MEASUREMENT OF SYSTEMATIC ERRORS IN CROP PREDICTION

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ABSTRACT

Precision agriculture typically attempts to answer grower questions using an increasingly more fine-grained analysis. However, some entities, such as cooperatives, can have an interest in answers that are spatially course-grained, such as obtaining an estimate of the overall crop production within a season. Errors in factors that most influence fine-grained predictions, such as soil quality, may have a smaller impact on overall yield forecasts since their effect is likely to average out. Systematic errors in observed quantities, such as atmospheric effects on satellite imagery can, in contrast, affect overall estimates much more strongly. We explore the importance of systematic measurement error in the prediction of crop productivity.

Keywords: Precision agriculture; Crop prediction; Systematic error

INTRODUCTION

The prediction of yield in crops based on the normalized difference vegetation index (NDVI) has long been a standard tool in precision agriculture (Jones and Vaughan, 2010). Growers are often interested in using predictions for creating management zones for their fields. Delineating high-yielding from low-yielding zones does not critically depend on high accuracy in predicting overall yield.

Large farm operations and cooperatives may, in contrast, be interested in a projection of their overall yield for planning purposes.For example, if the projected yield in sugarbeets exceeds the processing capacity, growers may have to be directed to leave beets in the ground. The problem of predicting overall yield based on satellite data is fundamentally different from the problem of estimating yield within production zones: Satellite images typically cover vast areas. If the image is subject to systematic error, such as changes in visibility conditions that affect large areas, it is unclear how reliable overall predictions will be. Projection of overall annual yield has been considered at the level of states

(Prasa et al. 2006), but this type of approach is not accurate enough for crop management decisions.

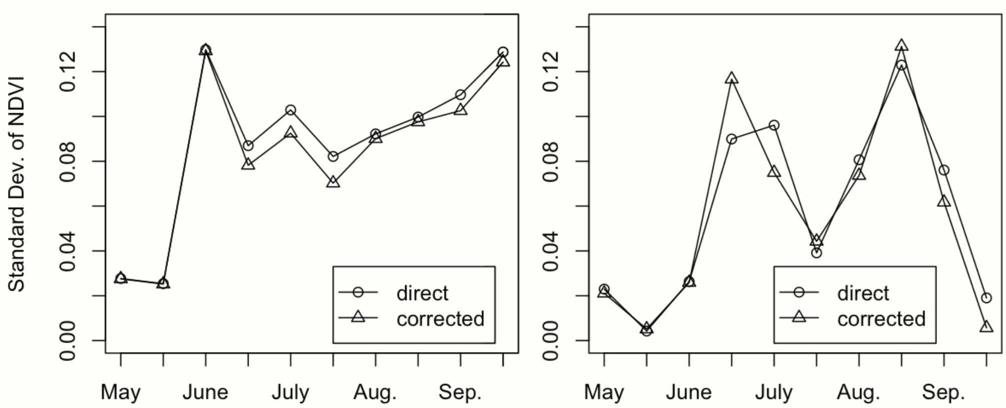

Fig. 1: Comparison between the standard deviation of NDVI results without correcting for yield (direct) and with such a correction (corrected), at the level of individual fields (left panel) and for entire years (right panel).

RESULTS

The presented work evaluates the usefulness of NDVI data towards the prediction of yearly yield averages and contrasts the result with their usefulness towards predicting yield at the individual field level. It is expected that for higher NDVI values the yield will be higher. To evaluate the variability of NDVI values, a linear regression model is built that predicts NDVI based on sugarbeet yield. For Fig. 1, left panel, the predicted NDVI values are subtracted from the actual ones, and the standard deviation is compared with its uncorrected value. Averages over non-cloudy images of the years 2007-2011 are reported in the figure (2 Landsat images cover the approx. 4000 fields). It can be seen that the correction consistently reduces the standard deviation. For Fig. 1, right panel, the standard deviations of mean NDVI values for all fields are compared. For those images, for which cloud cover did not prevent the analysis (in practice, 2-4 out of 5 Landsat sensing events) corrected and uncorrected overall mean NDVI values are computed and their standard deviation compared.

The results in Fig. 1 show that at a field level (left panel) the NDVI correction has the expected effect of consistently reducing standard deviation. The decrease is small in comparison to the overall value due to noise in NDVI data, but there is no case, in which the correction worsens the result. At the level of all fields (right panel), there are multiple examples, (e.g., late June), that show increasing standard deviation when overall yield of is considered. That means that there is no clear evidence that NDVI values that are averaged over one or more satellite images are useful towards predicting overall yield for the year.

REFERENCES

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