The NASA LCLUC Program –SCERIN Interactions: An Update

Garik Gutman,

LCLUC Program Manager

NASA Headquarters

Washington, DC

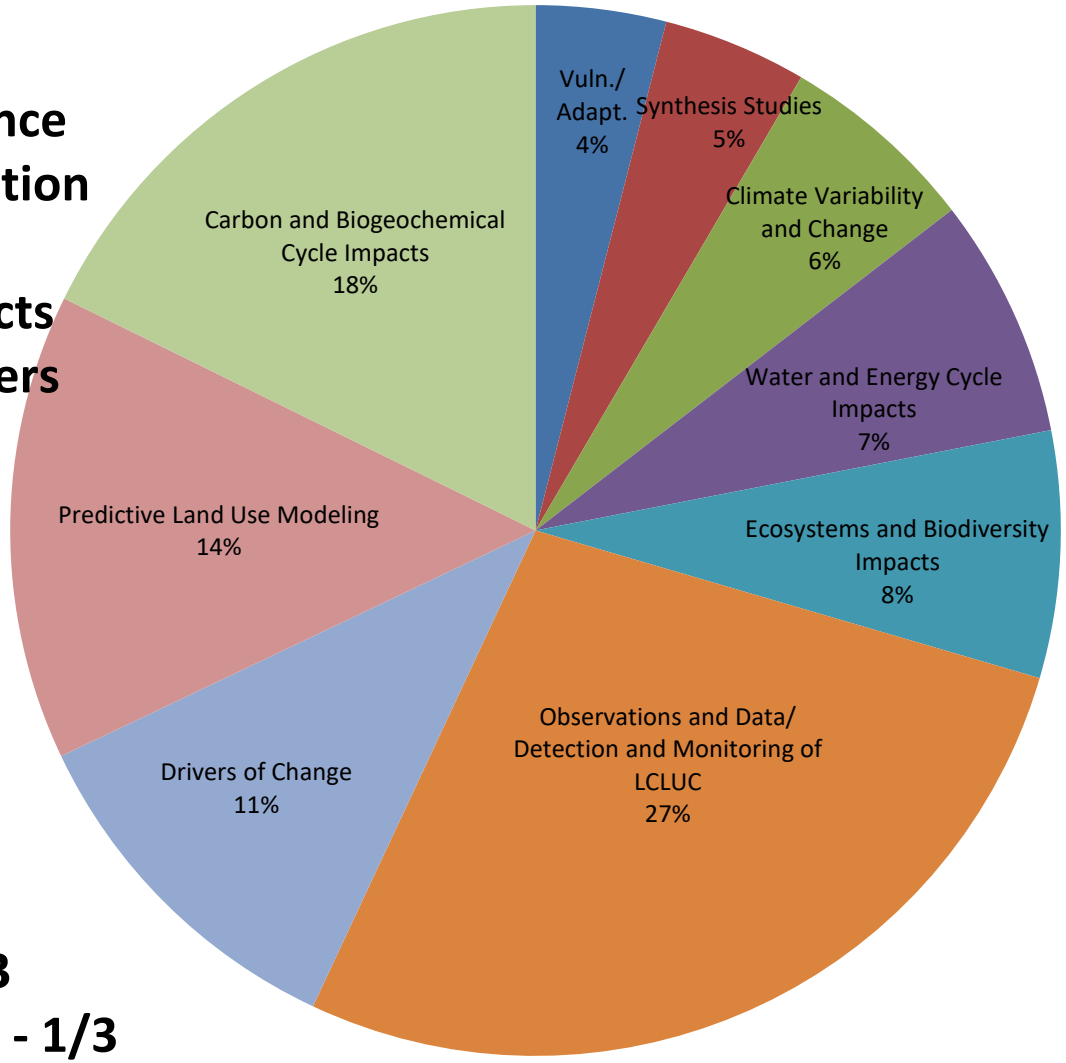
Land-Cover/Land-Use Change Program

LCLUC is an interdisciplinary scientific theme within NASA's Earth Science program. The ultimate vision of this program is ***to develop the capability for periodic global inventories of land use and land cover from space*, *to develop the scientific understanding and models necessary to simulate the processes taking place, and to evaluate the consequences of observed and predicted changes***

- Drivers of LCLUC
  - Natural Drivers
  - Anthropogenic Drivers
    - Socio-Economic Drivers
    - Landscape Modification
- Impacts of LCLUC
  - Carbon Cycle
  - Surface Hydrology
  - Atmosphere

LCLUC Program Content

>300 projects since Program's inception
Each year:
*** ~40 3-yr projects**
*** ~300 researchers**

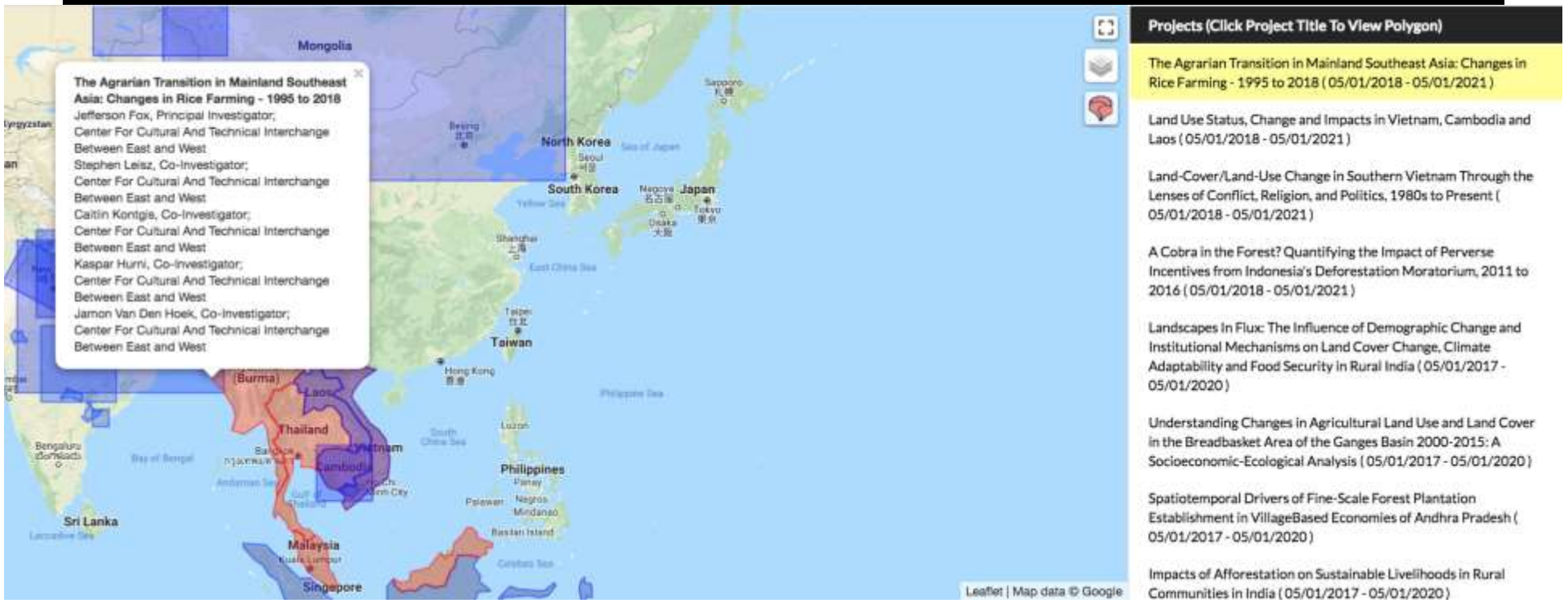


Impacts - 1/3
Monitoring - 1/3
Synthesis, other - 1/3

http://lcluc.hq.nasa.gov

The LCLUC Mapper: A Powerful Tool for Projects' Inventory

Geographic Areas of Research



NASA Capacity Building Programs: A Big Picture

Applied Remote SEnsing Training, ARSET: Online and hands on basic/advanced training to build skills (https://arset.gsfc.nasa.gov/)

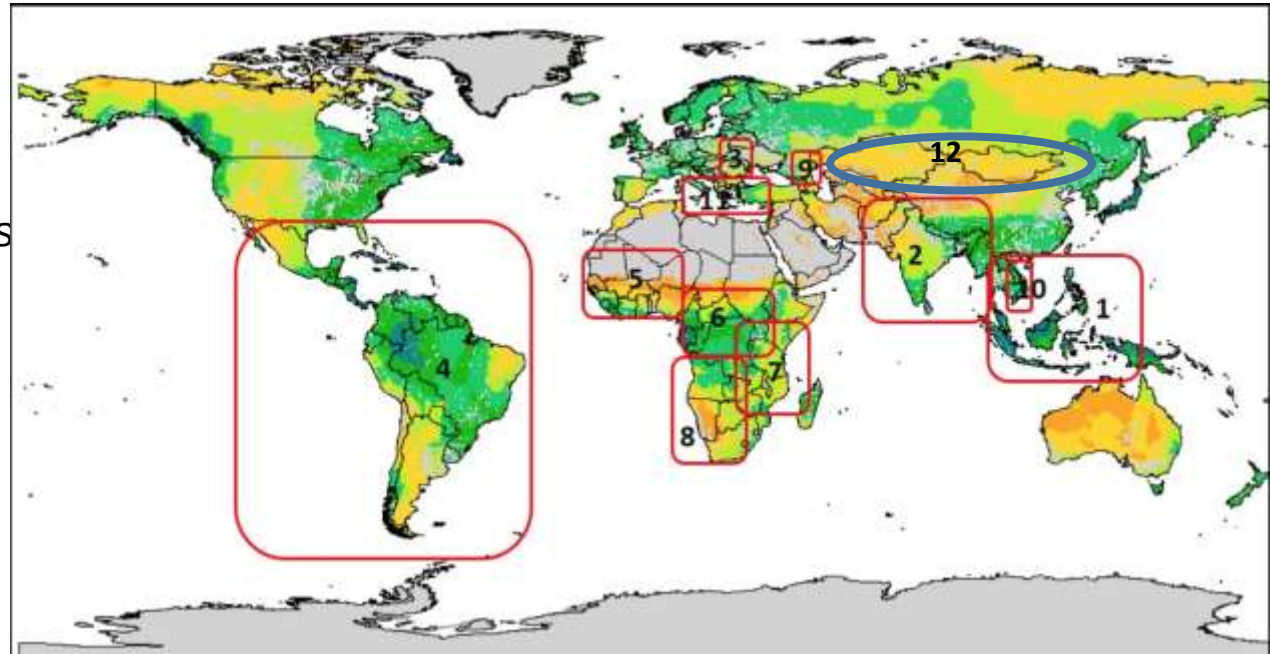
DEVELOP: Dual workforce/local government capacity building using collaborative feasibility projects, internships (https://develop.larc.nasa.gov/)

SERVIR: Building international capacity with hubs in East and West Africa, South and SE Asia (Hindu Kush-Himalaya and Mekong), and Amazonia (https://www.servirglobal.net/)

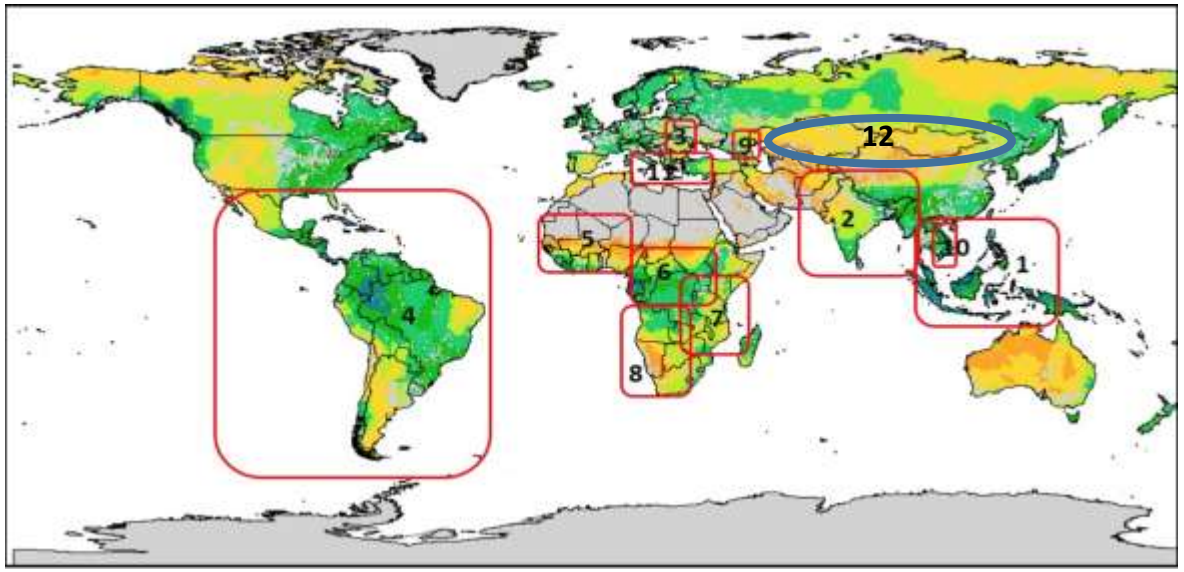
GOFC-GOLD: *Global Observation of Forest and Land Cover Dynamics*

Activities of two GOFC-GOLD regional networks (SEARRIN and SARIN) are coordinated with SERVIR-Hymalaya and -Mekong activities to promote the use of publicly available satellite imagery and related geospatial decision-support tools/products for key stakeholders and decision makers

Networks facilitate regional science and global products validation in the region



GOFC-GOLD Regional Networks



- **South/Central America**
  - **Red LatinoAmericana de Teledetección e Incendios Forestales** (RedLaTIF) - 4
- **Africa**
  - **South Africa Network** (SAFNet) - 8
  - **Southeast Africa Network** (Miombo) - 7
  - **West Africa Regional Network** (WARN) - 5
  - **Central Africa** (OSFAC) - 6
- **Asia**
  - **South East Asia** (SEARRIN) – 1
    - Mekong RIN (MekRIN) – 10, SEARRIN subset
  - South Asia Regional Information Network (SARIN) - 2
  - **Central Asia Regional Information Network** (CARIN) – 12 under resuscitation
    - CARIN meeting (jointly with CaucRIN) planned for Sep 2019 in Kazakhstan
- **Europe**
  - **South Central East European Regional Information Network** (SCERIN) - 3
  - **Caucasus Regional Information Network** (CaucRin)– - 9
    - not much network activity except for funded Projects' activities
  - **Mediterranean Region Information Network** (MedRIN) - 11
    - Joint SCERIN-MedRIN meeting planned for June 2020 in Greece hosted by MedRIN

GOFC-GOLD: Update

- This and next year GOFC-GOLD revamping
  - New Chair
  - Reestablished ExecCom activities
- Strategic points of GOFC-GOLD (including regional networks) to be revisited
- NETWORK SUMMIT held in Tbilisi, Sep, 2017
- The Second NETWORK SUMMIT in Sep 2020?

The New, Improved GOFC-GOLD Website: gofcgold.org

GOFC-GOLD
Global Observation of Forest and Land Cover Dynamics

HOME RESOURCES DOCUMENTS MEETINGS REGIONAL NETWORKS CONTACT

Welcome to GOFC-GOLD

Global Observation for Forest and Land Cover Dynamics (GOFC–GOLD) is a coordinated international program working to provide ongoing space-based and in situ observations of the land surface to support sustainable management of terrestrial resources at different scales. The GOFC–GOLD program acts as an international forum to exchange information, coordinate satellite observations, and provide a framework for and advocacy to establish long-term monitoring systems. It was established as a part of a Committee on Earth Observation Satellites (CEOS) pilot project in 1997, with a focus on global observations of forest cover. Since then, the program has expanded to include two Implementation Teams: Land Cover Characteristics and Change, and Fire Mapping and Monitoring. In addition, two working groups—Reducing Emissions from Deforestation and Forest Degradation (REDD), and Biomass Monitoring—were also formed. GOFC– GOLD activities are guided by an executive commit-tee, primarily with support from NASA and the European Space Agency (ESA). Recently, the GOFC–GOLD program celebrated its twentieth anniversary by convening a Regional Network Summit in Tbilisi, the capital of the country Georgia.

Upcoming Meetings

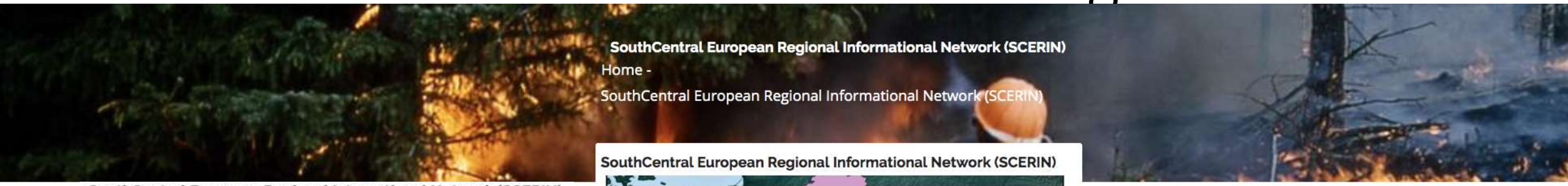
Title	Date
SCERIN meeting and training, Novi Sad, Serbia, 2019	06/24/2019
World Soils 2019 User Consultation meeting	07/02/2019
SARI-SEARRIN meeting and training, Malaysia, 2019	07/22/2019

Featured Network

SouthCentral European Regional Informational Network (SCERIN)

South-Central European Regional International Network (SCERIN) main focus is in Central & South Eastern

The SCERIN Network Page



SouthCentral European Regional International Network (SCERIN)

SCERIN is one of the regional networks of the GOFC-GOLD panel. GOFC-GOLD (Global Observation of Forest and Land Cover Dynamics) is a panel of GTOS. GTOS (Global Terrestrial Observing System) is a programme for observations, modelling, and analysis of terrestrial ecosystems to support sustainable development. SCERIN (originally SEERIN) is an informal network of scientists and other professionals based in the region or with scientific interests in the region of South Eastern and Central Europe.

For more information visit http://csebr.cz/scerin/

Meetings

Title	Start Date	End date
SCERIN meeting and training, Novi Sad, Serbia, 2019	06/24/2019	06/27/2019

US Contact Information

1. **Dr. Petya Campbell**
   NASA/Goddard Space Flight Center
   Code 618
   Greenbelt, MD 20771 USA
   Phone: (301) 614-6784
   Fax: (301) 614-6695
   Email: petya.campbell@nasa.gov

Regional Contact Information

Contact Information

1. **Prof. Jana Albrechtov**
   Department of Experimental Plant Biology
   Faculty of Science www.natur.cuni.cz ,
   Charles University in Prague,
   Czech Republic
   Tel.: +420 221 95 1959, (1687), mobile: +420-734272462,

SouthCentral European Regional Informational Network (SCERIN)

SCERIN network countries - Green - current SCERIN members; Pink – yet to include in SCERIN

South-Central European Regional International Network (SCERIN) main focus is in Central & South Eastern Europe, the Danube Watershed & Western Black Sea coast. SCERIN provides a platform for collaboration among remote sensing experts in South Central Europe through collaborative activities; Facilitate progress and consistent implementation of remote sensing and LCLUC methodology, in the region; Foster regional collaboration for monitoring the dynamics, stability, and vulnerability of the major ecosystems and Promote effective sustainable management and preservation, on the local, regional and pan-European level. SCERIN network is active since 2013. The seventh annual SCERIN meeting and

Mediterranean Regional Information Network (MedRIN)

Welcoming MedRIN to the GOFC-GOLD family of networks

On behalf of the NASA Land-Cover/Land-Use Change Program – the primary sponsor of the international GOFC-GOLD Program – I'd like to welcome the new Mediterranean Regional Information Network MedRIN to the GOFC-GOLD family of networks. Developed in 1997 under the Committee on Earth Observation Satellites (CEOS), the Global Observations of Forest Cover initiative was originally intended to test the concept of the Integrated Global Observing System (IGOS) to improve the use of Earth Observation data to address major problems of global concern and to improve coordination of national programs. Additionally, it was directed at improving cooperation between providers and user of Earth Observation data for regional and global applications. Later on, GOFC became one of the Panels of the Global Terrestrial Observing System (GTOS), and was further named GOFC-GOLD to include other landcover dynamics in addition to forest cover change. Traditionally, its sponsors have been such international entities as Food and Agriculture Organization (FAO), World Meteorological Organization (WMO), United Nations Environmental Program (UNEP), European Commission Joint

Meetings

Title	Start
Mediterranean Regional Information Network (MedRIN) Meeting and Workshop	03/2
MedRIN Kick-off Meeting Chania, Greece, 13-14 July 2018	07/1

Related Documents

Document Title
MedRin Agenda Kick-Off Meeting
MedRIN Meeting Agenda, March 20, 2019

US Contact Information

1. Vincent G. Ambrosia
   Sr. Research Scientist / Adjunct Faculty
   School of Natural Sciences
   California State University - Monterey Bay (CS
   Mail Stop 245-4; Bld. 245; Rm. 128;
   NASA-Ames Research Center
   Moffett Field, CA. 94035-0001
   Email: vincent.g.ambrosia@nasa.gov
   Office: (650) 604-6565
   Fax: (650) 604-4680

View Members of MedRin

Follow us on

Cyprus representation

- **Diofantos Hadjimitsis** (Professor-Vice Rector of Academic Affairs at Cyprus University of Technology);
- **Andreas Christofe** (Research Fellow – Department of Civil Engineering and Geomatics at Cyprus University of Technology);

France representation

- **Brice Mora** (former GOFC – GOLD representative)

Greece representation

- **Ioannis Gitas** (Professor at the Faculty of Forestry & Natural Management, Aristotle University of Thessaloniki);
- **Georgios Zalidis** (Professor at the Faculty of Agriculture, Aristotle University of Thessaloniki, Scientific Director at i-BEC, GEOSS High-Level Working Group Member);
- **Haris Kontoes** (Research Director at National Observatory Athens, National Contact Point for the Exchange of National Data in GEO, National Delegate of the H2020 SPACE Program Committee);
- **Ioannis Manakos** (Associate Researcher at the Centre for Research & Technology Hellas);
- **Stavros Stagakis** (Researcher at the Remote Sensing Lab, Institute of Applied and Computational Mathematics, Foundation for Research & Technology Hellas – FORTH);
- **Chariton Kalaitzidis** (Research & Studies Coordinator at the Geoinformation in Environmental Management MSc, MAICh);

Israel representation

- **Eyal Ben Dor** (Professor at Geography & Human Environment Dpt., School of Environment & Earth Sciences, Tel Aviv University);
- **Arnon Karnieli** (Professor at Ben-Gurion University of the Negev)

Italy representation

- **Deodato Tapete** (Researcher at the Italian Space Agency)

Turkey representation

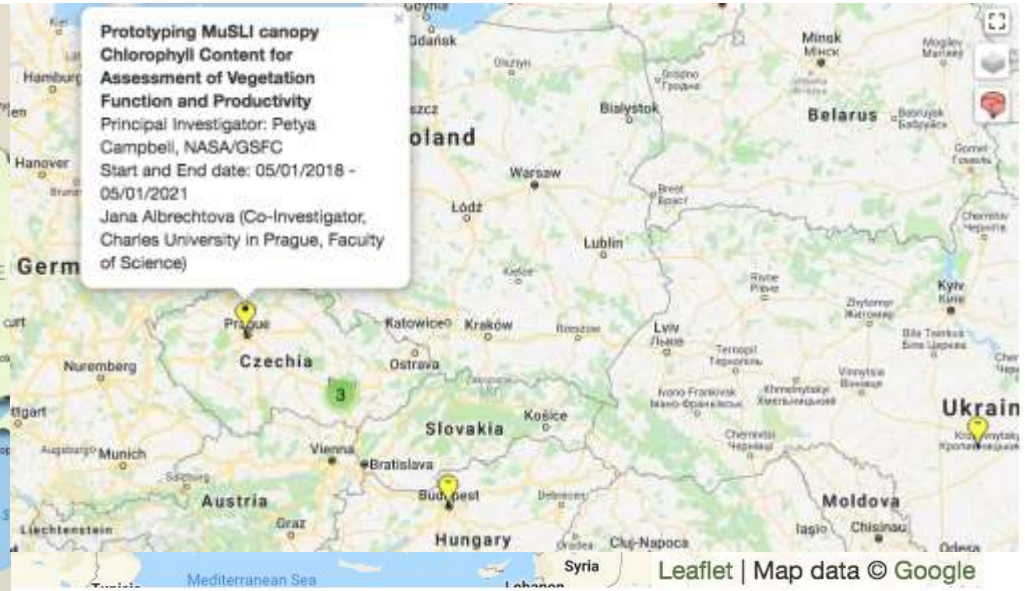
- **Levent Genç** (Professor at Çanakkale University)
- **Irmak Yay Algan** (Istanbul Technical University, Research and Application Center for Satellite Communications and Remote Sensing – CSCRS)

Proposed Network Mapper

- When clicked on the location the project should show the title, name, affiliation
- When clicked on the project it should show the details (the team members, affiliations, collaborations, abstract)
- Software was developed at UMD for LCLUC Mapper and is available for use in GOFC-GOLD network pages
- Need good inventory of projects!

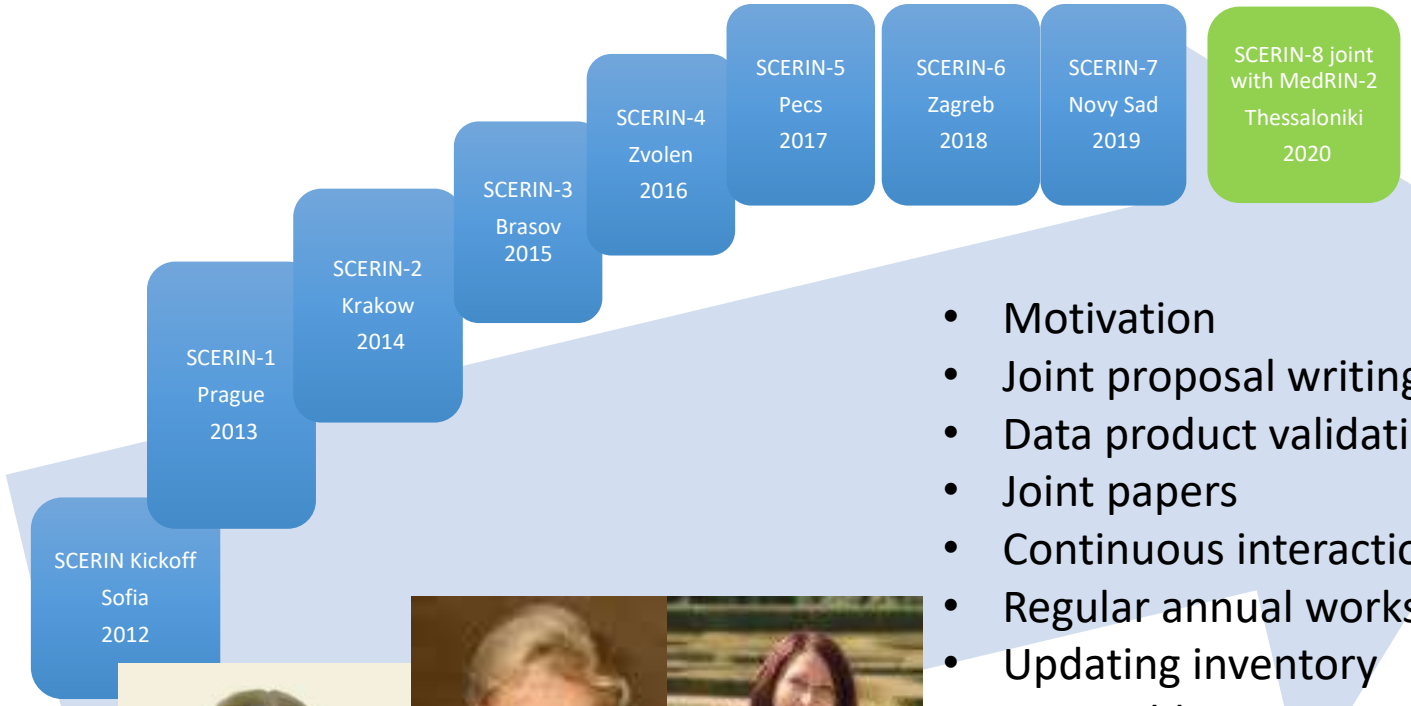
Team members:

Person Name	Person Role On Project	Institution
Volker Radeloff	Principal Investigator	University of Wisconsin-Madison



Year	Title	Team	Type
2016	Ziółkowska, E., K. Ostapowicz, V. C. Radeloff, T. Kuemmerle, A. Sergiel, T. Zwijacz-Kozica, F. Zięba, and N. Selva. 2016. Assessing differences in connectivity assessments based on habitat versus movement models for brown bears in the Carpathians. Landscape Ecology, 31: 1863-1882.	Volker Radeloff Tobias Kuemmerle	Publications
2013	Synthesis of studies on institutional change and LCLUC effects on carbon, biodiversity, and agriculture after the collapse of the Soviet Union	Volker Radeloff	Program Presentation

South/Central Eastern Europe Regional Information Network (SCERIN)



Petya Campbel (NASA)

Jana Albrechtova (Charles U.)

Lucie Kupkova (Charles U.)

- Motivation
- Joint proposal writing
- Data product validation
- Joint papers
- Continuous interactions
- Regular annual workshops
- Updating inventory
  - publications
  - projects
  - funding
- Educational component
  - Trans-Atlantic Training
  - Adjacent to SCERIN workshops

SCERIN: March Over the Empire

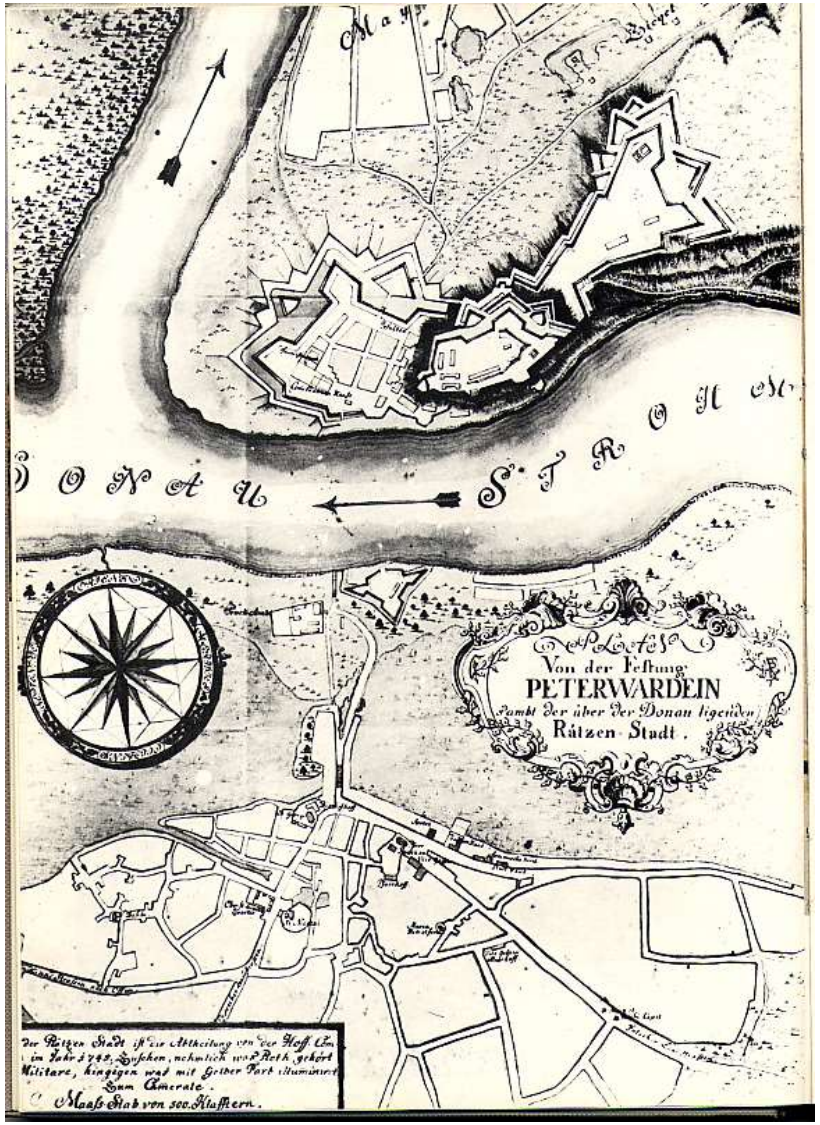
With an Excursion out to Mediterranean - a Friendly Gesture to a Friendly Med Network

Proposed Paradigm for Network Meetings

- Bi-annual joint meetings with another European network (MedRin)
  - Save some funds
  - Expand scientific horizons and networking
  - Leverage common interests and regions (e.g. Balkans)
  - 2020- joint with MedRin in Greece; 2021- separate SCERIN; 2022- joint with MedRIN in SCERIN domain, etc.
  - Caucasus network (CaucRIN) joint meeting with Central Asia (CARIN) in Sep 2019 in Kazakhstan; separately in 2020; joint in 2021 hosted by CaucRIN in Caucasus
  - Two-network Mini-Summits every other year
  - All-hands Network Summit every 3 years
  - Reps from networks are welcome to attend any of the other network meetings for sharing experience

Novi Sad in Time

- End of 17th century: people of Orthodox faith were forbidden from residing in Petrovaradin, ➔ Serbs were largely unable to build homes in the town
- *Petrovaradinski Šanac* – another name for Racki Grad
- 1748: became a "free royal city"
- Újvidék (Hungarian)
- 18th-19th centuries: was the largest city populated with ethnic Serbs in the World
- 1848-1849: People's Spring - revolutions over Europe; Novi Sad was part of Serbian Vojvodina, a Serbian autonomous region within Habsburg Empire
- 1849-1866: part of a separate Austrian crownland known as the Voivodeship of Serbia and Temes Banat.
- 1867: within the Hungarian part of Austria-Hungary.
- 1918: unification of Vojvodina region with the Kingdom of Serbia
- 1929: became the capital of the Danube Banovina, a province of the Kingdom of Yugoslavia
- 1941: annexed by Hungary
- 1945: the capital of Vojvodina, a province of the Socialist Republic of Serbia and Socialist Federal Republic of Yugoslavia
- 1992: part of the Federal Republic of Yugoslavia
- 1999: NATO bombardment during the Kosovo War – 20 years ago!!
  - Novi Sad left without all of its three Danube bridges, communications, water, and electricity
  - cluster bombed several times
  - its oil refinery was bombarded daily, causing severe **pollution and widespread ecological damage**
- 2003: transformed into the State Union of Serbia and Montenegro.
- 2006: part of an independent Serbia

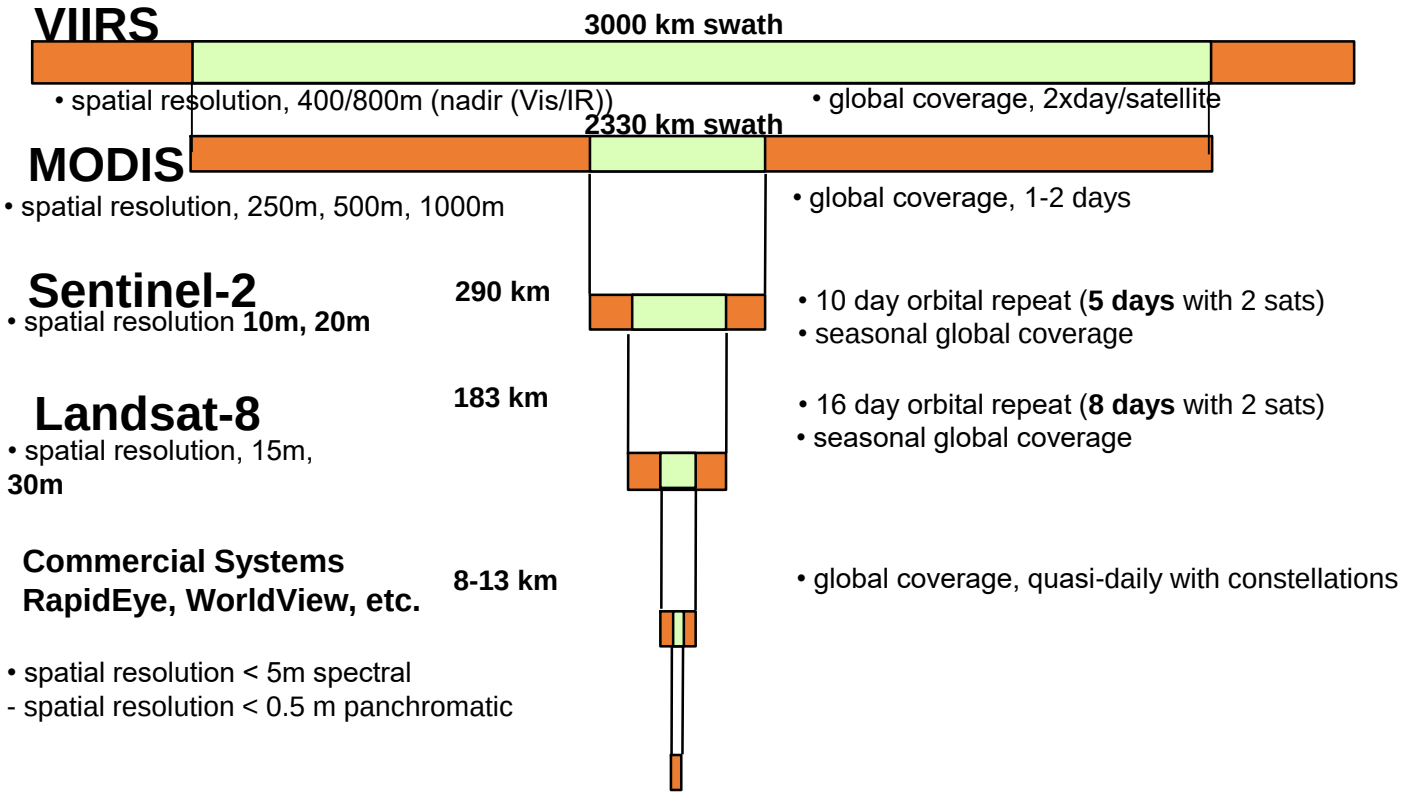


Map of Novi Sad (Ratzen Stadt) from 1745

Racki Grad

Belgrade from Landsat in 1992

Synergistic Use of Optical Remote Sensing

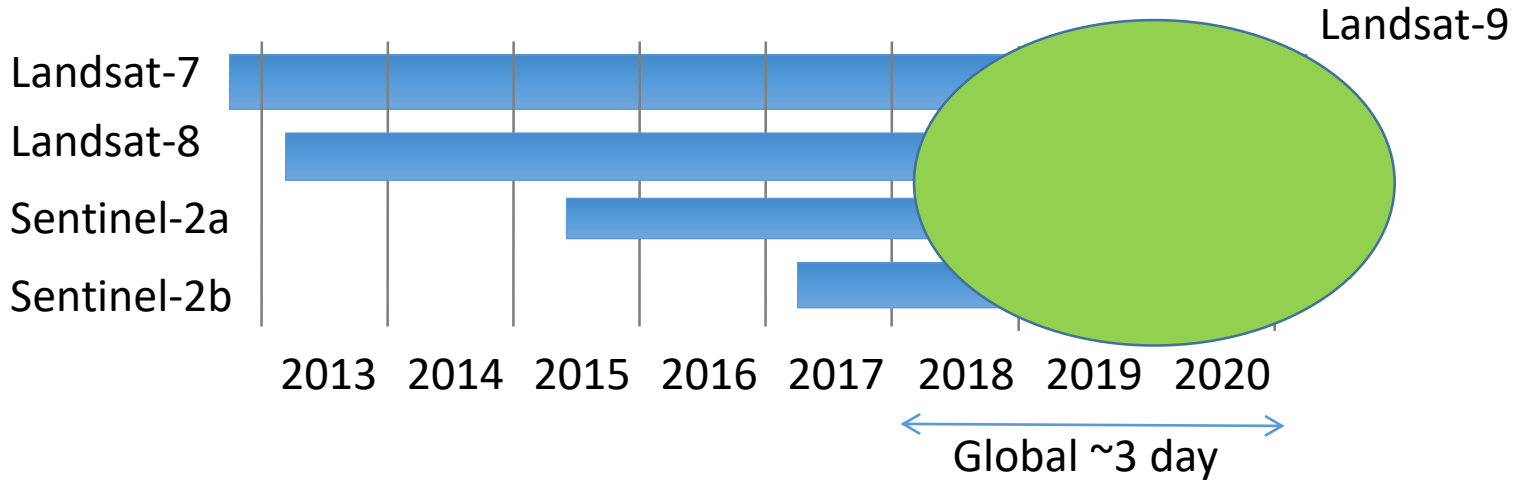


Current Prospects for Virtual Constellation of Mid-Resolution Sensors: Sentinel-2 - Landsat Fusion

Agriculture monitoring needs ~ 5-day coverage

Both sensors have 10-30m coverage in VNIR-SWIR

- Satellite orbits are complementary
  - Landsat-7 & -8 8 days out of phase
  - Sentinel-2a & 2b 5 days out of phase
  - Landsat and Sentinel sun synch orbits precess relative to each other

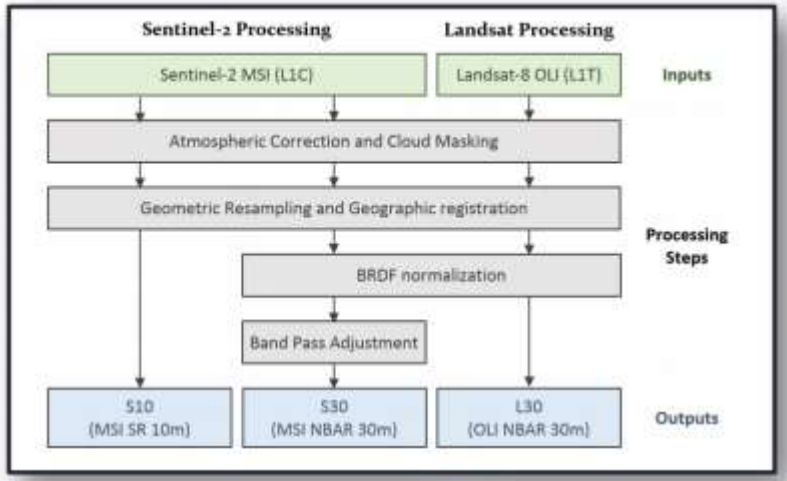


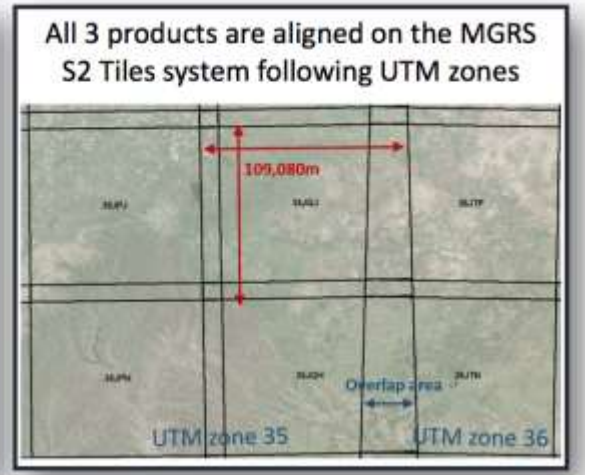
Harmonized Land Surface (HLS) reflectance

A Harmonized Surface Reflectance Product
Landsat and Sentinel-2 data represent the most widely accessible moderate-to-high spatial resolution multispectral satellite measurement. Following the launch of the two Sentinel-2 satellites in 2015 and 2017, the potential for synergistic use of Landsat and Sentinel-2 data creates unprecedented opportunities for timely and accurate observation of Earth status and dynamics. Harmonization of the Landsat and Sentinel-2 data is of paramount importance for the scientific community. This research project prototypes the harmonization for the entire North America and other globally distributed test sites. Technical details of harmonization can be found in the following paper and the User Guide in the Documents section.
Citation for HLS data set: Claverie, M., Ju, J., Masek, J. G., Dungan, J. L., Vermote, E. F., Roger, J.-C., Skakun, S. V., & Justice, C. (2018). The Harmonized Landsat and Sentinel-2 surface reflectance data set. *Remote Sensing of Environment*, 219, 145-161.

Courtesy:
Jeff Masek (NASA GSFC)

Algorithm Flow





S10 (from Sentinel-2)
Spatial: 10m, 20m, 60m
Spectral Bands: All MSI
NBAR: No

S30 (from Sentinel-2)
Spatial: 30m
Spectral Bands: OLI-like + MSI Red Edge
NBAR: Yes

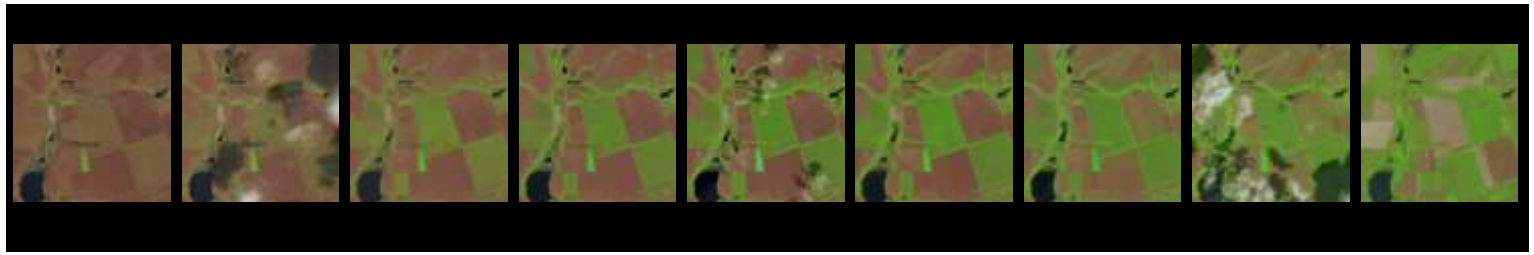
L30 (from Landsat 8)
Spatial: 30m
Spectral Bands: All OLI
NBAR: Yes

Atmospheric Correction	LaSRC/6S approach (image-based aerosol)	Vermote et al. (2016)
BRDF normalization	C-factor technique with the global constant coefficients	Roy et al. (2016)
Spectral bandpass	Linear regression using global training set from EO-1 Hyperion	Claverie et al., (in review)
Cloud/shadow mask	Landsat 8: output from LaSRC; Sentinel-2: Boston University Fmask algorithm	Vermote et al. (2016); Zhu et al. (2015)
Geographic registration	AROP: automated registration and orthorectification package	Gao et al. (2009)

Crop Yield Assessment and Mapping from Landsat-8 and Sentinel-2 observations

PI: Skakun, U. Maryland

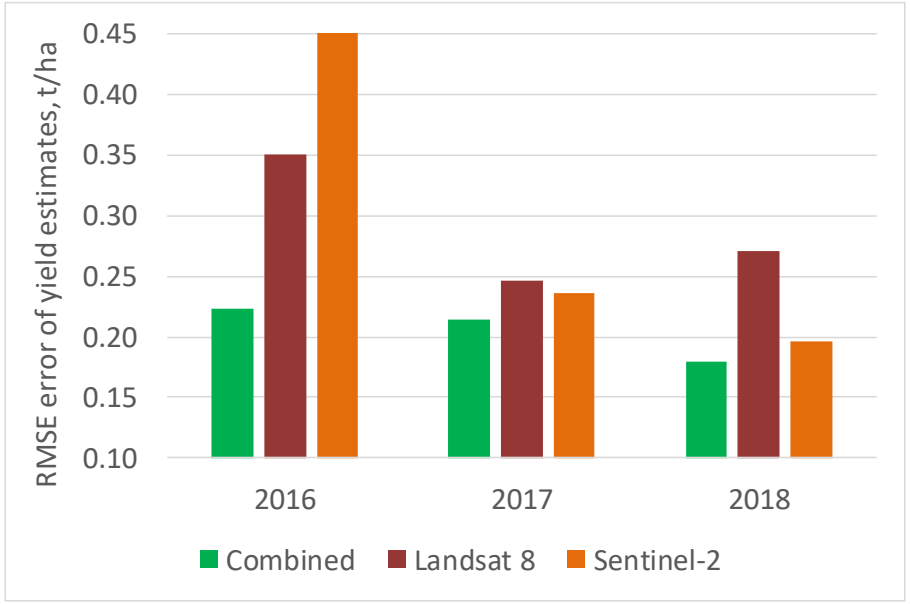
Ukraine
(Kirovograd obl.)



Root mean square error (RMSE) of the relationship between *crop yield* (ground data) and *cumulative satellite-derived vegetation index*

Multi-source (L8+S2) reduction in *RMSE* →

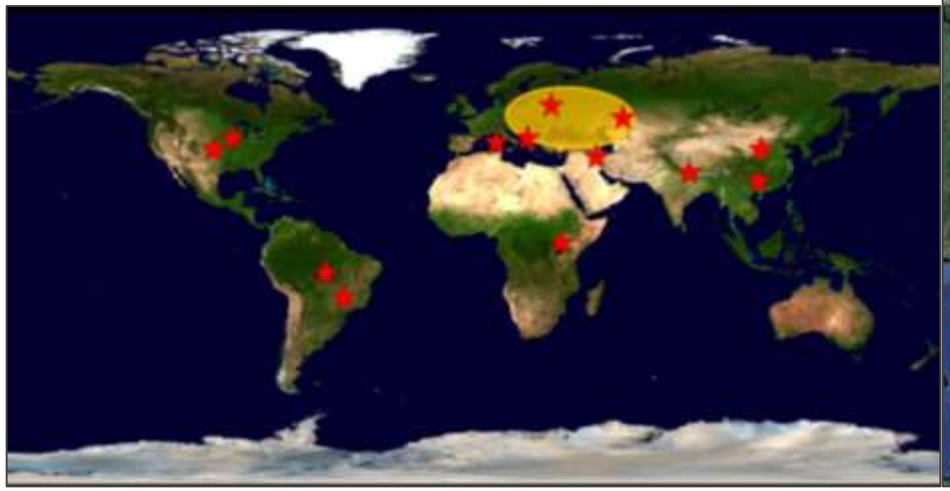
2016, 2017 – Sentinel 2a
2018 – Sentinel 2a,b

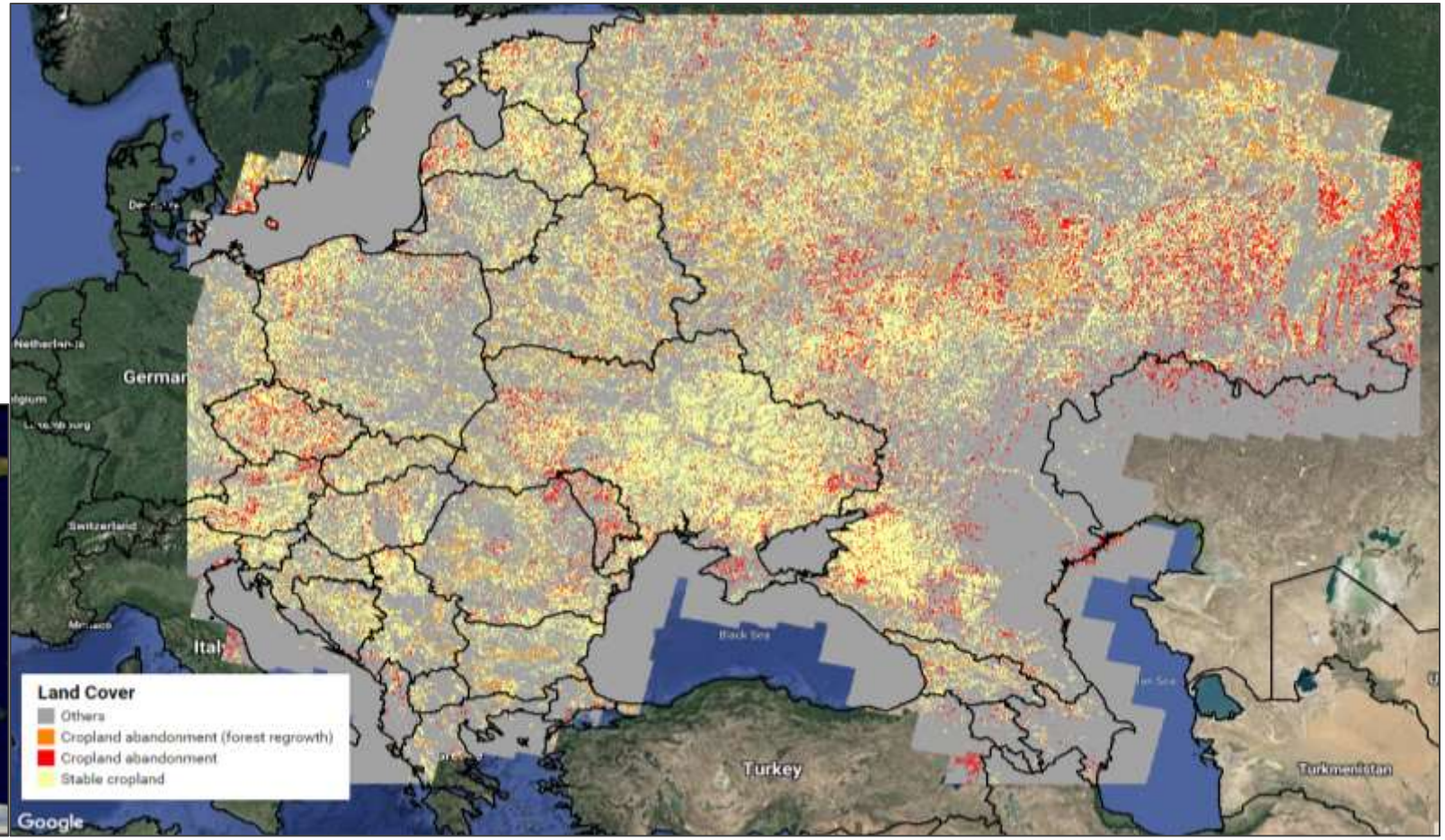


MONITORING THE DYNAMICS OF ABANDONED AGRICULTURE, FALLOW FIELDS AND GRASSLANDS

PI: RADELOFF (U. WISCONSIN)

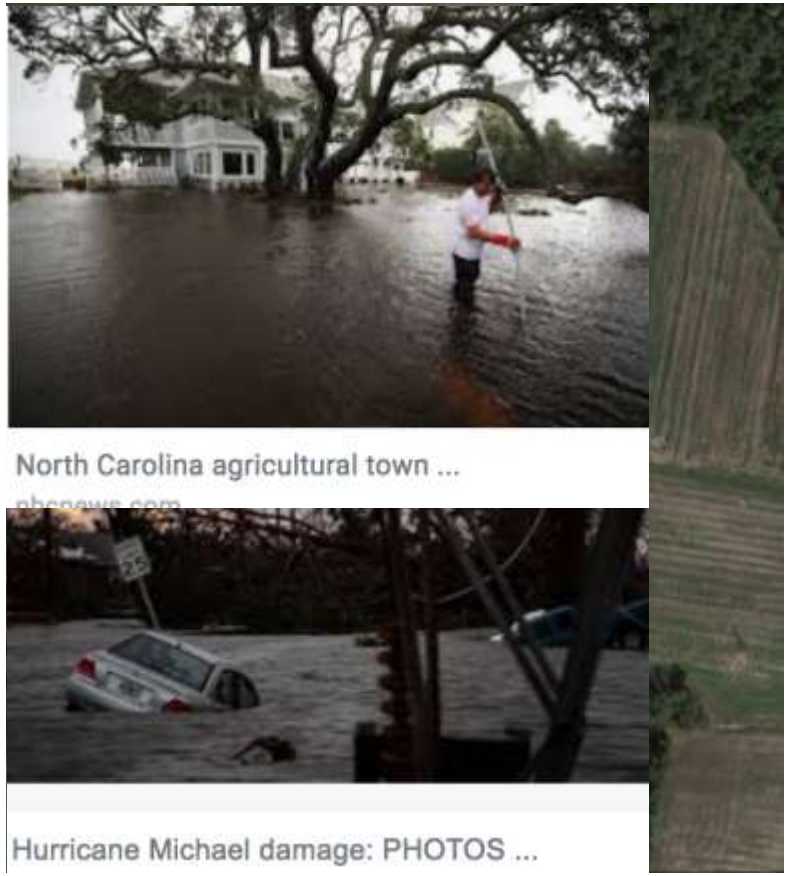
- Goal: to map agricultural abandonment routinely for large areas
- Two-step classification process based on all Landsat and Sentinel-2 data
- 13 global test footprints; one regional proof-of concept

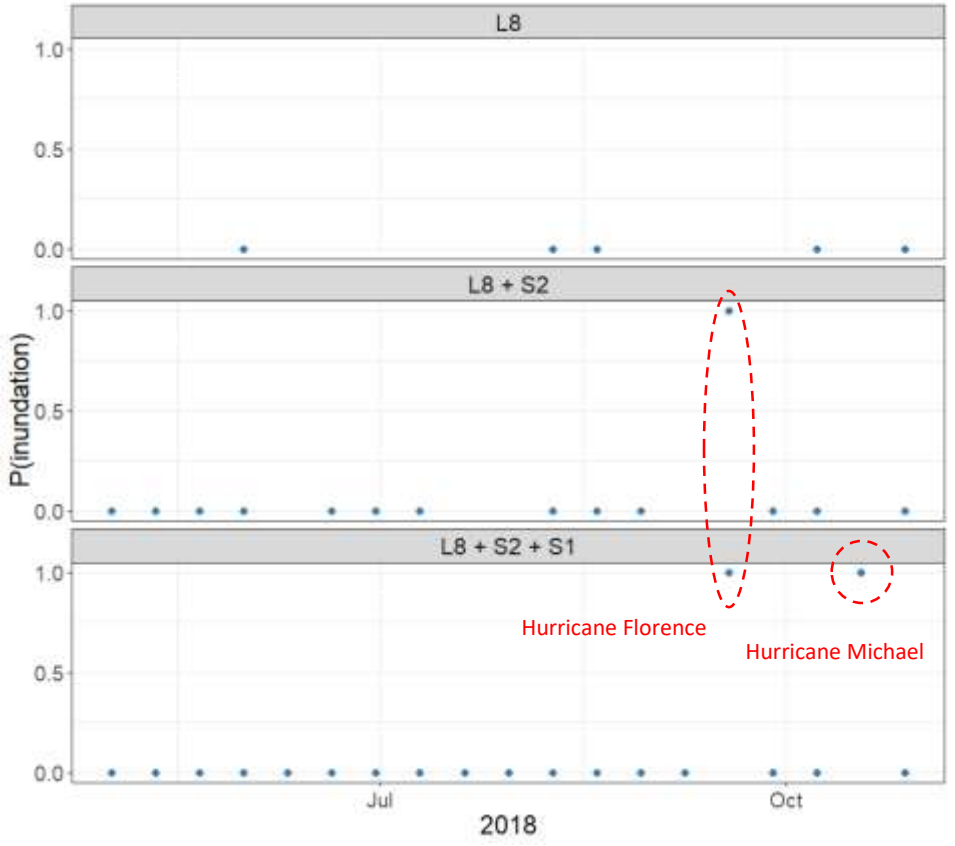




Fusing Mid-Resolution Optical and Microwave (Radar) Data for mapping inundation in North America

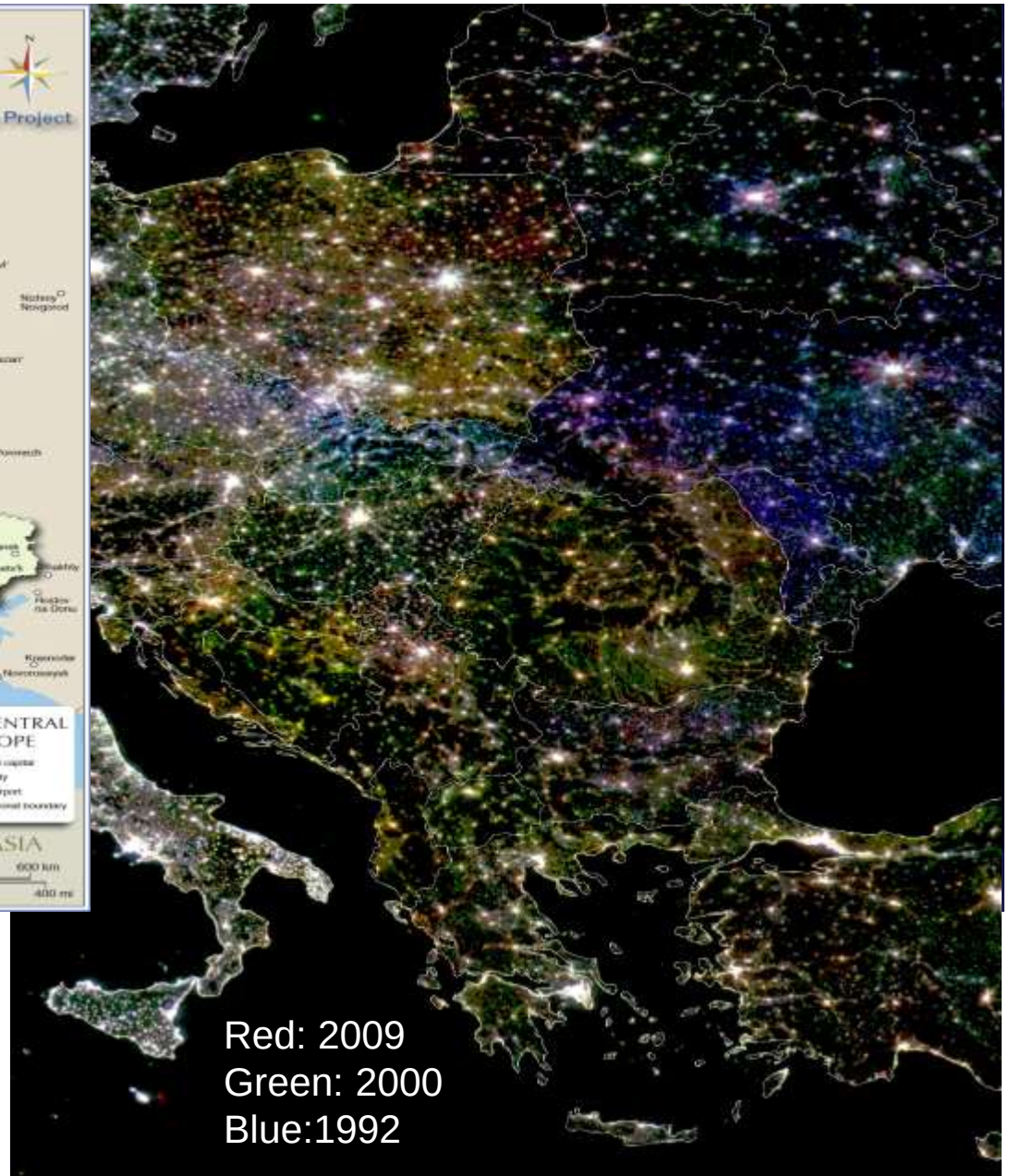
PI: Cheng Huang, U. Maryland





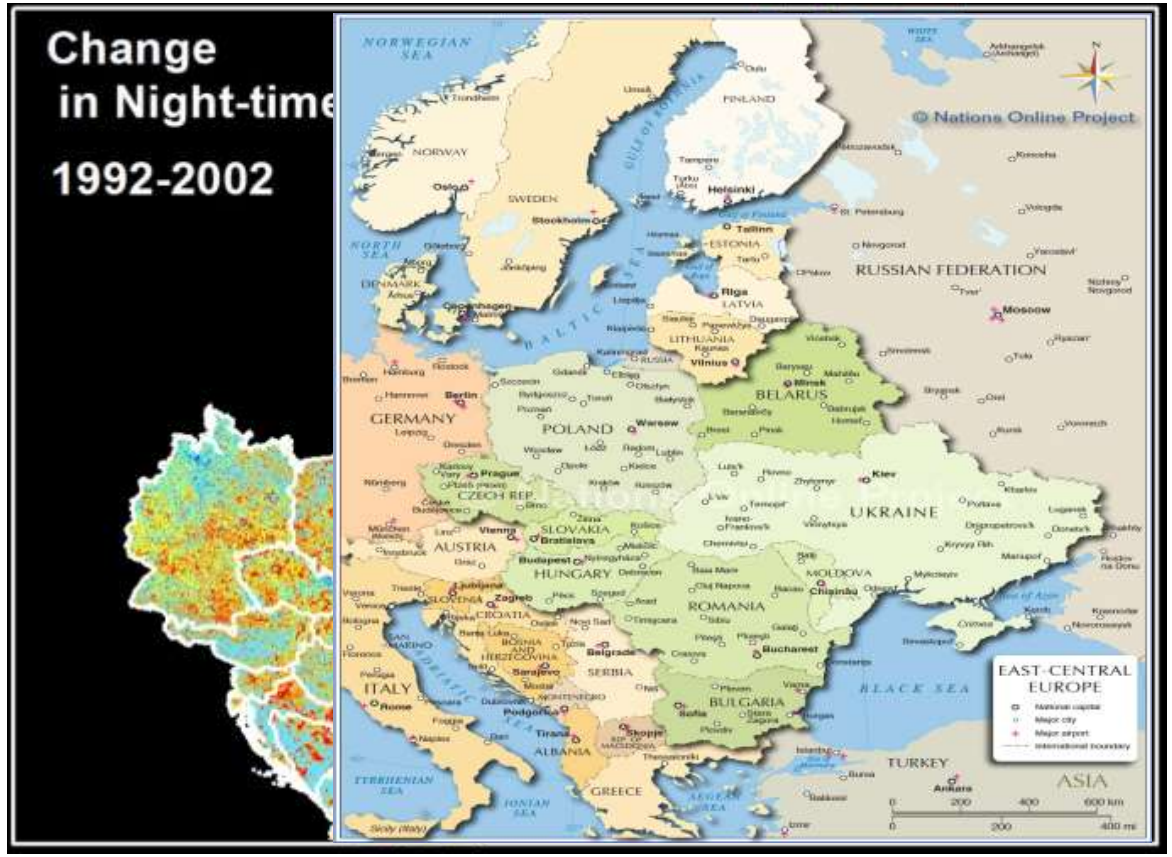
Two flooding events over crop fields in N. Carolina: 1) Hurricane Florence in Sep 2018 - captured by L8 + S2, 2) Michael in Oct 2018 Hurricane L8+S2+S1. These events are not captured by L8 data alone.

Earth Night Lights Observed by DMSP/OLI



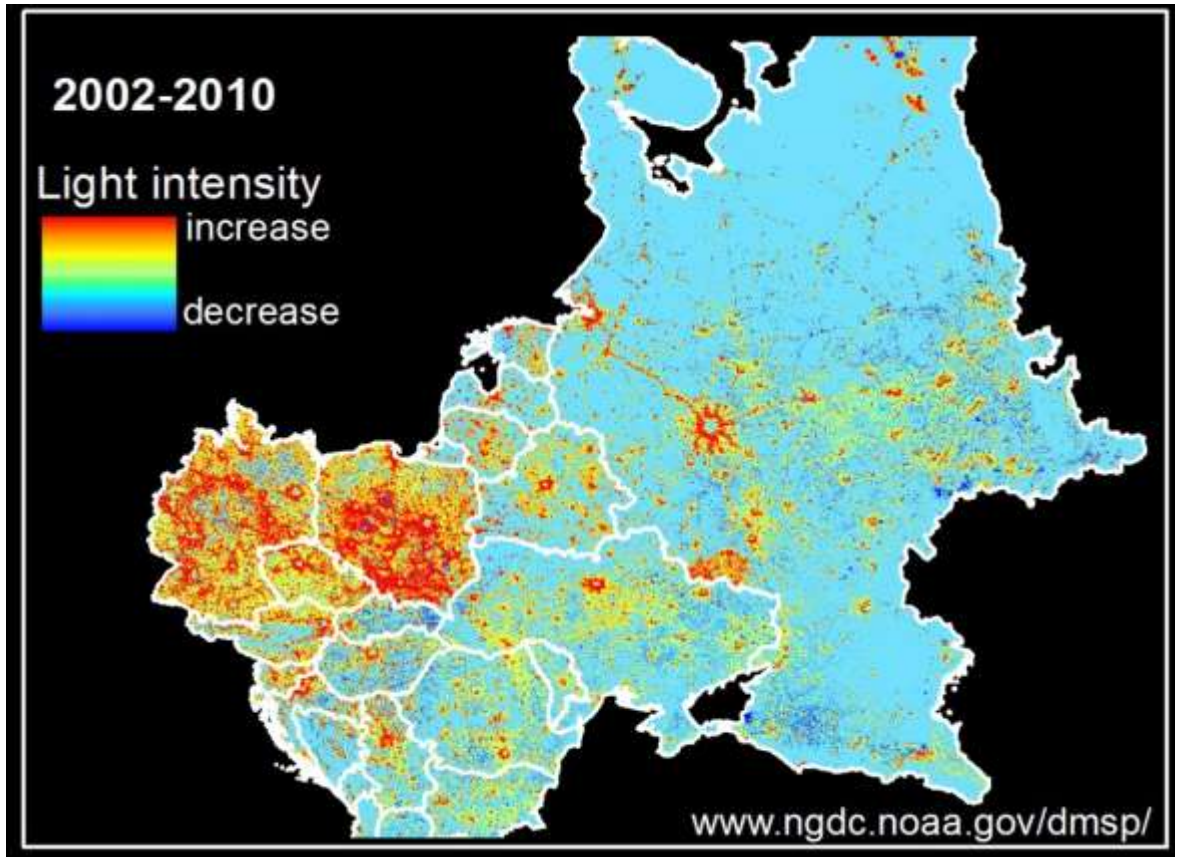
DMSP Night Lights Reflecting Changes in Economy

The Decade of Collapse



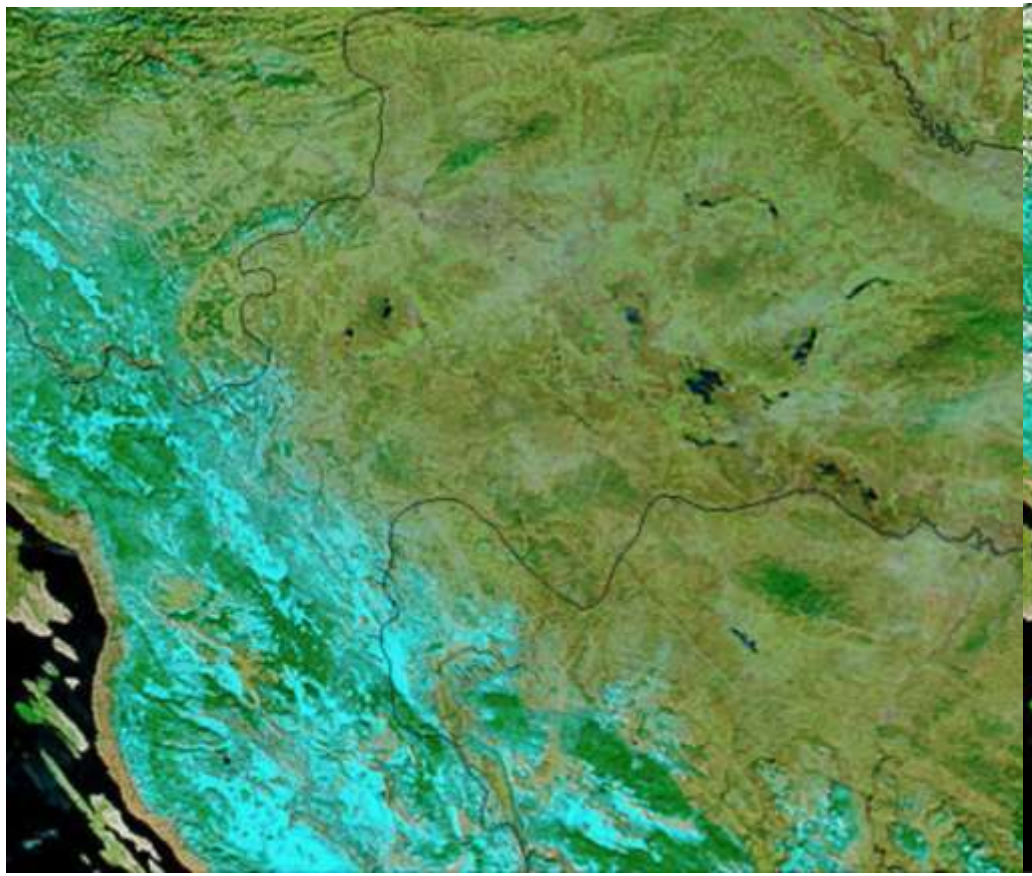
Deep Blue: Depressed Economies of Ukraine & Moldova
Red: Positive Economy Development

The Decade of Recovery



Light Blue: neutral (not much change)
Red: Economy and urban expansion (e.g. Moscow)

Flooding of Sava River Observed by MODIS

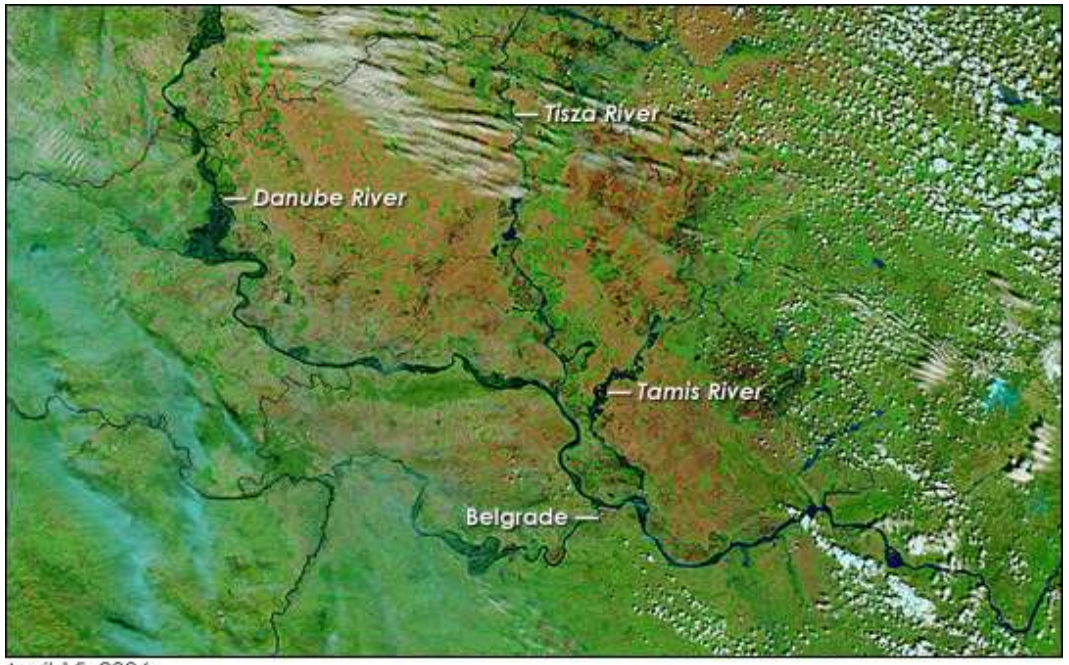


March 18, 2004

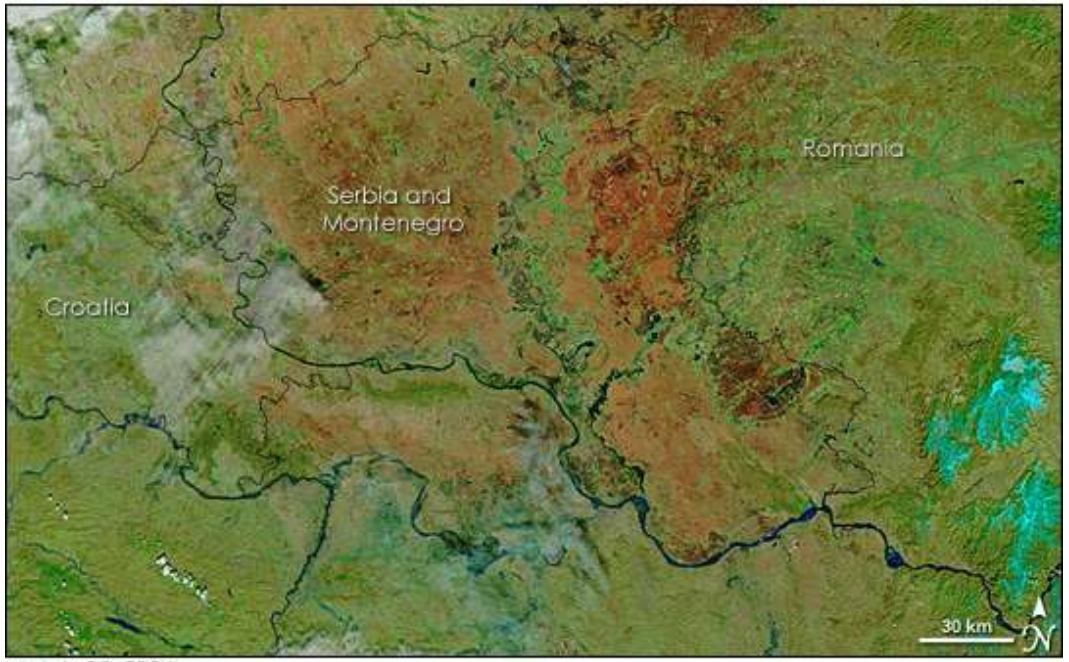
March 29, 2004

Flooding of 2006

- Northern Serbia was inundated with spring floods in mid-April 2006
- Melting snow and heavy rain pushed the Danube and its tributaries over their banks, causing flooding in many countries in Central Europe.
- Three major rivers were noticeably flooded when the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite captured the top image on April 15.
- Black pools of water surround the Danube, particularly in the far north near the Hungarian border.
- The reddest regions may be burn scars from extensive agricultural burning.
- The Tisza River and the Tamis River were also flooded.
- Serbia's capital city, Belgrade, reported flooding along low-lying regions, and many other river-side communities in northern Serbia were building flood defenses or evacuating as waters rose



April 15, 2006

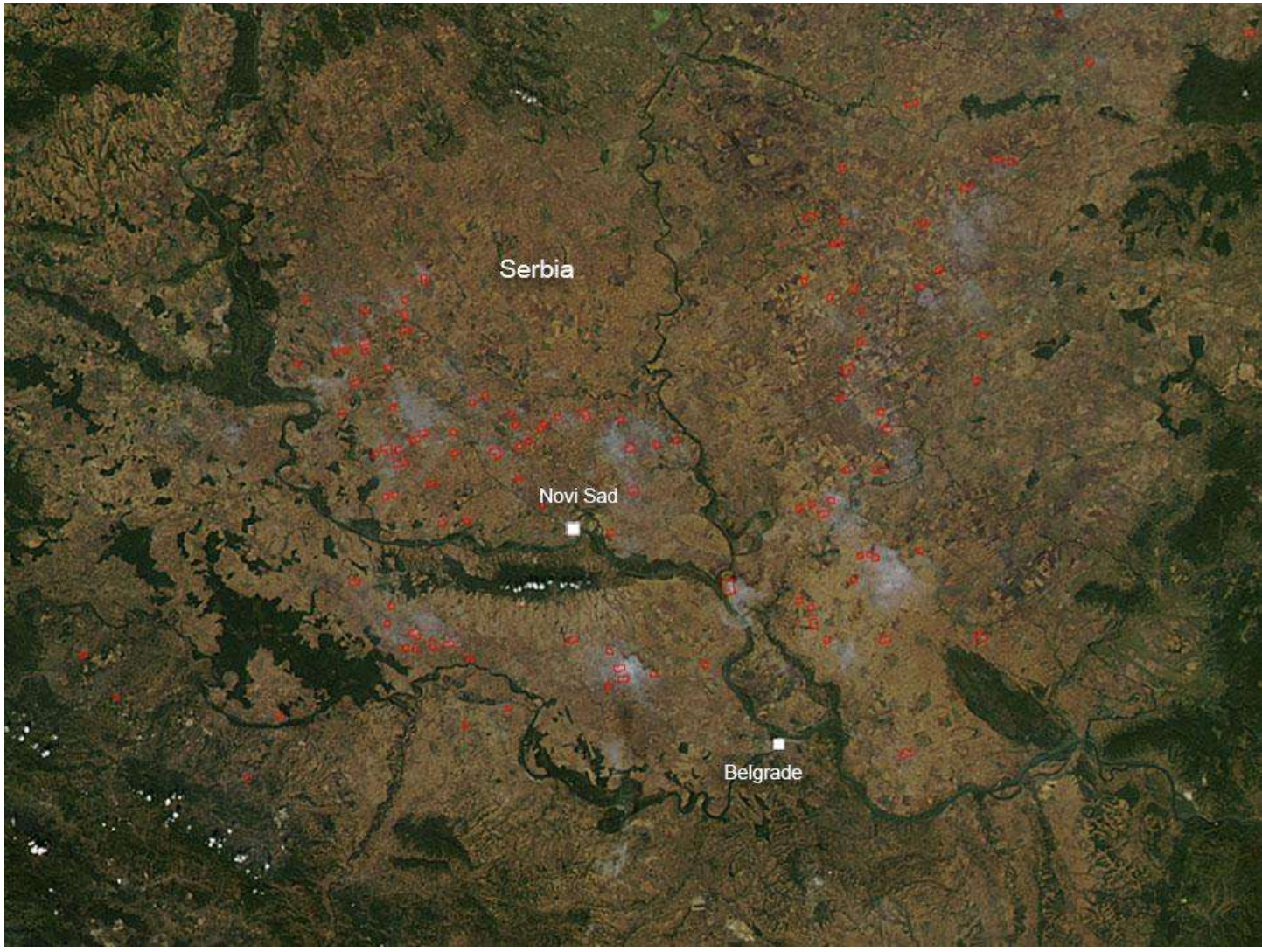


March 25, 2006

Fires in Serbia in 2012

- Actively burning areas, are outlined in red
- Blazes have destroyed hundreds of acres of forests and bush in Bosnia, Serbia, Croatia and Montenegro
- Some of the fires raging on the border between Serbia and Kosovo (not seen in this photo) are too dangerous to fight because of minefields left over from the war over the former Serbian province in 1999.

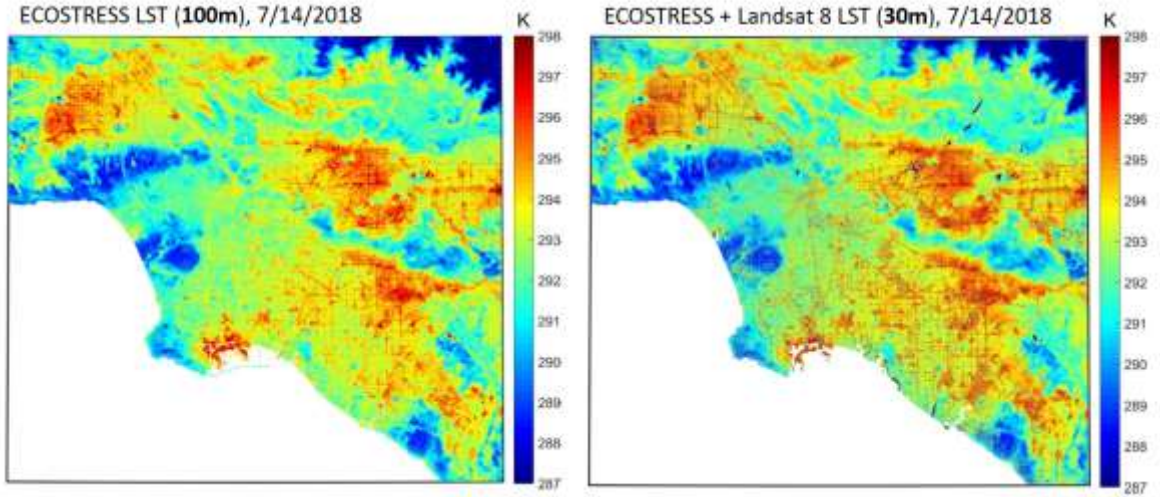
Aqua/MODIS October 04, 2012: natural color



NEW SENSORS FOR LCLUC STUDIES ON ISS

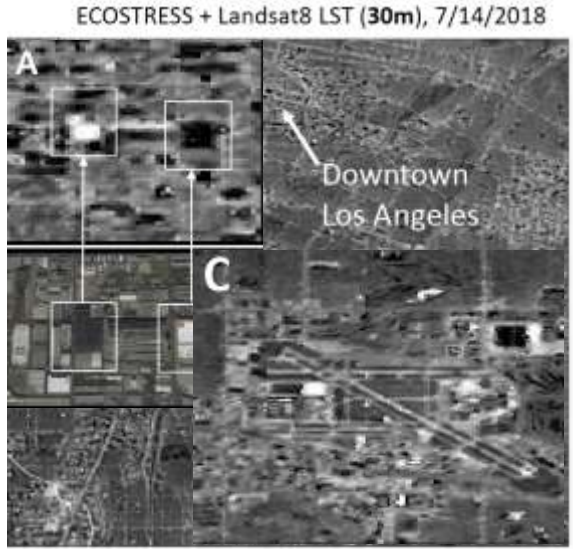
- ECOSTRESS: ECOsystem Spaceborne Thermal Radiometer Experiment on ISS
  - Prototype HyspIRI Thermal Infrared Radiometer (PHyTIR)
  - 5 spectral bands in the 8-12.5 µm range+1.6 µm (69m x 38m)
- DESIS: DLR Earth Sensing Imaging Spectrometer
  - 235 spectral channels with ground res. 30m
- GEDI: Global Ecosystem Dynamics Investigation
  - high resolution laser ranging observations of the 3D structure of the Earth
  - three lasers produce eight parallel tracks of observations
  - each laser fires 242 times per second and illuminates a 25 m spot (a footprint) on the surface over which 3D structure is measured

Sharpening of Coarse Resolution Thermal IR Images With Mid-Resolution Optical Images



ECOSTRESS Land Surface Temperature Imagery averaged into 100m cells and sharpened with Landsat 30m optical data for Los Angeles county, Ca

ECOSTRESS observations: throughout the diurnal cycle every week, while Landsat only the morning temperatures twice a month, at best



Distinguishing fine-scale thermal features of individual building roofs and transport network infrastructure (roads, runways)
A: upper thermal image vs Google Earth image

Courtesy: Glynn Hulley, NASA JPL

Fusing High-Resolution Commercial Imagery Data

- Currently, there are studies in which moderate resolution data from Landsat/Sentinel2 are fused with high-resolution imagery, e.g. Worldview
- It is expected that NASA-affiliated investigators will have free access to a very rich, dense dataset within the next couple of years from satellite constellations of both Planet Lab and Digital Globe over land including coastal zone and cryosphere
- Next step: fusing the DG Worldview images (non-pansharpened) having higher spatial resolution but low revisit time with Planet images having lower spatial resolution but daily re-visit times

Educational Component for E.Europe: NASA-ESA Trans-Atlantic Training Initiative

- Origin: after the training session for the LCLUC ST meeting, Latvia, 2010
- Concept: while visiting Karlov University in Prague, 2012
- NASA-ESA agreement
- Implementation: Prague, 2013
- Under careful supervision by a NASA Program Manager

TAT-1	2013, Prague, Czech Rep.
TAT-2	2014, Krakow, Poland
TAT-3	2015, Brašov, Romania
TAT-4	2016, Zvolen, Slovakia
TAT-5	2017, Pecs, Hungary
TAT-6	2018, Zagreb, Croatia
TAT-7	2019, Novi Sad, Serbia

7 years later: interest to continue confirmed!

Take Away Messages

- Current trend in the LCLUC theme
  - multi-source land imaging using virtual constellation of available space assets with compatible characteristics, such as Landsat and Sentinel-2 systems
  - Long-term time series datasets, even with coarser resolution, are still useful for studying trends, such as DMSP/OLI
  - intensification of using high-res. commercial data, such as Planet and DG
- Advance science by fusing observations from
  - Optical at nested multi-spectral resolutions (300m→30m→3m→0.3m)
  - Optical mid-resolution (10-30m) from different sources, e.g. Landsat+Sentinel2
  - Optical and microwave (radar), e.g. Landsat & Sentinel-1
  - Hyperspectral optical and multi-spectral thermal infrared
- NASA is committed to working with international partners
- **International partnership** is mandatory to maximize our Earth observations and collaborate efficiently on our analysis of our global collections
- Regional science – collaboration with regional network specialists
  - GOFC-GOLD regional information networks (SCERIN for this region)
  - Capacity building training activities
  - Participation in NASA projects as collaborators
  - Sharing experiences in joint network meetings (SCERIN+MedRIN next year)
  - The Second Networks Summit – in 1.5 year

Pecs

Zagreb →Novi Sad

Hvala!


A1
A1
A1
Sangaj
Novi Sad
Petrovaradin
Ветерник
Futoški
Sremska
Kamenica
Боцке
Лединци
Rakovac
Sremski
Karlovci
RACKOG
BUKOVACKI PUT
KARLOVACKI PUT