JECAM
Joint Experiment for Crop Assessment and Monitoring

GEO GROUP ON EARTH OBSERVATIONS

JECAM Site Ukraine

JECAM/GEOGLAM Science Meeting

Ottawa, Canada

21 – 23 July 2014

Team Leader: Kussul Nataliia

Members: Shelestov Andrii, Skakun Sergii

Site Description

- **Kyiv oblast (**SRI, area 28,000 km^2**) & intensive observation sub-site of Pshenychne** (National University of Life and Environmental Sciences of Ukraine, area 25x15 km^2)
- **Major crops:** maize, winter mainly wheat and rapes soybeans, sunflower, sugar beet, and spring (mainly barley) crops
- **Crop calendar:** winter: September-July, spring/summer: April-October
- **Field size:** 30-250 ha
- **Climate & weather:** humid continental
- **Topography**: mostly flat, slope: 0% to 2%
- **Soils**: different kinds of chenozems
- **Soil drainage**: from poor to well-drained. Irrigation is limited

Kyiv oblast & Vasylkiv district

Map of intensive observation sub-site

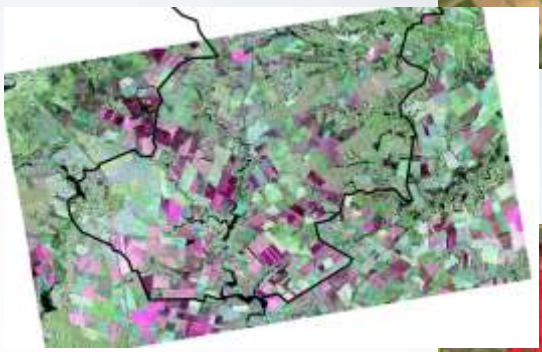
Project Objectives

- **Crop identification and Crop Area Estimation**
  - Large scale crop mapping
  - Integration of multi-temporal optical and SAR satellite images
- **Crop Condition/Stress**
  - Biopar parameters retrieval and global EO products validation
- **Yield Prediction and Forecasting**
  - Operational (2-3 months before harvest) winter wheat yield forecasting for NUTS2 (oblast) level in Ukraine

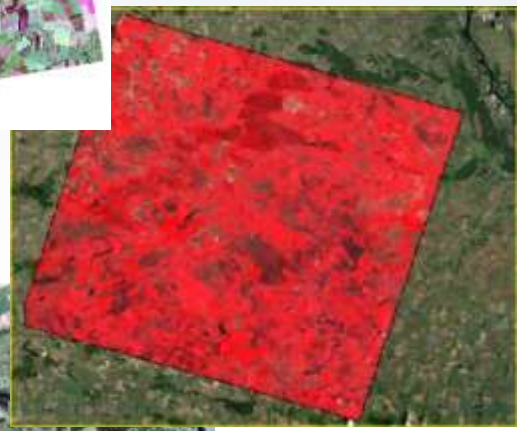



Earth Observation (EO) Data Received/Used (2013)

- **Landsat-8**
  - USGS
  - Optical
  - # scenes: **6**

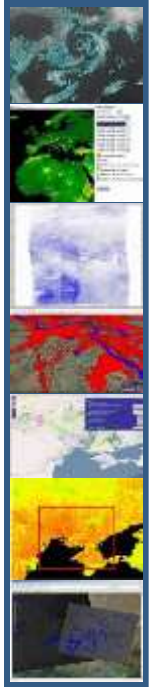


- **Radarsat-2**
  - CSA (SOAR-JECAM)
  - SAR
  - # scenes: **14**



- **SPOT-4**
  - ESA (Take-5/Sentinel4Agri)
  - Optical
  - # scenes: **17** (8 cloud & snow free)

- **RapidEye**
  - ESA (Take-5/Sentinel4Agri)
  - Optical
  - # scenes: **29** (7 cloud & snow free)



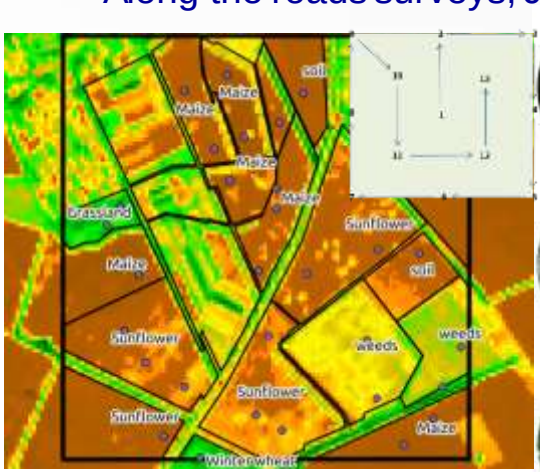
In situ Data

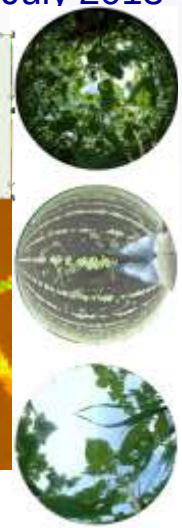
- **Along the roads**
  - Crop type
  - 2013: July, 390 fields
  - 2014: March, 420 fields
    - to target **winter crops** and **early stage crop mapping**

- **Biophysical parameters**
  - **LAI**, **FAPAR**, **FCover** following **VALERI** protocol
  - Using **Digital Hemispheric Photographs** (**DHP**) and **CAN-EYE** software
  - 2013
    - 3 campaigns: 14-17 May; 12-15 June; 14-17 July
  - 2014
    - 1 campaign: 12 June




Along the roads surveys, July 2013





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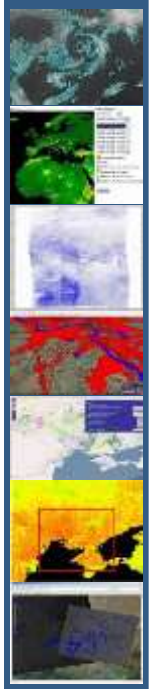
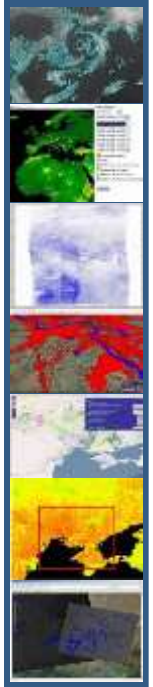
Collaboration



- EC-FP7 project "**Stimulating Innovation for Global Monitoring of Agriculture and its Impact on the Environment in support of GEOGLAM**" (**SIGMA**)
  - Tasks: crop/land cover mapping, crop yield forecasting
- EC-FP7 project **"Implementation of Multi-scale Agricultural Indicators Exploiting Sentinels"** (**ImagineS**)
  - Tasks: providing ground observations for EO products validation
- **ESA Sentinel2-Agriculture**
  - Participation as a "Champion User" (2013) and "Product Developer" (2014)
- SOAR-JECAM project no. 5102 "**SAR parameters optimization for crop classification**"
  - Tasks: exploring feasibility of SAR data for crop mapping in Ukraine

Results (1)



- **Crop mapping:** based on multi-temporal **6 Landsat-8 scenes** and **12 Radarsat-2 scenes** (6 – FQ20W, 40°; 6 - FQ8W, 28°)
  - **Ensemble of neural networks** improved **crop classification** overall accuracy comparing to individual network from +**0.9%** to +**4.1%**
  - **Adding** multi-temporal **SAR** images to multi-temporal **optical** images **improved** both **OA** and **individual class accuracies**, esp. for:
    - **Sunflower**: gains up to **+25.3%**
    - **Soybeans**: gains up to **+15.5%**
    - **Maize**: gains up to **+6.2%**
  - Better SAR using **shallow** angle (**FQ20W, 40°**) **OA=77%** than **steeper** angle (**FQ8W, 28°**) **OA=73.4%**

Results (2)

Water
Winter wheat
Winter rapeseed
Spring crops (wheat, barley)
Maize
Sugar beet
Sunflower
Soybeans
Other cereals
Forest
Grassland

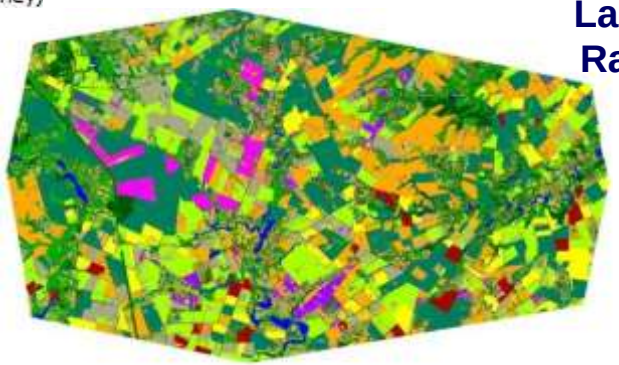
Classification maps

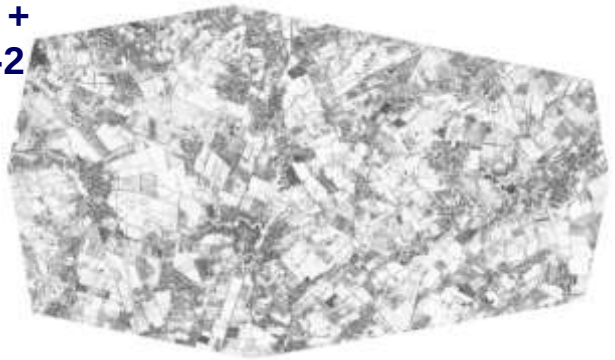
Probability

1

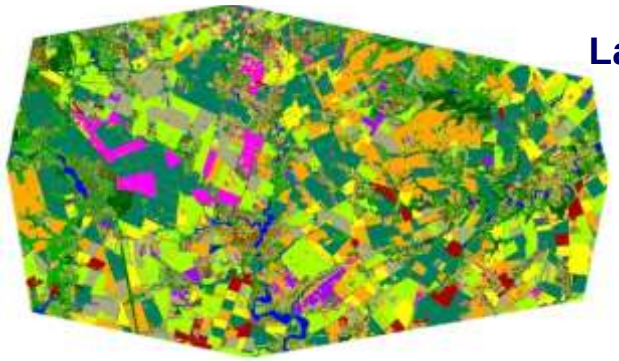
0

Landsat-8 + Radarsat-2

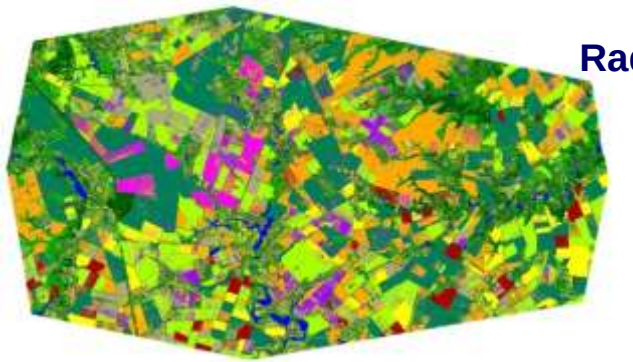




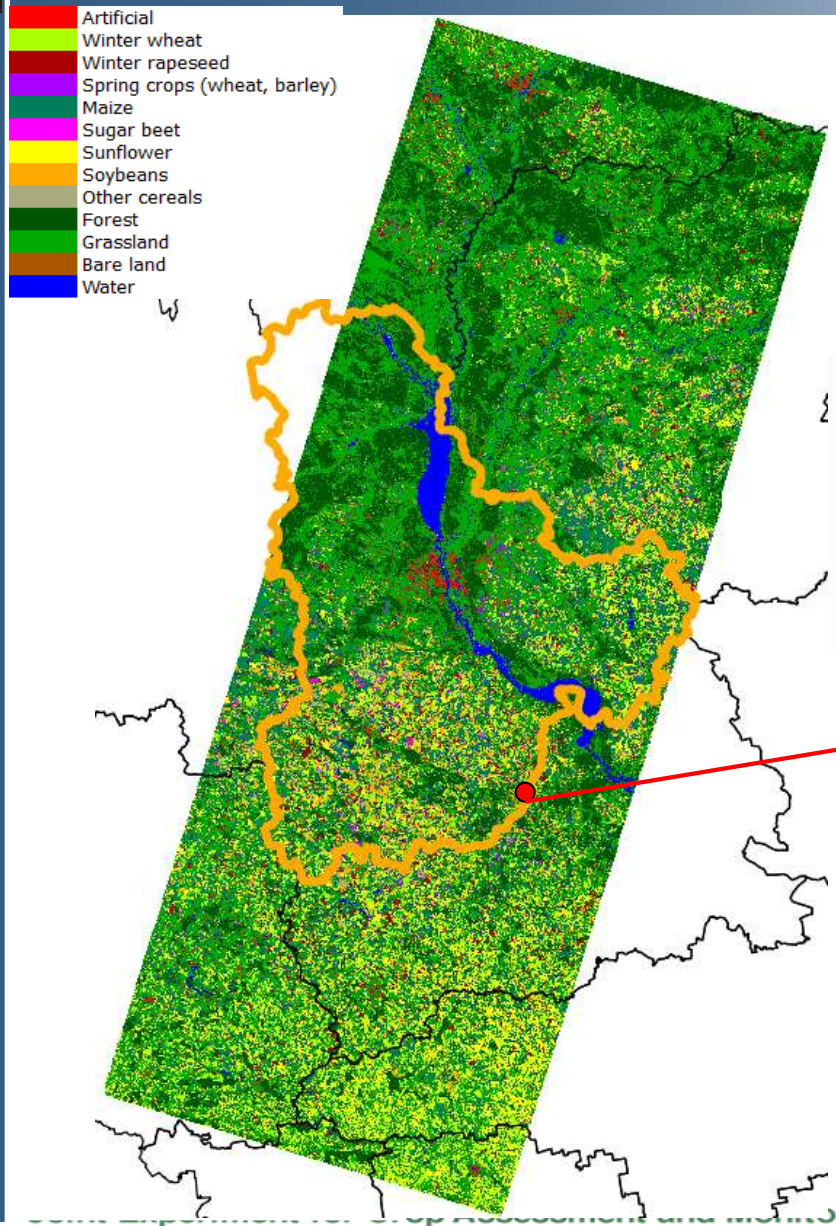
Landsat-8



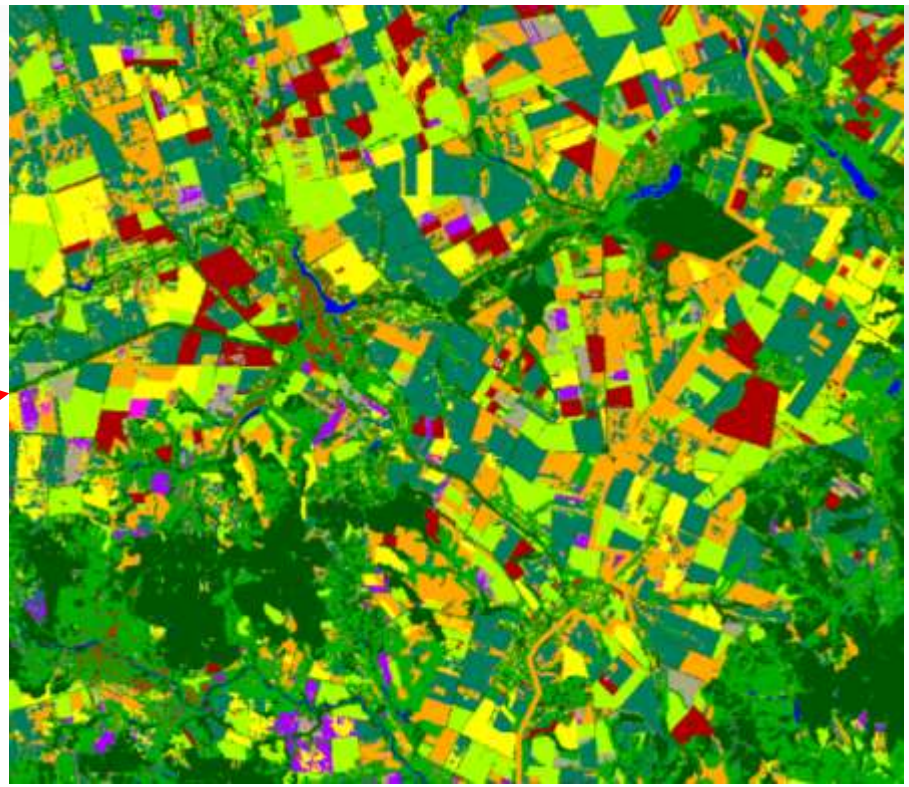
Radarsat-2



Results (3)

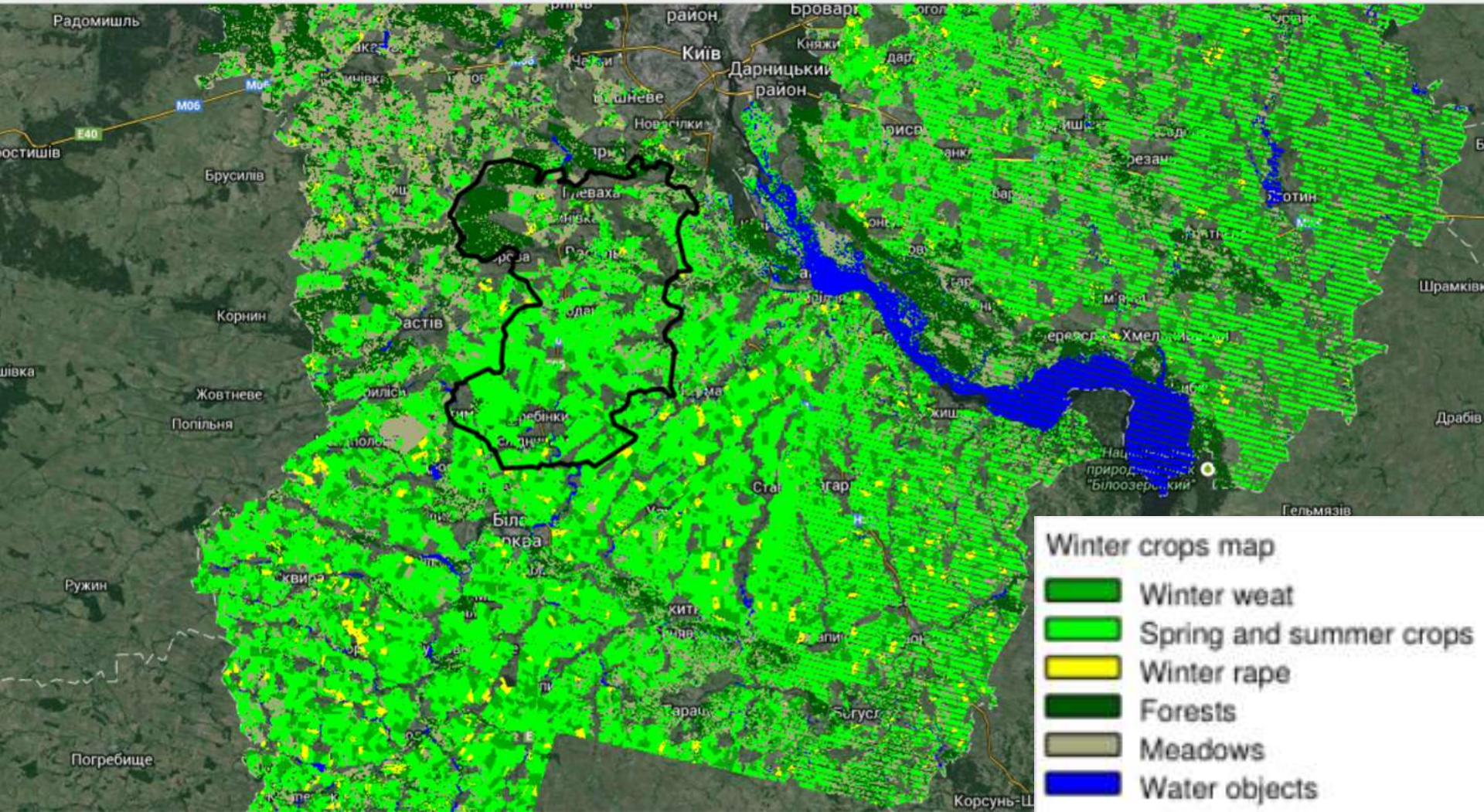


Large scale crop mapping for Kyiv oblast (area **28,000 km^2**) using multi-temporal **Landsat-8** in **2013**. **13 classes**, **OA=85.07%** (**ensemble of 6 neural nets**)



Results (4)

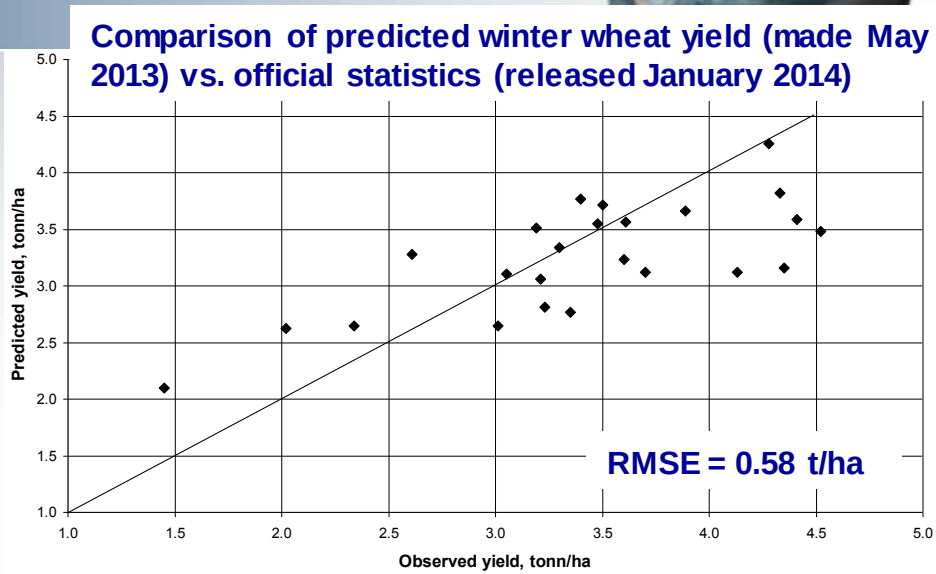
Early stage winter crops mapping for Kyiv oblast (area **28,000 km²**) using **Landsat-7** (10 March) & **Landsat-8** (09 March) in **2014**

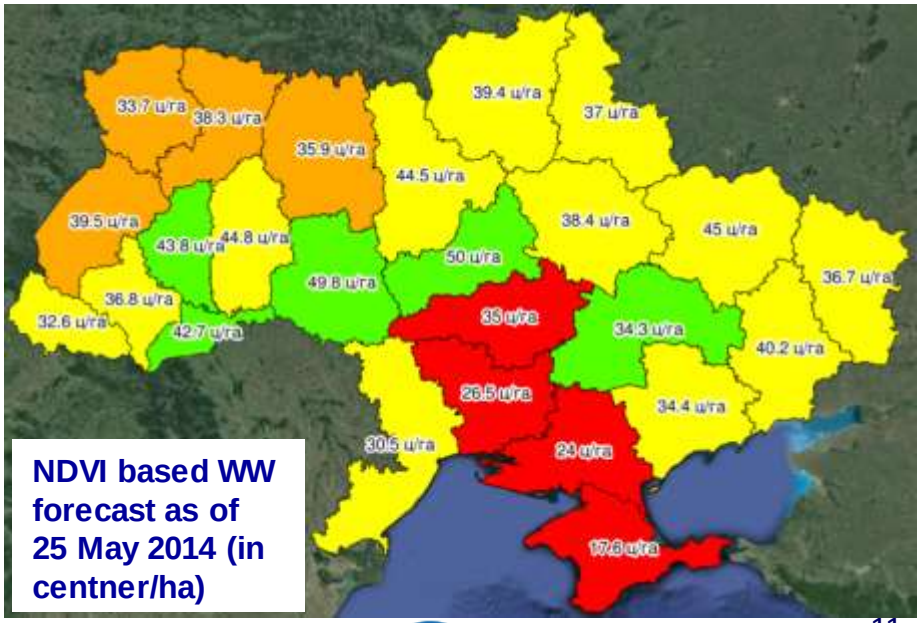


Results (5)

- **Winter wheat yield forecasting**
  - For **NUTS2** (oblast) level in Ukraine
  - Operationally (**2-3 months before harvest**) used **since 2011**
  - Recent results
    - biophysical variables (**VHI** and **FAPAR**) are approx. **+20%** accurate than **NDVI approach**
  - **UN-SPIDER Best Practice**

http://www.un-spider.org/advisory-support/recommended-practices/recommended-practice-crop-yield-predicition





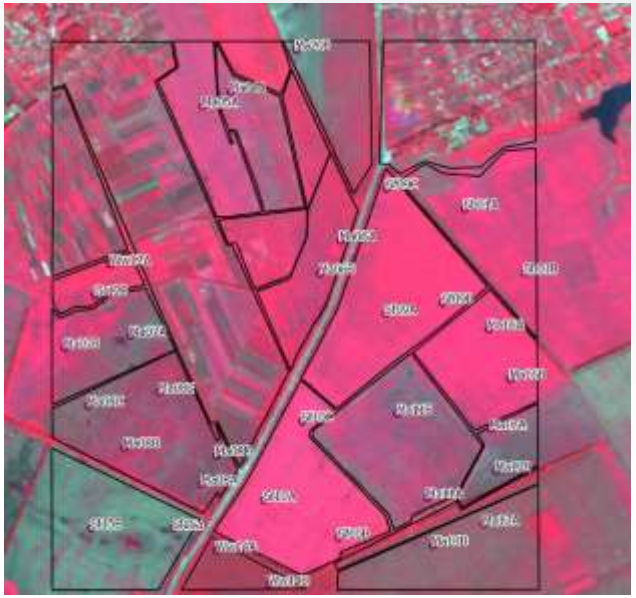
NDVI based WW forecast as of 25 May 2014 (in centner/ha)

Results (6)

- Biophysical parameters retrieval from HR satellite data of various spatial resolution (5 to 30 m)

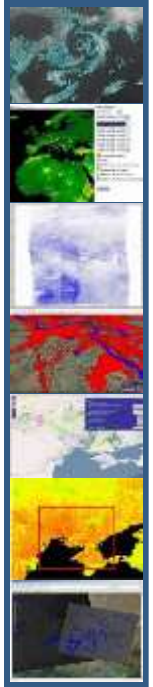
		First campaign		Second campaign		Third campaign	
		Mean	STD	Mean	STD	Mean	STD
Landsat-8	LAIeff	0.398	0.387	1.227	0.424	2.236	0.671
SPOT-4	LAIeff	0.486	0.340	1.200	0.394		
SPOT-5	LAIeff	0.482	0.595	1.418	0.508	2.344	0.550
RapidEye	LAIeff	0.506	0.413	1.223	0.443		
Landsat-8	LAI	0.513	0.565	1.724	0.569	3.296	0.847
SPOT-4	LAI	0.592	0.432	1.695	0.534		
SPOT-5	LAI	0.670	0.876	2.142	0.856	3.437	0.701
RapidEye	LAI	0.879	0.895	1.729	0.608		
Landsat-8	FAPAR	0.237	0.154	0.562	0.132	0.782	0.110
SPOT-4	FAPAR	0.347	0.239	0.557	0.127		
SPOT-5	FAPAR	0.288	0.239	0.592	0.144	0.800	0.079
RapidEye	FAPAR	0.321	0.228	0.562	0.145		

Mean and standard deviation (STD) values of biophysical parameters for the 3x3 km² Pshenichne site



Distribution of the sampling units in the study area (3x3 km²):

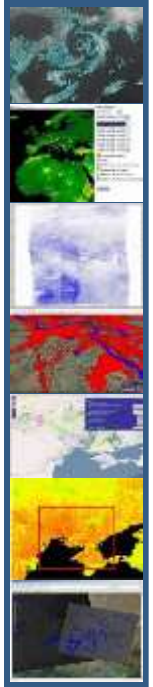
Research Plans for Next Growing Season



- Approach
  - In general, we will follow the existing course
  - Much attention will be paid to exploring **ensemble** approach to **crop mapping** and **yield forecasting**
  - Comparison of **pixel based** to **field based crop classification**
  - **Early stage (sequential) crop mapping** as data become available

- EO data:
  - We expect ordering the same type/quantity of EO data
  - Main sources: **Landsat-8** and **Sentinel-1/SAR**

Publications

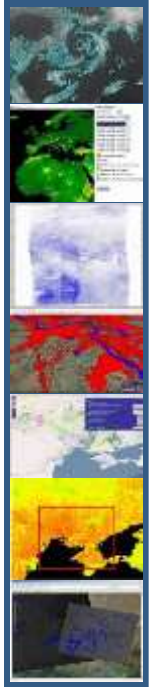


- Gallego, F.J. et al. (2014) "**Efficiency assessment of using satellite data for crop area estimation in Ukraine**", *International Journal of Applied Earth Observation and Geoinformation*, Vol. 29, pp. 22–30. (http://dx.doi.org/10.1016/j.jag.2013.12.013)

- Kogan, F. et al. (2013) "**Winter wheat yield forecasting in Ukraine based on Earth observation, meteorological data and biophysical models**", *International Journal of Applied Earth Observation and Geoinformation*, vol. 23, pp. 192-203. (http://dx.doi.org/10.1016/j.jag.2013.01.002)

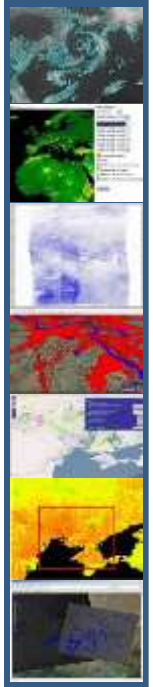
- Shelestov, A.Yu. et al. (2013) "**Geospatial information system for agricultural monitoring**", *Cybernetics and Systems Analysis*, Volume 49, Issue 1, pp 124-132. (http://dx.doi.org/10.1007/s10559-013-9492-5)

Acknowledgements



- The work was supported by the EC under FP7 Grant "**Stimulating Innovation for Global Monitoring of Agriculture and its Impact on the Environment in support of GEOGLAM**" (**SIGMA**) [number 603719].

- RADARSAT-2 data were provided to the Space Research Institute NASU-SSAU by the Canadian Space Agency (CSA) within the SOAR-JECAM project no. 5102 "**SAR parameters optimization for crop classification**".



Thank you!

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