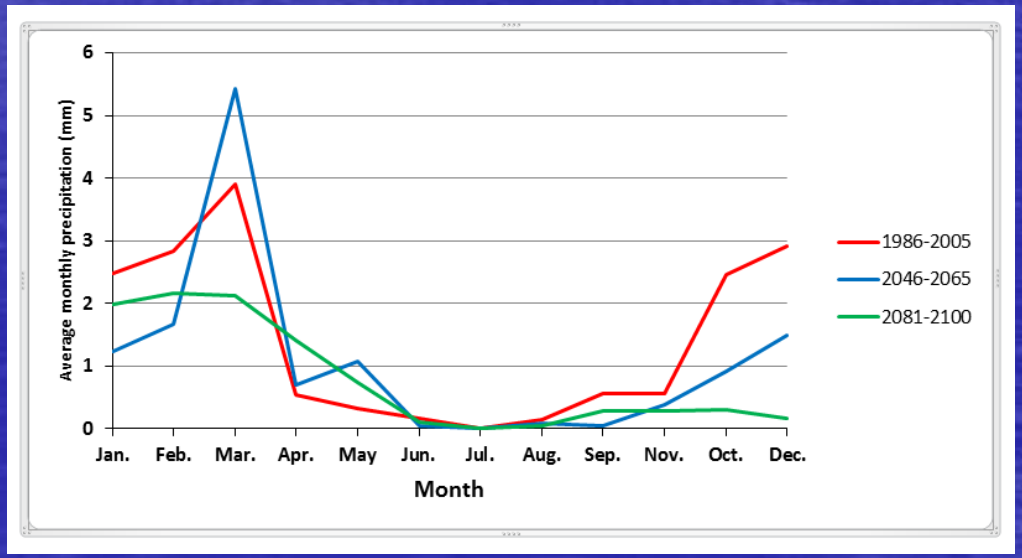
Summary

Rainfed crops will be more sensitive to climate change than irrigated crop

Adaption measures should be taken to alleviate impact of CC on crops

Proposed Adaptation Measures

– Adjust **sowing dates** according to temperature and rainfall patterns



Proposed Adaptation Measures

- Use **crop varieties** better suited to new climate conditions (e.g. more resilient to heat and drought)

Proposed Adaptation Measures

- Apply conservation agriculture:
  - Minimum tillage + land cover + crop rotation
  - CA increase soil moisture and OM content

Proposed Adaptation Measures

- Rainwater harvesting & supplementary irrigation

Proposed Adaptation Measures

- Change fertilizer application rate
- Apply crop rotation
- Modify irrigation depth and application time
- Enhancing water productivity through more efficient irrigation systems

Thanks