Utilization of remote sensing data for estimating damage ratio of rice crop –Part6- Examination of the yield estimation model based on kinds of agricultural weather hazard

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Abstract

The evaluation with objectivity is required by the policyholder because the estimate of damage ratio of rice crop is depending on the evaluation member's skill and also it has misgivings about the evaluation staff's aging.

In this study, the estimation of the rice yield affected by the storm and flood damage and the blast disease were conducted in Hokkaido and Miyagi prefecture, Japan. The five different models were adopted to estimate the rice yield of each damage. The predictive error of the blast disease derived from both the multiple linear regression and the ridge regression was within the range of value calculated through the external examination by the evaluation of expert staff.

The result suggested that, by the creating each yield estimation model for kinds of agricultural weather hazard, the predictive error will be improved.

***Keywords* : rice yield, storm and flood damage, blast disease, agricultural insurance**

1. Introduction

The agricultural benefit is an agricultural insurance system to protect the farm management from agricultural damages(Fig.1). The evaluation of the damage is labor intensive. For example, 83,787 assessors worked for 173,000days to evaluate damages occurred in 2.92 million cases/fields in 2003. The entire system has difficulties both to maintain the objectivity and to cope with the aging problem of the population. Our study aims at developing a damage evaluation system for rice crop based on satellite data, GIS, and ground observations.

In the previous study, the results showed that the predictive error of rice yield affected by the cool summer damage was 57kg/10a. In this study, the estimation of the rice yield affected by the storm and flood damage and the blast disease were conducted in Hokkaido and Miyagi. The five different models were adopted to estimate the rice yield of each damage.

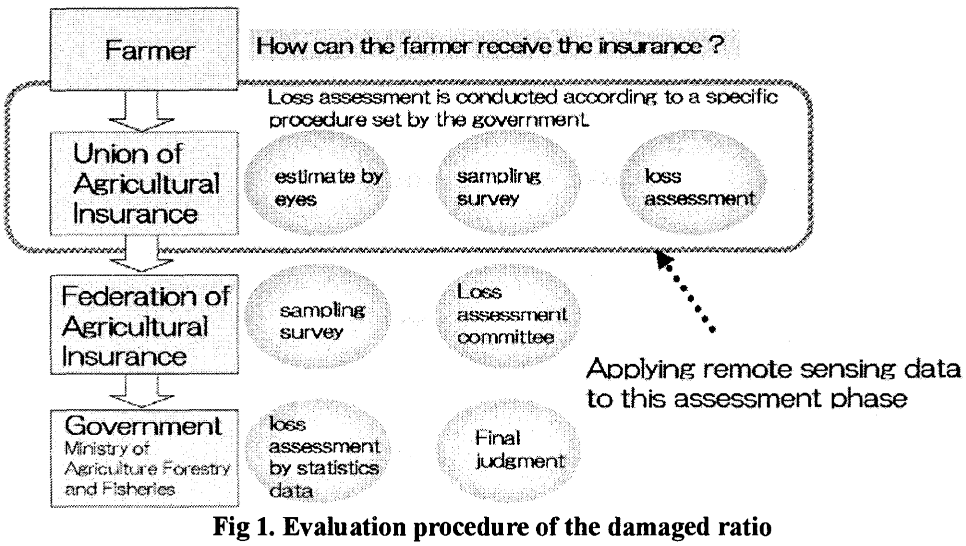

Fig 1. Evaluation procedure of the damaged ratio

2. METHODOLOGY

2.1 Study site

The study was conducted in Hokkaido and Miyagi prefecture, Japan(Fig.2). Three test sites were selected in this study. The K-district and O-district are from Miyagi and T-district is from Hokkaido.

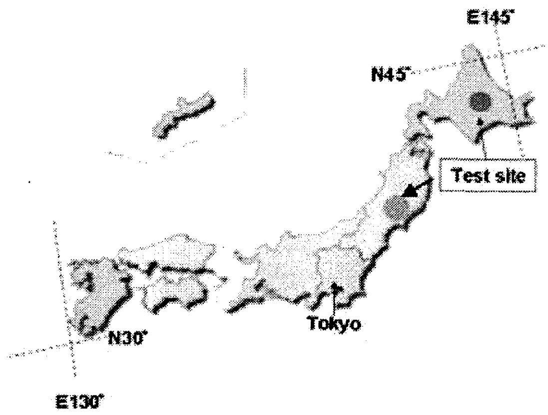

Fig 2. Study site

2.2 Ground truth data

The data of survey by reaping the plots, which is owned by agricultural insurance group, was used as the ground truth data in 2006. Eight species of rice crop were selected which are Kirara397 Hoshinoyume, Nanatsuboshi, Oborozuki,Hitomebore, Sasanishiki, Koshihikari and Miyakogane for estimating the rice yield. The numbers of ground truth samples of each damage Are: 401 fields of non-damage,47 fields of storm and flood damage and 23 fields of blast disease.

2.3 Satellite data and GIS data

The ALOS/AVNIR-2 data acquired on August 26, the SPOT5 data acquired on September 2 and September 17 of T-district were used to estimate the rice yields. The SPOT5 data acquired on September 21 of K-district and the data acquired on September 21 of O-district were used for analysis.

The GIS data of 2006 was used from the data base of Soil Improvement Organization to identify paddy fields in the satellite data.

2.4 Procedure

The image analysis procedure is described in Figure 3. The satellite data was rectified using GIS data by the nearest neighbor resampling algorithm using the selected ground control points. The shape file of paddy field was created from GIS data and overlaid on satellite data to extract paddy fields. The digital number (DN) values for selected points were extracted and the statistical models which are Multiple Linear Regression Analysis (MLRA), Partial Least Squares method (PLS), Ridge analysis(Ridge),L2 boosting(L2) and Projection Pursuit Regression Model (PPRM) were executed to estimate a rice yield. Finally, the comparison of prediction errors of each models were performed using the 10-fold cross-validation by random data partitioning.

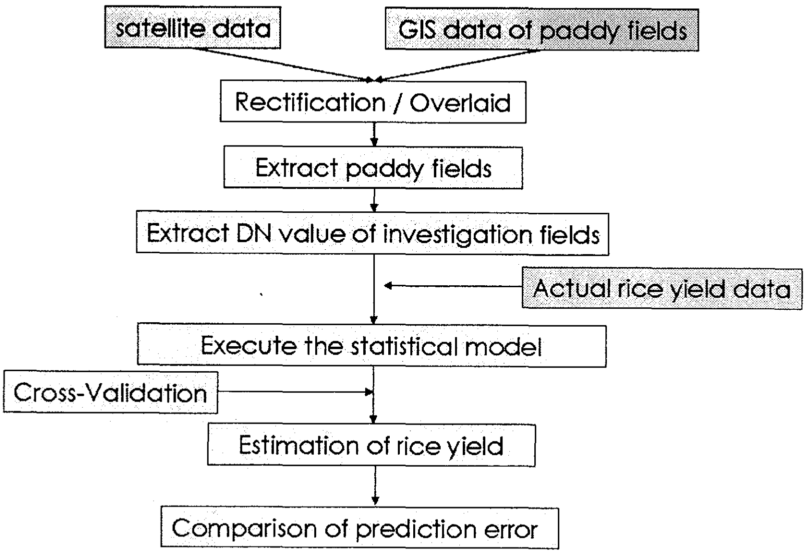

Fig 3. Procedure of analysis

3. RESULTS

The results of rice yield estimation are shown as follows.

K-district : The predictive error derived larger in the following order : Multiple linear regression analysis(85.3kg/10a)< Ridge analysis<L2 boosting<Partial least squares method<Projection pursuit regression model(123kg/10a), when adopted the combination of the storm and flood damage and the non damaged data(Fig.5). In the case of blast disease and non damaged combination data, the predictive error become larger in the following order : Ridge analysis(66kg/10a)<Multiple linear regression analysis<L2 boosting= Partial least squares method<Projection pursuit regression model(78.5kg/10a)(Fig.4).

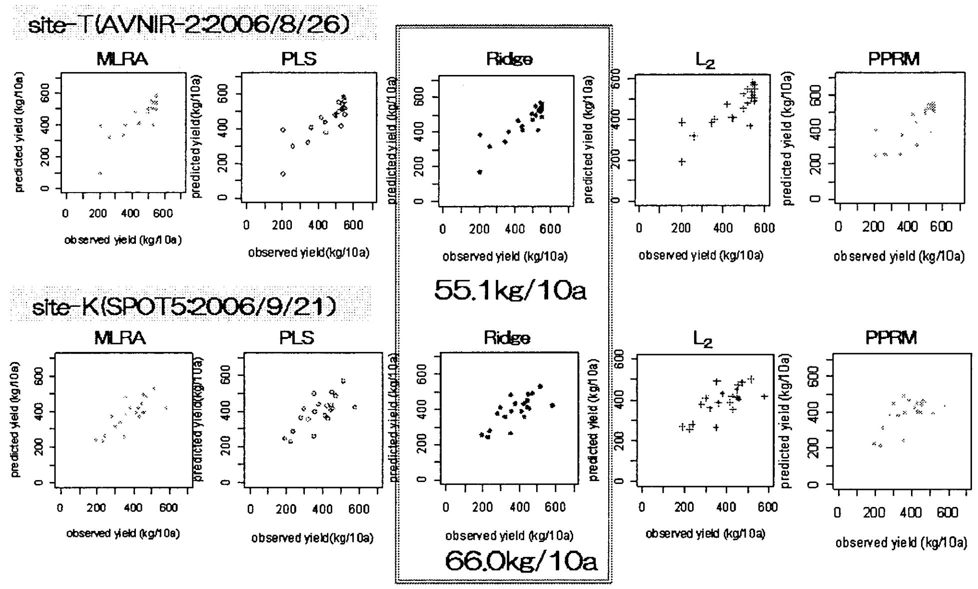

Fig.4 Predictive error of the blast disease

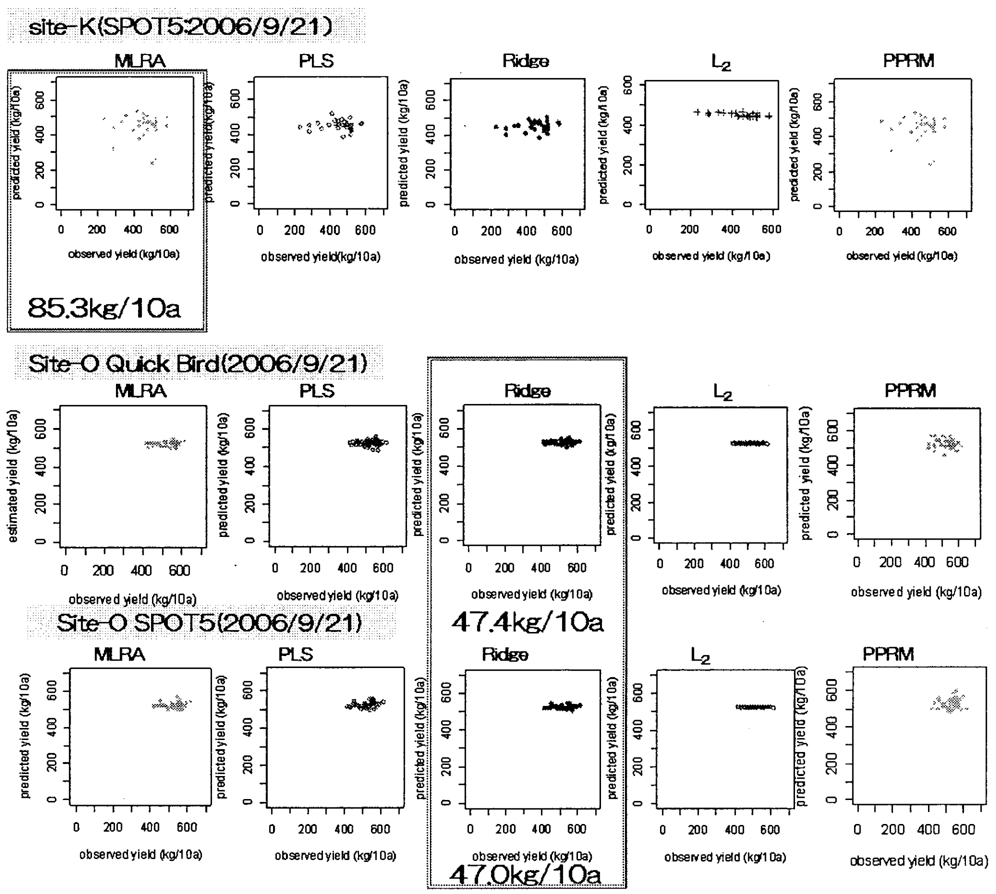

Fig 5. Predictive error of the storm and flood damage

O-district : The predictive error derived larger in the following order of Ridge analysis (47.5kg/10a)<L2 boosting <Multiple linear regression analysis<Partial least squares method<Projection pursuit regression model(54.2kg/10a), when adopted the combination of storm and flood damage and non damaged data(Fig.5).

T-district : In the case of using the ALOS/AVNIR2 data, the predictive error derived from the blast disease and non damaged combination data was larger in the following order of Ridge analysis(55.1kg/10a)<Partial least squares method<Multiple linear regression analysis<L2 boosting < projection pursuit regression model(72.9kg/10a)(Fig.4). The similar results were obtained using SPOT5 data. The error reduced from 55.1kg/10a to 54.1kg/10a when adopted Ridge analysis. The error reduced from 55.1kg/10a to 54.1kg/10a using the Ridge analysis when the observation date of satellite data was close to hervesting time.

3. DISCUSSIONS

The derivation of regression equation using remote sensing data helps us estimate the rice yield per 10a.The predictive error of the flood damage obtained through five different estimation models were not acceptable for practical use. There is a positive correlation between the degree of blast disease and the rice yield. On the other hand the rice yield of flood damage does not conform to this rule. The accuracy of predictive error was affected by this phenomenon. This is a reason why the predictive errors are bigger in the case of storm and flood damaged fields, than the blast disease damaged fields.

The results suggest that by creating each yield estimation model for kinds of agricultural weather hazard, the predictive error will be improved. The use of a specific agricultural weather hazard of rice crop leads to a beneficial regression equation. Based on the result, it may be concluded that this is an effective method for saving the expenditure and labor force. If we use such regression equations to reduce the workforce of expert staff, our simulation can play an essential role in reducing cost. We believe that the practical use of such techniques will be realized in the near future by tackling the remaining problems.

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