

# A BROAD OVERVIEW OF THE MAIN PROBLEMS DERIVED FROM CLIMATE CHANGE THAT WILL AFFECT AGRICULTURAL PRODUCTION IN THE MEDITERRANEAN AREA

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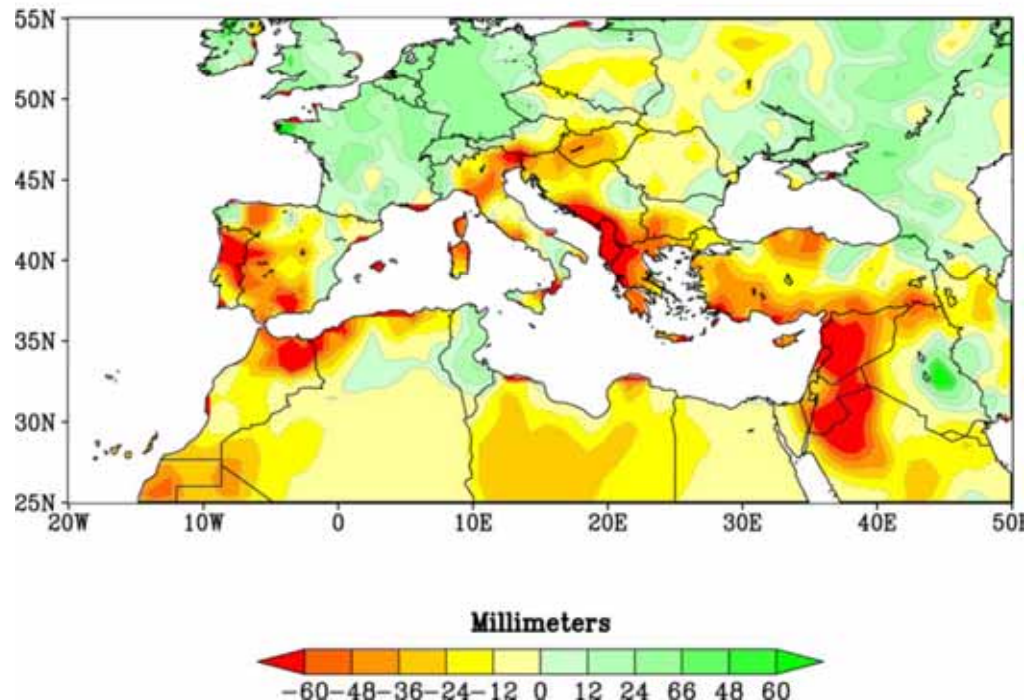
FAO/OECD WORKSHOP  
BUILDING RESILIENCE FOR ADAPTATION TO CLIMATE CHANGE  
IN THE AGRICULTURE SECTOR  
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# An Overview of the Presentation

- Aim: To provide a broad overview of the main problems that will affect agricultural production in the Mediterranean area and are derived by climate change
- Structure:
  1. Climate Change in the Mediterranean Area
  2. Climate Change Effects on Agriculture
  3. Mediterranean Forests under Climate Change
  4. Building Resilience to Climate Change
  5. Summary and Conclusions

# 1. Climate Change in the Mediterranean Area: Ongoing Climate Change

- Evidence of Climate Change:
  - Wintertime droughts are increasingly common and human-caused climate change is partly responsible for this
  - In the last 20 years, ten of the driest 12 winters have taken place in the lands surrounding the Mediterranean Sea



Reds and oranges highlight lands around the Mediterranean that experienced significantly drier winters during 1971-2010 than the comparison period of 1902-2010 (NOAA)

# 1. Climate Change in the Mediterranean Area: Future Climate Change – Main Elements

## **Increased Average Surface Temperature**

Despite the high degree of uncertainty regarding the regional distribution of climate change in the Mediterranean area, substantial temperature changes of partly more than 4 °C by the end of this century have to be anticipated under enhanced greenhouse warming conditions

## **Rainfall**

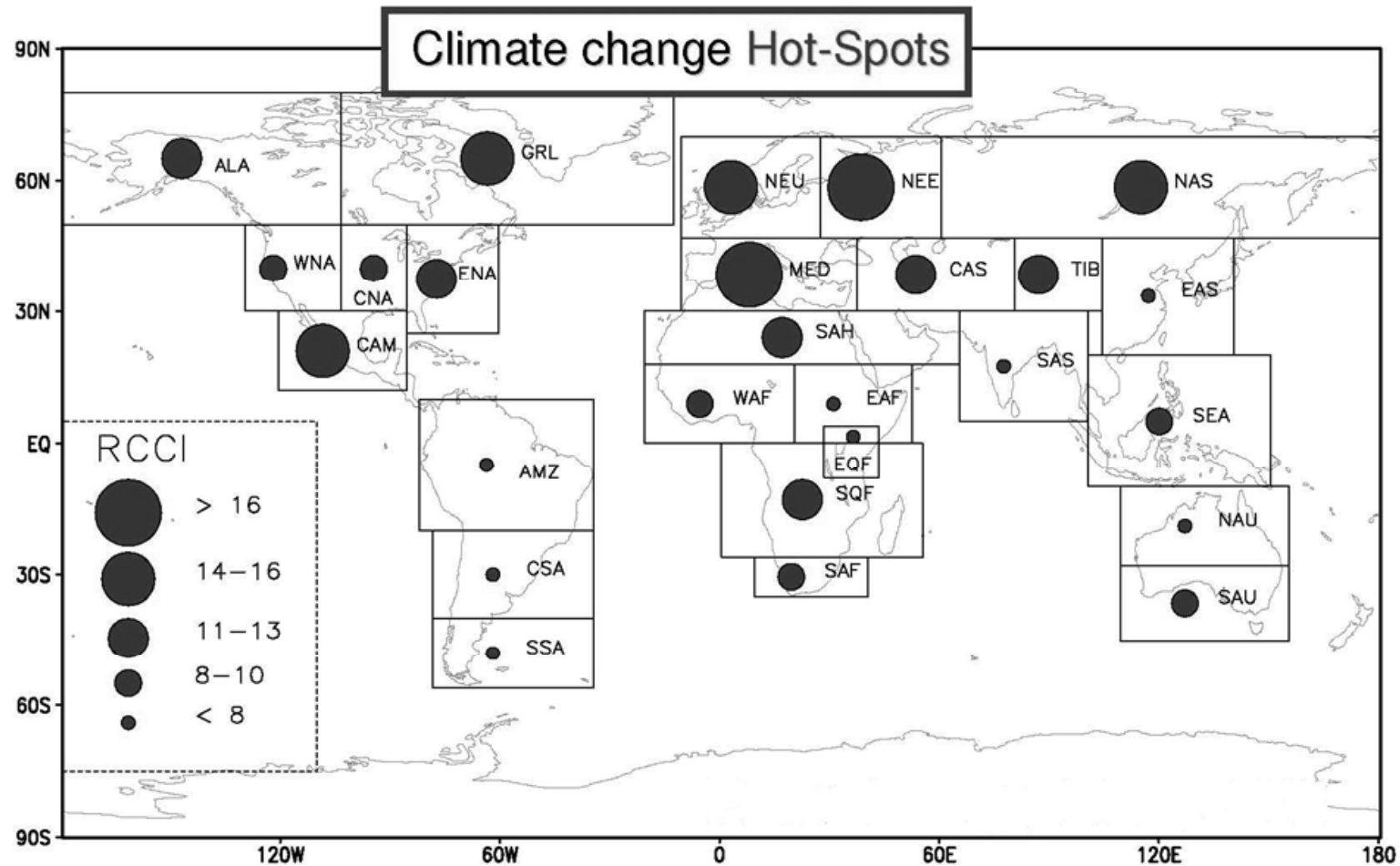
Western and Northern Mediterranean regions: Shortening and increase in the rainfall amount of the wet season

Eastern and southern parts: Mainly negative precipitation changes throughout the period from October to May. Precipitation will decrease by 10 to 30% across many of the desert areas of the region, with larger precipitation decreases of up to 200 percent along the coasts of Morocco, Algeria, and Tunisia and the South East Mediterranean region including Israel, Lebanon, Cyprus and parts of South West Turkey.

## **Extreme Events**

High temperature extremes and drought events were found to increase substantially in summer while winter low temperature extremes were found to decrease  
The likely occurrence of extreme precipitation events after prolonged droughts may give rise to more extreme phenomena such as deep erosion and landslides

# 1. Climate Change in the Mediterranean Area: A Climate Change “Hot Spot”



Climate Change Hot Spots after Giorgi (2006)

## 2. Climate Change Effects on Agriculture

- Climate change may affect:
  1. water resources and irrigation requirements;
  2. soil fertility, salinity and erosion;
  3. crop growth conditions, crop productivity and in crop distribution;
  4. land use;
  5. optimal conditions for livestock production;
  6. agricultural pests and diseases; and
  7. Economy wide effects through effects on the agricultural and rural economy

## 2.1 Climate Change Effects on Agriculture:

### Water resources and irrigation requirements

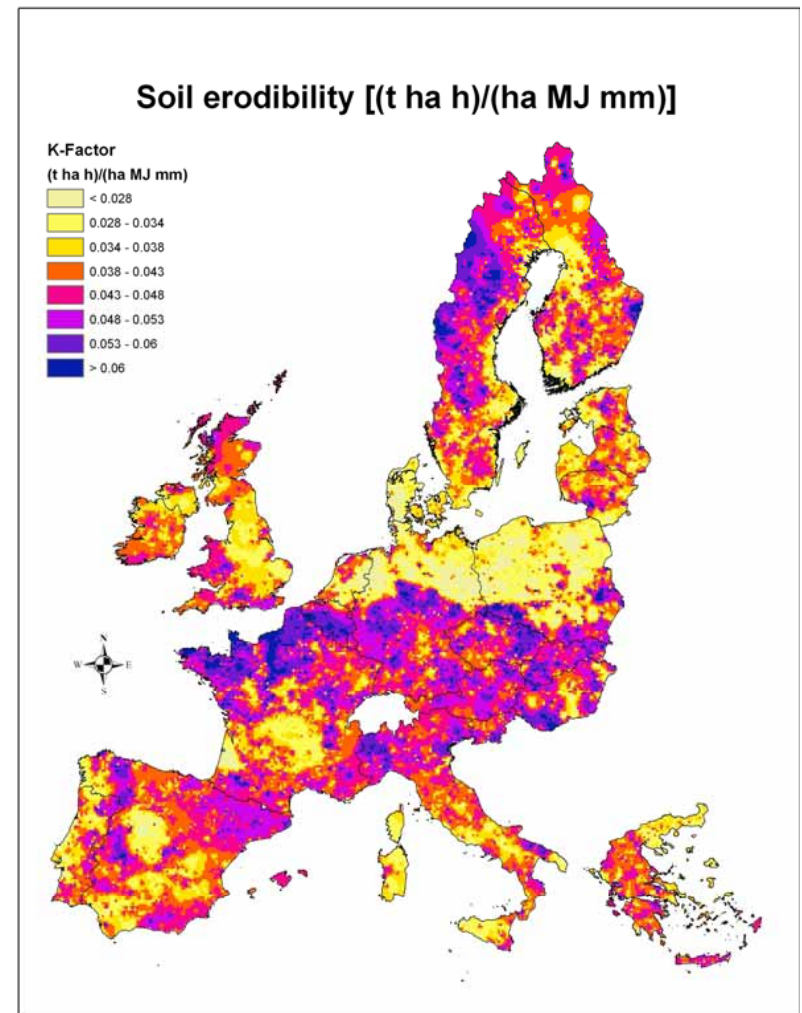
- Demand for irrigation water will be driven by:
  - the simultaneous changes in annual totals of precipitation and of average air temperatures and
  - the seasonality of precipitation and inter-annual variability
- More specifically:
  - In the Mediterranean parts of **Europe** the declining water balance has been documented over the past 32 years
  - **Egypt** depends on hydro-intensive crops contributing to the country's agricultural exports and to smallholders' income
  - **Tunisia** is already experiencing persistent droughts and its rain-fed agriculture represents 90% of its agricultural area, exposing this sector (especially cereals) to climate variability
  - In the late 1990s, water reserves did not satisfy the water needs of both Tunisia and **Morocco**, and several irrigation-dependent agricultural systems to ceased production
  - In **Cyprus**, a 15% decrease in precipitation from 540mm to 460 mm could lead to a 41% decrease in water resources
  - In **Israel**, an increase in the frequency and severity of floods may cause a 25% reduction in water availability and a reduction in groundwater recharge. Seal level rise by 50cm, may cause a loss of 16 million cubic meters of water for each km along the coastal plain and changes in the salinity level of the Sea of Galilee
  - In **Turkey**, a water budget model simulation indicated that by 2050, water runoff will be reduced by 35-48%, potential evaporation will increase by 15-17%, crop water demand will increase by 19-23% and surface waters will be reduced by about 35%

## 2.2 Climate Change Effects on Agriculture: Soil fertility, salinity and erosion

Three major driving forces behind desertification in the Mediterranean region Wrachien et al. (2006):

- i. a change in agriculture from extensive systems based on grazing and dry land wheat to intensive agriculture based on tree crops, horticulture and irrigation;
- ii. social changes accompanied by an improvement in the standard of living and migration from the countryside to the city or overseas;
- iii. the growth of tourism and the littoralization of the Mediterranean economy.

It is estimated that at present water erosion in the Mediterranean region could result in the loss of 20/40 t/ha of soil after a single cloudburst, and in extreme cases the soil loss could be over 100 t/ha. Soil erosion and the risk to desertification in southern Europe and the Mediterranean are closely related to forecasted increase of forest and wilderness fires and the consequent canopy removal especially on high slope areas.



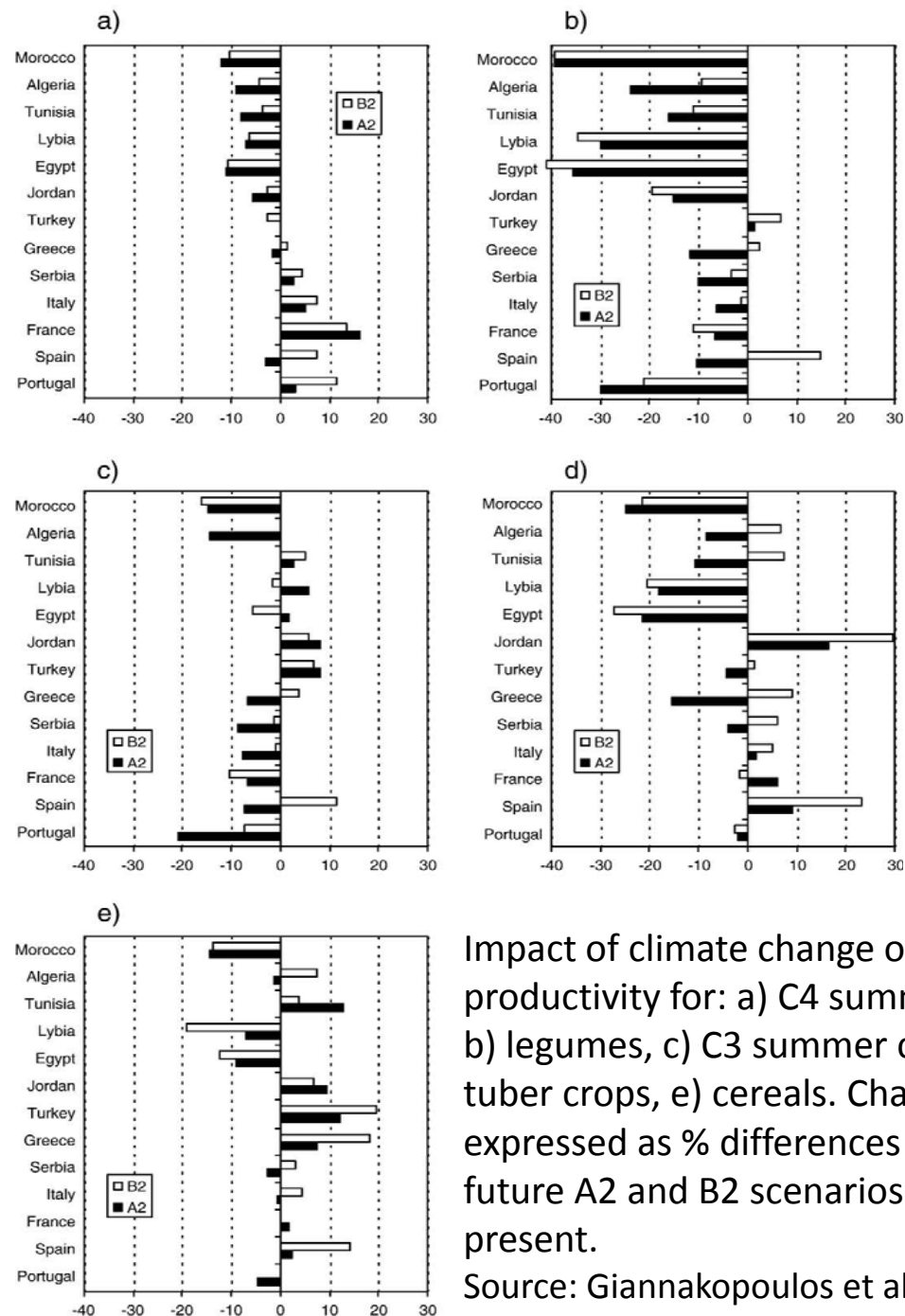
Soil erodibility in Europe, Panagos et al. (2012)



## 2.3 Climate Change Effects on Agriculture: crop growth conditions

- crop growth is affected by:
  - climate conditions (precipitation and air temperature that control soil moisture and available to plants water and affect evapotranspiration),
  - CO<sub>2</sub> concentration and,
  - Technology
- In **Southern Europe**, general decreases in yield (e.g., legumes -30 to + 5%; sunflower -12 to +3% and tuber crops -14 to +7% by 2050) and increases in water demand (e.g., for maize +2 to +4% and potato +6 to +10% by 2050) are expected for spring sown crops
- For **Morocco** in 2055, maize crop yield may increase from a baseline value of 317 kg/ha to a value of 550 kg/ha, an approximately 175% increase due to the positive effects of increased atmospheric CO<sub>2</sub>
- In **Israel**, some studies suggest the (rather disputable) conclusion that climate change could be beneficial to agriculture, due to the ability of Israel to supply international markets earlier in the season
- in **Morocco** likely changes include a reduction in the growth period of regional crops, a reduction in the duration of crop cycles, and an increase in the risk of dry periods during the course of crop cycles
- In **Egypt** studies show that a shift in crop sowing dates to earlier in the season, to prevent crop losses due to excessively warm growing conditions is very likely. Future sowing dates will shift one to eight weeks earlier, depending on the crop type, region, and year. By 2100, air temperatures will be high enough that growing wheat in Egypt will be impossible

Giannakopoulos et al. (2009) find that without adaptation “the effect of climate change on agriculture is likely to be more severe in the southern Mediterranean areas than in the northern temperate areas. In the warmer southern Mediterranean, increases in CO<sub>2</sub> help reduce the loss in yield arising from a warmer and drier climate, but are not able to completely recover the losses. In the cooler north-eastern Mediterranean, CO<sub>2</sub> increases associated with climate change result in little net effect on most crops, provided that the increase in water demands, especially for irrigated crops, can be met”.



Impact of climate change on crop productivity for: a) C4 summer crop, b) legumes, c) C3 summer crop, d) tuber crops, e) cereals. Changes are expressed as % differences between future A2 and B2 scenarios and present.

Source: Giannakopoulos et al., (2009).

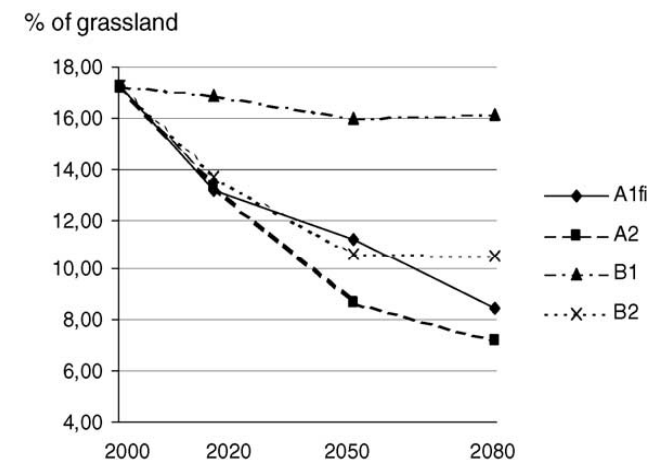
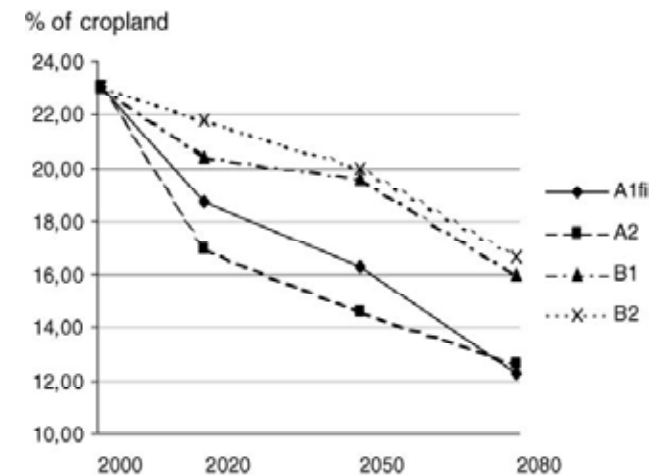
## 2.4 Climate Change Effects on Agriculture: land use

Share of cropland out of total land for the baseline and the four SRES scenarios in Mediterranean countries

	Baseline (%)	A1FI in 2080 (%)	A2 in 2080 (%)	B1 in 2080 (%)	B2 in 2080 (%)
Portugal	26.98	7.24 (-73)	14.22 (-47)	12.49 (-54)	17.23 (-36)
Spain	33.17	8.78 (-74)	17.54 (-47)	17.23 (-48)	23.69 (-29)
France	45.87	26.70 (-42)	24.71 (-46)	32.91 (-28)	32.52 (-29)
Italy	39.53	20.13 (-49)	20.87 (-47)	25.57 (-35)	27.21 (-21)
Greece	25.66	8.18 (-68)	13.50 (-47)	13.96 (-46)	17.30 (-33)
Europe 17	23.02	12.27 (-47)	12.66 (-45)	16.01 (-30)	16.65 (-28)

### The future of surplus agricultural land:

- recreational areas (high demand for water)
- forest land use (high demand for water)
- bioenergy production (?)
- increasing farm sizes (?)
- Other uses?



Changes in cropland and grassland under the four climate change scenarios as percentage of total European area.  
Source: Rounsevell et al. (2005).

## 2.5 Climate Change Effects on Agriculture: optimal conditions for livestock production

Higher temperatures results in greater water consumption and more frequent heat stress which causes declines in physical activities, including eating and grazing. Livestock production may therefore be negatively affected in the warm months of the currently warm regions of Europe. Climate change impacts will probably be minor for intensive livestock systems. More research is needed...

## 2.6 Climate Change Effects on Agriculture: agricultural pests and diseases

Climate change and especially higher air temperatures will create conditions suitable for the invasion of weed, pest and diseases adapted to warmer climatic conditions. Increasing temperatures may also increase the risk of livestock diseases by:

- supporting the dispersal of insects, e.g., *Culicoides imicola*, that are main vectors of several arboviruses, e.g., bluetongue (BT) and African horse sickness (AHS);
- enhancing the survival of viruses from one year to the next;
- improving conditions for new insect vectors that are now limited by colder temperatures

## 2.7 Climate Change Effects on Agriculture: economy wide effects

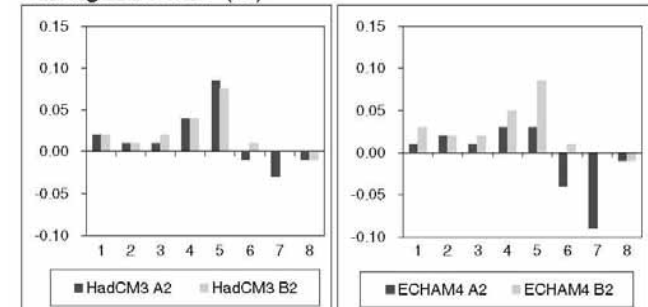
In areas with significant productivity losses such as the Mediterranean south and with the agricultural sector still playing a significant role in the overall economy, GDP changes are negative and significant especially under the A2 scenario.

Changes in agriculture imports and exports are wider than the changes in GDP. The agricultural trade balance would increase due to the lower crop prices induced by land productivity gains. These lower prices assign a competitiveness gain for European crops in world agriculture markets. However, in the Mediterranean regions the crop supply changes are negative, which result in higher prices and no gains for the agricultural trade balance. Especially in the Mediterranean south, the agricultural trade balance under the A2 scenario may deteriorate by almost 10 to 15% depending on climate model (HadCM or ECHAM).

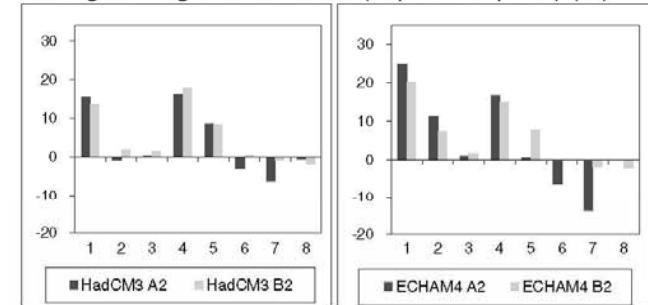
The price of labour moves in the same direction as land productivity

Source: Iglesias et al. 2011

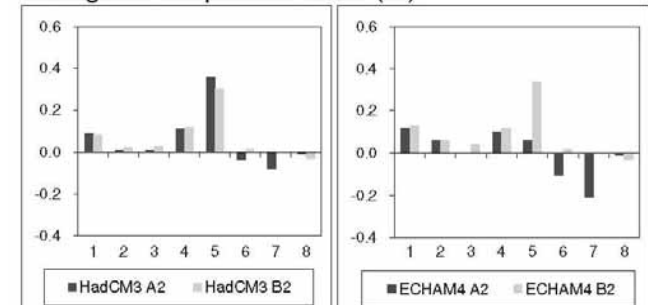
Changes in GDP (%)



Changes in agricultural trade (exports-imports) (%)



Changes in the price of labour (%)



Agroclimatic zones: (1) Boreal; (2) Atlantic North; (3) Atlantic Central; (4) Alpine; (5) Continental; (6) Medit.North; (7) Medit. South; (8) Rest of the World

### 3. Mediterranean Forests under Climate Change: Forest Fires

In general, fire risk will be higher during the summer, with the maximum increase in August in the North Mediterranean inland, Balkans, Maghreb, North Adriatic, central Spain, and Turkey which seem to be the most vulnerable regions, the South of France is as strongly affected as Spain, but only in August and September and the southeast Mediterranean (from Lebanon to Libya) sees no particular increase or decrease.

In particular, Giannakopoulos et al., (2005; 2009) predict:

- 2 to 6 additional weeks of fire risk everywhere except for Provence, southern Italy/Sardinia, northern Tunisia and Libya where one week more is foreseen, and Egypt and the Middle East coast where no increase is foreseen.
- A greater increase of up to 6-7 weeks is expected inland (central western Iberian Peninsula, the Atlas mountains and plateaus in North Africa, large parts of Serbia, Bosnia-Herzegovina and Montenegro in the Balkans, and north-eastern Italy). A smaller increase is expected in the coastal areas with almost no change in extreme fire risk, except for the Iberian Peninsula, Morocco, northern Italy and the eastern Adriatic coast.
- The maximum increase in fire risk will occur in July and August, especially in the central part of the Iberian Peninsula, northern Italy, the Balkans and central Anatolia.

## 5. Building Resilience to Climate Change: Farm Level

Climate change adaptation refers to actions aiming to improve the resilience of the agricultural sector and reduce its vulnerability to changing climate (Bockel 2009).

Adaptation actions are distinguished as technological, behavioural, or management based:

Example: climate change will decrease water supply and increase demand for irrigation water in the Mediterranean region.

Technological adaptation: A shift to water conservation on farm (drip irrigation techniques, liquid irrigation and new methods of applying plant protection substances)

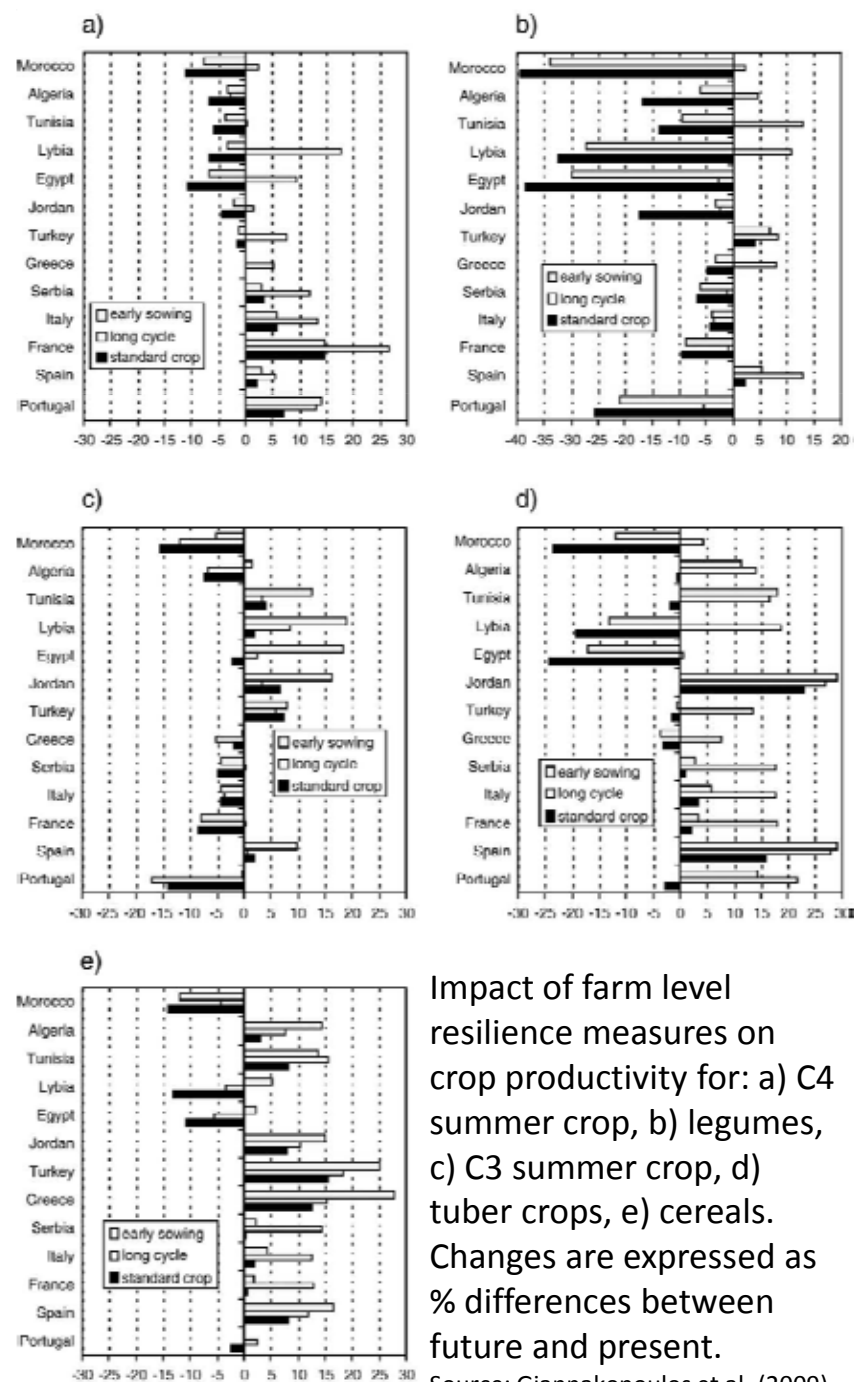
Managerial and behavioural adaptation: Adoption of drought resistant crops, the adoption of water saving cropping methods such as mulching, minimum tillage and maintenance of cover crops, a change in planting dates and cultivars and even a shift to cropping zones by altitude and latitude. The adoption of farm management techniques for producing more nitrogen by leguminous crops and animal feeds, for example, roots, cereals and legume rich leys, in rotation.

Giannakopoulos et al. (2009), examine the effects of two farm level climate change resilience strategies. Early sowing date because it is associated with the shortening of the growing season (due to high temperatures) may reduce the negative impacts of climate change or even enhance positive impacts allowing crops to escape higher temperature and water stress. In the case of C3 summer crops in Egypt, early sowing is shown to produce significant positive effects out of slightly negative climate change effects.

The use of longer growing cycle cultivars under higher temperatures triggers increase of development rate. For example, the negative climate effects on legumes are reverted to positive for Tunisia, Libya and Greece, if longer growing cycles are adopted.

Both adaptation practices, require additional water for irrigation which re-connects farming practices to a wider water management strategy under climate change.

The effective use of long cycle cultivars can demand 25–40% more water, which may be not available or may be not a cost effective measure under future climate change scenarios.



Impact of farm level resilience measures on crop productivity for: a) C4 summer crop, b) legumes, c) C3 summer crop, d) tuber crops, e) cereals. Changes are expressed as % differences between future and present. Source: Giannakopoulos et al.,(2009).



Farmers learn from past experience and dynamically adapt production to climate change.

The form of the learning curve differs from farmer to farmer and depends on the capacity and skills that farmers have to assimilate changes.

The likely success of resilience measures at farm level depends on a range of socio-economic factors including farm characteristics such as production type, size of the farm, level of intensity, the diversity of cropping and livestock systems, and the presence of other income sources apart from agriculture, access to relevant information, skills and knowledge about climate trends and adaptive solutions, the role played by advisory services in facilitating adaptation and the general socio-economic situation. In general, farmers with limited resources or living in remote rural areas are more vulnerable and have less access to available technology and infrastructure (European Commission, 2009a).

## 5. Building Resilience to Climate Change: Higher than Farm Level

There are limits to the effectiveness of simple farm-level resilience measures under more severe climate changes which may call for more systemic changes in resource allocation

Many argue for a “**country focus**” integrating adaptation and mitigation into national sectoral policies and strategies. A “country focus” should aim at the consolidation of the resilience of cropping systems, of watersheds and infrastructure to natural disasters and of vulnerable populations to shocks

Other argue for an “**implementation focus**” through the formulation and scaling up of projects and programmes. The “implementation focus” could involve the ex ante project and programme appraisal of carbon balance, the enhancement of the poverty reduction potential, food security and sustainable development through payments for environmental services and the strengthening of productive, social and environmental safety nets.

In a European Union (EU) context, the well-established agricultural policy has facilitated the entering of climate change in the lexicon of the Common Agricultural Policy (CAP).

The CAP post-2013 legal proposals and more specifically, the proposal for the post-2013 RDP Regulation seems to signal an even higher focus of the CAP towards climate change adaptation and mitigation. Climate change adaptation and mitigation is a cross-cutting objective of rural policy linked to:

1. increasing efficiency in water use by agriculture;
2. increasing efficiency in energy use in agriculture and food processing;
3. facilitating the supply and use of renewable sources of energy, of byproducts, wastes, residues and other non food raw material for purposes of the bio-economy;
4. reducing nitrous oxide and methane emissions from agriculture;
5. fostering carbon sequestration in agriculture and forestry.

## 6. Overall Conclusions

Building tolerance at farm level depends on the farmers' learning and adaptation abilities as well as on available technological and scientific innovations.

Resilience at farm level should be coordinated and planned at sectoral and regional level and beyond the farm level measures.

Sector-wide planning and advice are necessary, because some of the measures for adjusting to new climatic conditions are likely to be costly and may need significant investments by farmers, thus indirectly raising an issue of disproportionate resilience costs.

The reasons behind low uptake of resilience measures include uncertain information on climate change impacts and limited representation of farmers in decision making processes. We should invest on the hidden capabilities of the rural population.

Taking into account the specificity and diversity of the socio-economic factors in the Mediterranean basin together with the fact that this region of the world is considered to be a climatic change hot spot:

**Building a resilience strategy is a priority, “no regret” action.**