IMPACT OF CLIMATIC CHANGE ON WHEAT PRODUCTION OF THE AEGEAN REGION OF TURKEY: THE EFFECT OF A REDUCTION OF RAINFALL ON WHEAT YIELDS

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Introduction

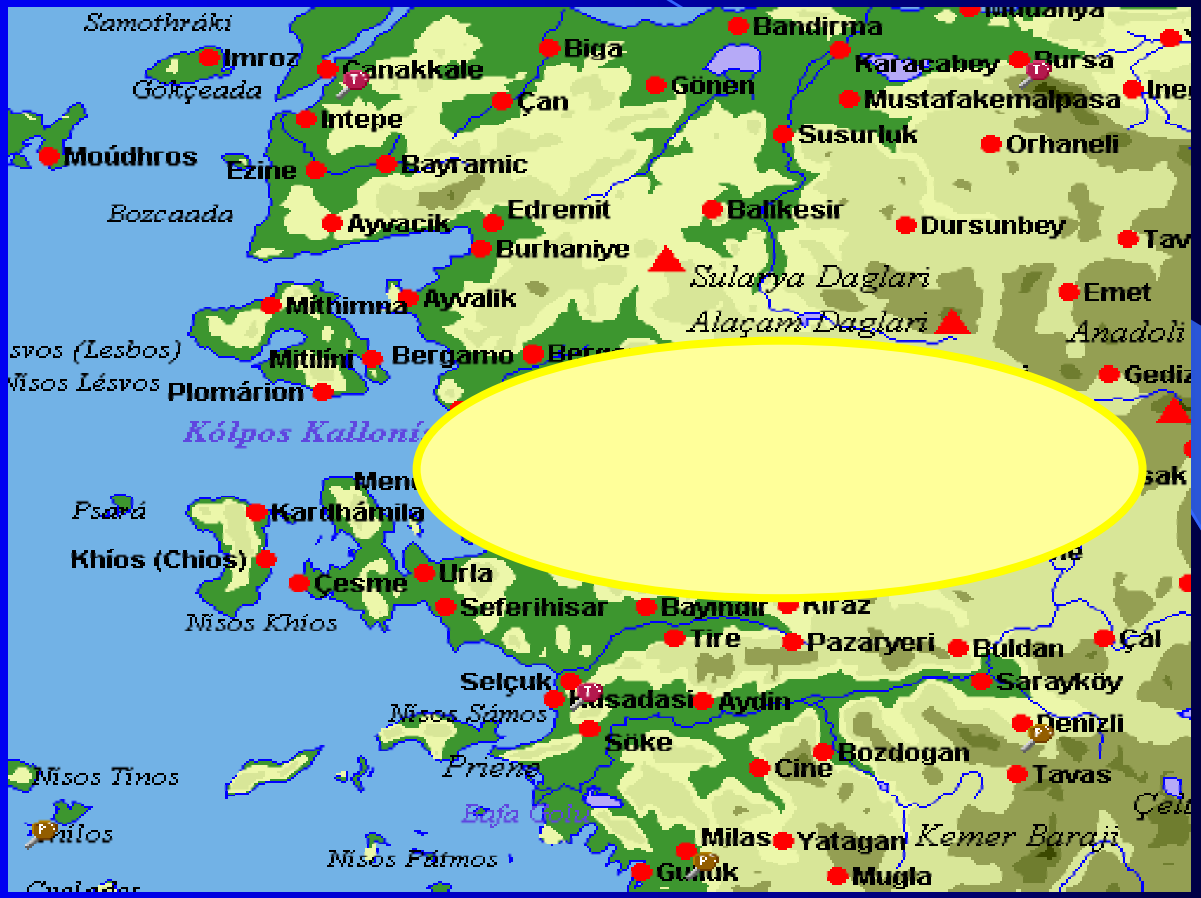
During the last 10 years the impact of climatic change on agricultural production has received considerable attention. Such conditions could have a considerable affect on wheat production of the Aegean region of Turkey.

The United Kingdom Meteorological Office atmospheric models simulated average atmospheric conditions for the period 2010-2039, taking into account expected increases in greenhouse gases and sulphate emissions.

For the area of the Gediz Basin in Aegean Region of Turkey, the model predicts an average decrease in annual precipitation of 50 mm (a reduction of 5-10 percent) and an average increase in temperature of 1.9 ^{o}C.

Gediz Basin location map

Aegean Region and Gediz Basin



Methodology

- This study has came on scene the Turkish-Israel Joint Research Project results.

- The **objective** of the Turkish-Israel Joint Research Project was to integrate the knowledge of the impact of climate, agricultural technology, soil and socio-economic conditions on variability of the wheat yields in the Aegean Region of Turkey.
- For this **purpose**, a data bank consisting of 3 main resources was established .

  - Climatic data .....(*National Meteorological Services*)
  - Statitical data .....(*National Statistical Institute & GDRS Menemen Research Institute*)
  - Experimental data ..(*5 districts x 29 years MRI-GDRS*),

Climatic database

The core database required to consider crop production systems is made up of the physical, biological, social and economic resources.

Comprehensive files of climate and weather data are essential because these are the primary inputs that dry biophysical processes of a crop system.

The climatic data was obtained from the national meteorological services and consisted of five meteorological stations in the Aegean Region.

In addition the research Institute of Rural Services, GDRS, provided data from the agrometeorological station at Menemen.

The Rainfall Climate

The spatial and temporal annual rainfall variations in Turkey was analyzed by Türkeş, 1996. He expressed the Aegean Region, which includes the Gediz Basin as part of the Mediterranean rainfall regimes.

The most frequent rainfall amount is some 500-530 mm, but extremes of 300 mm and 850 mm also occur.

Table 1. Rainfall amounts and locations of five stations

District	Rainfall Station	Station Location Longitude Latitude		Mean annual Rainfall (mm) 1970-1998
Balikesir	Dursunbey	39^{0}39’	27^{0}25’	548
Manisa	Salihli	38^{0}29’	28^{0}27’	488
Izmir	Menemen	27^{0}04’	38^{0}35’	444
Aydin	Aydin	37^{0}51’	27^{0}51’	605
Denizli	Nazilli	37^{0}55‘	28^{0}19’	566

Agro Climate

- Wheat pre-planting rainfall averages some 100 mm with October rainfall at 35-45 mm ± 30 mm and November rainfall some 70 mm ± 30-40 mm.
- December and January are rainy months with nearly 100 mm ± 50-60 mm each month.
- February rainfall decreases a little to 60-80 mm ± 30-50 mm.
- During March and April rainfall amounts decrease to 60 and 40-50 mm respectively ± 30-40 mm and rainfall season practically ends in May with some 25-35 mm ± 25 mm.

Table 2. The long term average monthly rainfall and average daily temperatures for Menemen (1970-1999) - Reference for scenarios

Months	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII
Mean monthly Rainfall mm	8.0	32.2	79.5	101.0	79.8	65.8	63.3	42.3	25.1	5.4	2.9	3.8
Mean Daily Temp. (^{o}C)	22.3	17.5	12.6	9.0	7.9	8.6	10.9	15.0	20.0	24.7	27.0	26.2

Rainfall Wheat Yield Relationships

The wheat crop is usually planted during mid-November and harvested in mid-June , making a total growing period of some 210 days.

The flowering period of the wheat crop is during the end of April or beginning of May, so that the vegetative period is some 150-160 days, the flowering period of 20-25 days and the grain filling and ripening period 35-40 days.

The average climatological water balance of the wheat crop, grown in Menemen over a period of 210 days is shown in the Table next.

Table 3. The mean climatological water balance of wheat grown in Menemen using long term climatic data (1970-1998)

Month	Phenology	Rainfall (mm)	Mean ET (mm)	Balance
15 Nov.	Planting	77	12	+ 65
Dec.	Early growth (5-8 cm)	102	24	+ 78
Jan.	Wheat (15 cm)	81	31	+ 50
Feb.	Spring growth	63	38	+ 25
March	Considerable growth	63	70	- 7
End of April	Flowering	43	120	- 77
May	Grain filling	25	202	- 177
15 June	Harvesting	6	34	- 28
	Total	**460**	**531**	

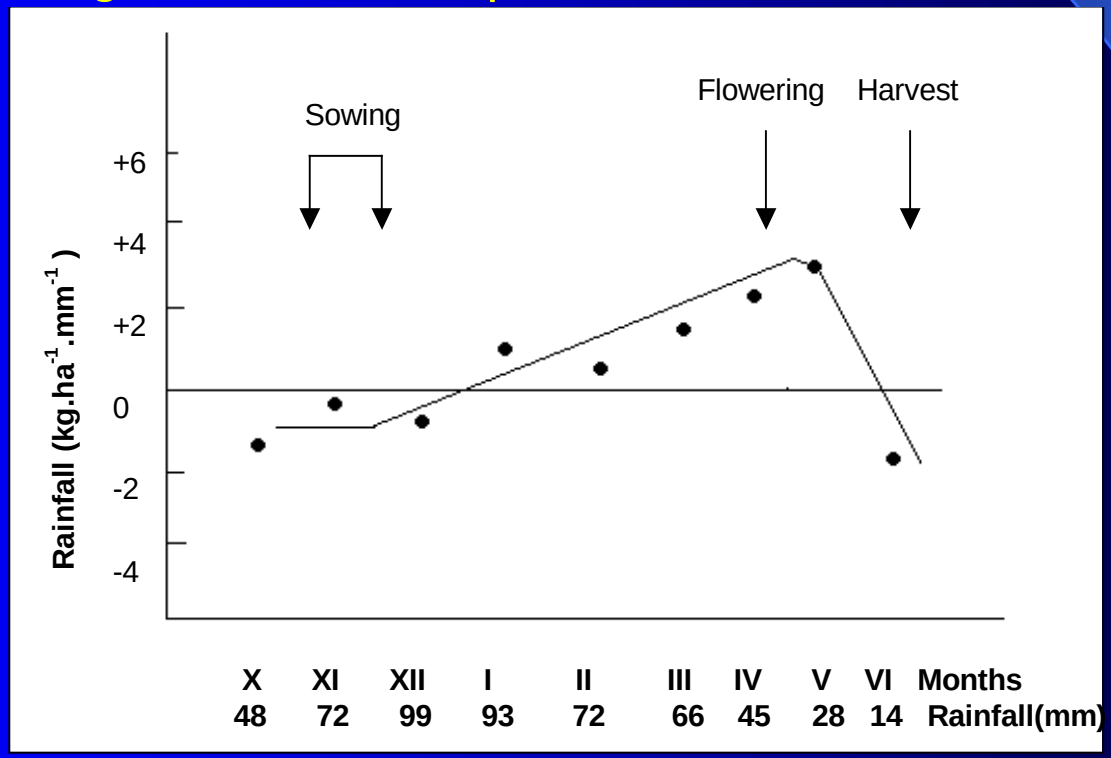
Although those assumptions are not found under field conditions, it does indicate that in an average year, there is considerable water surplus from November to February,

The month of March has a fairly balanced water budget and that increasing water deficit occurs during **April, May and June**, reaching critical values in **April and May.**

Effect of rainfall distribution on wheat yields in the Aegean Region

- Using standard statistical analysis to relate wheat yields (dependent variable) to monthly rainfall data (independent variable) over a periods of 27 years, the following average effect of rainfall distribution on wheat yields ($kg.ha^{-1}.mm^{-1}$) was obtained.

- This Figure shows the effect of a departure of an additional mm of rainfall above or below the mean monthly rainfall value at any point of time during the growth of the crop.



Rainfall scenarios

- *The present reference climatic scenario was shown in Table 2 based on the mean monthly rainfall amounts (mm) and mean daily temperatures (º C) for Menemen.

Months	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII
Mean monthly Rainfall mm	8.0	32.2	79.5	101.0	79.8	65.8	63.3	42.3	25.1	5.4	2.9	3.8
Mean Daily Temp. (ºC)	22.3	17.5	12.6	9.0	7.9	8.6	10.9	15.0	20.0	24.7	27.0	26.2

- Under the reference scenario, the effect of rainfall on wheat yields is determined basically by rainfall during the main season (December-February) affecting the **available soil moisture** during the reproductive period.

- *This will be modified by rainfall in April and May. This rainfall (April and May) contributes +2.4 and +3.1 $kg.ha^{-1}.mm^{-1}$ (See Figure1).
- The Available Soil Moisture storage during December-February is going to decrease by 5-10 % to 234 mm and 222 mm.
- *Such changes are unlikely to have a significant effect on the soil moisture regime.
- They are however likely to increase the response of wheat to rainfall in April and May.
- Thus the expected reduction in wheat yields due to –5 % and –10 % scenarios would be as follows:

Table 4. The expected effect of rainfall reduction on wheat yields of the Aegean region of Turkey.

Period considered	Rainfall reduction scenarios	
	- 5 %	-10 %
April May	- 6.6 kg.ha^{-1} - 6.5 kg.ha^{-1}	- 12.9 kg.ha^{-1} - 10.0 kg.ha^{-1}
Total	-13.1 kg.ha^{-1}	- 22.9 kg.ha^{-1}

At the present (1998) average wheat yield of 2750 kg.ha^{-1} this would be a reduction of **0.5** % for the –5 % rainfall scenario and a **0.8** % for the –10 % rainfall scenario.