THE IMPACTS OF FUTURE CLIMATE CHANGE ON LAND AND WATER PRODUCTIVITY OF STAPLE CROPS: A CASE STUDY FOR CHINA

Fresh water and arable land are scarce resources in China. Because of China's growing population and therefore food requirements, it is of great importance to have a high land and water productivity (LP and WP). Climate change could have a significant effect on the LP and WP of China. Therefore we investigated the effects on the land and water productivity of staple crops (rice, maize and wheat) in China as a result of climate changes from 2005 (the baseline year) to 2050 at the spatial resolution of 5 by 5 arc min. In order to do this, the downscaled climate data for 2050 in China of two global climate models (GCMs) under two representative concentration pathways (RCPs) have been used as input for the AquaCrop model. From its outputs, the future LP and WP of the considered crops were calculated.

According to the climate scenarios, the future climate will be wetter (+8% precipitation) and warmer (+1.5 °C to +2.8 °C). These climate changes lead to increases in both LP and WP in 2050 for all crops except maize, which suffers from a decrease in precipitation, causing the rainfed maize to fail with severe water stress. The sources of the water used to grow the crops were investigated by calculating the blue (originating from ground and surface water), and green (originating from precipitation) water footprints (WFs) for all crops. The green WF of crops is higher than the blue WF and both decrease in the future for rice and wheat. For maize both green and blue WFs increase due to the lowered LP.

Beside the increase in precipitation the main reason for the increase in LP is increased CO_2 fertilization, which has a smaller effect on maize than on the other crops. All in all, the possible future climate changes seem to have positive effects for China, increasing the food production while decreasing the water use. However, there is also a warning to be found in the maize results: a spatial redistribution of precipitation can have devastating effects, even if the total precipitation over the crop area increases.

Crop	Consumptive water footprint of crop growth								
	Baseline 2005 (l/kg)			Responses to climate change scenarios for 2050 (%)					
				RCP 2.6			RCP 8.5		
	Blue	**Green**	**Total**	**Blue**	**Green**	**Total**	**Blue**	**Green**	**Total**
Rice	567	1913	2480	-36	-9	-15	-39	-19	-23
Irrigated rice	615	1816	2432	-33	-6	-13	-37	-17	-22
Rainfed rice	-	3045	3045	-	-42	-42	-	-42	-42
Maize	202	1040	1242	+26	+5	+8	+15	+3	+5
Irrigated maize	311	775	1086	+13	-3	+2	+5	-5	-2
Rainfed maize	-	1531	1531	-	+25	+25	-	+20	+20
Wheat	939	1631	2570	-21	-7	-12	-23	-17	-19
Irrigated wheat	993	1607	2600	-13	+1	-4	-18	-13	-15
Rainfed wheat	-	2041	2041	-	-53	-53	-	-46	-46
Total	532	1553	2085	-19	-3	-7	-22	-12	-14
Irrigated	636	1488	2125	-18	-2	-7	-22	-12	-15
Rainfed	-	1881	1881	-	-10	-10	-	-90	-90

Marcel Muller

Graduation Date:
11 March 2016

Graduation Committee:
University of Twente
Prof. Dr. Ir. A.Y. Hoekstra
L. Zhuo

UNIVERSITY OF TWENTE.