

Promoting Food and Water Security in the Arab Region

Methodology for evaluating Climate change impacts on crop yield and crop water productivity

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

اثر التغيرات المناخية على القطاع الزراعي

- يمكن للتغيرات المناخية أن تؤثر على القطاع الزراعي من خلال التغير في

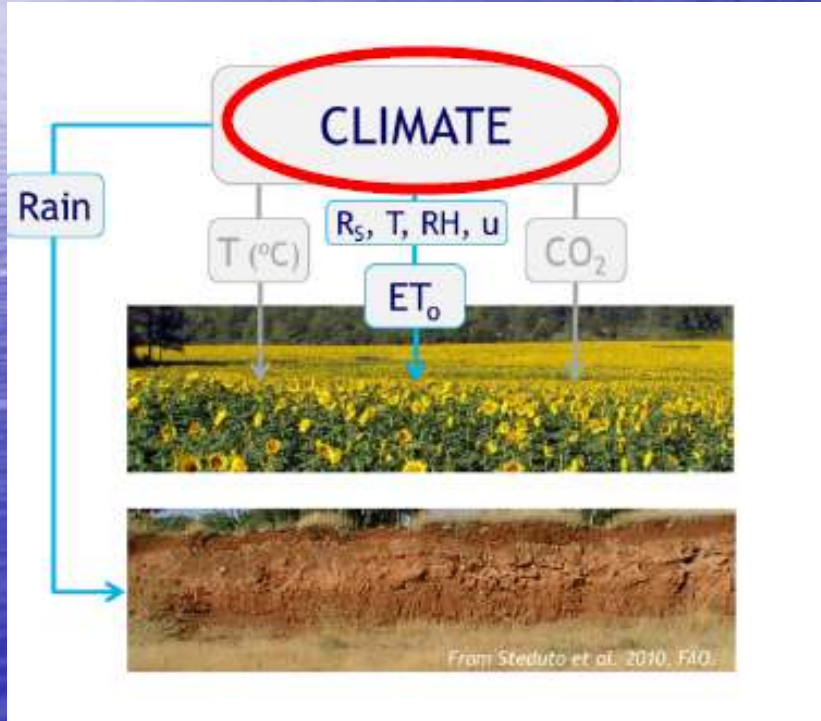
– درجات الحرارة

– الهطولات المطرية

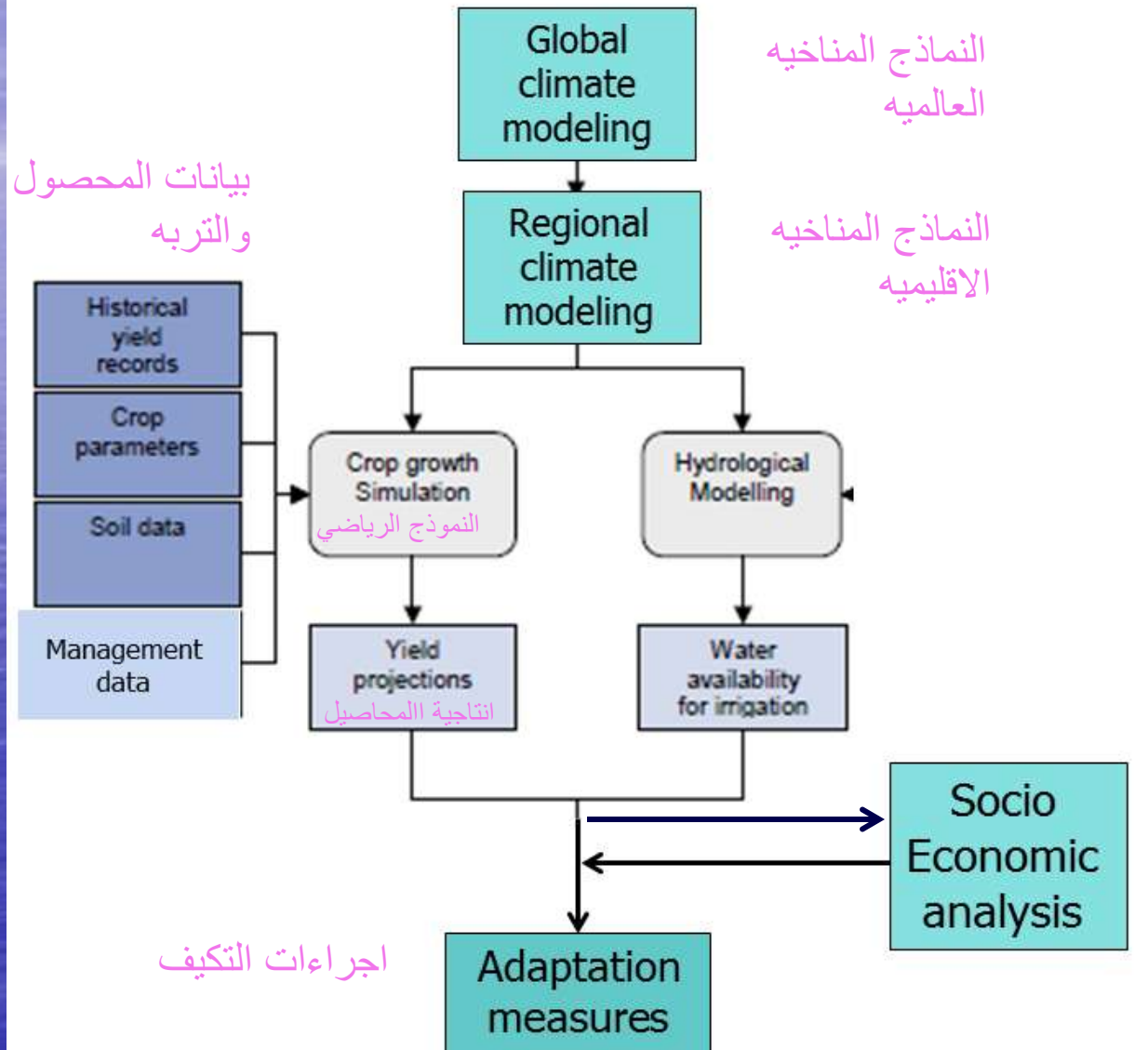
– رطوبة التربة

– تركيز CO₂

– زيادة موجات الجفاف



منهجية الدراسة



تقييم اثر التغيرات المناخيه على المحاصيل باستخدام النمذجة الرياضيه

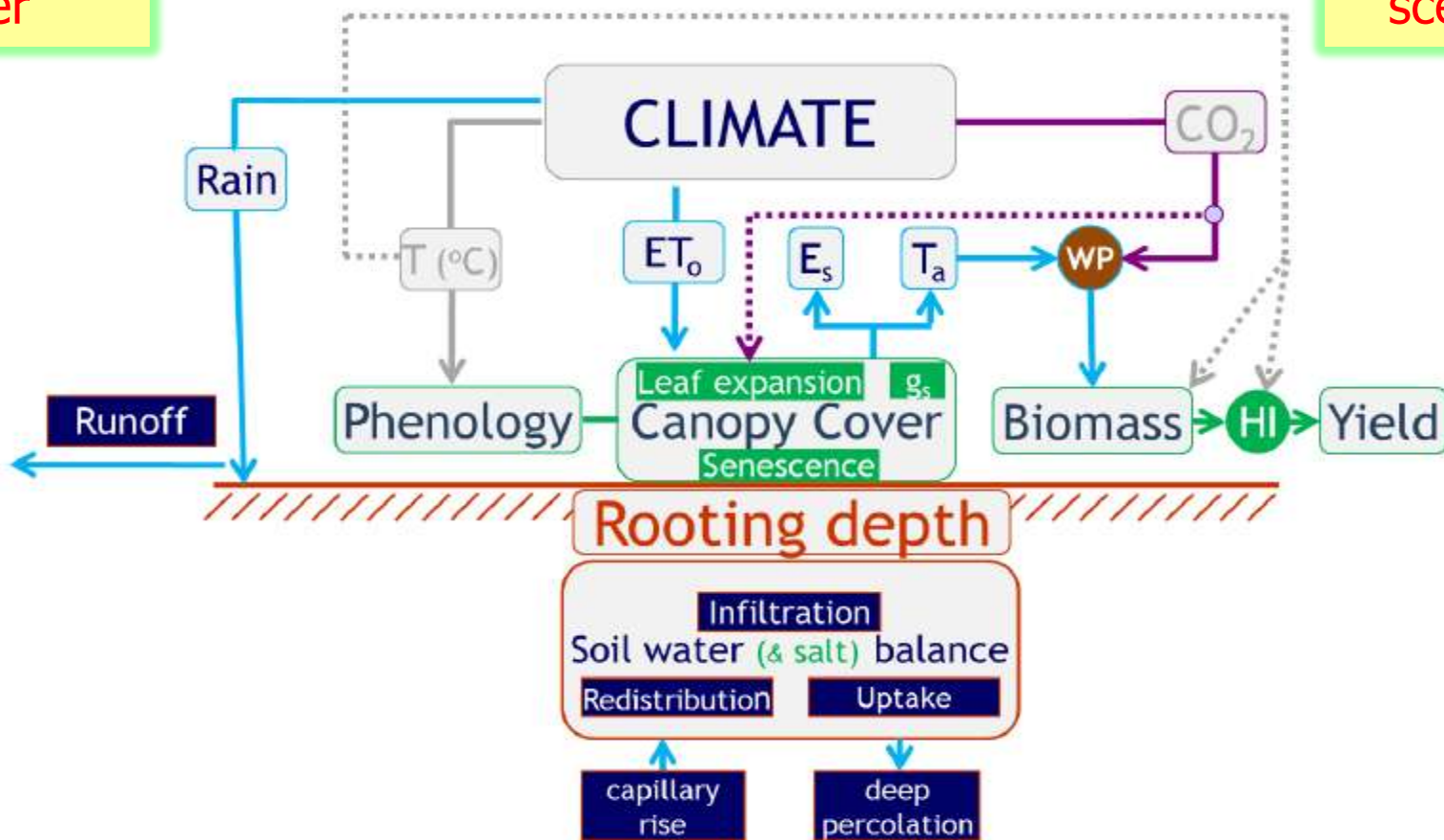
- هناك العديد من النماذج الرياضيه التي يمكن استخدامها لدراسة اثر التغيرات المناخيه على المحاصيل الزراعيه

(DSSAT, EPIC, WOFOST, AQUACROP,
FASSET, HERMES, CROPSYST)

AquaCrop model simulate yield response to water

النموذج الرياضي AquaCrop

AquaCrop predict yield under climate change scenarios



Developed by **FAO**

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

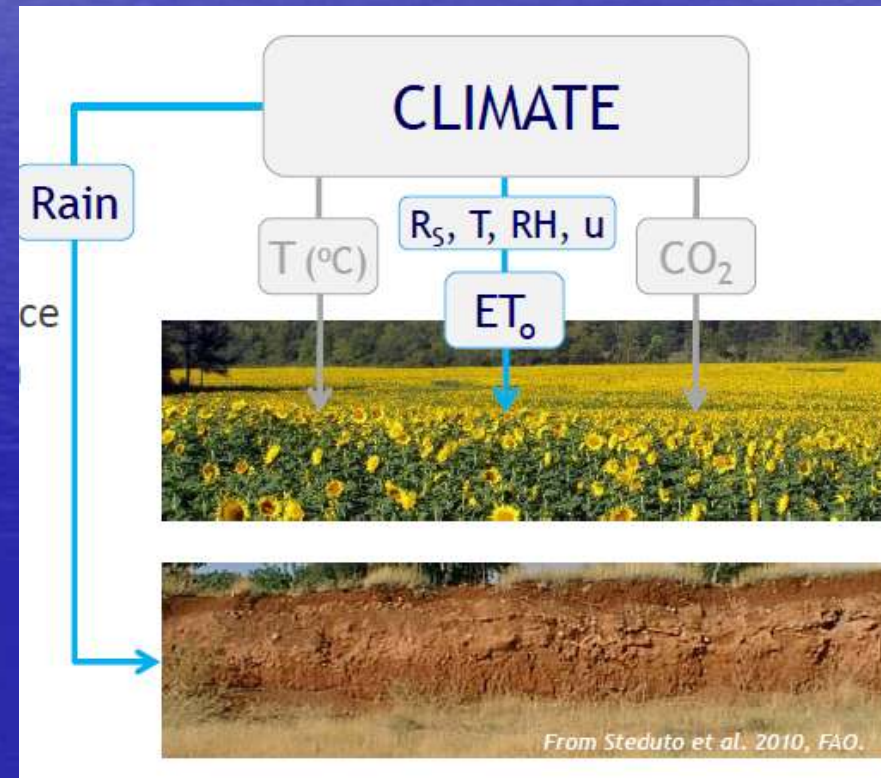
النموذج الرياضي AquaCrop

تم اختيار هذا النموذج للأسباب التالية:

- النموذج متاح بشكل مجاني
- البيانات المطلوبة لتشغيل النموذج محدوده مقارنة مع النماذج الأخرى
- سهل الاستخدام
- يأخذ تأثير التغير في الحرارة و الأمطار و تركيز CO2 بعين الاعتبار

The impact of climate change can be included in AquaCrop by three factors:

- adjusting the precipitation data file,
- adjusting the temperature data file,
- impact of enhanced CO₂ levels.



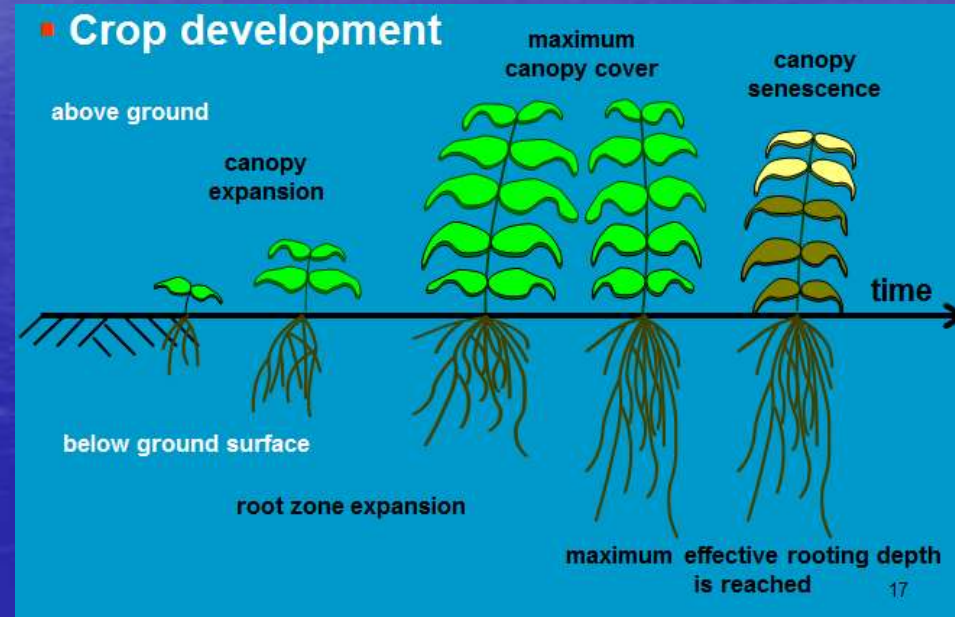
البيانات المطلوبه

● البيانات المناخيه:

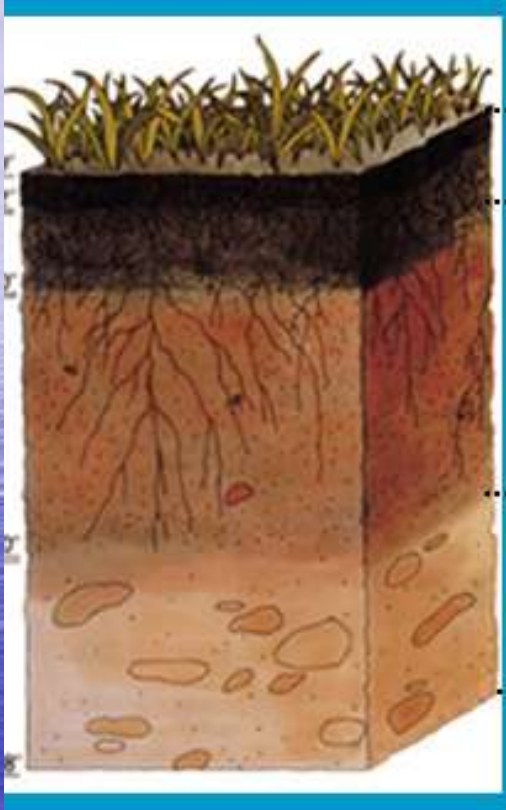
- الهطولات المطريه
- درجات الحراره العظمى
- درجات الحراره الصغرى
- تركيز CO2

بيانات المحصول

- Planting date; تاريخ الزراعة
- Plant density; كثافة الزراعة
- Maximum canopy cover (CCx); الغطاء النباتي الاعظمي
- المراحل الفينولوجيه
- عمق الجذور الاعظمي



بيانات التربة



– الخواص الفيزيائية للتربة :

السعة الحقلية ، قوام التربة ،

رطوبة الأشباع ، الناقلية

الهيدروليكية المشبعة

– عمق الطبقة الكتيمه ان وجدت

بيانات عن ادارة الحقل

- Parameters describing field management practices:
 - Cover and type of soil mulches;
 - Height of soil bunds;
 - Surface runoff: ON/OFF

→ 2. Mulches

mulches reduce soil evaporation



بيانات عن الري

– طريقة الري

– مقنن الري


– مواعيد اضافة الريات

– ملوحة مياه الري.


Irrigation method

- Soil surface wetted (%)
- Timing and depth of irrigation applications


furrow irrigation




sprinkler irrigation



basin irrigation



drip irrigation

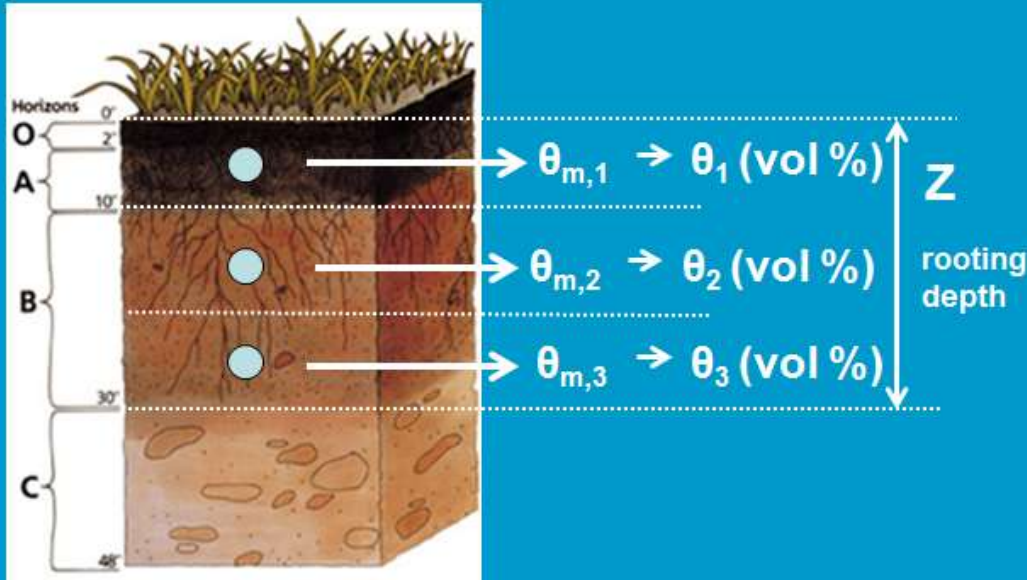


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الشروط الابتدائية

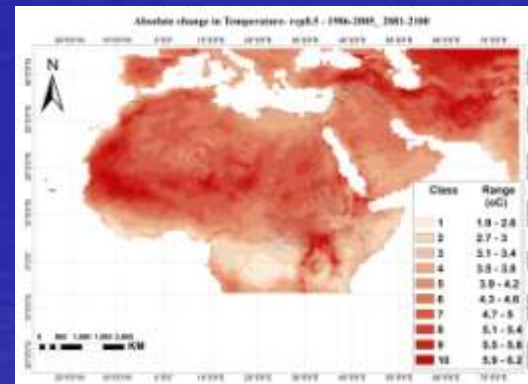
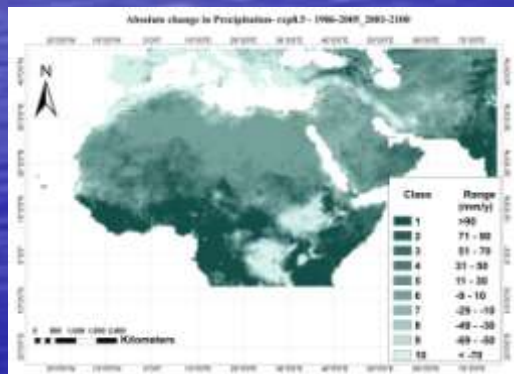
– الرطوبة الابتدائية
عند اعماق مختلفه

– ملوحة التربيه عند
اعماق مختلفه



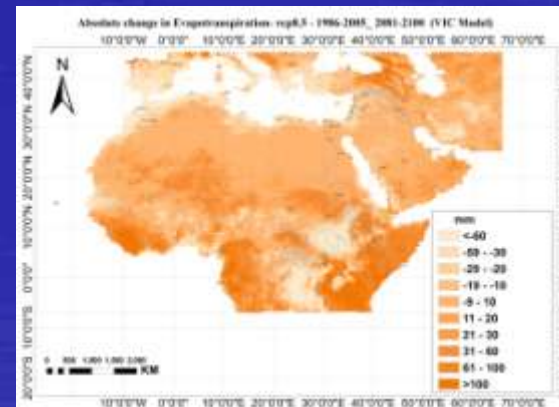
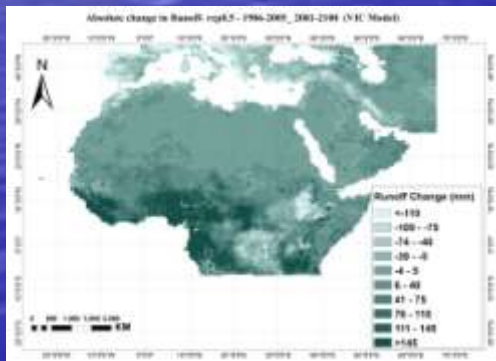
Climate change data from RICCAR outputs

- **Change in Temperature** : daily temperature for three Rcp4.5 and RCP8.5 projection
- **Change Precipitation** : daily precipitation for three Rcp4.5 and RCP8.5 projection



Example of RICCAR outputs

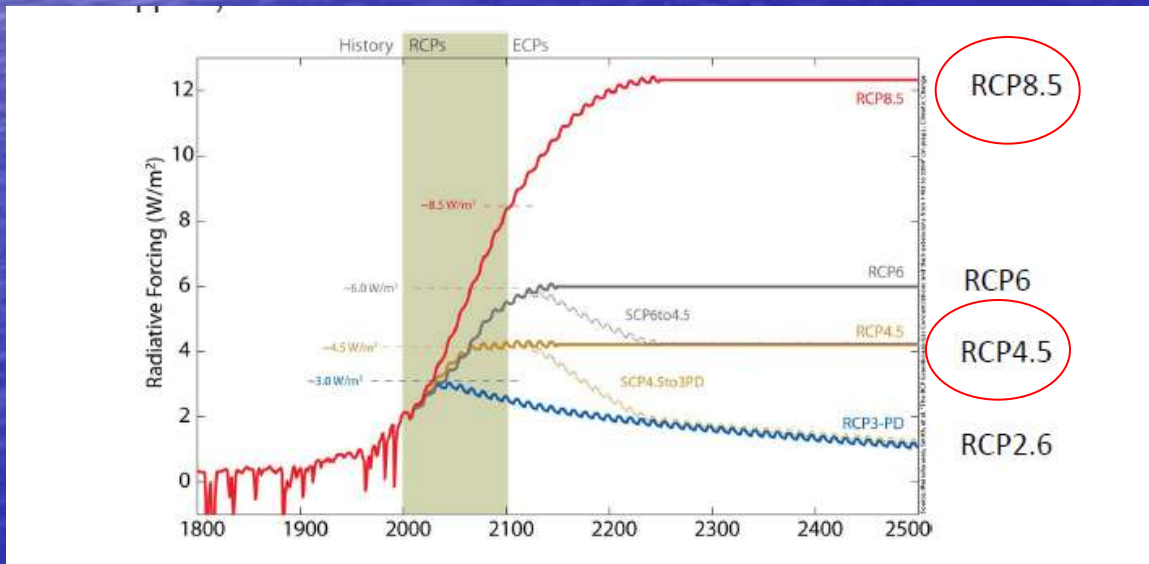
- **Change in RUNOFF** : daily RUNOFF for three Rcp4.5 and RCP8.5 projection
- **Change in Evapotranspiration** : daily Evapotranspiration for three Rcp4.5 and RCP8.5 projection



سيناريوهات الانبعاثات الغازية

Representative Concentration Pathways

- سيناريو الانبعاثات المرتفعة (**RCP 8.5**): يفترض بقاء الامور على حالها وعدم اتخاذ إجراءات للتخفيف من الانبعاثات الغازية
- سيناريو الانبعاثات المتوسطة (**RCP 4.5**): سيناريو متفائل نسبيا من حيث تخفيض انبعاثات الغازات حيث يفترض زياده مستقبلية بسيطة في زيادة انبعاثات CO_2 قبل أن تبدأ بالتراجع بحلول 2040



تجهيز النموذج الرياضي

Environment and Crop

Climate
Climate: delta.CLI, egypt

Crop
Growing cycle: delta.CRO
GDDay mode

Management
Irrigation: delta.IRR
Field: delta.MAN

Soil
Soil profile: delta.SOL
Groundwater: delta.GWT

Simulation
Simulation period: Simulation period
Initial conditions: 1, (None)
Off-season: X, Simulation period
Run <<<

Project
Project: (None)

Field data
Field data: 22, (None)

Crop characteristics

Description | Development | ET | Production | Water stress | Fertility stress | Temperature stress | Calendar

Crop development (non limiting conditions)

Initial canopy cover | Canopy development | Flowering and Yield Formation | Root deepening | Temperatures

Yield formation
Building up HI
Flowering

CC

100%
80%
60%
40%
20%
0%

0 15 30 45 60 75 90 105 120
sowing Growing cycle (days) maturity

From day 1 after sowing to:

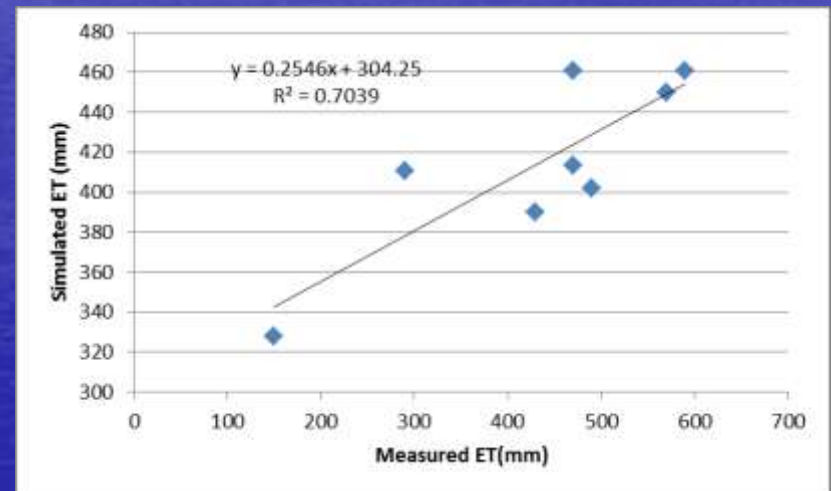
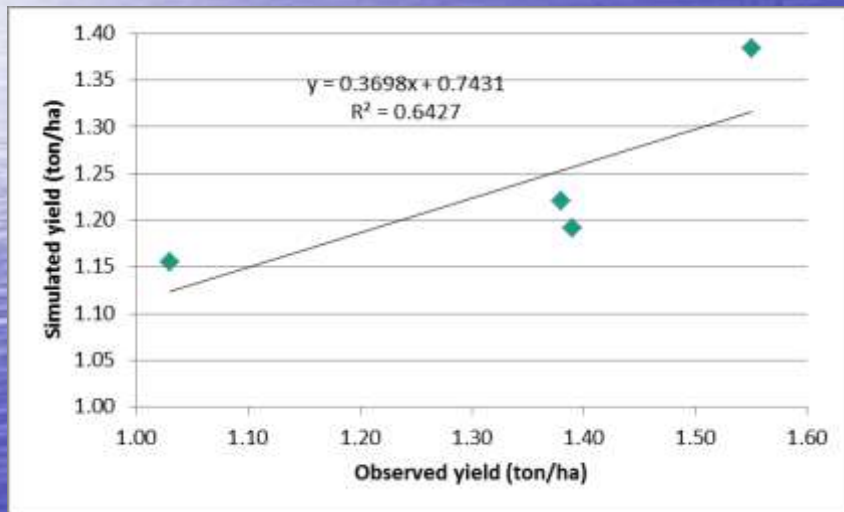
flowering
maturity

days
50
10
Excess of potential fruits
medium
- 50 %
70

Determinancy linked with flowering

Cancel Program settings Main Menu Save as

Model calibration



model application

Environment and Crop

Climate



Climate

delta.CLI

egypt

Crop



Crop

Growing cycle: Day 1 after sowing: 15 November 1999 - Maturity: 28 April 2000

delta.CRO Wheat delta, GDD (Valenzano, 23Nov07)

GDDay mode

Management



Irrigation

delta.IRR

egypt

Field

delta.MAN

0 % covered with organic mulches

Soil



Soil profile

delta.SOL

clay soil

Groundwater

delta.GWT

varying depth and salinity

Simulation



Simulation period

Simulation period: From: 15 November 1999 - To: 28 April 2000

Initial conditions

(None)

Soil water profile at Field Capacity

Off-season

Simulation period linked to cropping period



Run



Project



Project

(None)

No specific project

Field data



Field data

(None)

No field observations

 Exit Program

The background of the slide is a photograph of a vast blue ocean under a bright blue sky with wispy white clouds. The sun is visible on the left side, creating a shimmering reflection on the water's surface.

Example from modeling outputs

مشروع اثر التغيرات المناخيه على انتاجية بعض المحاصيل الزراعيه في المنطقة العربيه



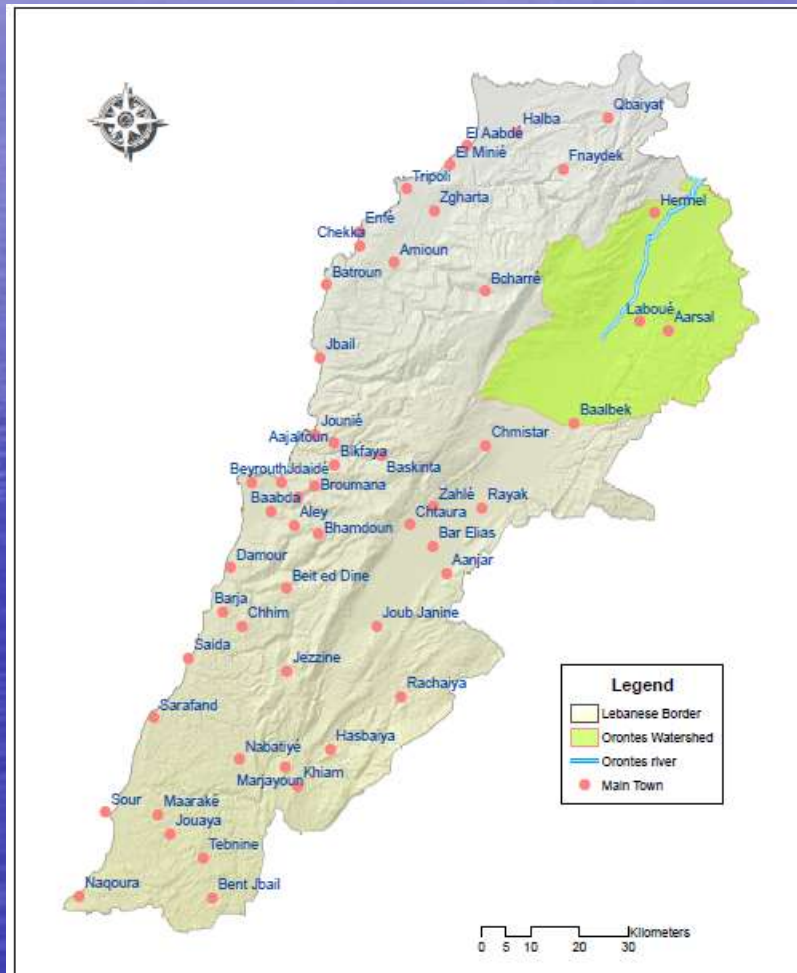
● الجهات المتعاونه : ESCWA - GIZ - FAO-ACSAD

● يهدف المشروع الى دراسة اثر التغيرات المناخيه على بعض المحاصيل الزراعيه الرئيسيه في المناطق التاليه:

1. محافظة الكرك في الاردن : القمح والشعير
2. حوض العاصي في لبنان: الباذنجان و البطاطا و الذرة
3. منطقة شمال الدلتا في مصر: القمح و الذره و القطن



Orontes Watershed (Lebanon)



Assessing the impact of climate change on Eggplant yield at Orontes watershed-Lebanon



Depth	FC (%)	PWP (%)	TAW (mm/m of soil)	TAW (mm/ 90 cm of soil)
90 cm	42	22	200	180

Irrigation method	Drip Inline drippers at 40 cm
Distance between rows	70 cm
Distance between plants in a row	40 cm
Plant density	35714 plants/ha
Harvest time	27-Sep-08

Plant phenology (DAS)	2008
Early growth	35
Full growth	52
Pre-flowering	60
Flowering	70
Fruit set	80
Fruit ripening	93
Mid fruit ripening	108
Harvest	122

Impact on the yield of eggplant



Average baseline yields of eggplant and predicted average change in it according to the **RCP4.5** scenario **without inclusion of elevated CO2 effects**

	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	1.42	
Absolute change (Ton/ha)	-0.1	-0.2
Relative change (%)	-9.4	-13.3

Change in growth cycle



the duration of growth cycle of eggplant at the baseline (1986,2005) , mid centaury (2046-2065), and at the end of the century under **RCP4.5** scenario

	Baseline 1986-2005	mid centaury 2046- 2065	end of the century 2081-2100
Duration of the growth cycle (days)	118	104	101

impact of climate Change on eggplant water requirement



the reference Evapotranspiration and actual Evapotranspiration of eggplant at the baseline (1986,2005) , mid centaury (2046-2065), and at the end of the century under **RCP4.5** scenarios

	Baseline 1986-2005	mid centaury 2046- 2065	end of the century 2081-2100
Reference Evapotranspiration (mm)	673.0	633.1 ↓	623.8 ↓
Actual Evapotranspiration of eggplant (mm)	465.4	-6.3% 436.0 ↓	-6.8% 426.4 ↓



Impact on the yield of eggplant

Average baseline yields of eggplant and predicted average change in it according to the **RCP8.5** scenario **without inclusion of elevated CO2 effects**

	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	1.42	
Absolute change (Ton/ha)	-0.1	-0.3
Relative change (%)	-9.8	-27.3

Change in growth cycle



the duration of growth cycle of eggplant at the baseline (1986,2005) , mid centaury (2046-2065), and at the end of the century under **RCP8.5** scenario

	Baseline 1986-2005	mid centaury 2046- 2065	end of the century 2081-2100
Duration of the growth cycle (days)	118	102	86

impact of climate Change on eggplant water requirement



the reference Evapotranspiration and actual Evapotranspiration of eggplant at the baseline (1986,2005) , mid centaury (2046-2065), and at the end of the century under **RCP8.5** scenarios

	Baseline 1986-2005	mid centaury 2046- 2065	end of the century 2081-2100
Reference Evapotranspiration (mm)	673.0	622.8 ↓	592.6 ↓
Actual Evapotranspiration of eggplant (mm)	465.4	-8.6% 425.4 ↓	-18.9% 377.6 ↓

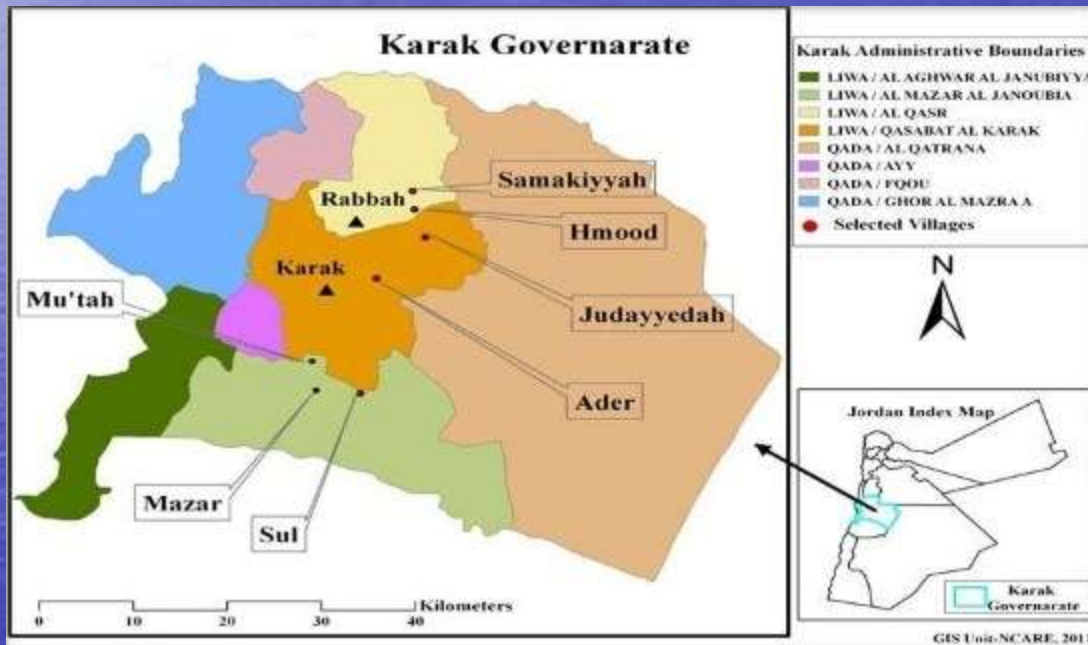
impact of climate Change on eggplant water requirement



the reference Evapotranspiration and actual Evapotranspiration of eggplant at the baseline (1986,2005) , mid centaury (2046-2065), and at the end of the century under **RCP8.5** scenarios

	Baseline 1986-2005	mid centaury 2046- 2065	end of the century 2081-2100
Reference Evapotranspiration (mm)	673.0	622.8	592.6
Actual Evapotranspiration of eggplant (mm)	465.4	425.4	377.6

Karak governorate of Jordan



Assessing the impact of climate change on Rainfed wheat at Karak governorate





Impact on the yield of wheat

Average baseline yields of wheat at Karack Governorate and predicted average change in it according to the **RCP4.5** scenario **without inclusion of elevated CO2 effects**

	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	1.41	
Absolute change (Ton/ha)	-0.02	-0.20
Relative change (%)	-1.5	-15.5

Impact on the yield of wheat



Average baseline yields of wheat at Karack Governorate and predicted average change in it according to the **RCP8.5** scenario without inclusion of **elevated CO2** effects

cnrm	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	1.41	
Absolute change (Ton/ha)	-0.1	-0.8
Relative change (%)	-5.2	-55.3



North Delta of Egypt



Assessing the impact of climate change on maize yield at north Delta –Egypt



Impact on the yield of maize according to the RCP4.5 scenario



	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	8.76	
Absolute change (Ton/ha)	0.03	-0.09
Relative change (%)	0.3	-1.0

Impact on the yield of maize according to the RCP8.5 scenario

	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	8.76	
Absolute change (Ton/ha)	-0.13	-0.77
Relative change (%)	-1.53	-8.92

Impact on the yield of wheat



Impact on the yield of wheat



Average baseline yields of wheat and predicted average change in it according to the **RCP4.5** scenarios **without** including elevation of atmospheric CO2 concentration

cnrm	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	6.50	
Absolute change (Ton/ha)	-0.3	-0.4
Relative change (%)	-4.1	-5.7

Impact on the yield of wheat

Average baseline yields of wheat and predicted average change in it according to the **RCP8.5** scenarios **without including elevation of atmospheric CO2 concentration**

	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	6.25	
Absolute change (Ton/ha)	-0.4	-0.7
relative change (%)	-4.9	-10.3

The background is a smooth blue gradient. On the left side, there is a bright, glowing sun that creates a shimmering reflection on the surface below. The top of the image features wispy, white clouds against a darker blue sky. The overall mood is serene and peaceful.

Thanks