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Assessing long-term spatial movement of wheat area across China

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ABSTRACT

In the context of climate change, assessing spatiotemporal dynamics of crop production is becoming an important component of food security, which is one of the United Nations Sustainable Development Goals. Wheat is a major staple food that is grown worldwide. Although many studies have analyzed wheat production, spatial analyses, particularly geographical centroid (GC) studies, are rare. The GC studies are of important scientific value and policy implications. This study aims to estimate the GC movement of wheat area (including winter and spring wheat) from 1949 to 2014 in China (the largest wheat-producing country). A centroid model was adopted to measure GC movements, and then a regression analysis was conducted to understand the driving factors of wheat area changes (as area changes lead to GC movement). Then multiple scenario analyses were built to study GC movement driven by climatic factors alone. The net GC movements of winter and spring wheat area were estimated at 31 km northwestward and 692 km southwestward from 1949 to 2014, with both displaying a turning point in their movement routes around 1970s (the GC of winter wheat area moved 89 km before 1970s and 66 km after 1970s; while the GC of spring wheat area moved 89 km before 1970s and 799 km after 1970s); furthermore, the major driving factor of winter wheat GC movement is a socioeconomic factor (i.e., expanded irrigation area) while that of spring wheat GC movement is a climatic factor (i.e., temperature) among the factors considered in this study. Our "climate only" scenarios highlighted that the impact of temperature on GC movement of winter wheat is more significant than that of precipitation. We assessed the spatiotemporal movement of wheat area to better understand its production dynamics in response to climate change and human activities. This study provides scientific evidence for policymakers and related stakeholders in China and other countries regarding food production patterns and planting decisions.

1. Introduction

Population growth, dietary change, and climate change are global challenges for food security (Hu et al., 2019; Peña-Gallardo et al., 2019; Tan et al., 2014). Wheat is an essential component for ensuring food security, and is extensively planted around the world, providing for approximately 20% of the human calorie demand (Wulff and Dhugga, 2018). Understanding the dynamics and driving factors of wheat production will help address the global challenges for food security, provide critical information for farmers, policymakers, and stakeholders, improve human welfare, and enhance environmental conservation (Hasegawa et al., 2014; Li et al., 2015; Urbanski et al., 2012). These are key issues, especially for developing countries with large populations. China is a case in point.

China is the largest wheat producer, with production touching 134.3 million tons (Mt) in 2017, accounting for approximately 18% of the global wheat production (Food and Agriculture Organization of the United Nations, 2019). Wheat production is equal to the sum over each of the region's harvested yield multiplied by its area, which has been steadily increasing over the past six decades in China. Many studies have focused on the increased wheat yield, resulting from soil and water management, and/or new varieties development (Juliana et al., 2019; Wei et al., 2015; Xiao et al., 2018). Nonetheless, spatial information on wheat area has been rarely studied, with only a few studies assessing the changes in the wheat planting extent in China (Gao et al., 2019; Li et al., 2013). However, they have not considered the geographical centroid (GC) movements of wheat area. GC refers to the weighed geometric central point of wheat area in this analysis.

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