Food, Price and Conflict: Earth Observations-based Agricultural Production forecasting to assess potential impacts on grain markets and civil unrest

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Abstract

A primary focus of agricultural land use is on crop production for trading on commodity markets. Croplands account for approximately 11 percent of global land cover, the majority used for cereal production, with wheat as a primary crop. Satellite observations have long been proposed as an effective means to monitor agricultural lands and their production. Yet despite several national and international agricultural monitoring systems, there is still a lack of reliable and timely information on grain commodities. The need for such information is internationally recognized and is highlighted in several recent reports, in particular in the June 2011 G20 Action Plan on Food Price Volatility and Agriculture. The recent volatility in global grain markets has brought the issue of food security to the forefront of government agendas. Between 2006 and 2011 grain prices soared twice leading to civil unrest with food riots in over 40 countries, and according to FAO estimates, pushing an additional 140 people million below the poverty line. Clearly improving our monitoring of fluctuations in crop production and their implications in a socio-economic context is fundamental for governing and managing world food supplies and could potentially play a critical role in stabilizing grain markets, developing effective agricultural policies, mobilizing aid in response to impending regional food shortages, and contribute to averting social instability.

We propose an exploratory project to examine the feasibility of generating timely and reliable satellite-based information on wheat production at national scales for the primary wheat export countries; assess the potential value of such information for reducing grain market volatility and thereby potentially reducing the associated food riots and civil unrest in vulnerable nations. We will focus specifically on wheat production estimation at national scales for a small number of countries that are responsible for the majority of global wheat exports.

Context

Wheat Monthly Price ($/Ton) 1993-2013
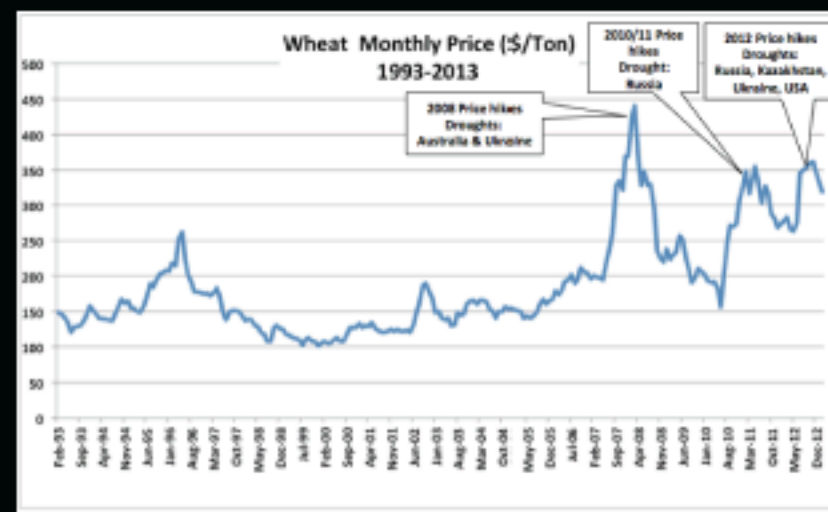
Shortfalls due to droughts in main crop producing countries were large factors leading to the food price hikes in recent years
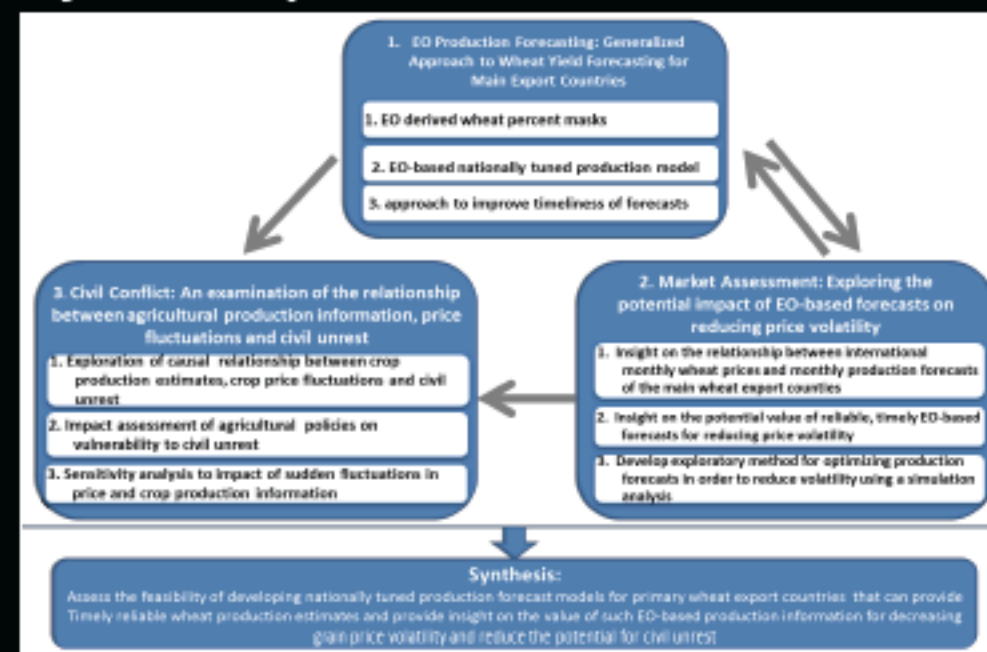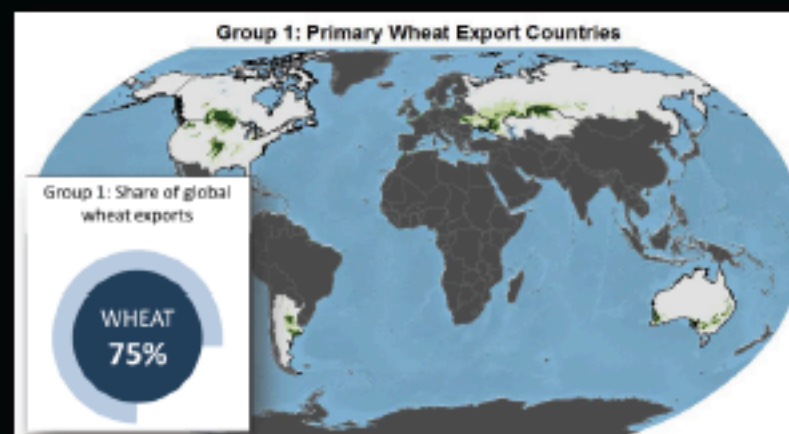
Why Wheat?

Wheat cultivation is one of the primary agricultural land uses worldwide with the highest planted area among food crops; it is the most important cereal crop traded on international markets; wheat shortfalls due to severe droughts in the principle export countries were major factors in the recent global grain price surges; it is the primary food aid commodity; and wheat shortages have dire implications for food security particularly in developing countries, as well as for national security

Project Components

This project is comprised of three interdisciplinary and integrated components:

i) Development of an EO-based generalized approach to wheat yield forecasting that is nationally tuned for implementation in the primary wheat exporting countries;

ii) A simulation and empirically based assessment to explore the potential impact of timely EO-based forecasts on reducing price volatility

iii) Examination of the relationship between the availability of agricultural production information, price fluctuations and civil unrest.

1. Wheat Yield Forecasting in Main Export Countries

Group 1: Primary Wheat Export Countries

Group 1: Share of global wheat exports

WHEAT 75%

Regions of Focus

Seven countries account for over 70% of world exports and 35% of total production, and production fluctuations in these countries largely govern international wheat prices. We will focus on these primary wheat export countries for the EO-based wheat production forecasting component and the related analysis of the relationship of forecasts with wheat price. To examine the relationships between production forecasts from these countries with civil uprising and wheat price fluctuations we will focus on two case studies one in Egypt and the other in Pakistan.

Approach to yield forecasting

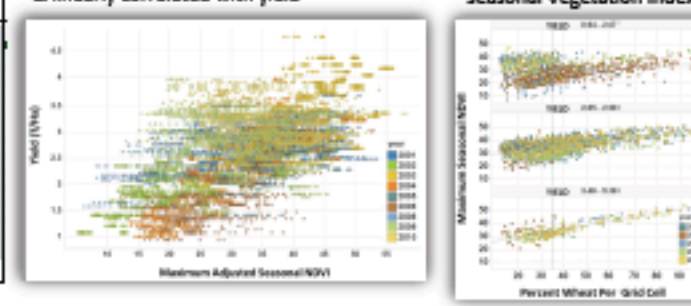Strong Correlation Between NDVI Peak and Wheat Yield

Example of Daily Normalized Difference Vegetation Index (NDVI from MODIS) 2000-2008, Versus Crop Yields (Blue numbers are Yield (MT/Ha)) in Harper County Kansas
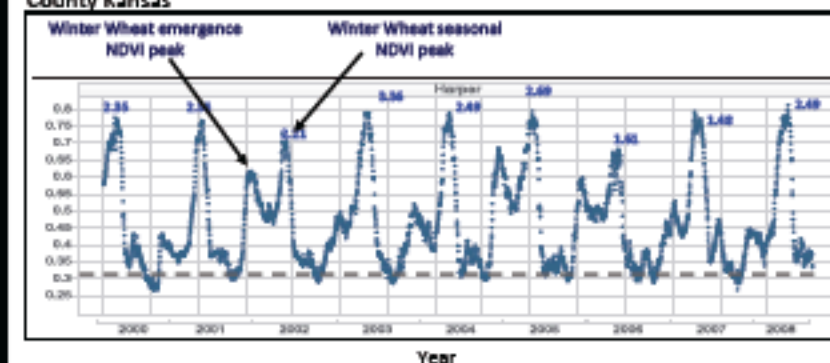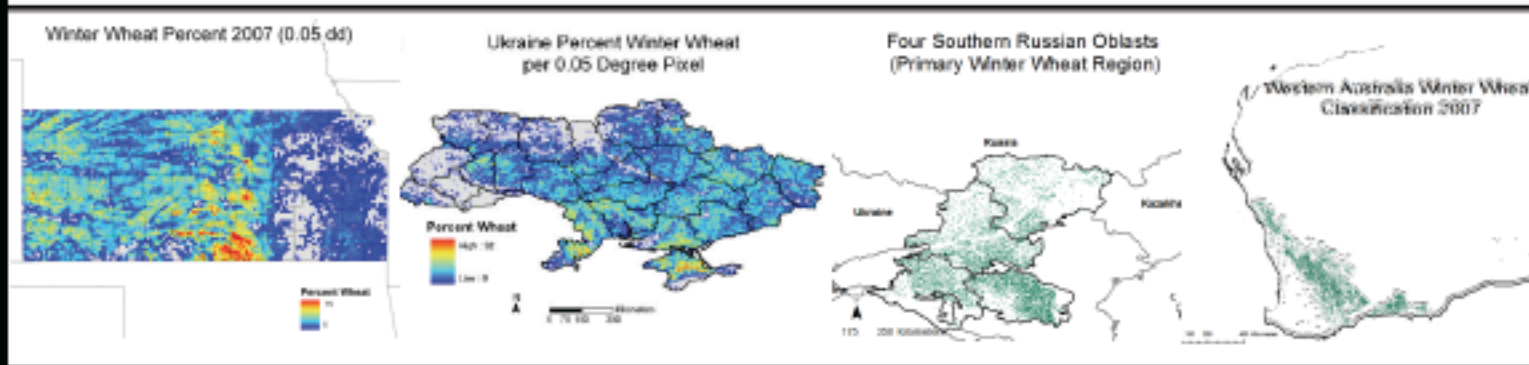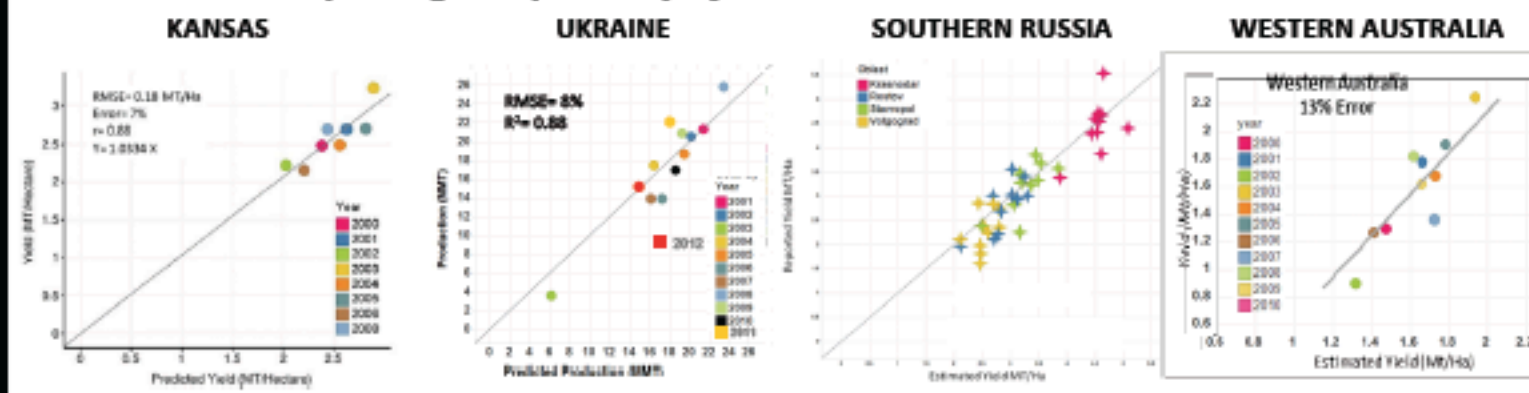
Regression-based model developed as a function of:
- a seasonal maximum NDVI (adjusted for background noise)
- Per grid cell percent wheat

Peak Seasonal Vegetation Index is positively & linearly correlated with yield
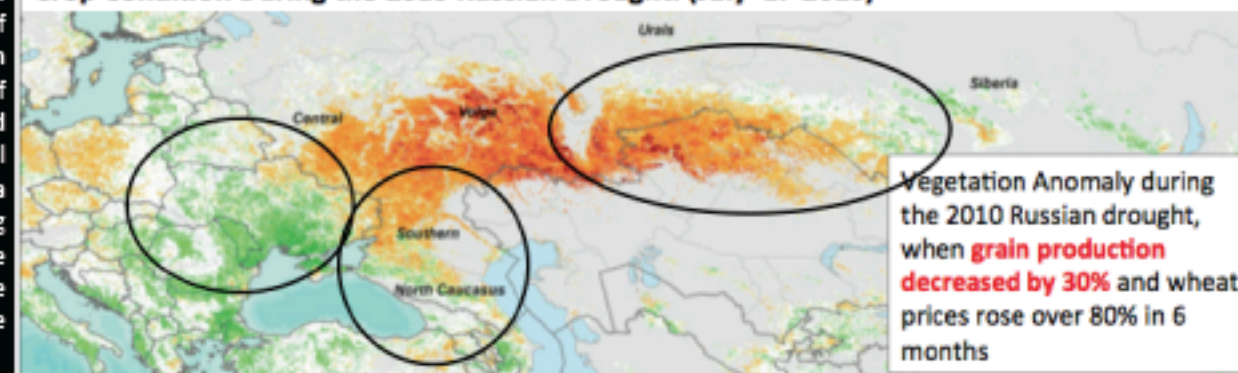
% wheat per grid cell is positively and linearly correlated with peak seasonal Vegetation Index

Exploring Adaptability of EO based Yield Forecast Model

KANSAS — RMSE= 0.18 MT/Ha Error= 7%

UKRAINE — RMSE= 8% R²= 0.88

SOUTHERN RUSSIA

WESTERN AUSTRALIA — Western Australia 13% Error

Winter Wheat Percent 2007 (0.05 dd)

Ukraine Percent Winter Wheat per 0.05 Degree Pixel

Four Southern Russian Oblasts (Primary Winter Wheat Region)

Western Australia Winter Wheat Classification 2007

2. Exploring the relationship between forecasts and price volatility: Strengthening the case for EO-based crop monitoring

The factors governing recent food price volatility are complex and the subject of intense debate, yet it is often stated that improvement of timeliness, transparency and reliability of global agricultural information has a critical role to play in helping to stabilize grain markets. the recent 2010/2011 wheat price surge due in part to the Russian drought.

Crop Condition During the 2010 Russian Drought: (July 17 2010)

Vegetation Anomaly during the 2010 Russian drought, when **grain production decreased by 30%** and wheat prices rose over 80% in 6 months

Following the 2010 drought international wheat prices increased over 80% in less than a year and the Russian grain production shortfall was cited as one of the primary instigators for this dramatic price hike.

Fluctuations in production, primarily driven by weather events, seem to have a significant impact on market fluctuations
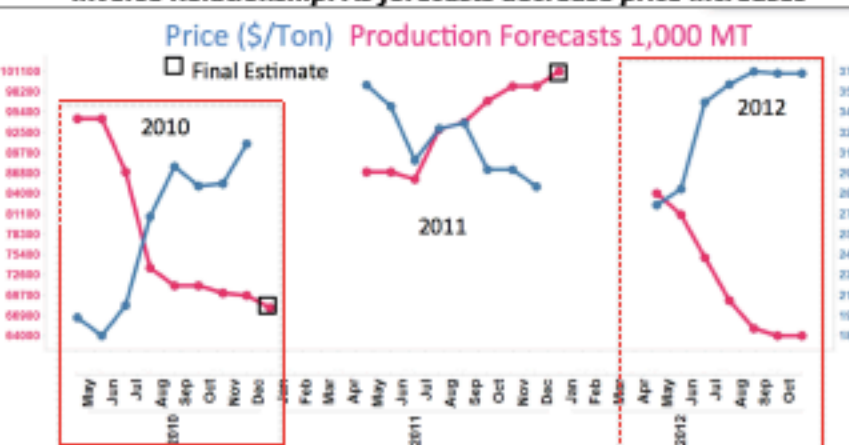
2010 Official Monthly Wheat Production Forecasts for Russia

Forecast gets within 10% of final production less than one month prior to harvest
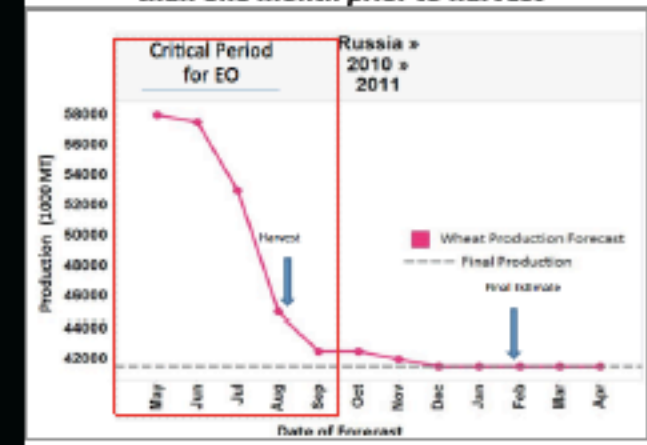
Wheat Production Forecasts from Main Wheat Export Countries (Pink) vs. International Market Price (Blue) 2010-2012

Inverse Relationship: As forecasts decrease price increases

Price ($/Ton)   Production Forecasts 1,000 MT

Collaborators:

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