GROUP ON EARTH OBSERVATIONS

The GEO Global Agricultural Monitoring Initiative (GEOGLAM): Overview

Chris Justice (UMD)

GEOGLAM
Global Agricultural Monitoring

GEO the Group on Earth Observations

an Intergovernmental Organization with 90 Members and 67 Participating Organizations

U.S. Department of State, Washington DC. July 31, 2003

Led to the Establishment of a

Global Earth Observing System of Systems (GEOSS)

GEO is focused on societal benefit

Agriculture is one of the GEO societal benefit areas
GEO provides an international framework for collaboration

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GEOGLAM
Global Agricultural Monitoring

GEOGLAM vision

…the use of coordinated, comprehensive and sustained Earth observations to inform decisions and actions in agriculture

…through a system of agricultural monitoring systems


International recognition of critical need for improved real time, reliable, open information on global agricultural production prospects
Critical for agricultural policies, stabilizing markets, averting food crises
Need to increase food production by 50%-70% by 2050 to meet demand
Intensification to close crop yield gaps – Extensification band use change
Plus increasing frequency of extreme events and climate change

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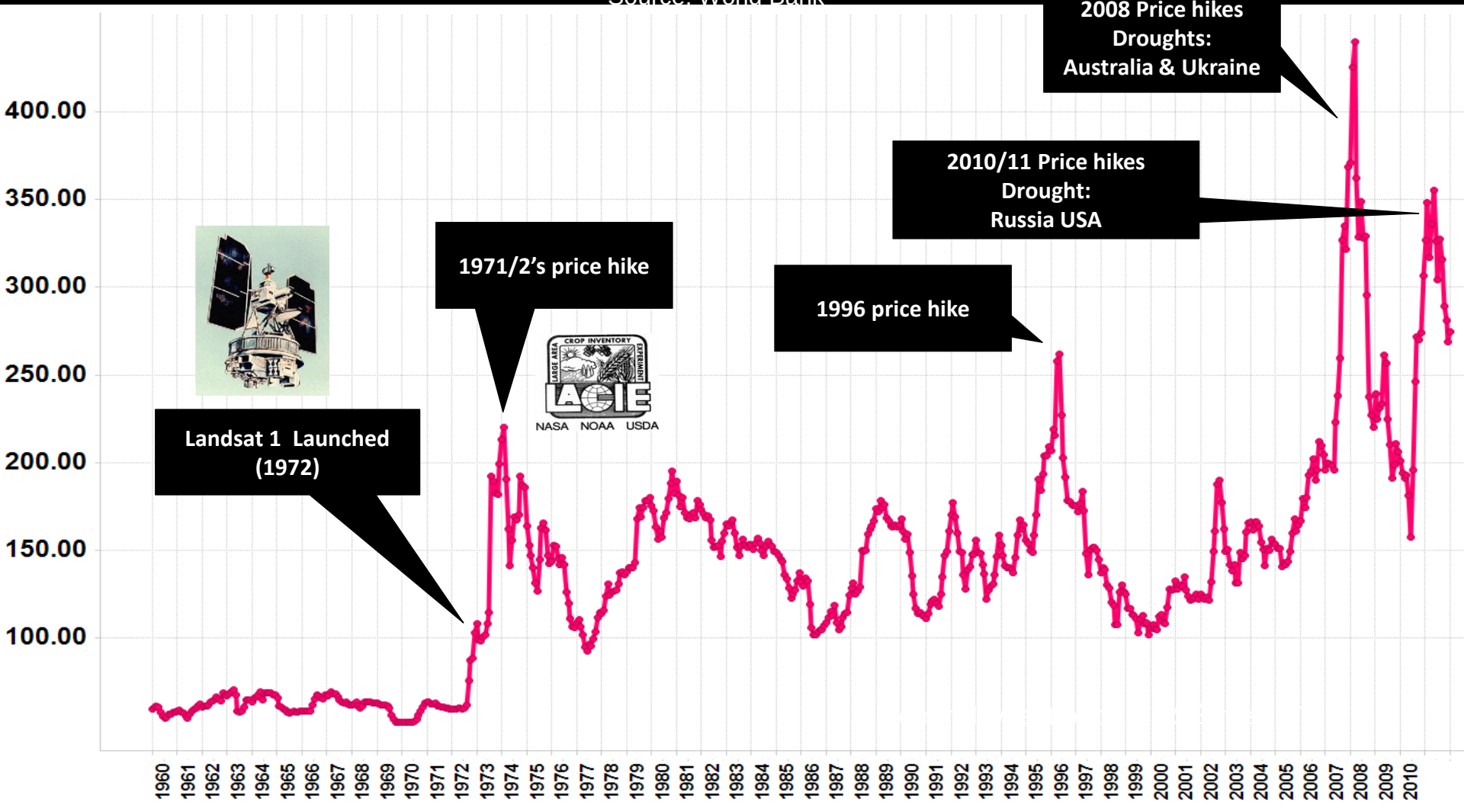
Context For GEOGLAM

Monthly Wheat Prices 1960-2011($/Metric Ton)

Source: World Bank



Initial Thematic Workshop Series to Identify "Community of Practice" Priorities and Best Practices

- **April 2011, ISRSE, Sydney: Workshop on Rangelands and Pasture Monitoring**
- **May 2011, Curitiba Brazil (SBSR): JECAM South America Workshop**
- **June 2011, Vienna Austria: Agricultural Land Cover Mapping Workshop**
- **September 2011, Nairobi Kenya: Agricultural Capacity Building Workshop**
- **October 2012, China: Workshop on Agricultural Water Availability**

Who We Are

Open Community made up of international and national agencies concerned with agricultural monitoring including ministries of Ag, space agencies, universities, and industry

We have preliminary involvement with Kazakhstan

Where are the other countries of Central Asia ?

Policy Framework for GEOGLAM

G20 Final Declaration

44. We commit to improve market information and transparency in order to make international markets for agricultural commodities more effective. To that end, we launched:

- The "Agricultural Market Information System" (AMIS) in Rome on September 15, 2011, to improve information on markets ...;

- The **"Global Agricultural Geo-monitoring Initiative" (GEO-GLAM)** in Geneva on September 22-23, 2011. This initiative will coordinate satellite monitoring observation systems in different regions of the world in order to enhance crop production projections and weather forecasting data.

GOAL AND SCOPE

- **To strengthen the international community's capacity to produce and disseminate relevant information on agricultural production at national, regional and global scales, through reinforced use of Earth Observations.**

- GEOGLAM is a 'coordination program', aiming at:
  - supporting, strengthening and articulating existing efforts through the use of EO
  - developing capacities and awareness at national and global level
  - disseminating information

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GEOGLAM Global Agricultural Monitoring

The GEOGLAM Components

1. GLOBAL/ REGIONAL SYSTEM OF SYSTEMS

Main producer countries, main crops

2. NATIONAL CAPACITY DEVELOPMENT

for agricultural monitoring using Earth Observation

3. MONITORING COUNTRIES AT RISK

Food security assessment

4. EO DATA COORDINATION

CEOS Committee on Earth Observation Satellites

5. METHOD IMPROVEMENT through R&D coordination (JECAM)

6. Data, products and INFORMATION DISSEMINATION

GEOGLAM Monthly Crop Monitor for AMIS

- Objective: develop consensus crop condition and prospects assessment in primary agricultural production areas highlighting potential hotspots of stress/bumper crops

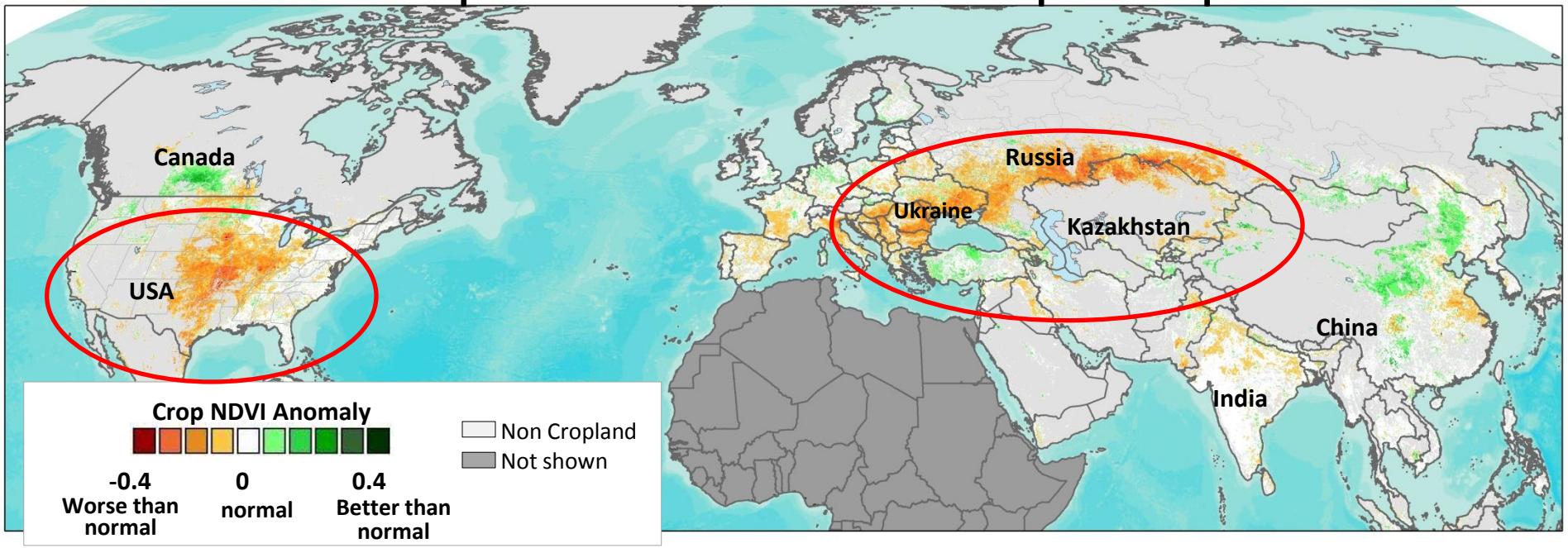
  – inputs from international and national agencies, based on evidence from satellite, weather, agromet, and national expert assessments

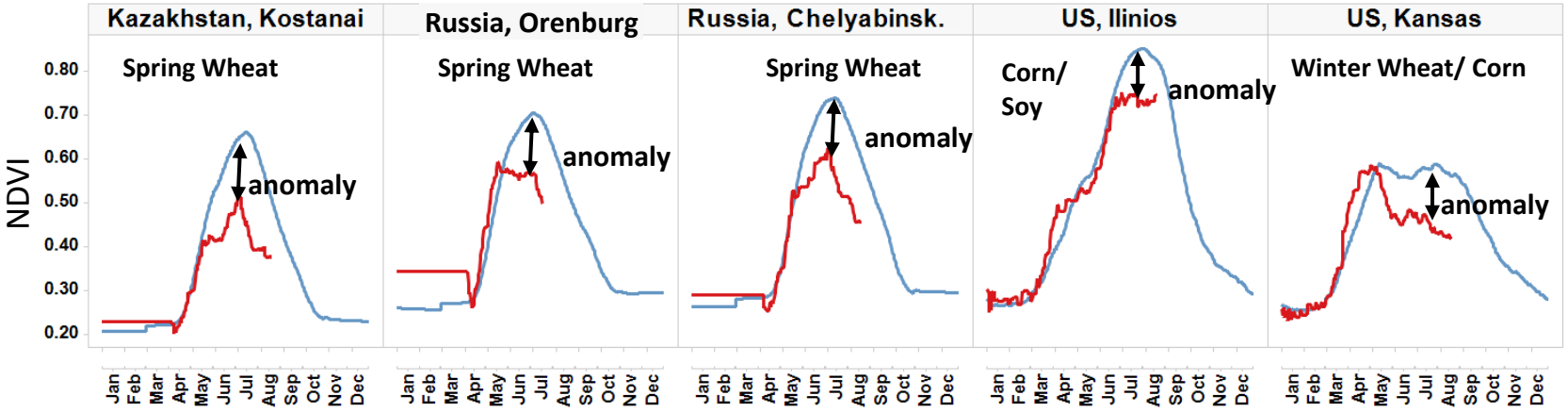
Component 1 Phase 1 (2012-2103)

GEOGLAM Global Agricultural Monitoring

Crop Condition Global Outlook: Building International Consensus

Assessment of Crop Conditions in Northern Hemisphere- input to AMIS





Current season crop development (2012)

Average season development (2000-2011)

Crop NDVI Anomaly, August 13th, 2012

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GEOGLAM Prototype Global Crop Assessment

August 1, 2013

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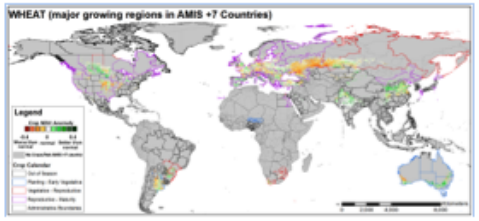
Wheat



NDVI anomaly image (NASA MODIS) depicting vegetation growth anomalies on July 22nd over the main wheat growing areas. (Orange to red indicates less green vegetation than average, green indicates higher than average vegetation). Administrative unit outline colors indicate growth stage: Blue- planting to early vegetative, Red- Vegetative to Reproductive, Purple- Reproductive to Maturity, Black- out of season. Note: only AMIS+7 countries are highlighted.

Wheat Comments and Highlights

Overall wheat conditions have been favorable. In the **United States** winter wheat has mostly been harvested. By end of July 94% of spring wheat was at or beyond the heading stage, and close to 70% is reportedly in good to excellent conditions according to USDA. In **Canada** crop conditions are favorable across the country for reproductive spring grains with only minor delays and development issues. Winter wheat harvest is in progress in Ontario and early reports indicate excellent yields. In **Russia** winter wheat has mostly been harvested. Widespread showers maintained favorable conditions for heading spring wheat in the Volga District while warm and dry conditions are affecting the southern Urals and Southern District. Rainfall in eastern Russia and **Kazakhstan** improved yield prospects for heading spring wheat. In **Ukraine** wheat harvest was in progress in early July. In **China** wheat has mostly been harvested. In **Europe** this agricultural year has so far been marked by an unusually prolonged winter for western and central Europe and heavy rainfall in May and June. Soft wheat yield at a total is currently forecast by MARS to be above last year's. Forecasts for **France** as the biggest producer show lower yields compared to last year, whereas higher yield levels are foreseen in **Spain, Romania, Bulgaria and Hungary**. In **South Africa** winter wheat is in emergence stage. Although still early in the season, vegetation index anomalies indicate some stress and one or two significant rainfall events are needed in coming months. Growing conditions for **Australia** wheat crops are generally favorable across most of the country. Recent rainfall in Western Australia has reversed the dry conditions of the past few weeks. Southeast production areas are in good condition. Better than average conditions in southern of New South Wales offsets an area of concern in northern New South Wales due to extended dryness in July. In **Argentina** winter wheat planting is mostly complete. Cool weather slowing early wheat development. In **Brazil** wheat is vegetative stages with cool wet temperatures affecting the southern portions of the country.

AMIS **Market Monitor**

No.11 – September 2013 www.amis-outlook.org

*The **Market Monitor** is a product of the Agricultural Market Information System (AMIS), a G20 initiative to provide information, analysis and short-term supply and demand forecasts. It covers*

Contents

Crop Monitor (As of 28 August)

This is the first GEOGLAM Crop Monitor developed for AMIS*. It summarizes latest crop conditions for AMIS crops based on regional expertise and analysis of satellite data, ground observations, and meteorological data, and was conducted by experts from global, national and regional monitoring systems. For each of the four crops, a paragraph summarizing current conditions is provided, accompanied by a satellite-based indicator map. Each map depicts crop vegetative growth anomalies from August 28th (relative to a 12 year average), over the main crop growing regions within AMIS countries.

Wheat: Prospects are favourable in the Northern Hemisphere. Winter wheat harvest is complete and spring wheat is in late-maturity to harvest stages. In the **US, Canada, Russia** and **Kazakhstan** spring wheat conditions are good though final yields will depend on favourable weather in the coming month. Crops in the Southern Hemisphere are in early-vegetative to reproductive stages and conditions are mostly favourable. In **Australia** overall conditions are average to above-average but rainfall in the next month will be critical as there is some concern over dry conditions in parts of the country. In Argentina conditions are good although additional moisture is needed. In **Brazil** frosts caused some significant crop damage and there is some concern over excessive wetness. In **South Africa** winter wheat conditions have improved since July, following widespread precipitation.

Maize: General conditions are good. In the US approximately half of the maize is in good to excellent condition and in spite of dry weather and rising temperatures in August, a bumper production is expected largely due to increased planted area. In **Canada**, conditions are favourable and yields are expected to be average to above average. In the **EU**, prospects are good except in northern Italy, Hungary, Austria, Slovenia and Croatia where there is concern due to late sowing and dry and hot conditions. In **Russia**, current yield prospects are favourable despite low soil moisture in the south. In **China, India, Mexico** and **Ukraine** conditions are generally good. In **Brazil** the second maize crop harvest is almost complete and it is expected to be favourable.

Rice: Growing conditions are favourable. The monsoon season in **South** and **Southeast Asia** has maintained good moisture across most of the region. In **India**, conditions are favourable as monsoon rains have been well distributed. In **Thailand**, precipitation has been widespread, though there is some concern over localized dryness. Mostly favourable conditions were maintained in **Vietnam** and the **Philippines** with some concern over excess moisture and flooding. In **China**, good moisture conditions were maintained in the North China Plain though there is some concern over flooding in the northeast and excess moisture in the southwest. Meanwhile, south of the Yangtze River, dry conditions and above normal temperatures raise concern. In **Japan**, conditions are mostly favourable in the south for early developing rice.

Soybeans: Growing conditions are favourable. In the US, about half of the crop is in good to excellent condition although prolonged dry conditions in the Midwest are raising concern. In **China**, conditions are favourable in the North China Plain and in the Northeast production regions. In **India**, conditions are favourable but there is some concern over excessive moisture.

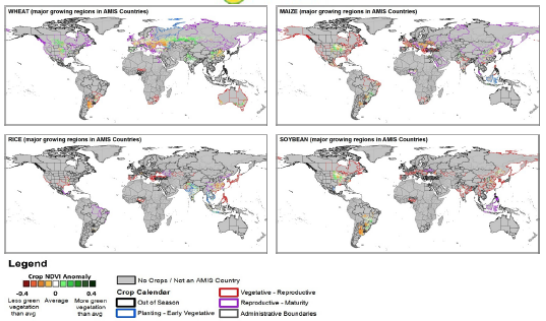
*GEOGLAM aims at strengthening global agricultural monitoring by improving the use of satellite information for crop production forecasting. It is implemented within the framework of the inter-ministerial Group on Earth Observations (GEO). Both GEOGLAM and AMIS were endorsed by the G20 Heads of States Declaration (Cannes, November 2011) when GEOGLAM was tasked to "coordinate satellite monitoring observation systems in different regions of the world in order to enhance crop production projections and weather forecasting data." Within this framework, GEOGLAM is providing global crop outlook assessments in support of AMIS market monitoring activities.

More detailed information on the GEOGLAM crop assessments is available on: www.geoglam-crop-monitor.org

Satellite-Based Vegetative Growth Anomalies
based on the Normalized Difference Vegetation Index (NDVI)

NDVI is an indicator of photosynthesis often used for monitoring croplands. These anomaly images compare the NDVI for August 28th 2013 to the average NDVI for the same date from 2000-2012, over the main growing regions of the four AMIS crops. Orange to red indicates less green vegetation than average, green indicates higher than average vegetation. Administrative unit outline colours indicate crop growth stage: **Blue-planting to early vegetative, Red-Vegetative to Reproductive** (generally the most sensitive crop growth period), **Purple-Reproductive to Maturity, Black-areas out of season.** Note: only AMIS countries are highlighted.

GEOGLAM

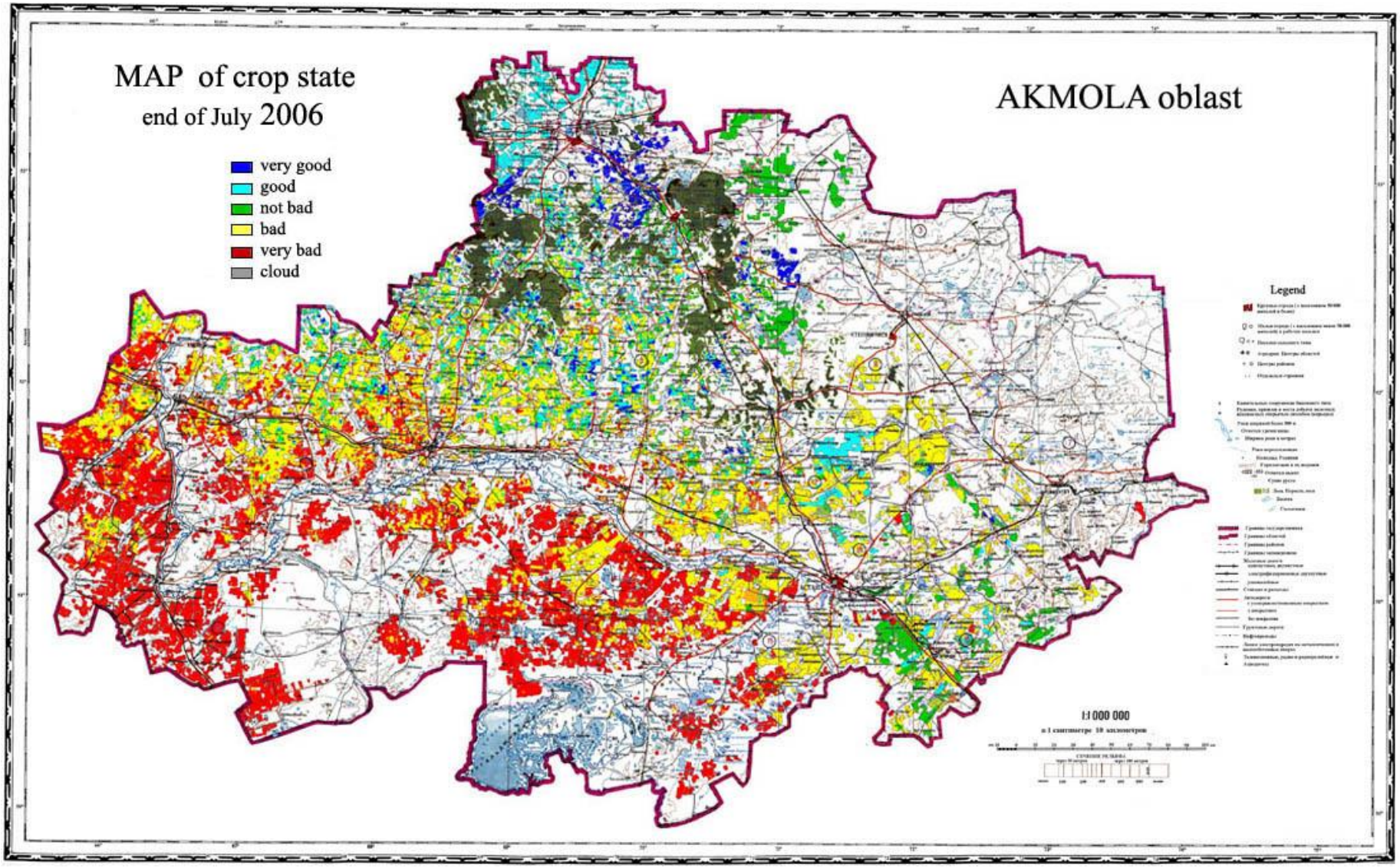


Sources & Disclaimer

The Crop Monitor assessment has been conducted by GEOGLAM with inputs from the following partners (in alphabetical order): AAFC (Canada), CAS CropWatch (China), CSIR/ARC (South Africa), ABARES/DAFF/CSIRO (Australia), CONAB/INPE (Brazil), GISTDA (Thailand), EC JRC-MARS, FAO, ISRO (India), JAXA (Japan), ASIA RICE, IKI (Russia), INTA (Argentina), LAPAN/MOA (Indonesia), Mexico (SIAP), NASA, UMD, and USDA FAS/ USDA NASS (US), Ukraine Hydromet Center/NASU-NSAU (Ukraine), VAST/VIMHE (Vietnam).

The findings and conclusions found in this joint multiple-agency reporting are only consensual statements from the GEOGLAM expert group, and do not necessarily reflect those of the individual Agencies represented by these experts. Map data sources: Main crop type areas based on the IFPRI SPAM 2005 beta release (2013). Crop calendars based on FAO and USDA crop calendars. NDVI anomaly data produced by NASA/USDA/UMD based on NASA MODIS data.

Example of cereals state map Kazakhstan



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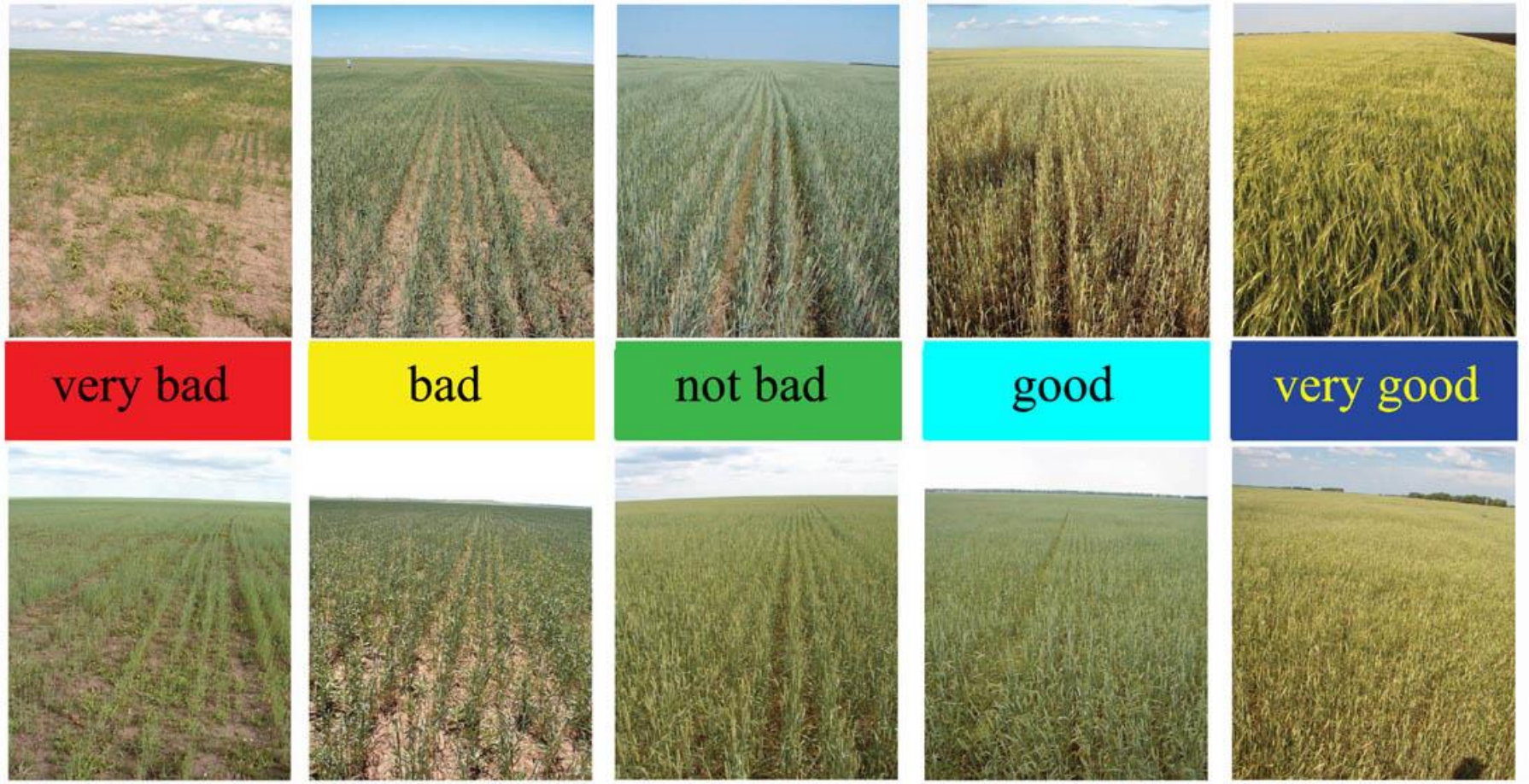
5 Classes of Crop State: Spring Wheat Kazakhstan



Typical classes of spring wheat state (end of July)
phase: flowering.

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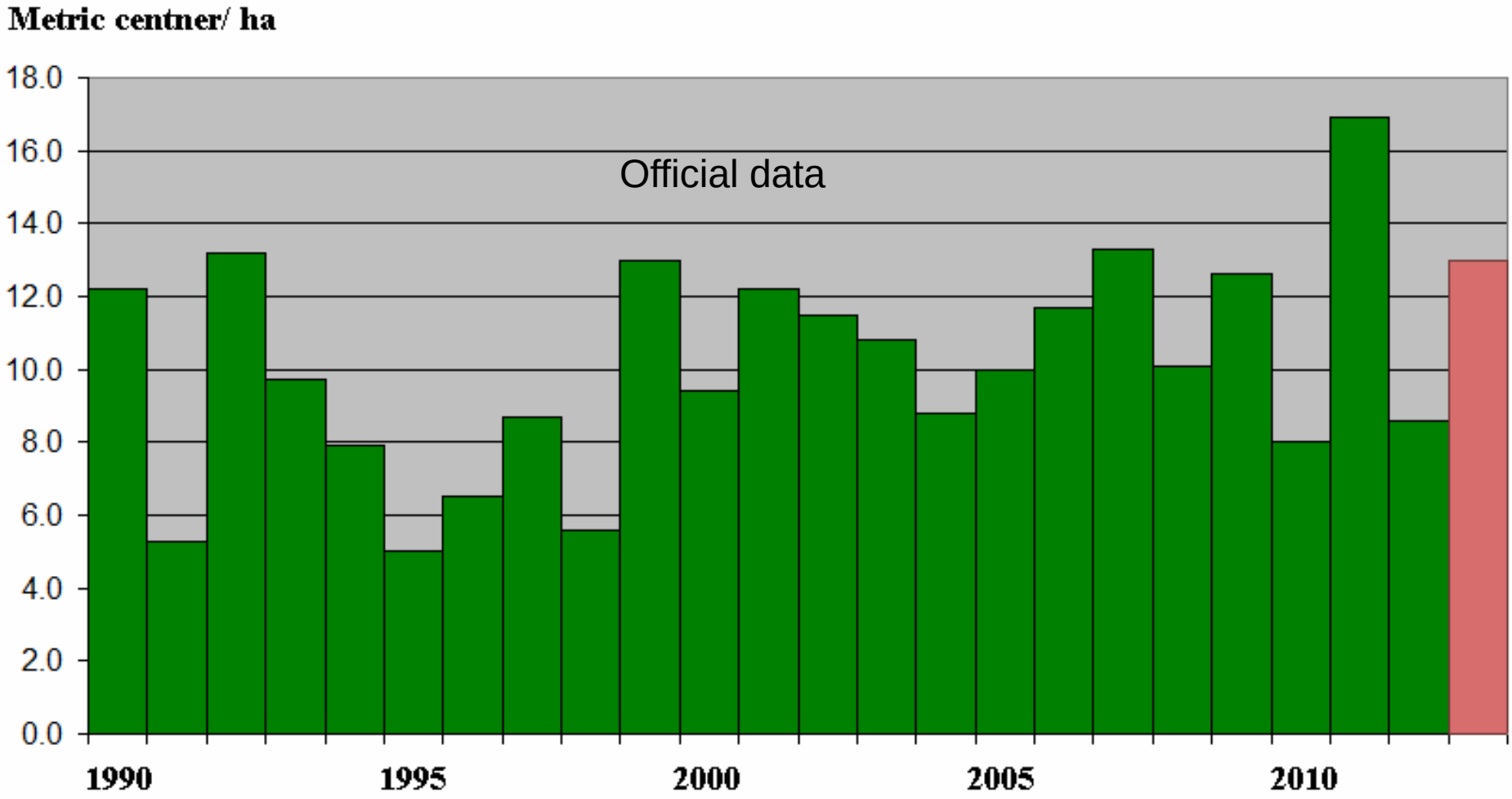
Changes in key parameters of agriculture in Kazakhstan

Cereals productivity in Kazakhstan



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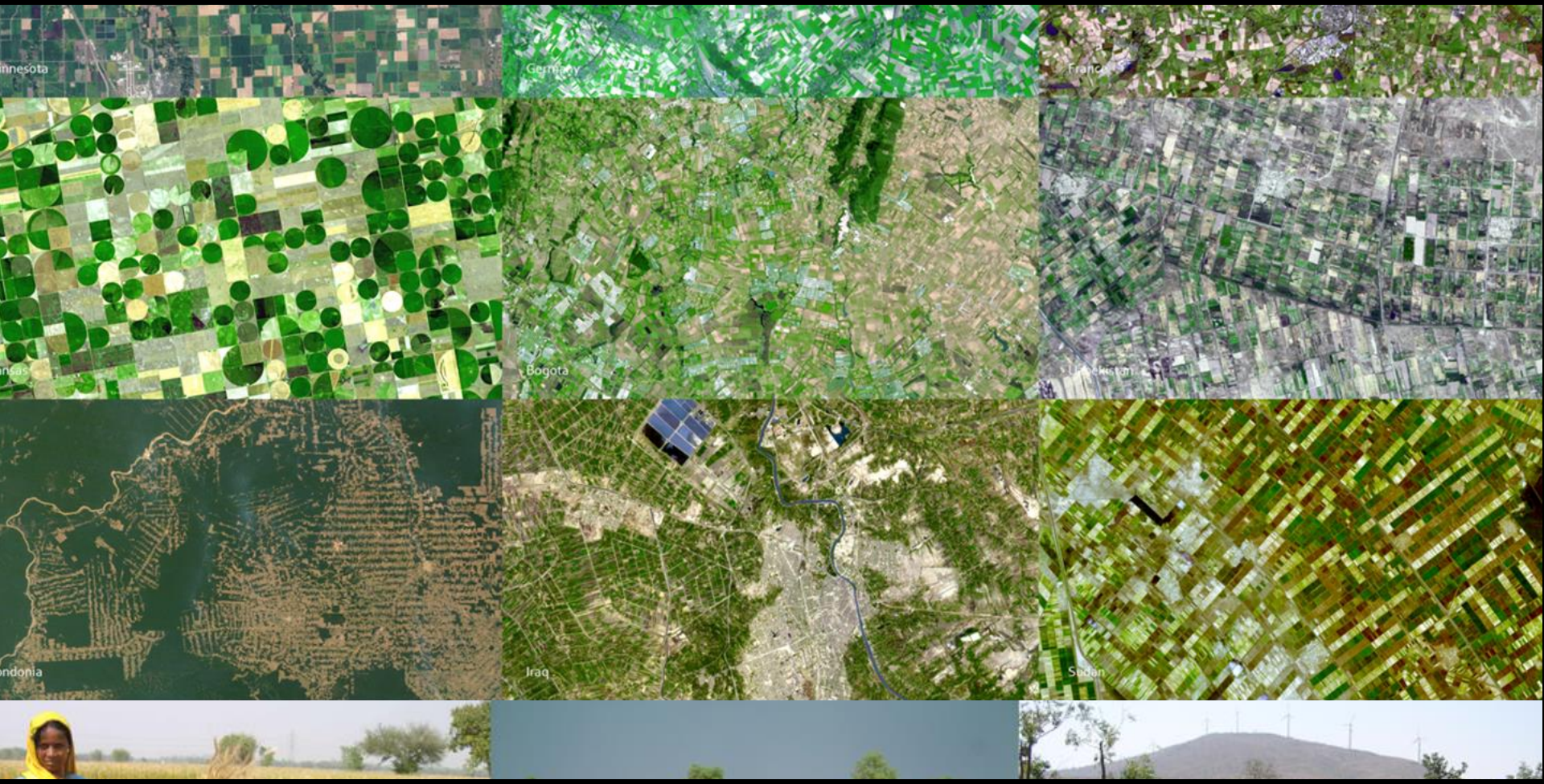
Developing the EO Data Requirements for GEOGLAM: Through a CEOS/GEOGLAM Technical Team



Recognition that cropping systems are inherently diverse which dictates the monitoring observations and methods

No one system can meet ag monitoring needs

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Identifying Information and Product Types

Information Products

- Crop outlook / Early warning
- Area estimate
- Yield forecast
- Production estimate
- Food Sec/vulnerability report
- Statistics reports

EO Data Products

- Cropland mask /Pasturelands
- Ag practices
- Crop condition indicators
- Crop type
- Biophysical variables
- Environmental variables (soil moisture)
- In-situ Weather

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GEOGLAM CEOS: EO Data Requirements Table

developed taking into consideration the observation needs, the derived products they will serve, and regional specificities; CEOS-GEOGLAM July 2012 Montreal)

	OBSERVATION & SENSOR TYPE			REGIONAL CHARACTERISTICS & GEOGRAPHICAL EXTENT						DERIVED PRODUCTS & MONITORING APPLICATONS							
	SPATIAL RES.	SPECTRAL RES.	TEMPORAL RES.	WHERE? (+ cropland mask & sampling scheme)				WHEN?									
Sensor Mission	Spatial resolution	Spectral range	Effective observ. frequency (cloud free)*	Swath / Extent	Sample (s), Refined (rs) or Wall -to-Wall (w2w)	Large, Medium, Small fields	Crop types diversity	Calendar/ Multiple cropping	Cloud coverage	Use (Primary or Secondary Source)	Cropland s mask	Crop type area	Crop cond. indicators	Crop bioph. var.	Env. variables (reservoir, water, soil moisture)	Ag. Practices / Cropping systems	Crop yield
MODIS (aqua/Terra), VIIRS(NPP), Vegetation (SPOT-5)	2000 - 500 m	thermal IR + optical	few per day	global	w2w					NRT products (PS)			x	x (L)			
MODIS (optical not SWIR), Sentinel 3? (future), CMA FY series?, Proba-V (future)	100-300m	optical + SWIR	2 to 5 per week	global	w2w	L/M/S		*		NRT products (PS)	x	x	x	x (L)		x (L)	x (L)
FUTURE	1-15km	passive microwave	daily	global	w2w					NRT products (PS)					x		
	50-150 m	SAR dual pol. (X,C,L) ****	5 per season	main crops	s	L/M/S	rice area	entire growing season	high cloud cov.	NRT products (SS/PS)*	x	x	x	x (L)	x	x (L)	
FUTURE	5-20m	SAR dual pol. (X,C,L) ****	5 per season	main crops	s	L/M/S	rice area		high cloud cov.	NRT products (SS/PS)*		x	x	x	x	x	
FUTURE	Footprint	RADAR Altimetry	weekly		s					NRT products (PS)					x		
ETM+ (Landsat-7), ASTER (Terra), TIRS(LDCM), IRMSS (CBERS-3)	50-100m	thermal	daily ?	main crops	s	L/M/S		entire growing season		NRT products (PS)			x				
All Optical Mid-Resoltuion (Landsat, Terra, EO-1, ResourceSat-2, CBERS-3, Sentinel-2)	20-70m	optical + SWIR	1 per month (if possible same sensor) (min 2 out of season + 3 in season)	croplands	w2w	all M/S		year-round, focus on growing season		annual products (PS)	M/S	M					
All Optical Mid-Resoltuion (Landsat, Terra, EO-1, ResourceSat-2, CBERS-3, Sentinel-2)	20-70m	optical+SWIR	1 per week (min. 1 per 2 weeks)	main crops	s	country specific (see phasing) L/M/S		entire growing season		NRT products (PS)	L/M/S	M/S	x	x	x	x	
HGR (SPOT-5), Rapid Eye (optical)	5-10 m	optical (+SWIR)***	1 per month (if possible same sensor) (min 2 out of season + 3 in season)	croplands	rs	L/M/S (focus on S)		year-round, focus on growing season		annual products (PS)	L/M/S	L/M/S					
HGR (SPOT-5), Rapid Eye (optical)	5-10 m	optical (+SWIR)***	1 per week (min. 1 per 2 weeks)	main crops	rs2	country specific (see phasing) S		entire growing season		NRT products (PS)			x	x	x	x	
HIRI (Pleiades), IKONOS, GeoEye, WorldView2 (optical)	< 5 m	optical	1 to 2 per month	croplands	rs3	demo. case (2 - 5% of croplands L/M/S)		2 - 4 coverages per year		annual products (PS)		x				x	x

spatial & spectral

How often ?

Where?

When?

For What?

GEOGLAM data plan to be submitted to the CEOS plenary in 2013

WHERE?

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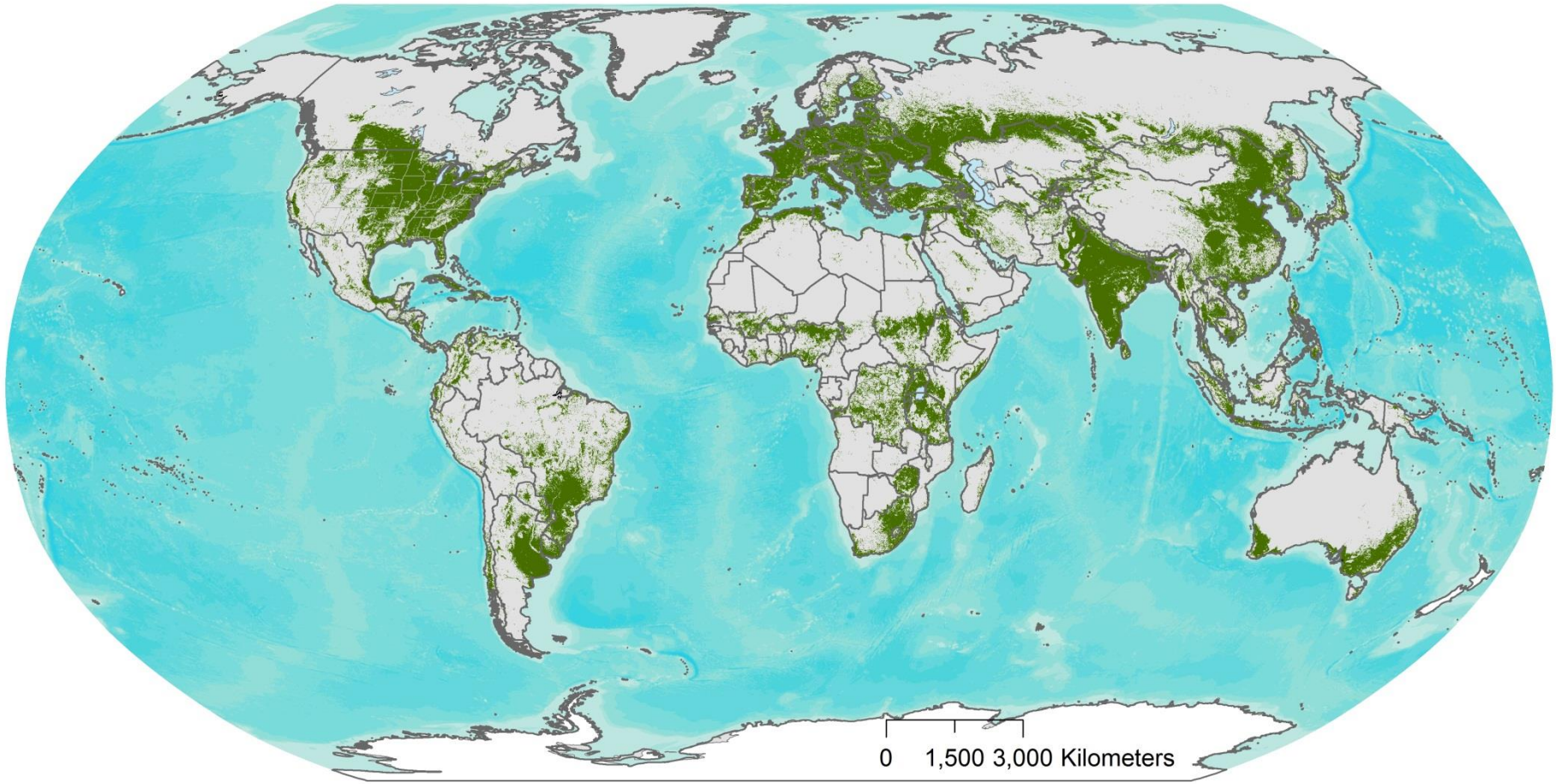
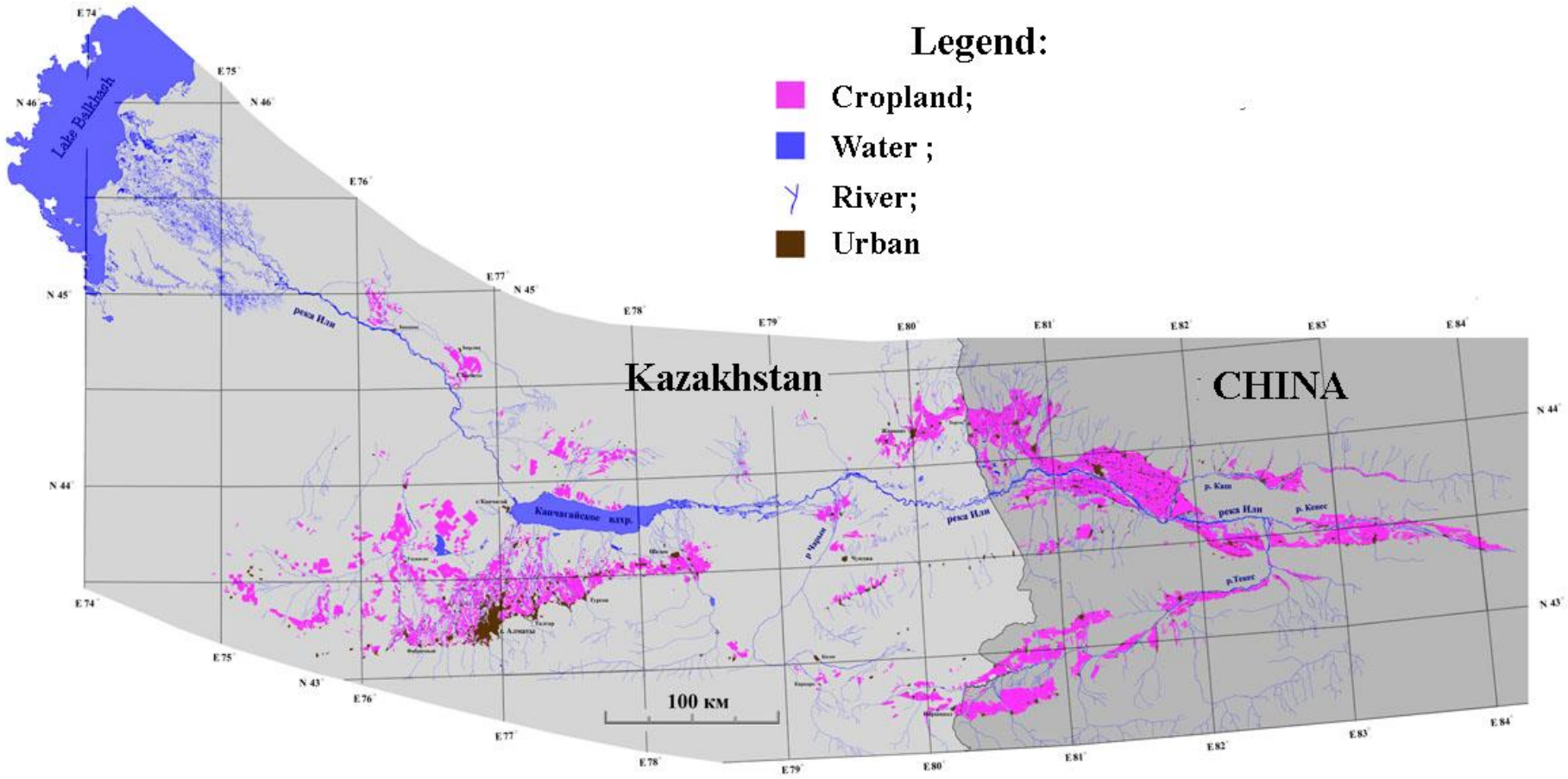


Fritz et al. IIASA


ARABLE LAND
Satellite estimation
Москва
RUSSIA
Казань
Ханты-Мансийск
Екатеринбург
Волгоград
Оренбург
Омск
Астрахань
Каспийское море
ASTANA
KAZAKHSTAN
Almaty
Information source:
SRI AS, RUSSIA
NC SRI, KAZAKHSTAN

Agriculture land use in river Ili basin

Landsat mapping (2010 year)



AT WHAT LEVEL OF DETAIL(SPATIAL RESOLUTION)?

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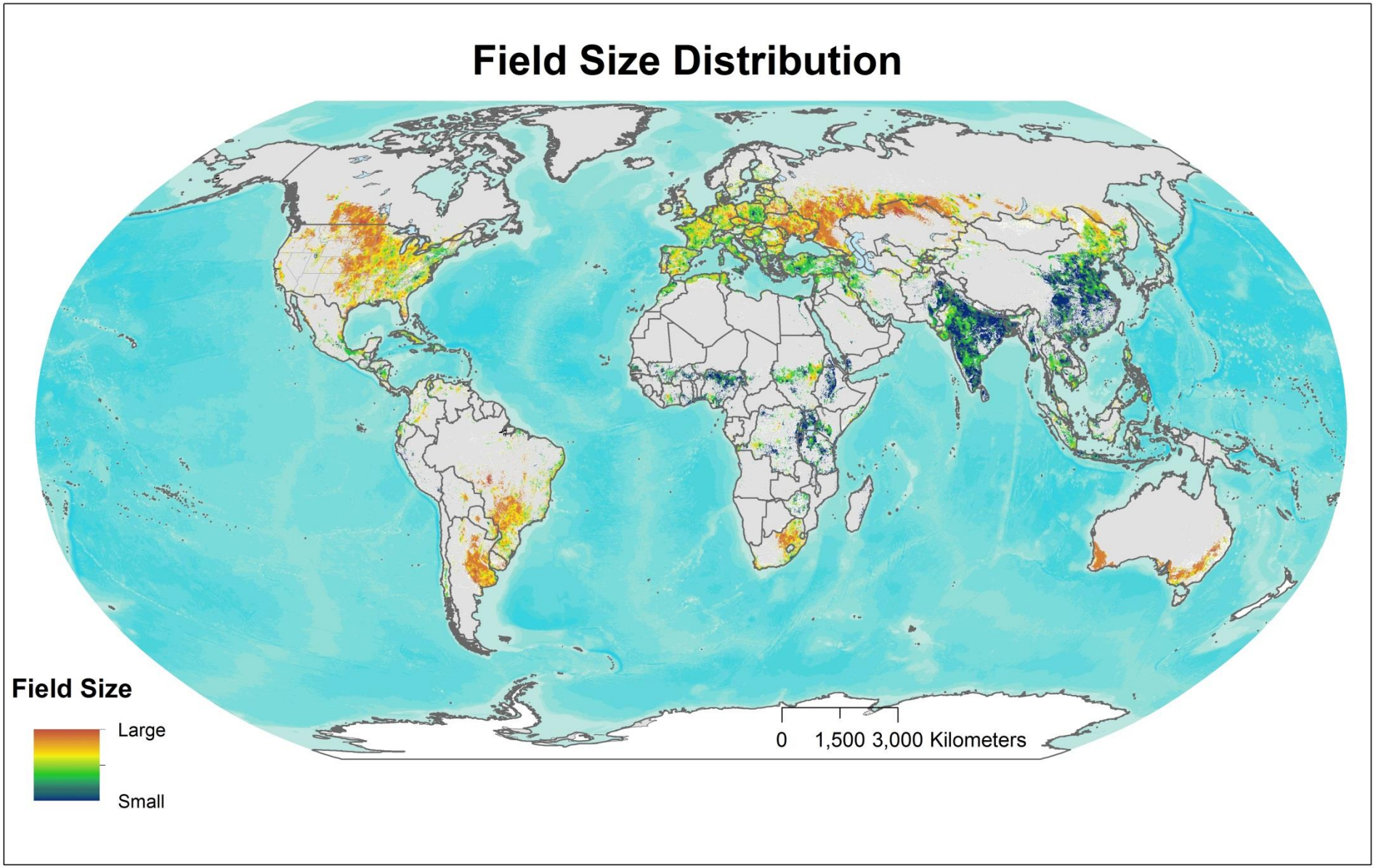

Fritz et al. IIASA


Typical steppe landscape in Northern Kazakhstan
Terekhov et al

WHEN?

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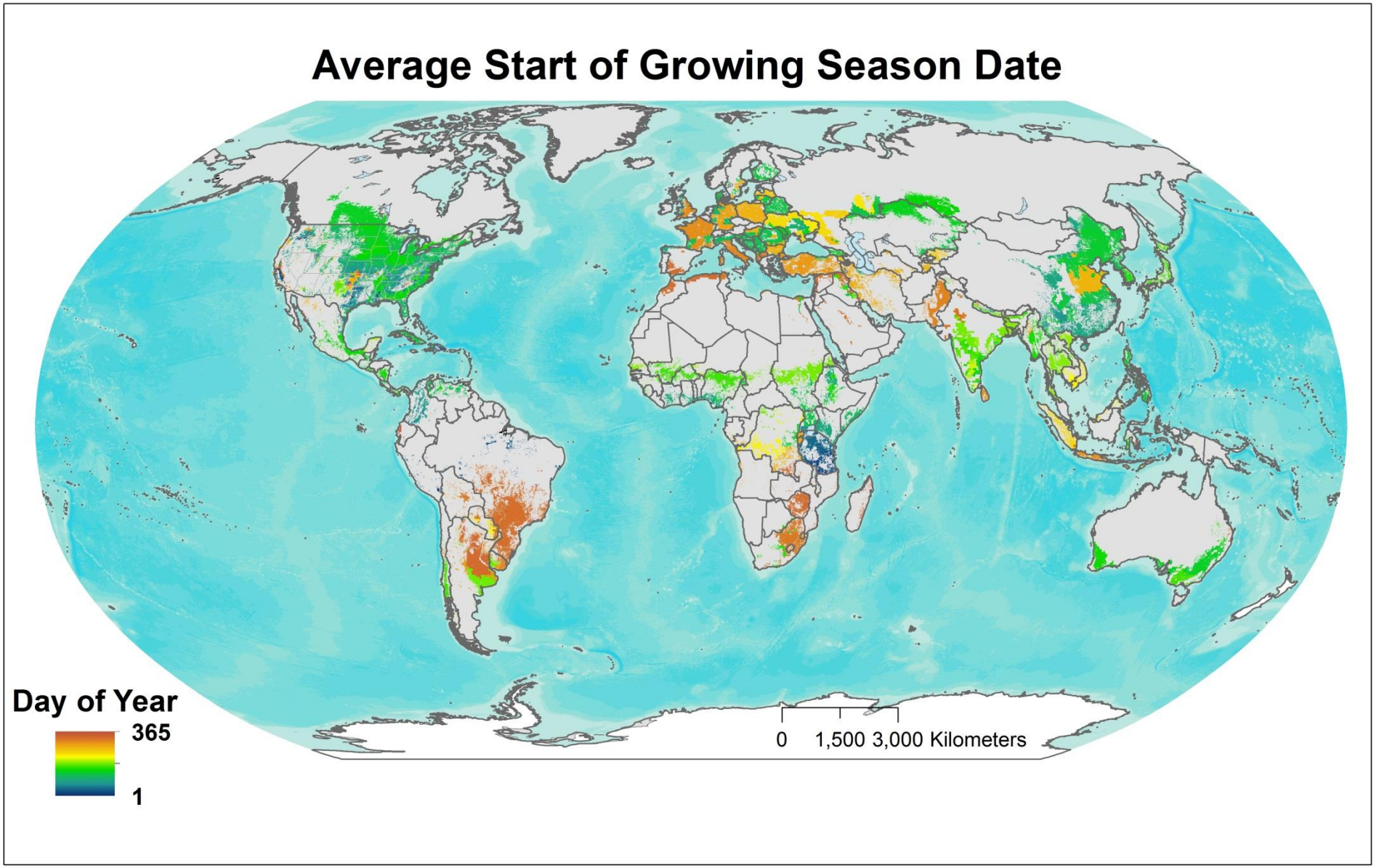
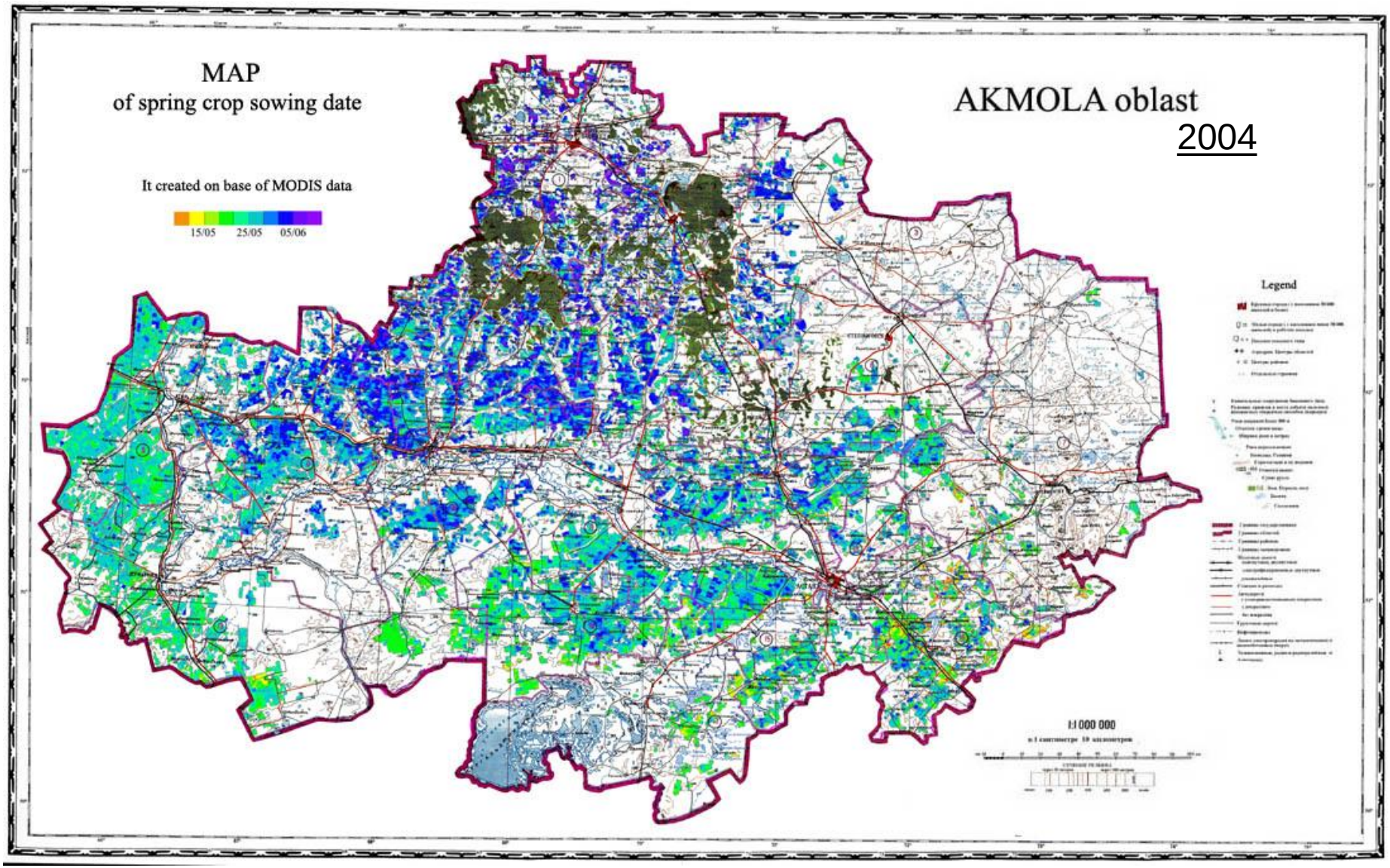


Whitcraft et al. UMD

Example of sowing data map using MODIS data



Terekhov et al

WHEN?

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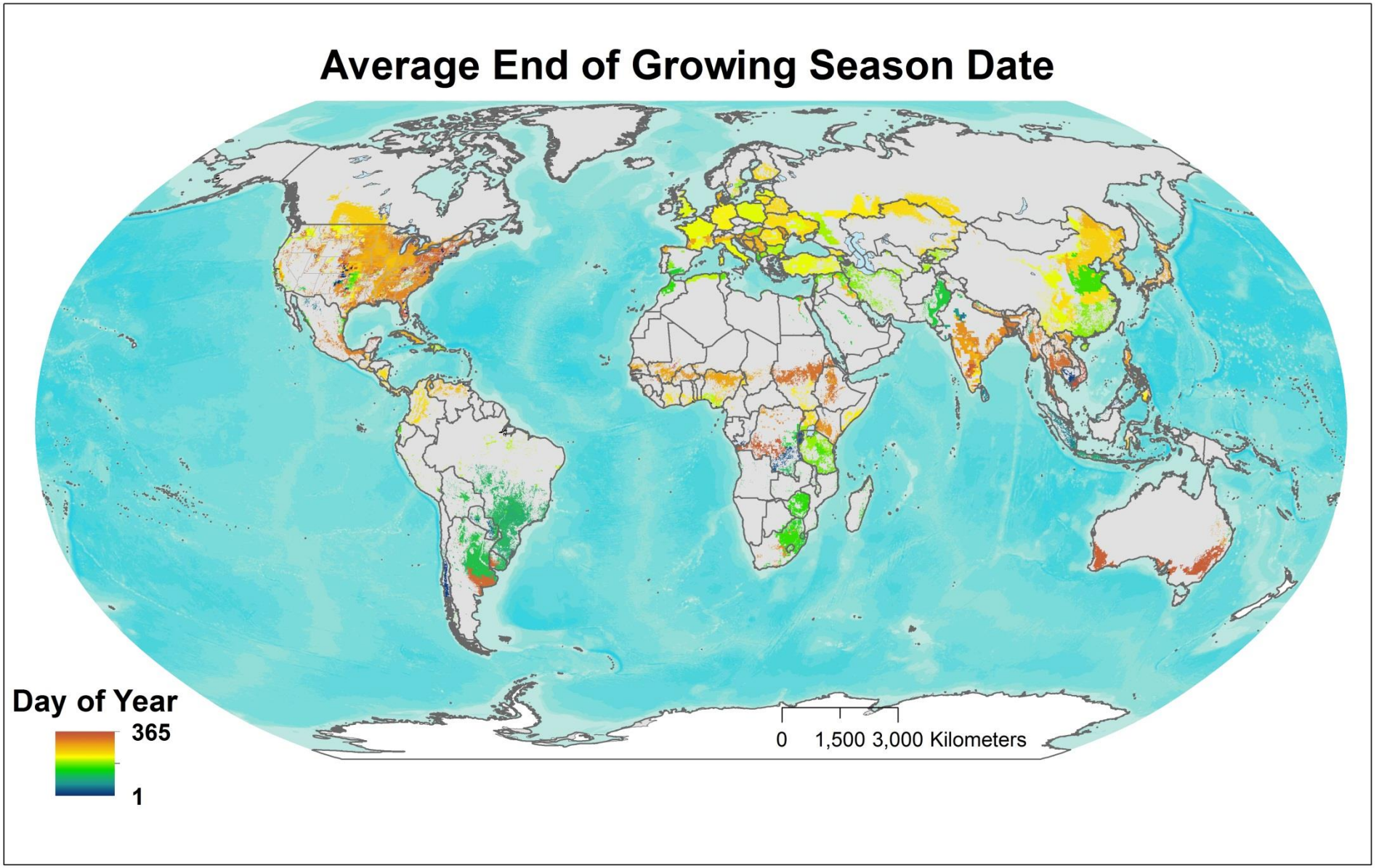
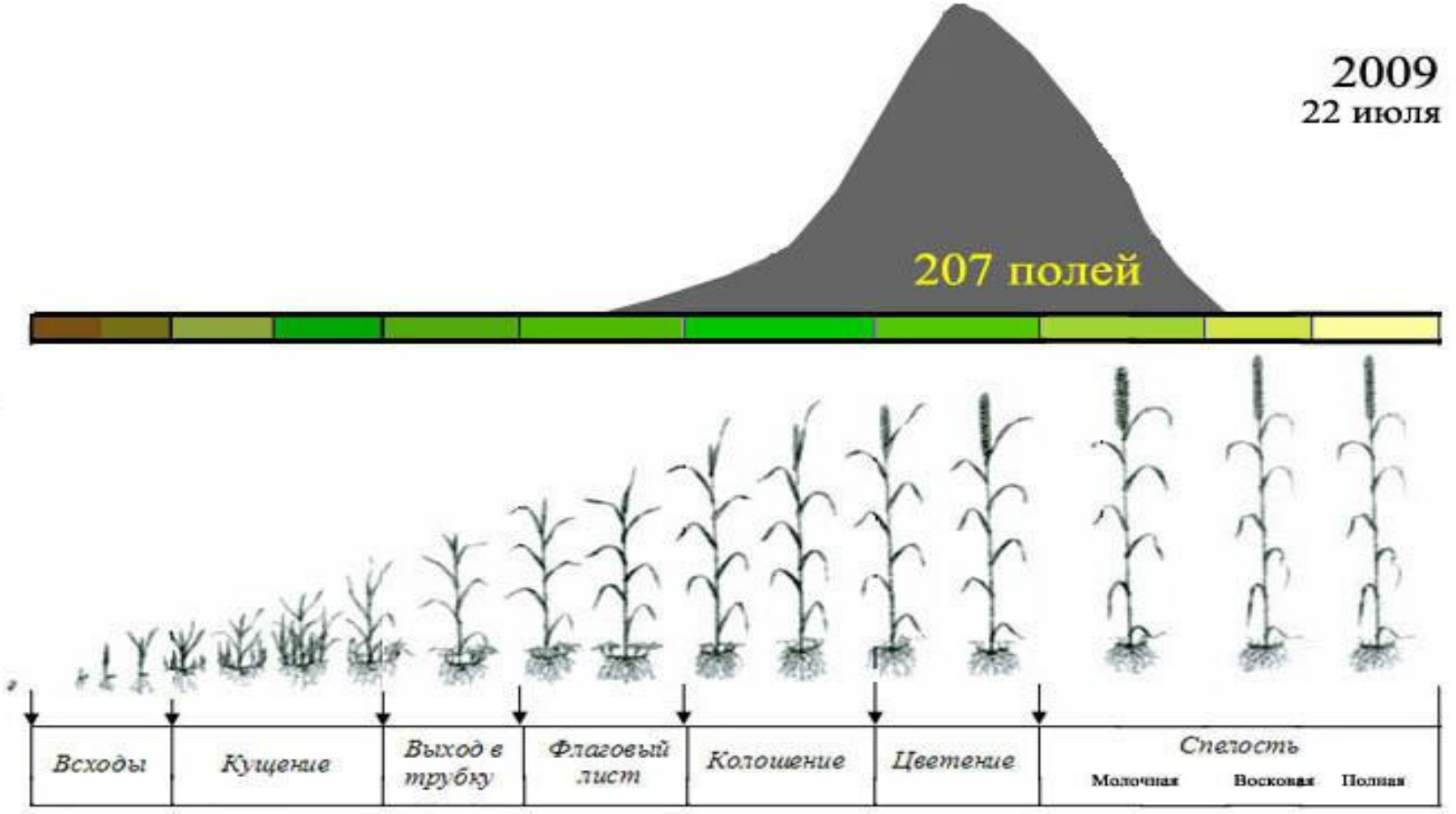


Whitcraft et al. UMD

Example histogram of growing phases of spring wheat in Northern Kazakhstan

route observation [207 fields], July 22.2009



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HOW OFTEN?

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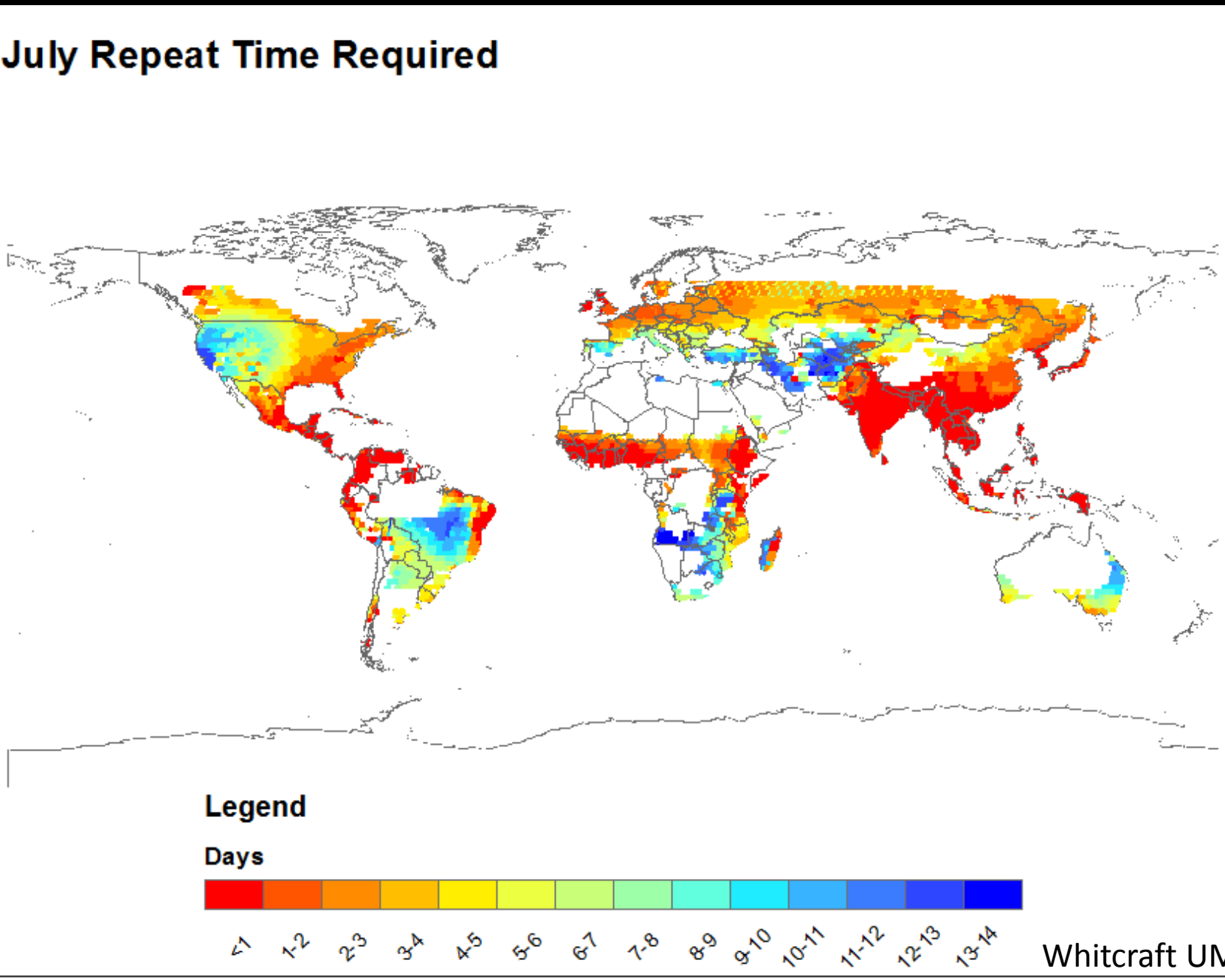


Whitcraft UMD

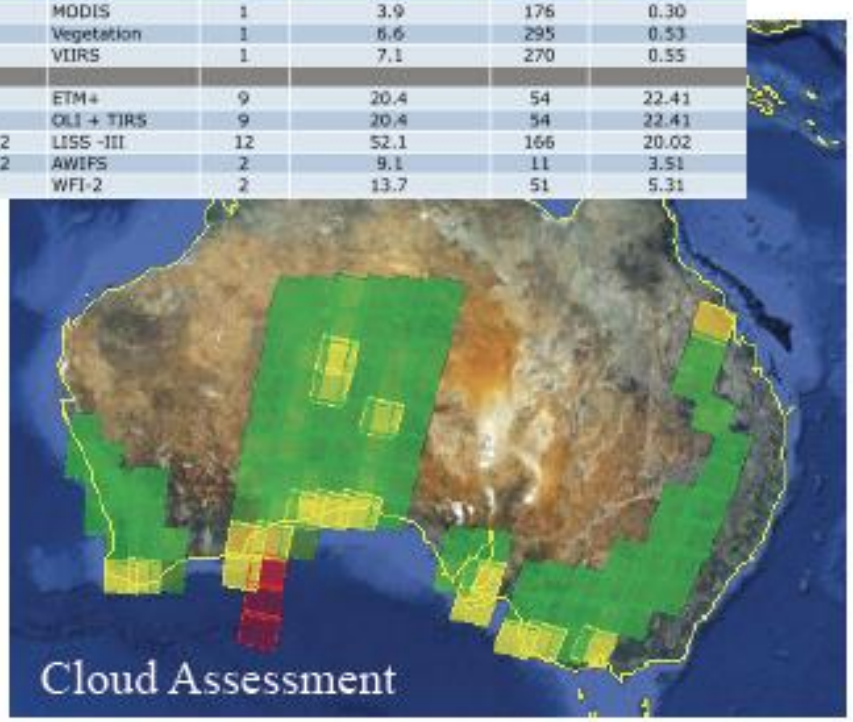
SDCG-3 Meeting
Sydney, Australia
7-9 February 2013

CEOS SEO Support to GEOGLAM

Data Acquisition Planning and Analysis

- Crop Masks, Crop Calendars
- Cloud Statistics (MODIS and ISCCP)
- Data Volume (# paths, duration, # scenes)

Mission	Instrument	Total Paths	Total Duration of Acquisitions (min)	Total Scenes	Total Data Volume (GB)
Terra	MODIS	1	3.9	176	0.30
Aqua	MODIS	1	3.9	176	0.30
SPOT-5	Vegetation	1	6.6	295	0.53
NPP	VIIRS	1	7.1	270	0.55
Landsat 7	ETM+	9	20.4	54	22.41
LDCM	OLI + TIRS	9	20.4	54	22.41
Resourcesat-2	LISS -III	12	52.1	166	20.02
Resourcesat-2	AWIFS	2	9.1	11	3.51
CBERS-3	WFI-2	2	13.7	51	5.31



B. Killough

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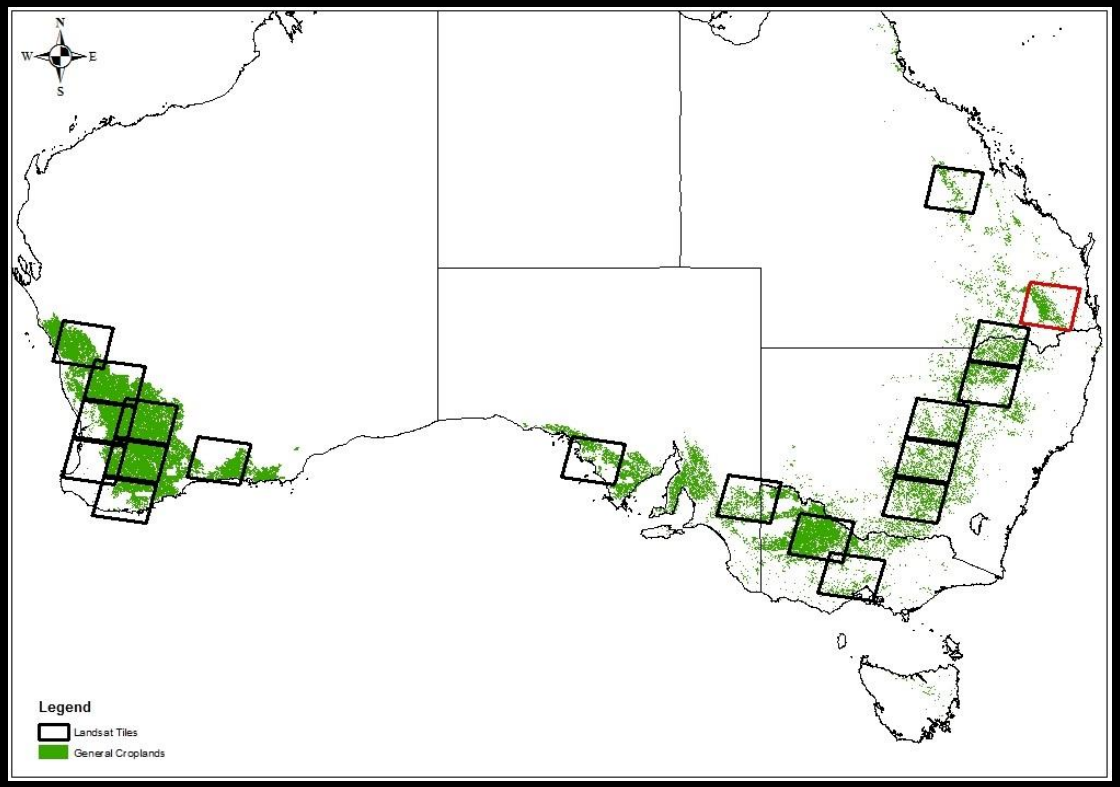
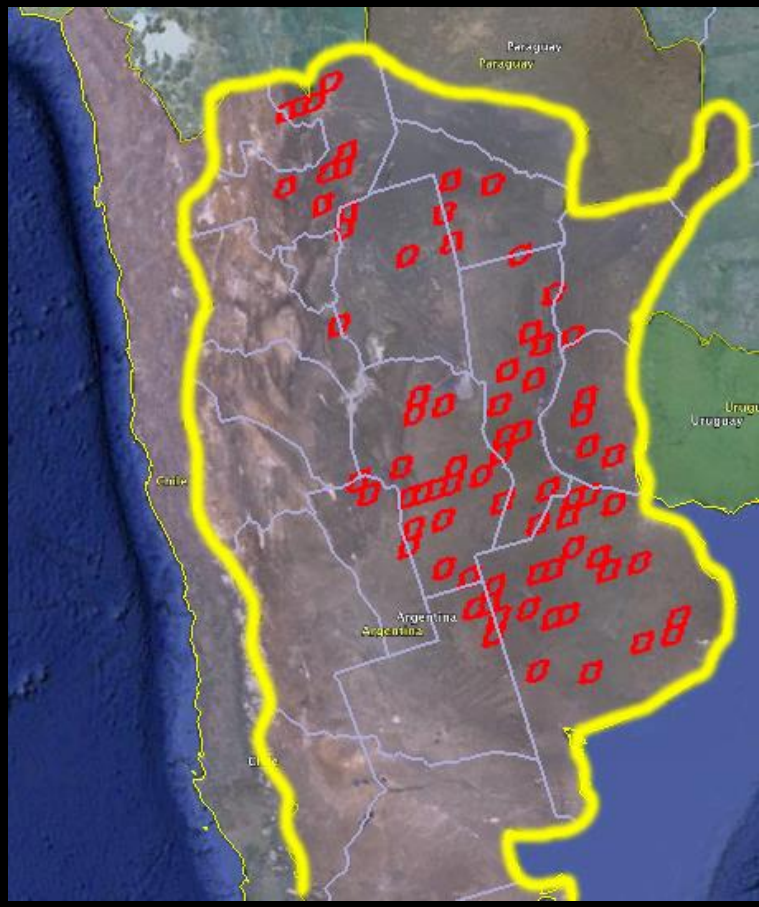
Sampling Strategy for high resolution data for Phase 1a Countries





NASA Near Real Time EOS Data for Agricultural Monitoring

Timely data is critical for crop monitoring!!

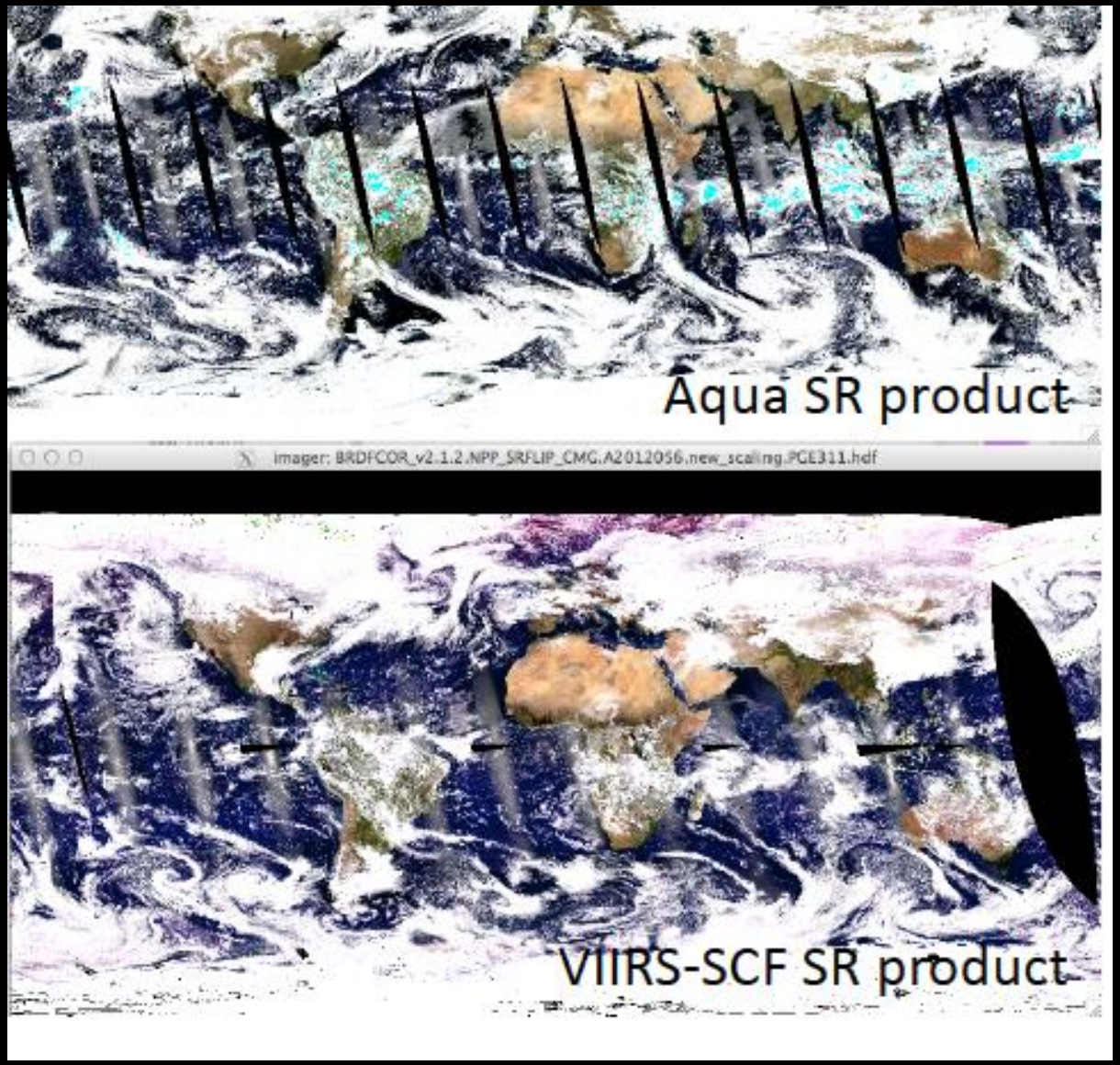
NASA EOS near-real-time daily observations are processed and integrated into USDA FAS system (< 3 hours from observation)

A contribution to GEO-GLAM

GEOGLAM
Global Agricultural Monitoring

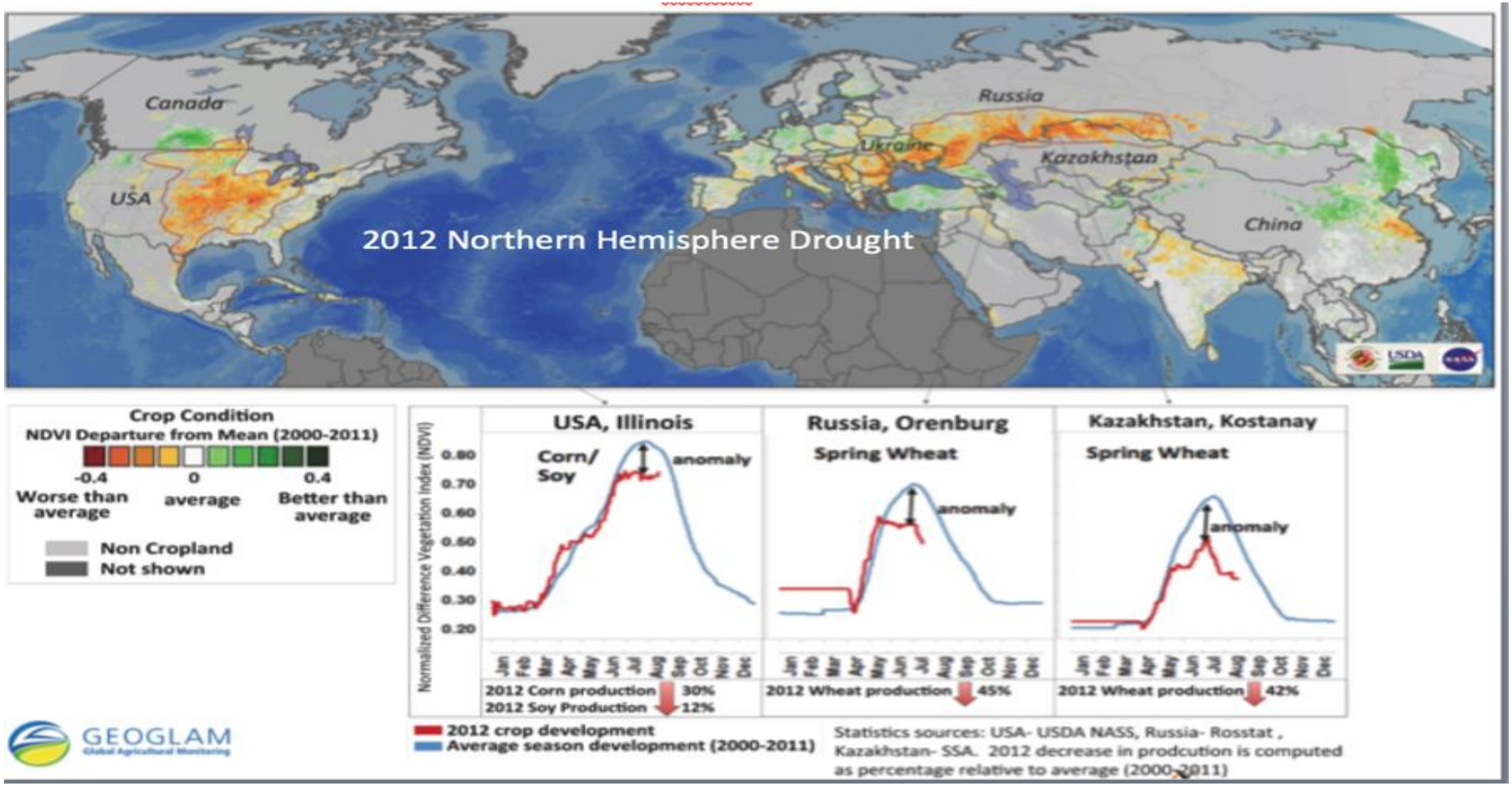
Component 4 Phase 1: Pilot Study on Data Interoperability

JPSS VIIRS / MODIS interoperabilty for agricultural monitoring



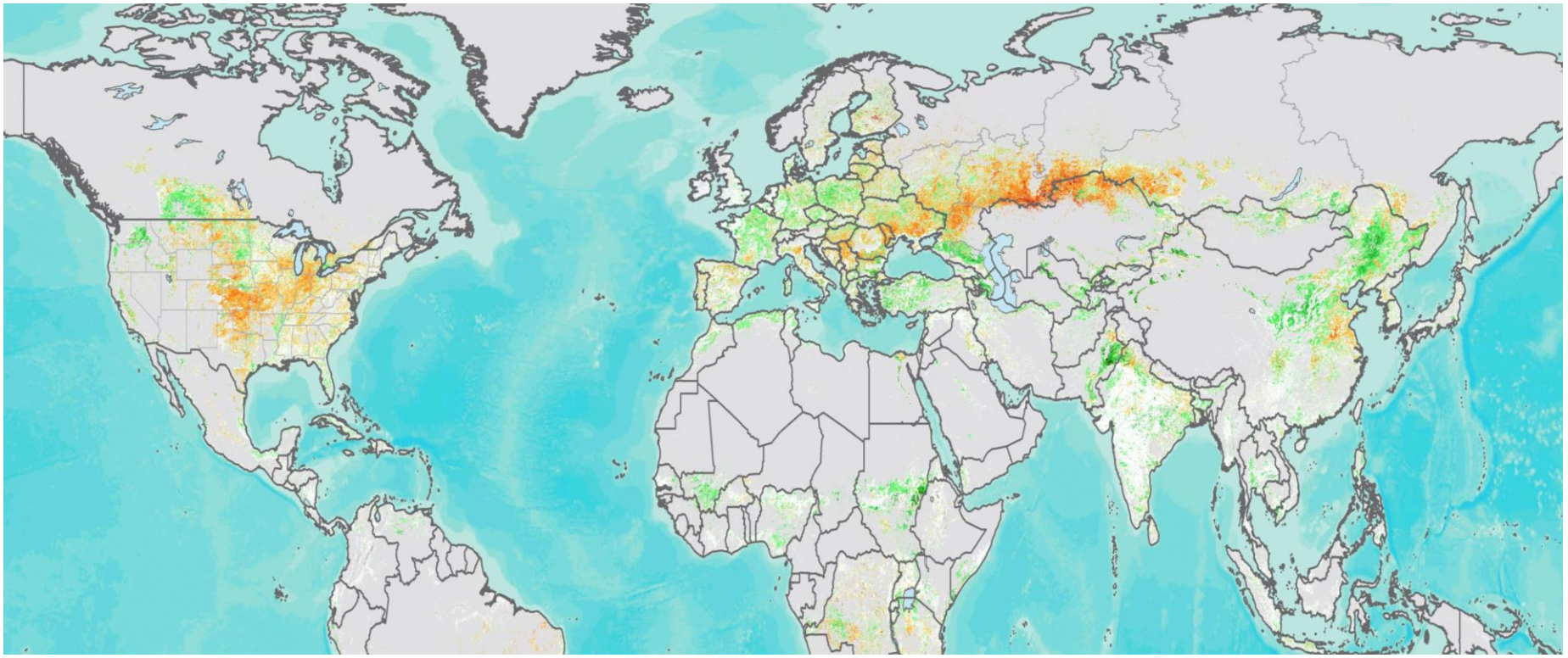
Vermote et al.

MODIS NDVI Anomaly July 30th 2012



Assessment of the impact of the 2012 Northern Hemisphere Drought from the MODIS Climate Modeling Grid daily NDVI data. The anomaly image shows the cropland NDVI departure from the average (2000-2011) on **July 30th 2012**, highlighting hotspots of crops under stress during the 2012 droughts that affected the United States and the Black Sea region. The time-series curves below compare the daily development of croplands in 2012 (red) to average (2000-2011) in 3 important crop growing regions: Illinois, USA; Orenburg Oblast, Russia; Kostanay Oblast, Kazakhstan. The crop development through the season depicted by NDVI shows consistent negative anomalies with regard to a ten year average, with highest discrepancies during the crops peak development period. In 2012 crops in the US, southern Europe and the Black Sea region suffered from prolonged high temperatures and lack of moisture, which resulted in significantly reduced production. This information was available one month prior to harvest and several months before the release of official statistics.

Prototype VIIRS NDVI Anomaly, July 30th 2012



A VIIRS NDVI anomaly (prototype) image computed for the same date (July, 30th 2012) as the MODIS NDVI anomaly shown in the previous slide, generated from data produced at the GSFC Land PEATE.

Vermote et al. 2012

GEOGLAM ‘ National Capacity Building’

Generic Enhancement Process

Step 1. Regional Status Assessment, Needs and Priorities Workshop

Step 2. National Engagement / Commitments from interested parties

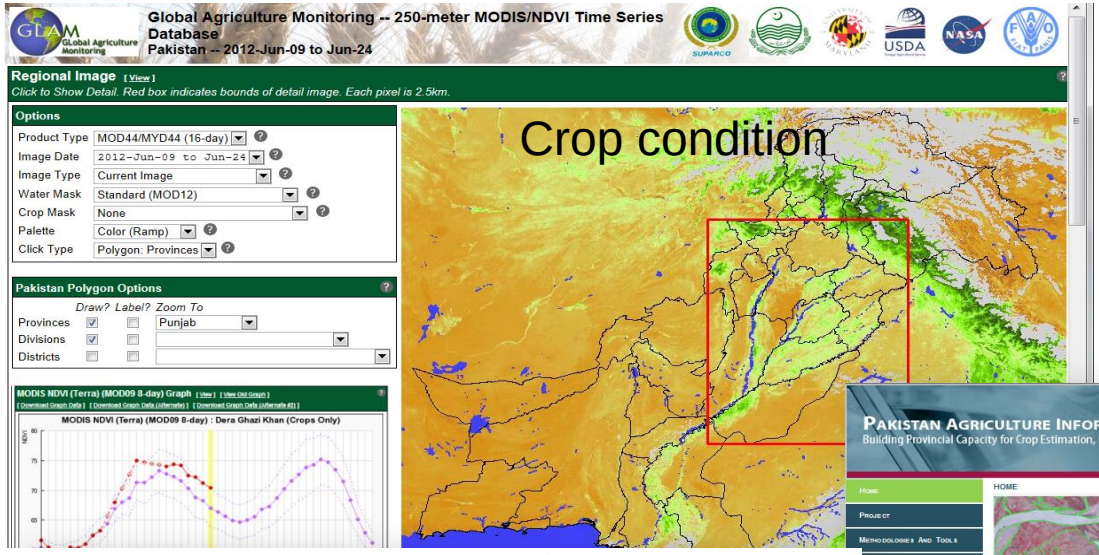
Step 3a. National Implementation

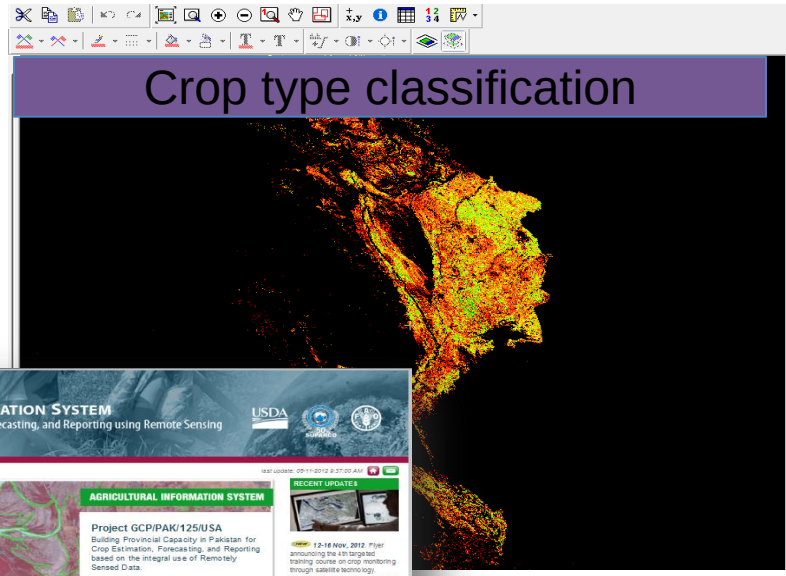
Step 3b. Regional Training / Information Exchange and continued regional networking

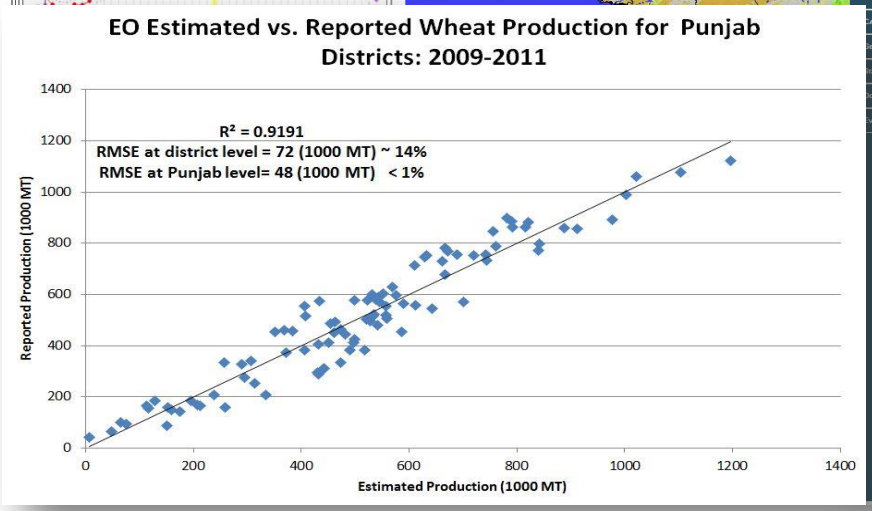
Linkages & feedback between the global/regional monitoring systems and activities

GROUP ON EARTH OBSERVATIONS

Pakistan Agricultural Information System (Collaboration between USDA, FAO, SUPARCO, CRS, & UMD)







National Capacity Building Pakistan (USDA/FAO/UMD)

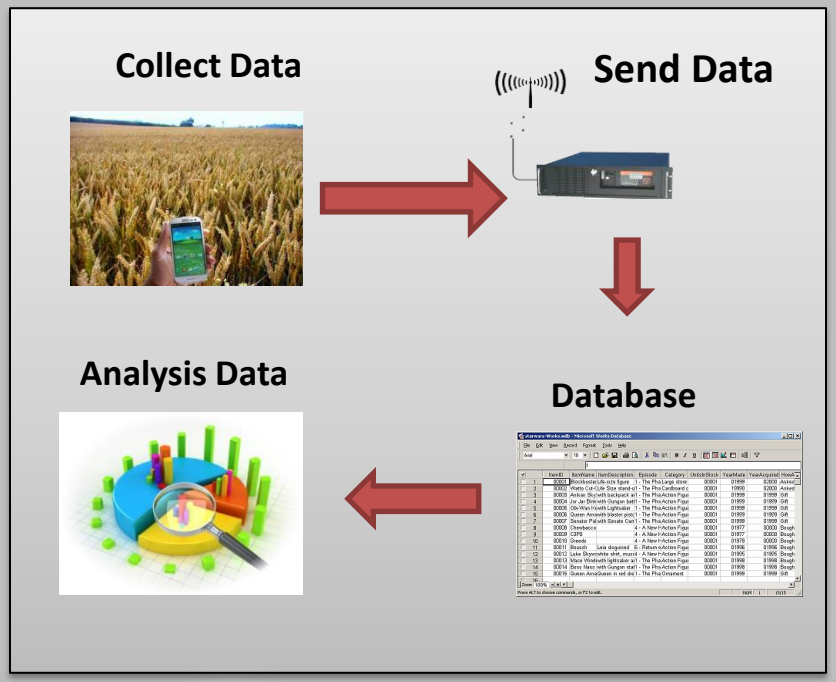
1038 full-time crop reporters continuously inspect agricultural fields in 1240 villages in Punjab Province.

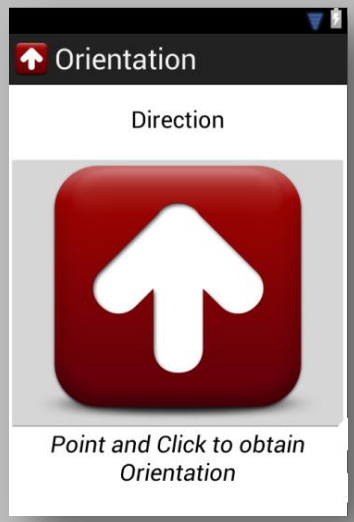
Modernizing Crop Reporting Systems

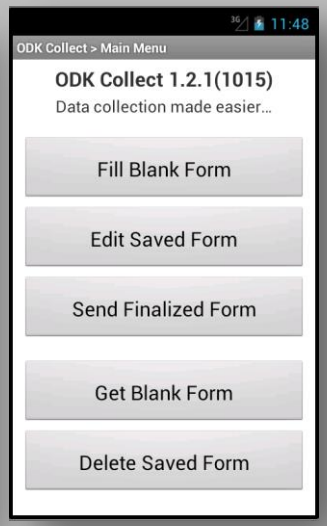
- Collect data digitally in 1240 villages of Punjab.
- Use GPS-enabled cell phones, location-aware software.
- Automatic upload data to central spatial database.

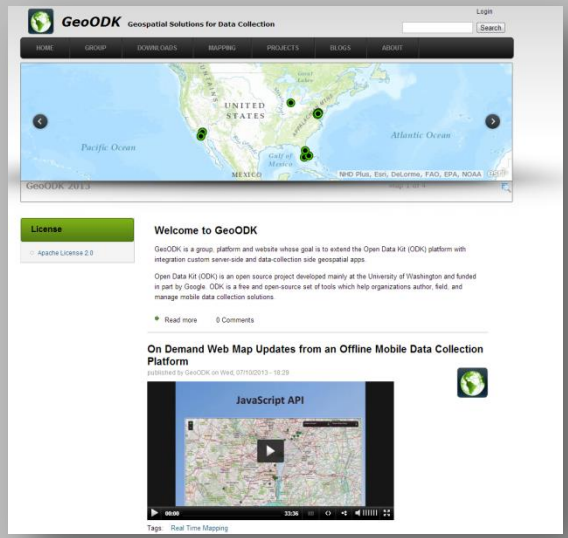
GEO ODK : field data collection tool

- Environment for geographical software, tools, blogs, and ODK Collect plugins.
- Primarily used for agriculture monitoring and remote sensing validation and field work
- Used in Brazil, Uganda, China, US and Pakistan









Jon Nordling, Mike Humber UMD

Geoodk.com

Examples GEOGLAM Related Research Initiatives using satellite remote sensing : Kazakhstan

- Cropland Acreage Estimation
- Cereals production forecast
- Estimation of cropland weed infestation
- Estimation of parameters of crop-fallow rotation system
- Estimation of spring soil humidity of arable land

Terekhov et al. Moscow Geoglam Meeting 2013

GEOGLAM Research Initiatives

Organizing GEOGLAM Sessions at Scientific Conferences: focusing on Operational R and D – engaging the broader research community e.g.

- American Geophysical Union Conference, Dec 11, 2013, San Francisco, USA (Justice/Doorn)

- Global Vegetation Monitoring and Modeling Meeting, Feb 3-7th 2014, Avignon, France (Defourny/Justice)
  - 27 requests for 8 oral presentation slots !

Summary for Central Asia

- Central Asian countries are highly agrarian (45% of the population employed in agriculture - on average for 25% of GDP) – cotton and wheat primary crops
- Kazakhstan has systems in place for agricultural monitoring using EO and is participating in GEOGLAM?
- International community can help provide data and tools for ag. monitoring - US, EU, Russia, China
- New GEOGLAM initiative forming on livestock production (led by CSIRO Australia) relevant to C. Asia
- Is there an interest from other CA countries to participate - opportunities for regional capacity building through CARIN

GROUP ON
EARTH OBSERVATIONS

THANK YOU !

GEOGLAM
Global Agricultural Monitoring