JOINT WORKSHOP OF THE EWRS WORKING GROUPS:
NOVEL AND SUSTAINABLE WEED MANAGEMET IN ARID AND SEMI-ARID AGRO ECOSYSTEMS AND WEED MAPING
29 September to 03 October 2013, MAICH, Chania, Greece

The possible impact of a 20 C air temperature increase on the weed flora and an arable crop in Greece. Studying the case of wild oat (Avena sterilis L.) and wheat (Triticum durum L.).

Στυλ κύριου υπότιτλου

Dimitrios Voloudakis, Vasilios Kotoulas, Christos Vlahos, Garyfallia Economou,

Agricultural University of Athens, Laboratory of Agronomy, 75 Iera Odos str, 11855 Athens , Greece

Climate of Greece (1961-1990)

WCM 12,3˚C

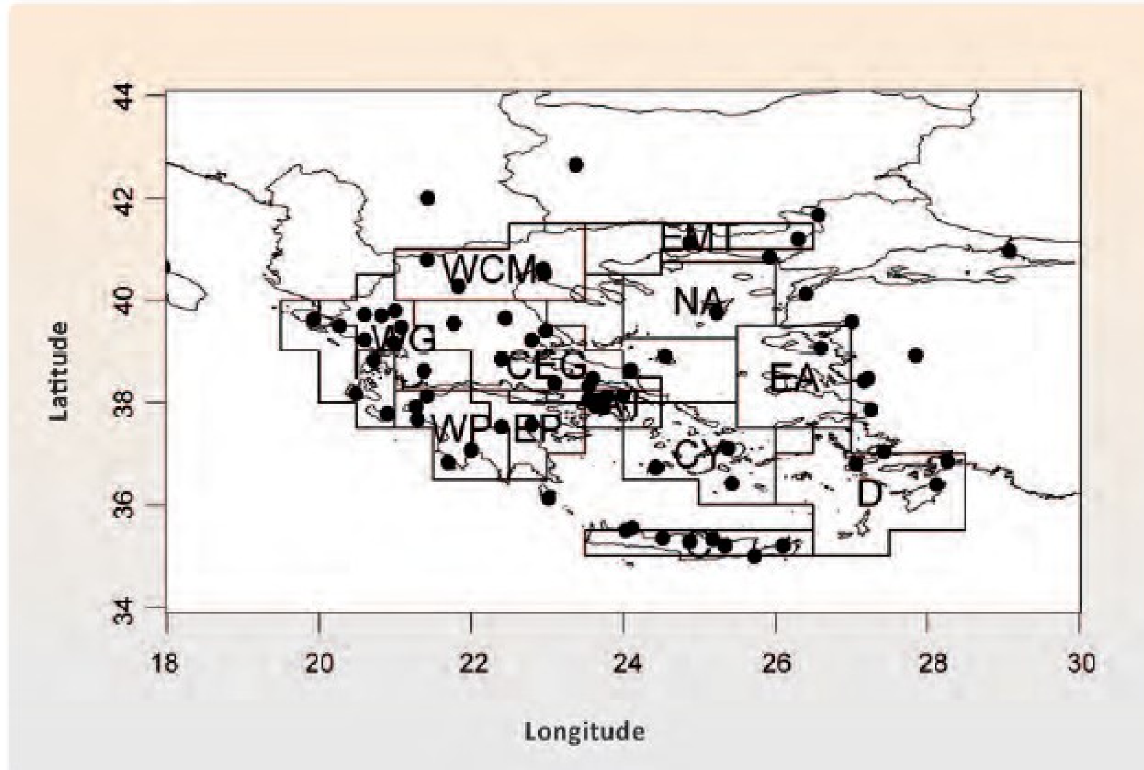
EMT 12,9˚ C

NA 15,8˚ C

CY17,6˚C

EA 16,8˚C

D 18,2˚C

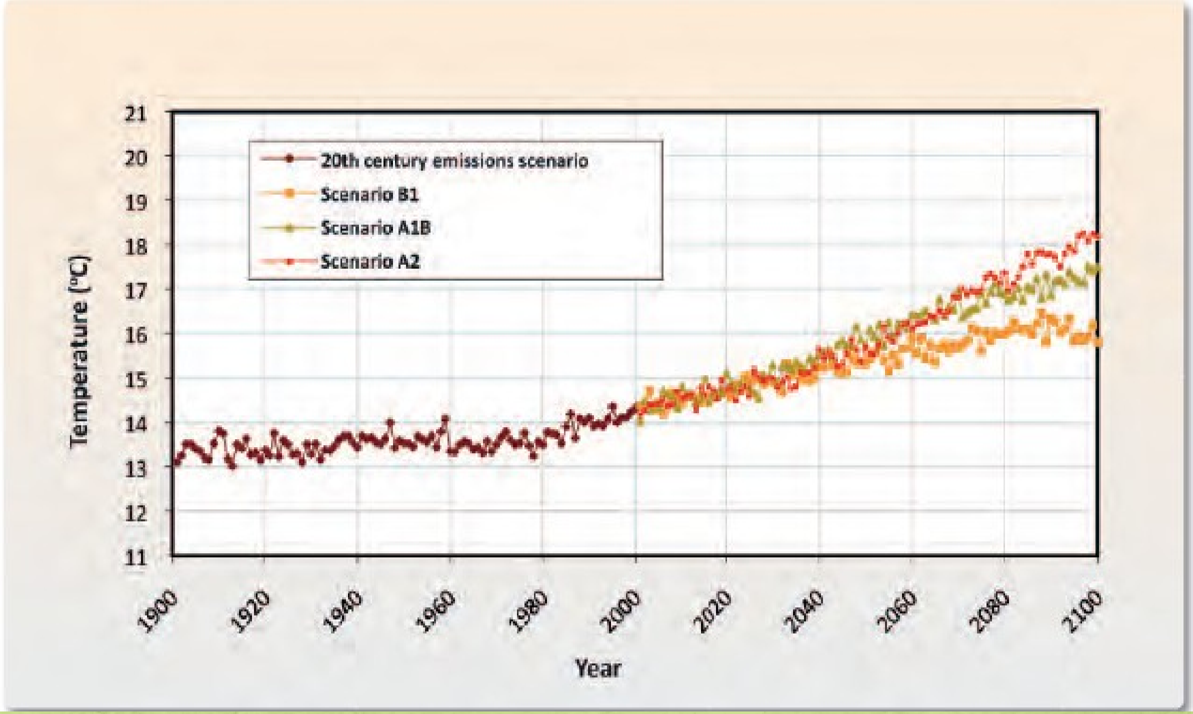


Climate Change Scenarios (IPCC 2001)

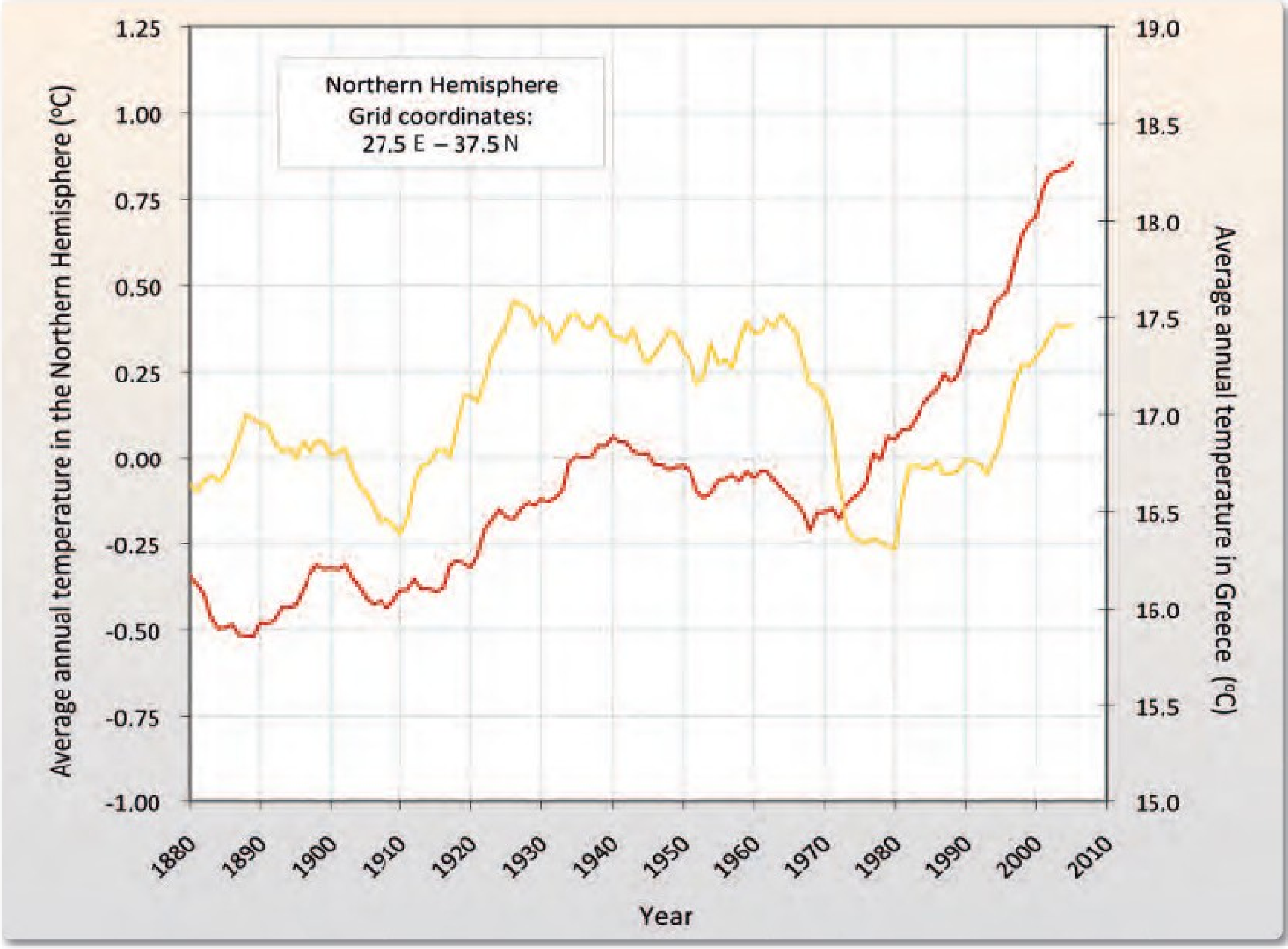
A2: moderate increase in global average per capita income. Particularly strong energy consumption. Rapid rise in Global population. CO_2 to 850ppm by 2100.

A1B:Rapid economic growth. Strong consumption of energy but spread of new and efficient technologies. Rapid rise in global population until 2050 and then decline. CO_2 to 720ppm by 2100

B1: Large increase in global average per capita income. Reduced use of conventional energy sources and swift towards renewable energy. CO_2 to 550 ppm by 2100

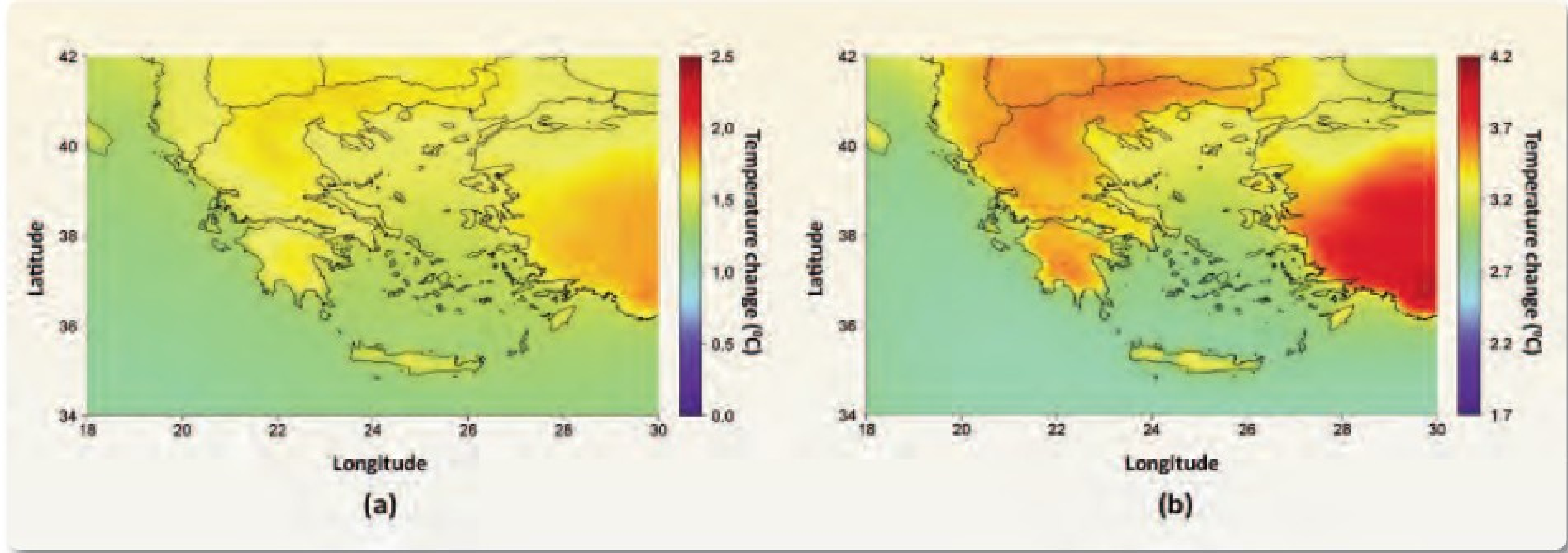


Comparing average annual temperature in Greece to Northern Hemisphere



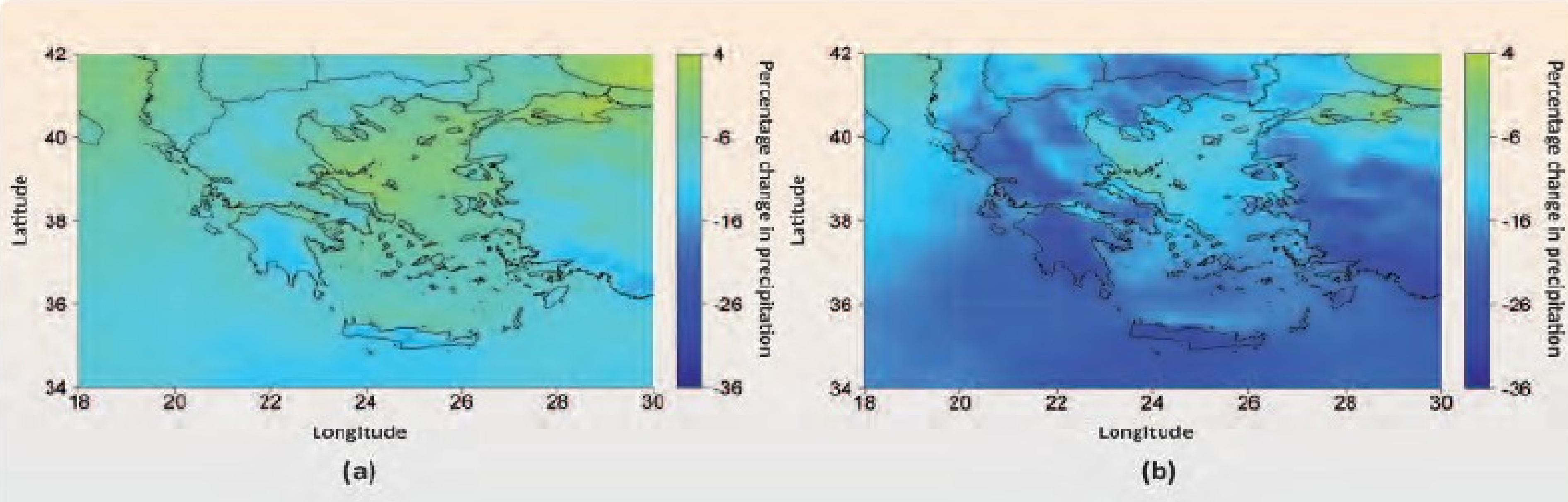
(a) in the Northern Hemisphere (red line), and (b) in the grid box which includes Greece (yellow line).

Projection of climate change in Greece



Temperature increase
1961-90 to 2021-50   1,5˚C
1961-90 to 2071-2100 3,5˚C

Projection of climate change in Greece



- Precipitation decline

1961-1990 to 2021-2050 -5%

1961-1990 to 2071-2100 -20%

Previous research (climate change and wheat)

- PESETA project (2009) Mediterranean South Europe → 5% to -27% crop yields
- Olesen et al (2011) → negative impacts in most of the European climate zones
- Giannakopoulos et al (2009) → cereals +8% to +19% until 2060
- Parry&Rosenzweig (1999) → i) shortening of the growing period

  ii) decrease in water availability

  iii) poor vernalization
- Supit et al (2010) → higher yield decrease in Greece and Romania 0.09 tn/ha/year and 0.07 tn/ha/yaer respectivly
- Greek Climate Change Study Committee (2011) → positive effect in North-Eastern Greece and Western Greece from 0-10%

  negative effect in Central Eastern Greece and Eastern Peloponnese >10%

Previous Research (climate change and weeds)

- Olesen et al (2011): Higher intensity of weed occurrence or introduction of new weed species
- Lee (2011): Chenopodium album (C3) & Setaria viridis (C4)

Plant phenology was more affected by increased temperature than elevated CO_2 . Biomass and harvested seed were significantly decreased for **only Temperature** effect on **C3** while they were increased by **combination** of **Temperature+CO_2** increase. In **C4** biomass did not differ significantly from that of the control. Elevated temperature strongly influences biomass production during reproductive stage compared to the vegetative growth stage with greater effect in C3 weeds than in C4.

Materials and Method

- Study Areas

Alexandroupoli –Eastern Macedonia/Thrace (NE)

Mikra- Western and Central Macedonia (N-NW)

Arta&Agrinio – Western Greece (W)

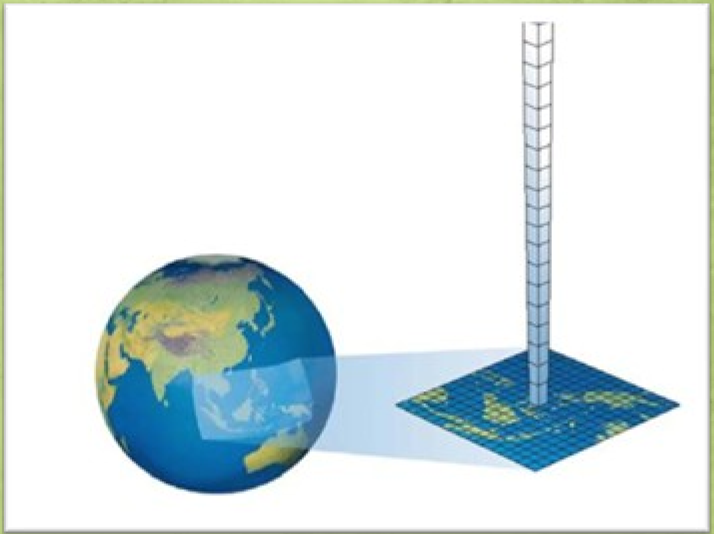
Karditsa&Yliki- Eastern and Central Greece (C-E)

Pyrgos- Western Peloponnese (SW)

Wheat yields (tn/h) in the seven study areas for the period 1961-1990

	AGRINIO	ARTA	YLIKI	ALEX/LI	PYRGOS	MIKRA	KARDITSA
mean	1,99	1,32	2,27	2,29	1,77	2,05	2,66
Standard error	±0,05	±0,02	±0,06	±0,07	±0,04	±0,05	±0,08

Climate scenario and models



- Emission Scenario A1B IPCC (2001)
- **CO_2** 359ppm (1990) 532ppm(2050) 714ppm(2100)
- **Temp** +1.8°C (2050) +3.9°C (2100)
- **Precipitation** -10% (2050) -25% (2100)
- **Climate Models** derived from the ENSEMBLES project
- HadRM3
- C4I
- ETHZ
- DMI-HIRHAM
- *Max&min Temperature, Relative humidity, Wind speed, Solar irradiance, Precipitation*

Crop simulation model

- **AquaCrop** is a crop water productivity model developed by the Land and Water Division of the Food and Agricultural Organisation (FAO)

Basic Components

- the <u>climate</u>, with its thermal regime, rainfall, evaporative demand and carbon dioxide concentration;
- the <u>crop</u>, with its development, growth and yield processes;
- the <u>soil</u>, with its water (and salt) balance;
- the <u>management</u>, with practices including irrigation, fertilization and mulching.

- **Simulation of wheat yield** with the use of AquaCrop
  Salemi et al (2011), Andarzian et al, (2011), Mkhabela&Bullock (2012), Aloui et al (2012)
- AquaCrop simulations respond to changes in **CO_2 concentration** (Vanuytrecht et al., 2011)
- Use of AquaCrop for wheat simulation under **climate change** conditions, Droogers&Hunink (2012), Karamanos&Voloudakis (2011)

- **Atmosphere**

Daily minimum-maximum air temperature, rainfall, ETo, CO_2 annual concentration

- **Crop**

Phenology, canopy cover, rooting depth, biomass production, harvestable yield, reduction of the canopy expansion rate, acceleration of senescence, closure of stomata, planting/sowing data, thermal based on Growing Degree Days (GDD)

- **Soil**

hydraulic conductivity at saturation, volumetric water content at saturation, field capacity, wilting point

- **Field Management**

- **Irrigation management**

AquaCrop application in wheat

Filed experiment Yliki 2010, 2 soil types, 5 plots

Pre-calibrated wheat crop file in AquaCrop required small changes to adapt it to Yliki

Planting date 15.11.2010

Harvest date 27.06.2011

No irrigation applied

No fertilization stress

Harvest Index 44%

Soil clay loam

Loam with restrictive layer 60cm

Future projections of some climatic parameters

Wheat yield response to climate change

	Agrinio		Alex/lis		Arta		Karditsa		Mikra		Pyrgos		Yliki	
	1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050	
	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2
HadRM3	-7,5	19,8	5	47,2	-1,2	18,3	-10,8	30,9	36,5	69,9	-6,2	16,1	3,5	21,2
C4I	-11,5	14,6	-3,9	13,6	1,2	18,9	-3,6	38,8	-11,7	13,9	-8,7	14,2	1,1	31,3
ETHZ	10,2	24,6	11,32	20,87	6	8,6	-14,3	20,15	23,8	5,89	-12,1	16,9	-38,1	-19,7
DMI-HIRHAM	-5,2	19,8	-3,9	21,7	-5,4	18,9	-11	15,3	13,4	44,1	-9,2	14,5	-20,7	2,2

no CO_2: ambient concentration of CO_2

CO_2 : effect of CO_2 concentration increase

Simulation of wild oat development with AquaCrop

- 5 plots 30cmX30cm Agricultural University of Athens 2013
- 8.1 18.1 29.1 12.2 25.2 6.3 19.3 28.3 9.4 22.4 30.4





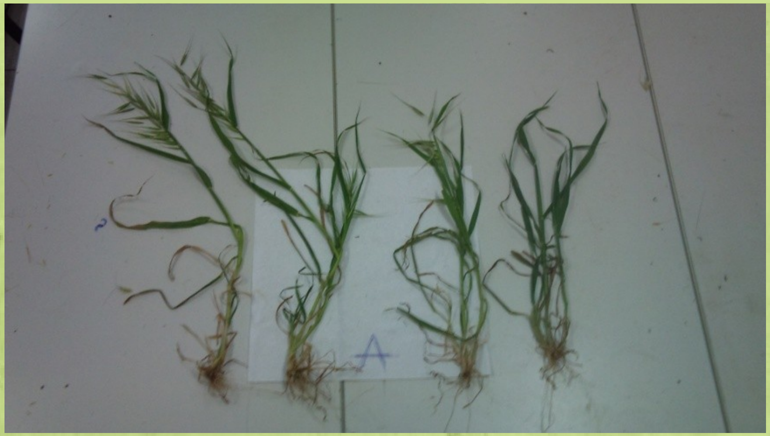


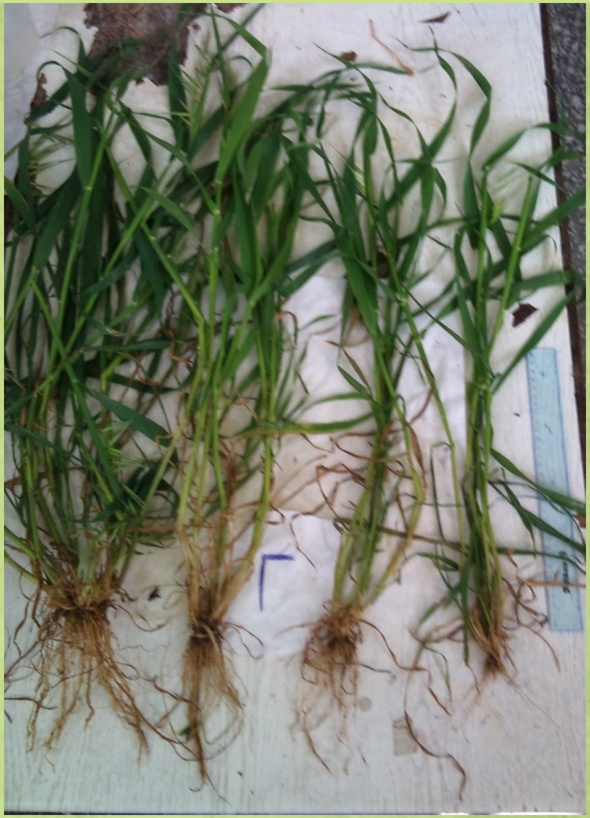




10plants/m2

observations

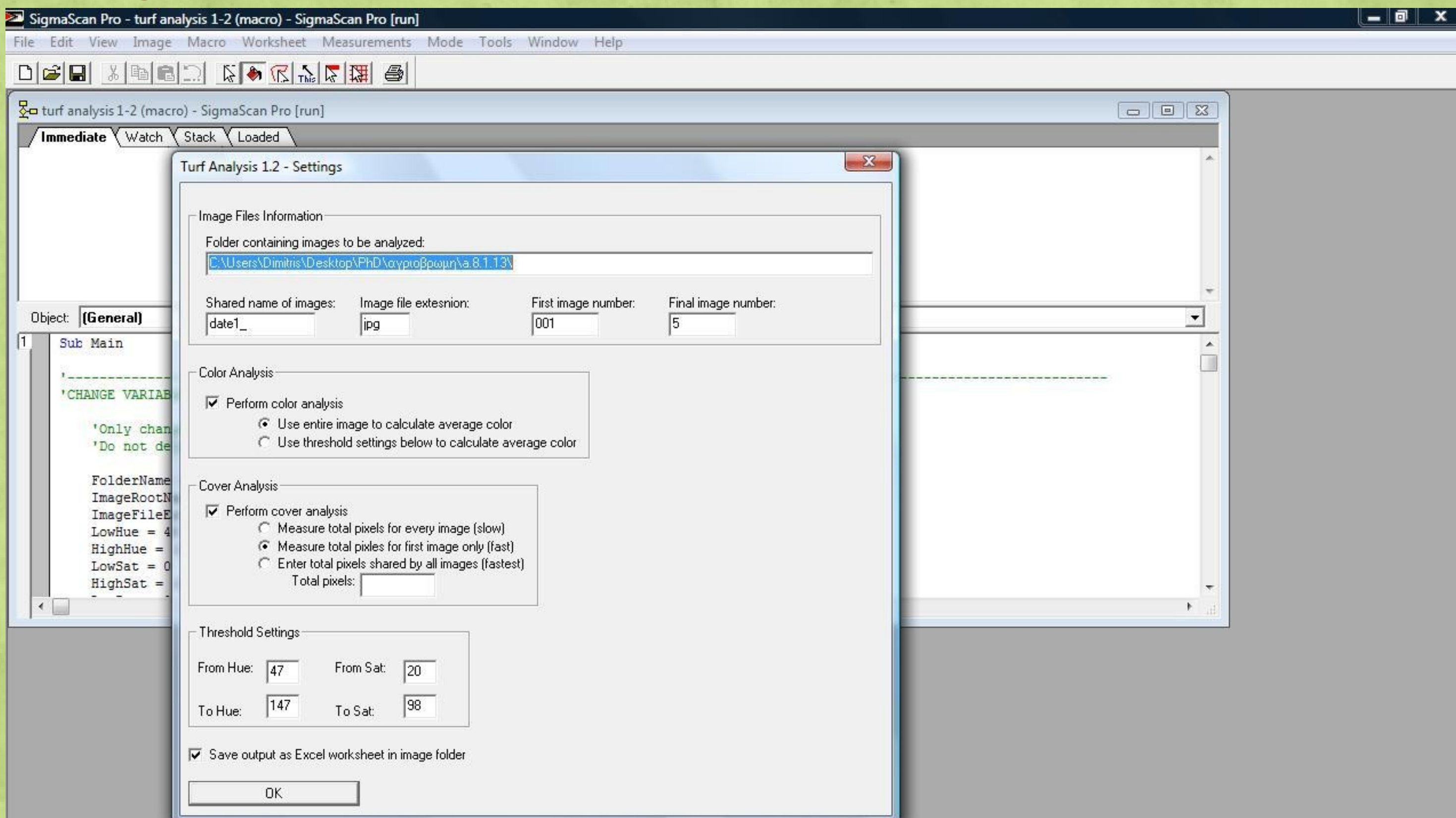


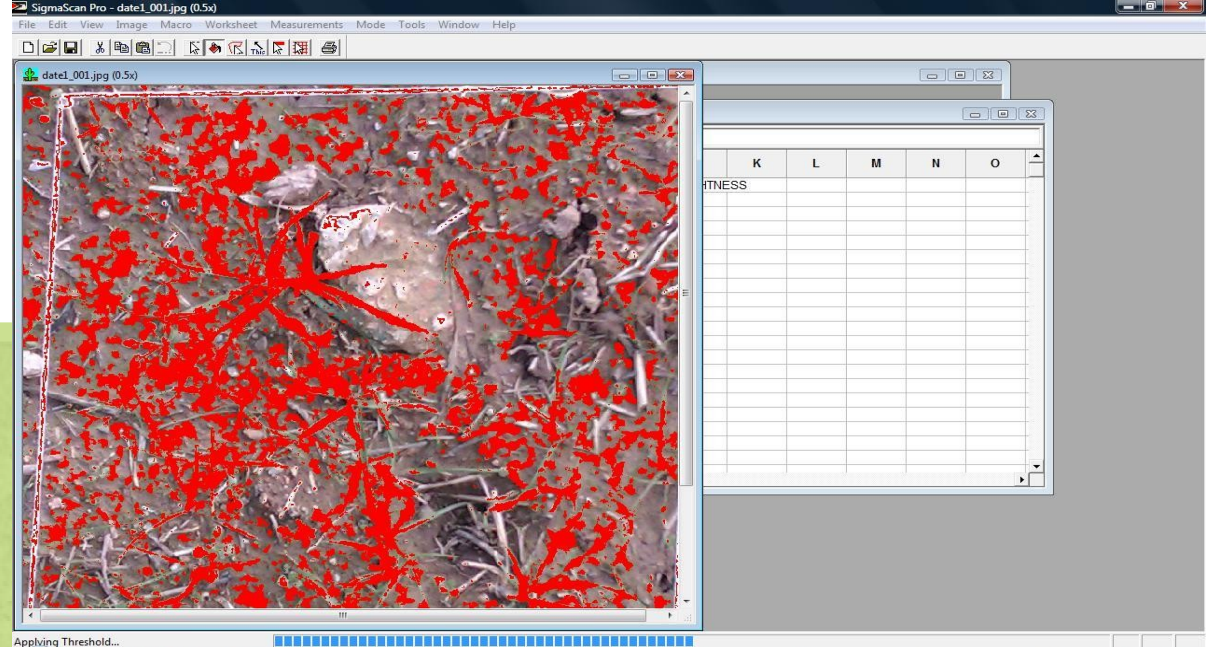


a. Length of root
b. Dry biomass above ground
c. Dry biomass underground
d. Phenological observations
e. Yield production

Simulation of growth development

- Digital photos
- Sigma Scan Pro

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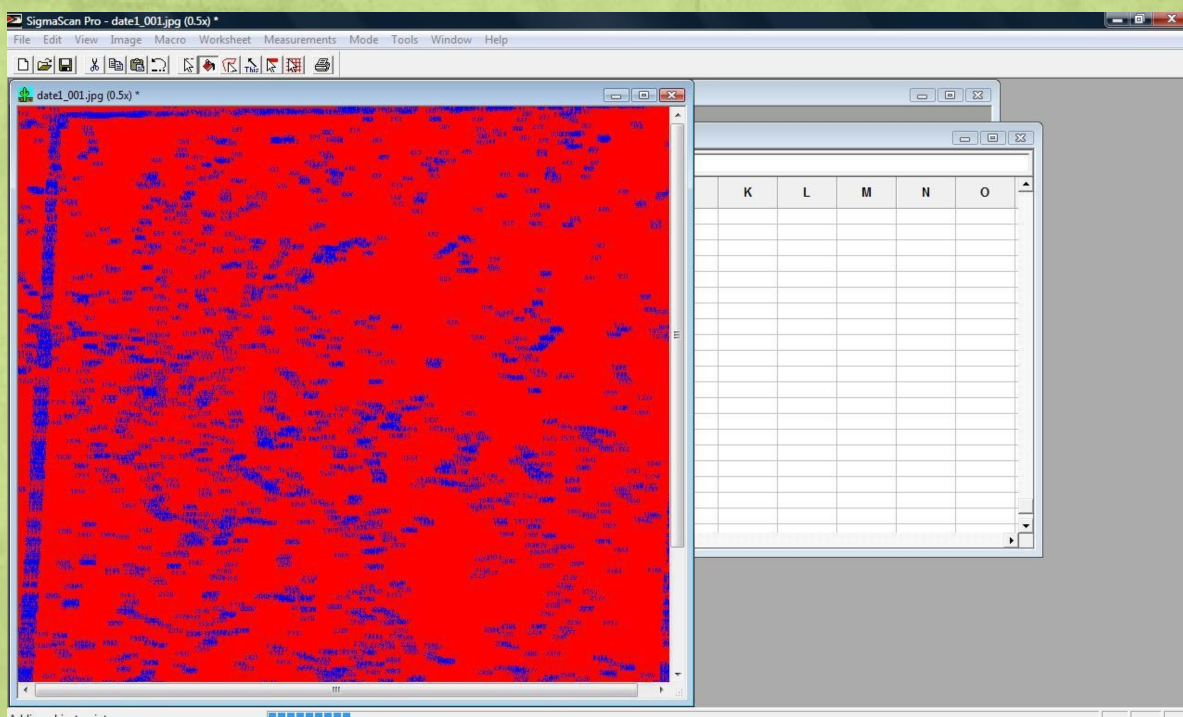
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	8/1/2013	18/1/2013	29/1/2013	12/2/2013	25/2/2013	6/3/2013	19/3/2013	28/3/2013	9/4/2013	22/4/2013	30/4/2013
	%COVER	%COVER	%COVER	%COVER	%COVER	%COVER	%COVER	%COVER	%COVER	%COVER	%COVER
A	7,0	22,5	44,3	69,6	74,3	78,6	83,9	89,1	93,7	87,6	85,5
B	6,4	21,9	56,3	78,0	80,6	97,8	97,4	92,5	93,0	95,9	95,6
C	5,2	11,0	25,4	43,2	61,2	66,2	75,7	80,9	82,2	88,9	90,9
D	7,9	17,8	36,8	68,7	72,5	86,7	90,0	92,2	94,5	96,2	93,0
E	2,7	3,6	9,9	23,9	47,7	58,7	58,0	58,6	65,9	70,2	78,1

A	%change in Canopy Cover	15,6	21,7	25,3	4,7	4,4	5,2	5,2	4,7	-6,1	-2,1
B		15,5	34,4	21,6	2,7	17,2	-0,5	-4,8	0,5	2,9	-0,3
C		5,8	14,4	17,9	17,9	5,0	9,5	5,2	1,3	6,7	2,0
D		9,9	19,0	31,9	3,9	14,1	3,4	2,2	2,3	1,7	-3,2
E		0,9	6,3	13,9	23,9	10,9	-0,6	0,5	7,4	4,3	7,9

- Failure to simulate high rate growth plants
- Better simulation with low rate growth plants for Canopy Cover

RMSE= 0,39 d=0,78

- For yield we compared the dry weight of grains from the plot and we projected for an hectare

RMSE= 0,24 d= 0,85

Wild oat productivity response to climate change

	Agrinio		Alex/lis		Arta		Karditsa		Mikra		Pyrgos		Yliki	
	1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050		1961-1990 to 2021-2050	
	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2	no CO_2	CO_2
HadRM3	-2	15,1	11,2	35,6	2,5	16,4	-11,2	24,5	29,1	44	-2,3	14,8	5,1	24,1
C4I	-6,2	19	-1,1	16,2	1,2	10,1	1	24,3	-7,8	12,3	-4,3	8,9	1	42
ETHZ	2,4	13,7	14,4	18,4	6	9,1	-4,3	13,6	12,3	21,1	-7,8	8,4	-14,6	3,4
DMI-HIRHAM	1,2	12,6	-4,1	15,5	-5	10,4	-3,3	12,3	16,2	28,9	-4,5	12,1	-15,7	4,1

Conclusion

- In general wild oat and wheat had a similar response to climate change
- It seems that in most of the cases under no CO_2 enrichment the wild oat is more tolerant to climatic vulnerability especially in the driest climate models
- Mikra and Alexandroupolis (Northern Greece) are more favorable to climate change. Increase in productivity for wheat and wild oat
- Karditsa, Pyrgos and Yliki had the highest decrease among the study areas while wild oat had lower reduction than wheat

Uncertainties

- No FACE experiments for weeds in general
- Lack of experimental data for wild oat
- Separate plots for wheat and wild oat

ACKNOWLEDGEMENTS

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ΕΣΠΑ 2007-2013
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ΕΥΡΩΠΑΪΚΟ ΚΟΙΝΩΝΙΚΟ ΤΑΜΕΙΟ
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ AGRICULTURAL UNIVERSITY OF ATHENS

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