Main Achievements of the ICCAP Project by the Israeli team 2004-2005

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Reasearch objectives for the year 2004-2005

A. Regional climate change (TAU)

1. Analysis of the global warming models over the Mediterranean.
2. Daily classification of synoptic systems for 1948-2000 including : change of seasons,

B. Global warming effect on biomass production and water requirements.(BGU)

3. Quantification and development of models to predict the effect of extreme GCC scenarios on biomass production (Goal No. 1)
4. Integration with two of the other branches of the project, "Climate predictions" and "Socio-economic evaluation" (Goal No. 2).

C. Socio-Economic impact of GCC. (HU)

5. Assessment of Damage and Adaptability to Regional Climate Change.
6. To determine how farming would change with the expected changes in precipitation patterns.

Regional Climate Analysis (Pinhas ALPERT Shimon KRICHAK Colin PRICE and Julian DANIELS ; *Dept. of Geophysics and Planetary Sciences, TAU.*

1. The paradoxical increase of Mediterranean extreme daily rainfall in spite of decrease in total values, has been demonstrated.
2. Long-term variations in Summer Temperatures over the Eastern Mediterranean, (EM) were analysed.
3. Semi-Objective Classification for daily synoptic systems over the EM was performed for 1948-2003. Several applications for better understanding of climate changes over the EM are in progress.
4. Application to the Eastern Mediterranean climate change has shown the significant increase of Red-Sea Trough synoptic patterns.
5. A new seasons definition based on the classified daily synoptic systems: an example for the Eastern Mediterranean.
6. The factors governing the Summer regime of the Eastern Mediterranean were clearly separated: the cooling due to the Ethesian winds and the heating due to air subsidence imposed in our area by a) the Indian Monsoon; b) the Hadley Circulation.

The Ethesian winds are determined by Britannica 2004 as: remarkably steady southbound drift of the lower atmosphere over the eastern Mediterranean and adjacent lands in summer. From about mid-May to mid-September. The etesian wind, which reaches maximum intensity in the early afternoon and may cease during the night, is part of the general inflow of air toward an intense low-pressure area usually centred over northwestern India in summer. The wind is not of the class generally termed monsoon winds because it is practically rainless, is not accompanied by high relative humidity, and is not replaced in winter by a drift from the opposite direction.;

The Hadley circulation (Britannica 2004) simple model of the Earth's atmospheric circulation that was proposed by George Hadley (1735). It consists of a single wind system in each hemisphere, with westward and Equatorward flow near the surface and eastward and poleward flow at higher altitudes. The tropical regions receivemore heat from solar radiation than they radiate back into space, and the polar regions radiate more than they receive; because both areas have nearly constant temperatures, Hadley theorized that warm air must therefore rise near the Equator, flow poleward at high altitudes, and lose heat to the cold air present near the poles. This cooler and denser air then descends and flows Equatorward at low levels until it nears the Equator, where it is warmed and rises again.

7. The connection between the El Nino climatic phenomenon and rainfall in the EM show statistically significant correlations. The El Nino of 2002/3 resulted in extreme rainfall amounts and flooding in the northern part of the EM , while the La Nina years prior to this wet winter were drier than usual.
8. Analyses of the effects of global climate trends on the EM precipitation have been performed. Mechanism of the origin of the positive trend of East Atlantic western Russia pattern and its role in the EM climate variations has been determined.
9. Climate version of MM5 model has been developed and adapted for regional climate simulations of the current climate conditions in in the EM. Preliminary results of the climate simulations with the model have been analysed.
10. Climate model RegCM3 of the ICTP, Trieste Italy, has been adapted for application at TAU. Regional climate simulations with the model are presently in progress.

Climate Change and Agriculture (Jiftah BEN ASHER[1], Pedro BERLINER[1], Dan BLUMBERG[2] and Avraham ZANGVIL[1]; [1]*Jacob Blaustein Institute for Desert Research and the* [2]*Dept. of Geography and Environmental Development, Ben Gurion University of the Negev.* German Partner: Lucas MENZEL, *Centre for Environmental Systems Research, University of Kessel)*

The Chukurova basin provides a good case study for analyzing the impact of global climate change on a regional basis. The predicted increase in temperature by 2-4°C and the expected decrease in precipitation by 30% may adversely affect crops productivity and water availability by the year 2050. Moreover, any changes in atmospheric composition and characteristics due to global warming is brought about through "agents" of the atmosphere, called synoptic disturbances -- the characteristic behavior of which, namely, intensity, location and frequency of occurrence, may be strongly affected by global warming. Thus, it is important to pay attention to changes in synoptic disturbance characteristics -- not only to changes in the mean conditions.

Computer crop models and intensive field measurements in the Chukurova basin in Turkey and the Negev Desert and the Jordan River basin in Israel were used to evaluate possible yield changes caused by climate change including the beneficial effect of increasing CO2 levels on crop growth. Results showed that wheat yield may increase by 20-25% for respective increase of 2°C and 4°C. But the associated increase in water consumption is 18% and 40% and the water cost for increased productivity may be too high. (Fig.1)

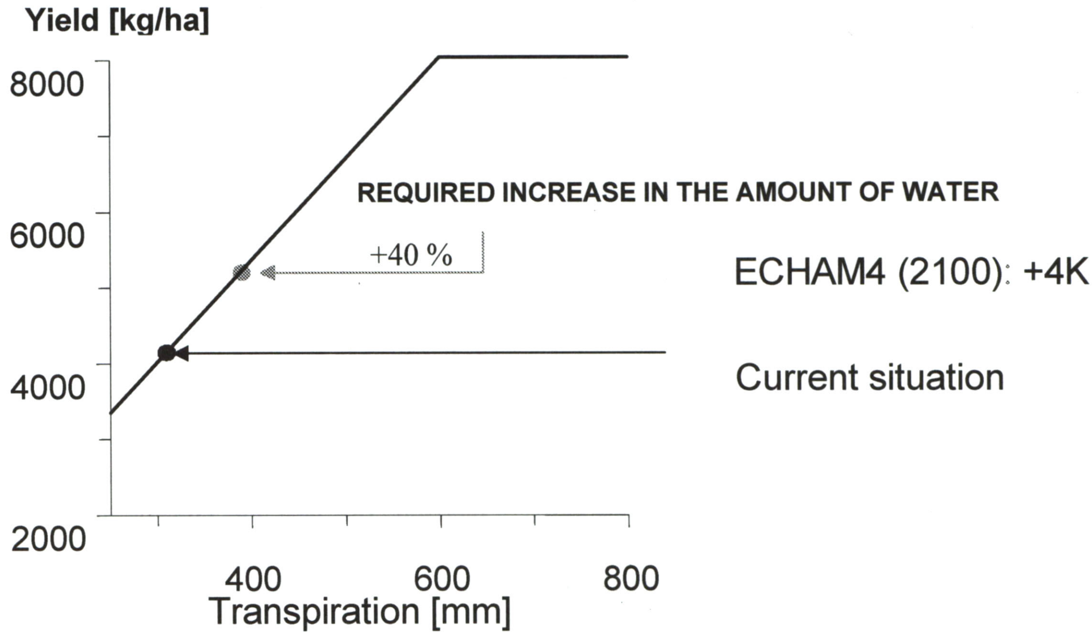

Fig. 1 Preliminary results from ECHAM4 climate change scenarios Simulated effects for wheat production

Effect on plant and soil: Two ways in which the Greenhouse Effect may be important for agriculture were investigated. First, increased atmospheric CO_2 concentrations can have a direct positive effect on the growth rate of cropping plants. Secondly, CO_2 induced changes of climate may alter levels of temperature, rainfall and solar radiation that can negatively influence plant productivity. Our research shows that enhanced agricultural activity may serve as an excellent agent for global carbon sequestration. Climate change could improve wheat yields, but it is not necessarily so for all crops. Similar analysis should be carried on with several other crops especially with C_4 pathway. Wheat is generally rain-fed and our scenario simulations indicated crop failure when rain was below a certain threshold unless supplemental irrigation was added. Thus, the improvement in wheat yield comes along with exacerbated problems of irrigation water due to increased consumption. Moreover, the combination of impacts of climate change on agriculture that could stem from the direct effects of increased atmospheric CO_2, in the Chukurova basin together with increased water requirement is likely to be extremely complex. In the long run it is expected that soil quality and water availability continue to deteriorate due to increased salinity (Fig. 2) while agro-productivity may be better in the short run. Thus production is still likely to decline with global warming. Water management could become a problem in semi-arid areas. Finally, because climate change is a long-term global environmental issue, assessing adaptation and mitigation strategies helps to encourage responsible sustainable development.

Ecosystem Functioning (Jiftah Ben-Asher1 and Fatih Evrendilek,2)

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Diurnal rates of net CO2 assimilation (PN) and soil respiration (Rh) in the summer were measured in six Mediterranean ecosystems through an automatic continuous monitoring system. The six sites include a typical evergreen Pinus pinea L. forest with two co-occurring sclerophyllous shrubs (Pistacia terebinthus L. and Phillyrea latifolia L.), citrus (Citrus limon L.), corn (Zea mays L.), cotton (Gossypium hirsutum L.),
soybean (Glycine max L.) and vineyard (Vitis vinifera L.). All six sites exhibited similar behaviour in that low soil water availability and high evaporative demand not only depressed PN and Rh rates, but also changed the diurnal time course of

Fig.2. Spatial distribution of EC in the Syhan basin. The numbers are the EC of the respected contour. The largest value is 25 dS/m which was determined on the coast of the Mediterranean.

Table 1 Mean values and standard errors of environmental variables for the different

Sites	n	P_N (μmol m^{-2} sec^{-1})	LUE	n	R_h (μmol m^{-2} sec^{-1})	NEE (μmol m^{-2} sec^{-1})	PAR (μmol m^{-2} sec^{-1})	Atm. CO_2 (ppm)	T (°C)	RH (%)	VPD (kPa)
Forest	234	0.24	0.0018	78	-14.92	-14.7	318.7	326	26.9	75.8	1.0
		(0.1)a	(0.0002)a		(0.3)a	(0.3)a	(55.4)a	(1.1)a	(0.4)a	(1.8)a	(0.1)a
Citrus	147	1.35	0.0055	49	-8.86	-7.5	449.8	332	27.4	71.1	1.2
		(0.3)a	(0.0006)bc		(0.8)b	(1.0)bd	(84.3)ab	(3.2)ac	(0.5)ab	(1.8)a	(0.1)ae
Corn	120	2.91	0.0069	40	-26.76	-23.9	511.0	364	26.2	77.1	0.9
		(0.9)bc	(0.0008)c		(0.9)c	(1.5)c	(99.5)abc	(8.0)b	(0.6)a	(2.8)a	(0.1)a
Cotton	237	2.88	0.0114	30	-7.75	-6.9	420.9	343	28.3	71.4	1.6
		(0.6)c	(0.001)de		(0.3)db	(0.6)d	(67.5)ab	(3.5)c	(0.7)ad	(2.5)a	(0.2)be
Soybean	138	3.86	0.0104	46	-5.62	-1.8	560.8	342	29.4	69.6	1.7
		(0.8)dc	(0.001)e		(0.3)e	(1.0)ef	(96.4)bd	(5.0)dc	(0.9)bde	(3.2)a	(0.2)ce
Vineyard	75	0.31	0.0009	25	-0.87	-0.6	765.0	336	31.8	52.6	3.0
		(0.2)a	(0.0002)a		(0.2)f	(0.)f	(158)cd	(8.5)ac	(1.4)ce	(6.8)b	(0.5)d

a Means with different letters for each of the variables denote significant differences at $p \leq 0.001$ as determined by the LSD test. Values in parentheses refer to standard errors. PT: Pistacia terebinthus L. subsp. palaestina (Boiss.) Engler, PL: Phillyrea latifolia L., PP: Pinus pinea, PN: net photosynthesis, Rh: soil respiration, NEE: net ecosystem emission of CO2, LUE: light use efficiency (6:00-19:00), T: air temperature, PAR: photosynthetically active radiation, VPD: vapour pressure deficit, and RH: relative humidity. n = 79 in the soybean site for all environmental variables except for PN, LUE, and Rh. Net ecosystem CO2 uptake and CO2 loss were designated as positive and negative signs, respectively.

their peak rates. Except for P. terebinthus and corn, PN rates of all the species peaked in the morning (7:30–9:30), and Rh rates in all the sites were higher during the night than during the day (p o 0.05). Mean rates of net ecosystem emission (NEE) of CO2 to the atmosphere were highest (_23.9 mmol CO2 m_2 s_1) in the corn site and lowest (_0.6 mmol CO2 m_2 s_1) in the vineyard site. On average, all six ecosystems were a net source of CO2 to the atmosphere, due to Rh effluxes exceeding PN rates. Net CO2 assimilation and Rh explained 25% (for corn) to 87% (for citrus) of the diurnal fluctuations of the atmospheric CO2 concentration (Table 1).

Multiple linear regression (MLR) models accounted for 42% (P. pinea) to 95% (cotton) of diurnal variations in PN rates and 30% (forest) to 92% (citrus) of diurnal variations in Rh rates (p p 0.001). The dependence of diurnal PN and Rh rates on water vapour pressure deficit and soil water deficit for dry and hot summer days appeared to be major and needs to be re-examined for biogeochemical models of climate change effects on CO2 dynamics of Mediterranean ecosystems.

Socio-economic Aspects of Global Climate change (Mordechai Shechter and Ido Kan *Natural Resource and Environmental Research Centre, University of Haifa*)

The objective of the research is to evaluate how the benefits of the agricultural sector (with Israel in the EM as a case study) would vary with the expected changes in climatic variables. A field-level economic model was developed, where variations in a single climate variable, annual precipitations, were considered. Given the annual precipitations, the model calculates the annual amount of irrigation water required for maximising the field's net profits. The effect of climate change on the net profit is evaluated by running the model according to various scenarios of annual precipitations.

Table 2 Calculation of reductions in net annual profit for a projected decline in rainfall of 1.5%, 3% and 6% for the years 2020, 2050 and 2100 respectively.

	1945	1975	2020	2050	2100
All Crops					
Entire State	93.0	101.8	99.3	96.5	90.7
North	44.9	47.4	46.5	45.6	43.6
Center	16.4	17.1	16.9	16.7	16.2
South	16.6	24.8	23.0	20.8	16.2
Field Crops					
Entire State	25.5	29.3	28.4	27.3	24.7
North	8.9	9.5	9.3	9.1	8.5
Center	2.1	2.2	2.2	2.1	2.0
South	1.0	6.6	5.6	4.2	1.2
Vegetables					
Entire State	36.6	38.4	37.8	37.2	36.0
North	13.7	14.2	14.1	13.9	13.5
Center	8.0	8.2	8.1	8.1	7.9
South	12.5	13.8	13.4	13.0	12.2
Fodders					
Entire State	30.9	34.0	33.1	32.0	29.9
North	22.2	23.7	23.2	22.6	21.5
Center	6.4	6.7	6.6	6.5	6.3
South	3.1	4.4	4.0	3.6	2.9

Profits associated with three crops (tomatoes, wheat and lettuce) were considered with respect to climate conditions in the north, centre and south regions of Israel. (Table 2).

The results show relatively minor changes in the agricultural sector's income in the past and in the future. Past trends in distributions of annual precipitations show that the profit expectations of these crops were increased, particularly due to the increase in the frequency of rainy years. For wheat there was an annual increase of 8.9 million NIS, for tomatoes nearly 0.6 million NIS, and an insignificant 0.1 million NIS for lettuce. However, continuation of these trends into the future is expected to reverse this tendency, leading to a total reduction of approximately 9.0 million NIS in the profit associated with the three discussed crops. This implies that the overall future sector's incomes are expected to decline by about 1%, unless various forms of adaptation strategies other than irrigation water will be implemented.