Crop Water Demand for Rain-Fed Maize in Northeast of China

Hanqing Xu\textsuperscript{1,2,*}, Zhan Tian\textsuperscript{1,2}, Minlan Wang\textsuperscript{1}, Dongli Fan\textsuperscript{1}, Biao Hu\textsuperscript{1,2}, Xiangyi Wang\textsuperscript{1,2}

1 Shanghai Institute of Technology, Shanghai, China
2 Shanghai Climate Center, Shanghai, China
E-mail: xuhanqing2015@gmail.com

Abstract. Drought risk is one of the main constraint for stable high maize production in the Northeast of China (NEC), where about 30% of the national maize is produced. Maize in the NEC is especially vulnerable to climate change and extreme weather. Previous studies on water demand of maize are based on field experiments by crop model, but water demand of different maize growth stages is rarely studied. Given the importance of NEC in China’s food security, it is crucial to optimize the irrigation schedule to mitigate the negative effects of drought. In this study, we use the AEZ model to examine the climate change impacts on maize water demand in NEC. This model is employed to simulate the future maize water demand on climate scenario from NorESM1-M model driven by 2 Representative Concentration Pathways (RCP2.6 and RCP8.5). Results indicate that climate change will affect water demand of maize in NEC. The increasing frequency and rising amount of water demand in the western part of NEC where should be given priority for soil moisture monitoring and irrigation.

1. Introduction
Drought risk has been one of the main limiting factors for maize production in the Northeast of China (NEC). The total maize planting area in the NEC takes more than 36% of the total crop area in NEC and accounts for 30% of the nation’s total maize production [1]. But this region has experienced a warming trend about 0.38 °C per decade in the last 50 years [2]. The warmer climate accelerates crop growth, reduces crop growing length and causes yield loss [3]-[5]. Although maize yield has shown an increasing trend during recent decades in NEC, maize production has been highly affected by climate change in this region [6], and the projected less precipitation and more frequent drought events in the coming decades [7], [8], and may put maize production in NEC under greater risk in the expanded cropping area in recent years [9].

Previous studies on assessing the impact of climate change on maize yield and water demand based on field experiments in NEC, without considering that water demand of maize at a regional scale [10]. Therefore, in this study, we estimate the spatial variation of crop water demand under climate change in NEC, which could provide a better understanding of water demand under climate change.

2. Study Region
The Northeast Farming Region is located in the Northeast China (118° 50′ –135° 05′ E, 38° 43′ –53° 24′ N) (Figure 1), it includes Heilongjiang, Jilin and Liaoning Provinces. The total area of NEC is 787,300 km² with a population of 112 million (in 2010). During the maize growing season, the average temperature is 24.7 °C and annual average precipitation ranged from 308 to 657 mm.
3. Datasets and Methods
The data used in this research include climate/weather data, land and soil information, and cropland data in the NEC. Climate change in the NEC and its impact on maize production in 2050s is obtained with NorESM1-M climate model under 2 RCP scenarios. Figure 2 summarizes the procedure of our work.

![Figure 1. The map of maize cropping area in the NEC.](image)

![Figure 2. Flowchart to examine the climate change impacts on the crop water demand of maize.](image)

3.1. AEZ Model
The Agro-Ecological Zone (AEZ) model was jointly developed by IIASA and FAO. AEZ model employs simple and robust crop models and provides standardized crop-modeling and environmental matching procedure to identify crop-specific limitations of prevailing climate, soil and terrain resources under assumed levels of inputs and management conditions. The standardized crop-modeling and environmental matching procedure in the AEZ makes it well suited for crop productivity assessment at regional, national and global scales.
4. Results

4.1. Crop Water Demand of Rainfed Maize

The crop water requirement (CWR) which is the amount of moisture that is expected to be supplied from the irrigation system to replenish the moisture loss through evapotranspiration in order to sustain the growth of the crop in different climate scenarios. The regions with the highest CWR of maize was western Liaoning, while the regions with the lowest CWR were northern and eastern Heilongjiang province. Under the baseline condition, the average CWR of rainfed maize were 415 mm. Our simulation showed the spatial variation in average crop water requirement under rainfed condition of maize across the study area, with highest in the middle part of Liaoning province and some parts of western Jilin province (Figure 3).

The changes in crop water demand are calculated using the results from climate variables of temperature and solar radiation. Under future climate projection, our results highlight spatial CWR patterns of rainfed maize in increasing significantly over NEC from baseline to 2050s. Under the scenario of RCP2.6, the CWR of rainfed maize decreased in the west of Jilin and southwest part of the Heilongjiang province. CWR increases across by 2050s compared to the baseline (1981-2010).

![Figure 3. The crop water requirements change for rainfed maize at the middle in the century (2050s)](image)

5. Conclusion

In this research, we combined outputs with observational data to produce more detailed climate scenarios of local climate suitable for assessing the impact of climate change on water demand of rainfed maize across NEC. Under the baseline, crop water demand is higher in the western NEC. Climate change will affects water demand of maize in NEC. We found that the uncertainty of the impact of climate change on water demand of maize increases. The future climate scenarios indicate an increasing frequency and rising amount of water demand in the western part of NEC where should be given priority for soil moisture monitoring and irrigation.

6. References

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