

Using MODIS data for estimating rice yield in South Korea

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[Introduction]

Rice is a staple food and very important for the food security in South Korea. Thus, rice yield prediction is essential for food security. The present study was to develop a method for predicting rice yield in South Korea using Moderate Resolution Imaging Spectroradiometer (MODIS) data.

[Materials and Methods]

Remote sensing data used were MOD09A1 data of 8 day interval from day of year (DOY) 113 to 329 and MCD12Q1 data of one year interval in MODIS. Rice planting area was estimated using vegetation indices including Simple Ratio (SR), Enhanced Vegetation Index (EVI), Normalized Difference Vegetation Index (NDVI), and Land Surface Water Index (NSWI) which were calculated with reflectance values of MOD09A1. Using local maximum fitting algorithm, EVI and NDVI data were gap-filled for the missing pixels caused by cloud and noise according to MOD09A1 QA description of cloud contamination. Rice planting area was calculated according to the the following, i.e. $EVI \leq NSWI + \text{threshold value}$, maximum $EVI > \text{threshold value}$, and the area was estimated by overlapping with croplands of MCD12Q1. Instead of using the reported threshold values, the threshold values were estimated to improve the detection accuracy of rice fields. NDVI values were extracted based on the map of detected rice planting area to predict rice yields, the NDVI values from transplanting DOY (i.e. date when $EVI > NSWI + \text{threshold value}$) to DOY with maximum NDVI and from DOY with maximum NDVI to DOY after 40 days were summed for each pixel. The summed NDVI values were averaged across the whole rice planting area. Multiple regression analysis was performed between the averaged NDVI values of each growth phase and reported rice yields from 2002 to 2010, and dataset from 2011 to 2016 was used for evaluating the performance of rice yield prediction.

[Results and Discussions]

The rice planting area was estimated similar to the reported area (RMSE = 174.5 kha, and nRMSE = 17.1%). The regression model using averaged NDVI values or two growth phases as predictor variables showed fairly close correspondence ($R^2 = 0.76$) to the reported rice yields from 2002 to 2010. and rice yields from 2011 to 2016 in validation set were estimated close to the reported rice yields ($R^2 = 0.56$, RMSE = 189.0 kg/ha and nRMSE = 3.7%). Even though NDVI values during the specific period had a high correlation to rice yields, other factors related to the rice yields should be taken into account for improving the accuracy of yield prediction.

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