AGRIDEMA PILOT ASSESSMENT PROJECT

Determination of crop yield in the Region Lake Neusiedl under future climate conditions

Final Report 2006

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1 Introduction

To explore crop yield in the Region Lake Neusiedl under future climate conditions the following investigations were carried out:

1) Determination of crop yield reduction as consequence of climate warming using the Wofost-Perun Software
2) Climate change effects on ozone uptake: a case study of wheat and grapevine in the contrasting years 2002 and 2003

Work and results of 1) are discussed in this Final Report, those of 2) in "Final Report 2.

2 Project meeting in the Seewinkel Region

The project group had a first meeting on 30th of March 2006 in the Seewinkel Region, see Diagram 1, to become acquainted with the research area.

?? On several places with different soil conditions a soil sample was taken, and the suitability for agricultural use was discussed.
?? The automatic ZAMG weather station in Andau was inspected.
?? Weather simulation data of four different climate scenarios (regionalised by statistical downscaling procedures) was distributed to the project group.

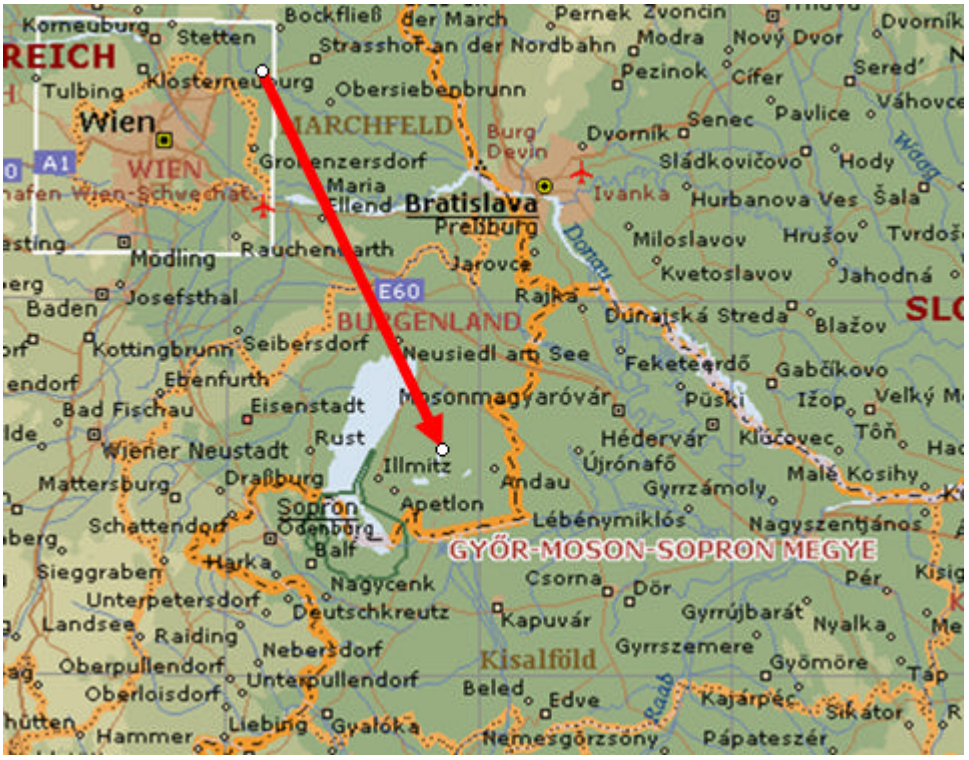


Diagram 1: The project region – Seewinkel, located in Austria at the border to Hungary

The characteristics of the project area can be summarized as following:

?? Flat plain in the Danube River basin at the Austrian Hungarian border
?? Total area approximately 400 km^2
?? Mean elevation 125 m above sea level
?? Big influence of pannonian climate
?? Mean annual precipitation 580 mm
?? Mean annual temperature 10,3°C (1961-1990)
?? Prevailing land use: agriculture (crops, grapes, vegetables) and nature protected areas

3 Used Data

Diagram 2 shows the data basis, which was used for simulation with the WOFOST-PERUN software.

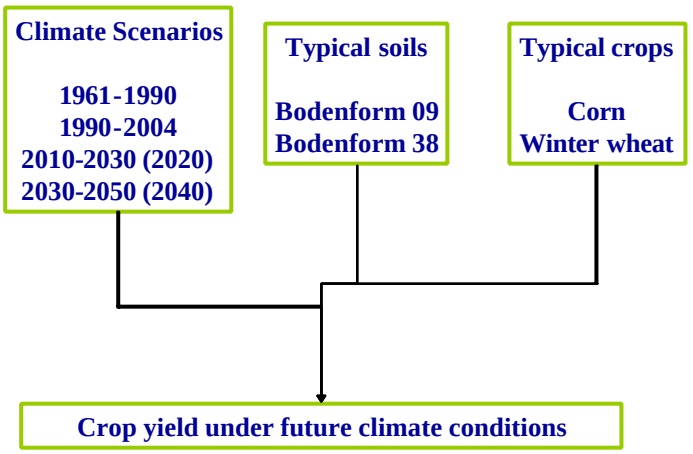


Diagram 2: Data used for simulation with WOFOST-PERUN software

3.1 Climate scenario data

Within the project "Auswirkungen einer Klimaänderung auf den Wasserhaushalt des Neusiedler Sees" (Eitzinger et al., 2005), where the water balance of the Lake Neusiedl under future climate conditions was investigated, different climate scenarios were downscaled and regionalised for the project region:

Climate normal period:	1961-1990	**6190**
Measurement period:	1991-2004	**9104**
Climate scenario:	2010-2030	**2020**
Climate scenario:	2030-2050	**2040**

Diagram 3 shows the results of the downscaling procedure as the annual mean temperature shift and the annual course of temperature changes, compared with the climate period 1961-1990.

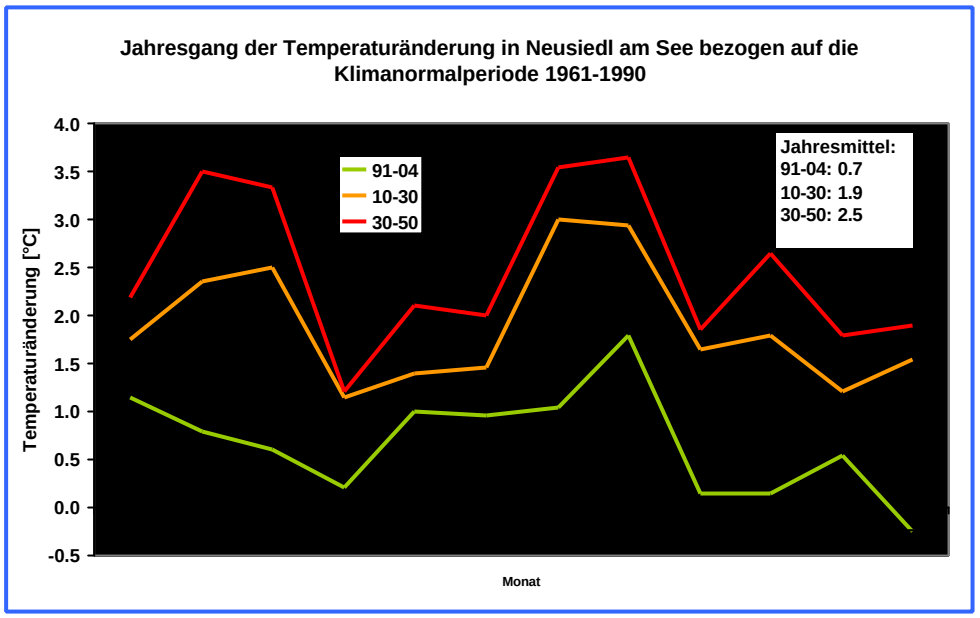


Diagram 3: Results of regional downscaling

Compared with the period 1961-1990 the period 1991-2004 had already a mean annual temperature shift of 0.7°, for 2010-2030 1.9° and for 2030-2050 2.5° are expected.

Using the results of the above mentioned project, 100 out of 500 years of daily weather data, generated by LARS WG, were used for the investigation, see Diagram 4.

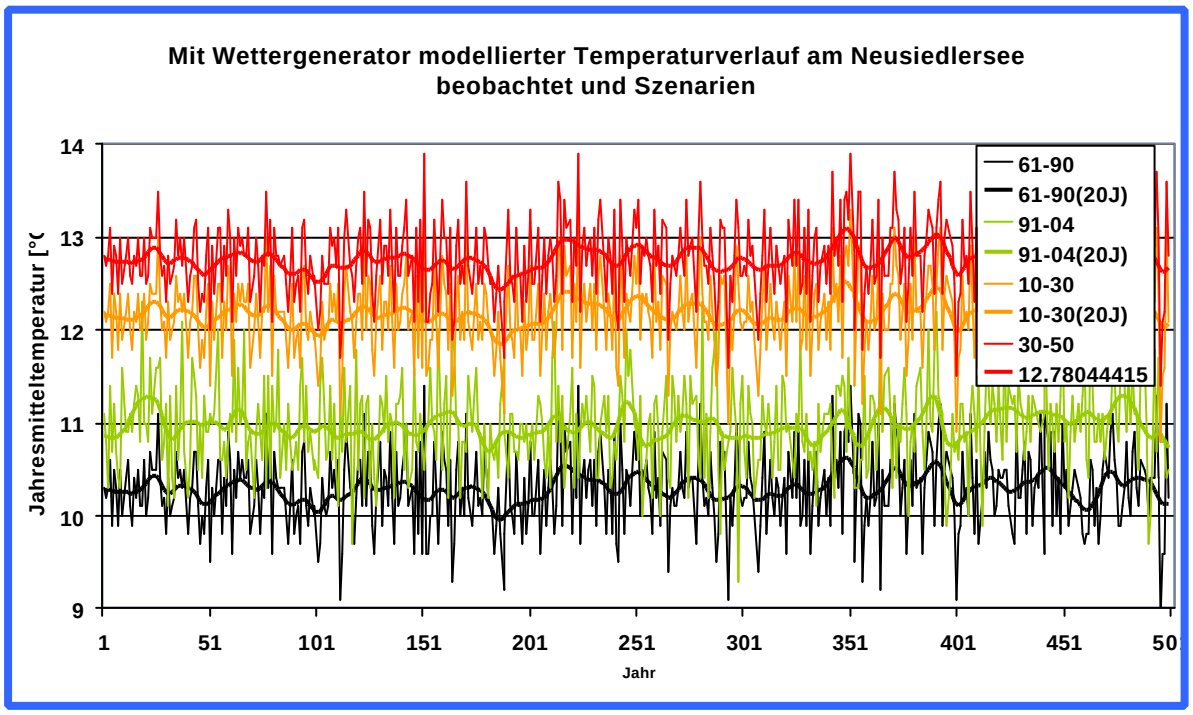


Diagram 4: Course of temperatures through 500 years, generated by LARS WG

3.2 Soil data

Basis for the relevant soil parameters as input to the simulation model is the Austrian soil classification map (Oesterreichische Bodenkartierung, 1986). Out of the soil classification region 139 two typical soil types number 09 and 38 were chosen.

The following parameters:

- Soil moisture content at wilting point, at field capacity and at saturation
- Hydraulic conductivity of saturated soil

were calculated with the texture information for all soil layers and Rosetta, a computer program for estimating soil hydraulic parameters with hierarchical pedotransfer functions (Schaap et al., 2001).

3.3 Crops

Corn and winter wheat were chosen as considerable crop in the project region. Two sample files of the AGRIDEMA 2005 workshop were used as crop data file for WOFOST. The yield data from simulation was compared with real yield data from a farmer in the region and showed good correspondence.

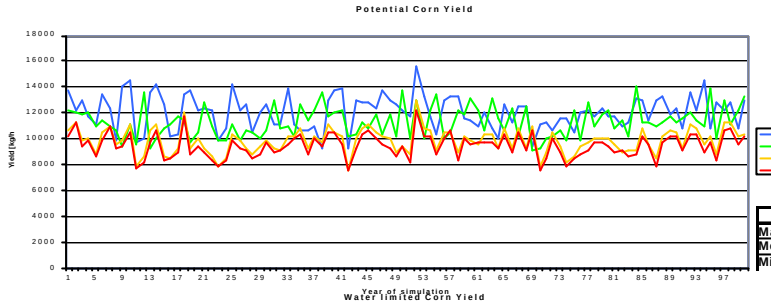
4 Results

The crop yield under 4 different climate scenarios was calculated, using the WOFOST PERUN software for:

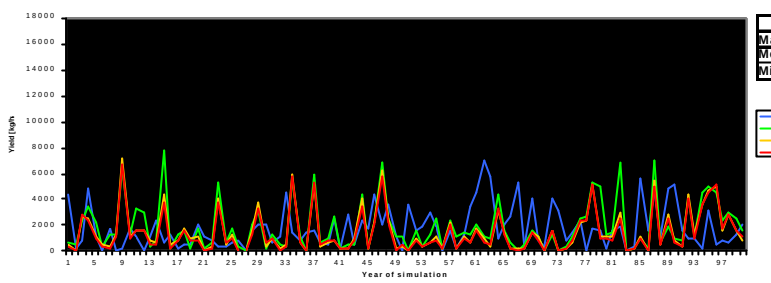
- corn and winter wheat
- on the soil types 09 and 38
- with and without water limit
- no shortage of nutrients

using 100 years of weather generator data on a daily basis.

The following Diagram 5 shows the potential and the water limited yields of corn. The potential mean corn yields show a clear yield reduction by higher temperatures. The difference between the period 1961-1990 and 2030-2050 is a mean yield reduction of more than 20 %. The water limited mean corn yields are in general much less then the potential yields and show a decrease of 20 % from the 1961-1990 to the 2030-2050 period.



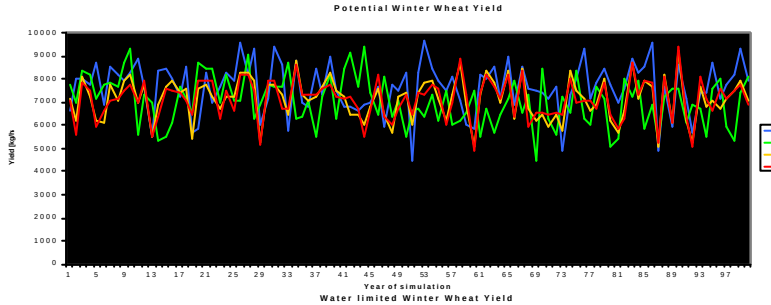
	61co09pp	91co09pp	20co09pp	40co09pp
Max	15,516	14,068	13,026	12,149
Mean	12,077	11,326	9,870	9,490
Min	9,210	9,097	7,580	7,614



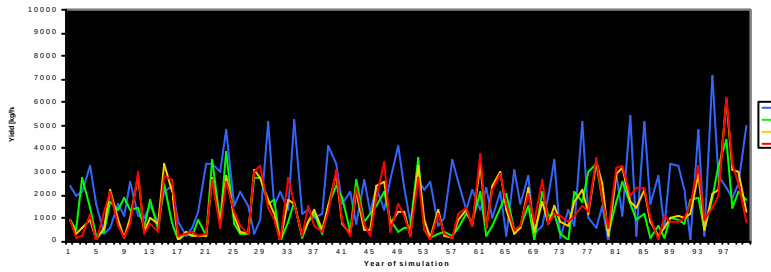
	61co09pw	91co09pw	20co09pw	40co09pw
Max	6,929	7,706	7,193	6,763
Mean	1,765	1,897	1,507	1,416
Min	-	-	-	-

Diagram 5: Simulation results for potential and water limited corn yield

The following Diagram 6 shows the potential and the water limited yields of winter wheat. The potential mean yields show a yield reduction by higher temperatures, about 7 % between 1961-1990 and 2030-2050. The water limited mean yields decrease about 33 % from the 1961-1990 to the 2030-2050 period. It is assumed, that this high yield reduction is not only a matter of plant physiology but also of increasing evapotranspiration at higher temperatures.



	61ww09pp	91ww09pp	20ww09pp	40ww09pp
Max	9,678	9,416	9,189	9,410
Mean	7,652	7,064	7,147	7,127
Min	4,448	4,485	5,074	4,927



	61ww09pw	91ww09pw	20ww09pw	40ww09pw
Max	7,188	4,358	6,153	6,209
Mean	2,059	1,270	1,378	1,395
Min	11	-	-	-

Diagram 6: Simulation results for potential and water limited winter wheat yield

A comparison of water limited yields on different soils is shown in Table 1. In general the yield reductions are similar on both soils (**22 %** on soil 38 and **20 %** on soil 09) for corn and (**39 %** on soil 38 and **32 %** on soil 09. However, soil type 09 with higher field capacity than soil type 38 has higher yields in any case.

Table 1: Water limited yields on different soils

	corn				winter wheat			
soil type 38	**1961-1990**	**1991-2004**	**2010-2030**	**2030-2050**	**1961-1990**	**1991-2004**	**2010-2030**	**2030-2050**
Max	6,368	7,181	6,340	5,782	6,377	3,458	4,506	4,887
Mean	1,580	1,752	1,413	1,324	1,494	900	943	912
Min	-	-	-	-	-	-	-	-
soil type 09	**1961-1990**	**1991-2004**	**2010-2030**	**2030-2050**	**1961-1990**	**1991-2004**	**2010-2030**	**2030-2050**
Max	6,929	7,706	7,193	6,763	7,188	4,358	6,153	6,209
Mean	1,765	1,897	1,507	1,416	2,059	1,270	1,378	1,395
Min	-	-	-	-	11	-	-	-

5 Summary

Climate warming will affect agriculture in the Austrian Region at Lake Neusiedl. Simulation results of the WOFOST PERUN software for simulating plant growth and yields under different climate scenarios showed, that higher temperatures do not only increase Evapotranspiration but also the plant physiology will lead to lower yields. Crops on soils with higher field capacity are naturally less affected.

There are also differences in the sensibility of crops. Winter wheat showed higher yield losses than corn.

The simulation of plant growth and yield with WOFOST PERUN seems to be a useful method to plan adaptation strategies on a regional level.

Thanks to Mirek Trnka (Institute of Agriculture Systems and Bioclimatology, Mendel University of Agriculture and Forestry in Brno) and to Martin Dubrovski (Institute of Atmospheric Physics, Academy of Sciences of the Czech Republic) for simulation support.

6 Reference List

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