YIELD ESTIMATION OF WINTER WHEAT IN NORTH CHINA PLAIN USING RS-P-YEC MODEL

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1. INTRODUCTION

Food is the foundation of human life. The accurate prediction of crop yield is great help for grain policy making [1]. At present, there are many statistical methods to estimate crop yield, such as spatial sampling, meteorological model, remote sensing estimation [2-4], crop growth model [5, 6], and so on. These methods have been used for many years, in which the relationships between yield and meteorological data, normalized difference vegetation index (NDVI) or other factors are built according to statistics. So some inevitable uncertainties exist. With the development of science, theoretical model combined with remote sensing data has become a trend for estimating and predicting crop yield at large spatial scale.

Nowadays, remotely sensed net primary productivity (NPP) has been adopted to estimate crop yield [1, 7]. Meanwhile, crop growth models have also been developed to estimate crop yield. Wu, Ma and Xie studied the applicability of WOFOST (World Food Studies) model to winter wheat in North China Plain and rice in Zhejiang Province in China [5, 8, 9]. They found that WOFOST model can simulate the growth process after regionalization. However, WOFOST model emphasized on the growth process of the crop and left yield estimation hardly studied. Yu divided the canopy of maize into several layers according to the leaf area index and simulated photosynthesis of each layer in theory [10]. However he aimed at the photosynthesis of maize but not yield. Therefore, it is necessary to build a model to estimate the yield of crop theoretically.

2. METHODOLOGY AND DATA

In this paper, a model named RS-P-YEC (Remote Sensing – Photosynthesis – Yield Estimation for Crop) was put forward for estimating the yield of winter wheat in North China Plain. The foundation of RS-P-YEC is photosynthesis. Firstly, by assuming a homogeneous and vertical laminar structure, we layered the canopy of winter wheat and got a simplified multilayer-two-big-leaf model. Secondly, simulating instantaneous photosynthesis of each layer and summing them to get the gross photosynthesis. Thirdly, subtract autotrophic respiration of winter wheat from the gross photosynthesis to get daily net primary productivity. Fourthly, summing daily net primary productivity in the whole growth period and obtaining the biomass of winter wheat in growth period. Finally, according to the harvest index (HI) of winter wheat in North China Plain, convert the biomass into economic yield to realize the yield estimation using theoretical model with remote sensing images.

The input parameters of RS-P-YEC model are remote sensing data and meteorological data. We used the IGBP land cover classification system of MODIS land cover product (MOD12Q1) and 8-day LAI products (MOD15A2) at 1-km spatial resolution to estimate wheat yield. Meteorological data come from national meteorological information center in China. They are interpolated using Kriging method to get the spatial distribution maps.

3. RESULT AND CONCLUSTION

Based on this model we estimated yield of winter wheat in 2006 in North China Plain. The result demonstrates that the yield of winter wheat in North China Plain is high in south and low in north. In northern region, the cropping area is small and sporadic. Spatial heterogeneity exists and the yield is low. In southern Hebei and Shandong province, the yield is about 5000 to 8000 kg/hm^2. In Henan province, because of its low latitude, higher air temperature and more incident solar radiation, the yield is higher than other regions. 17 agro-meteorological stations are selected for validating the simulated results of winter wheat in North China Plain. From the comparison between observed and simulated yield, we found that the simulated results with RS-P-YEC is very close to the yield observed from agro-meteorological stations and the correlation coefficient is more than 0.9. This study demonstrates that RS-P-YEC model is useful in the yield estimation of winter wheat in North China Plain with available remotely sensed images.

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