# 気候変化がトルコの干ばつ常襲地域のコムギ生産に与える影響とその空間的異質性

# Impacts of Climate Change on Wheat Production in a Drought-Prone Area in Turkey and their spatial heterogeneity

Hiroshi Nakagawa[1], Tohru Kobata[2], Tomohisa Yano[3], Ceraleddin Barutçular[4], Müjde Koç[4], Kenji Tanaka[5], Takanori Nagano[6], Yoichi Fujihara[6], Keisuke Hoshikawa[6], Takashi kume[6] and Tsugihiro Watanabe[6]

## 1. Introduction

Adana Prefecture in Turkey is faced to the Mediterranean Sea and the coastal area belongs to the Mediterranean climate with mild winter, although the other end extends deeply into the inland mountainous area, which experiences severe winter, along the Seyhan River. Wheat cultivation in Adana often faces to the shortage of water. Also, the water availability and temperature conditions are widely varied in a relatively small area. They made us select Adana as a case study for our research to assess the impact of global climate change on wheat production under drought-prone environments. The impact of climate change on wheat production in Adana was predicted by using a wheat growth model, SimWinc, outputs of climate models for 9 years (MRI and CCSR models, Fig. 1) and soil water conditions simulated by SiBUC (SImple Biosphere model including Urban Canopy).

## 2. Results

SimWinc was parameterized with the growth data of wheat crops grown under nearly ideal conditions at Çukurova University in Adana in 2003/2004 and 2004/2005. In the model, a change in $CO_2$ concentration from 370 ppm (the current level) to 690 ppm (an assumed level in 2070s) enhances biomass production by 23.6%. Simulated yields can be converted into actual farmers' yields, multiplied by 'technological coefficient (TC)', which is the ratio of actual farmers' yields to simulated yields. The values of TC under the current climate conditions were relatively stable (51 to 65 %) in the districts of the plain area in Adana and ranged 28 to 57% in the mountainous area. We simulated wheat yields under the future climate conditions, assuming that the value of TC would be unchanged in each district.

Without the $CO_2$ effect, wheat yields were expected to be decreased by MRI and CCSR climates in the plain area mainly due to decreases in precipitation (Figs. 1, 2 and 3), and to be increased by both climates in the mountainous area due to increases in temperature (Fig. 4). At the simulation runs with the $CO_2$ effect, wheat yields in all districts were expected to be increased by

[1] 石川県立大学 (Ishikawa Prefectural University)
[2] 島根大学 (Shimane University)
[3] 九州共立大学 (Kyushu Kyoritsu University)
[4] チュクロバ大学 (Çukurova University)
[5] 京都大学防災研究所 (Disaster Prevention Research Institute, Kyoto University)
[6] 総合地球環境学研究所 (Research Institute for Humanity and Nature)
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climate change, excluding one district under the CCSR climate. The average predicted yield was 4.03 t $ha^{-1}$ in Adana Prefecture under the current climate. Reductions of 8.1 and 9.5 % in average yield in Adana were predicted for MRI and CCSR climates without the $CO_2$ effect, respectively. The predicted yield reduction of CCSR was larger than that of MRI, because precipitation in CCSR decreased from the current level more than that in MRI (Fig. 1). When we included the $CO_2$ effect in simulation runs, average yields were predicted to increase by 13.5 and 11.9 % for the two pseudo-warming climates, respectively. The yield variability was predicted to increase in the plain area under the future climates, while to decrease in the mountainous area. In conclusion, a decrease in precipitation by climate change would have a possibility to reduce and destabilize wheat yields in the plain area of Adana, although $CO_2$ fertilization effects will be able to partly compensate for the negative effects of climate change. In the mountainous area with severe winter, an increase in temperature would improve the wheat production under the future climates.

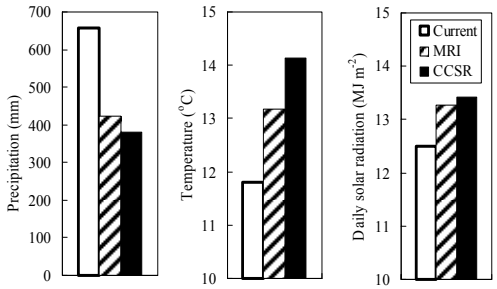


Fig. 1. Total precipitation, mean temperature and mean daily solar radiation during the growth period of wheat crops under the current, MRI (outputs of CGCM2.2 model of MRI) and CCSR (outputs of AGCM + CCSR OGCM model of CCSR/NIES) climates, which are the average values of 16 representative locations in Adana.

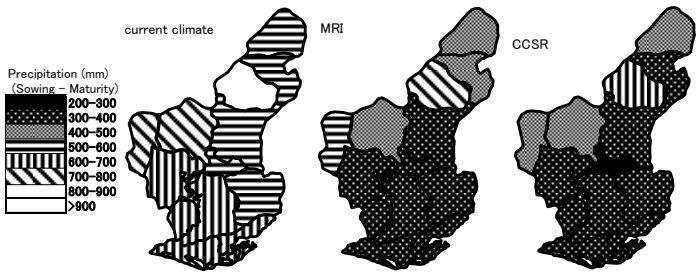


Fig. 2. Total precipitation during the growth period of wheat in each district in Adana under the current and two projected climates.

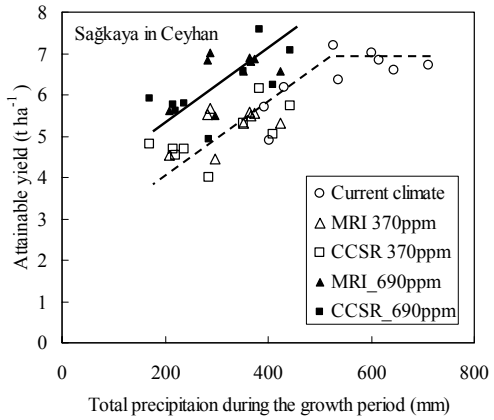


Fig. 3. Simulated attainable yield of wheat as a function of total precipitation during the growth period of wheat at Sağkaya in Ceyhan District, Adana.

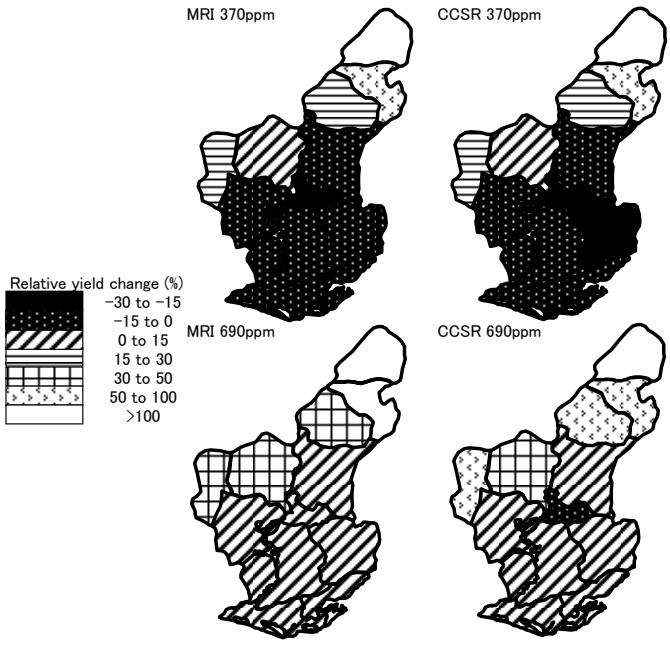


Fig. 4. Effects of climate change predicted by two GCMs with and without the $CO_2$ fertilization effect on wheat yield in Adana (predicted by SimWinc).