Wrap-up
Final Remarks

Garik Gutman,
NASA Headquarters
Manager, LCLUC
LCLUC is a global program supported through regional partnerships to enhance
  - Regional scientists' access to NASA assets
  - NASA scientists access to national data and facilitate field data collection

LCLUC is a catalyst for regional science initiatives through
  - Networks by leveraging national/local knowledge and resources and strengthening NASA research projects
  - Workshops focused on societal priorities and policy-relevant land-use science

LCLUC is a promoter of regional capacity building through
  - NASA data-use training
  - International data sharing
Operational algorithms and products for near real time maps of rice extent and rice crop growth stage using multi-source remote sensing

PI: W. Salas, N. Torbick, AGS
Thuy Le Toan, CESBIO; Dirk Hoekman, Wageningen

- Fuse SAR-optical for mapping agricultural conditions; technology transfer with partners
- S. Asia
- Sentinel-1, PALSAR-2, Landsat-8, Sentinel-2, Radarsat-2
- Fusion provides more and better information; the approach strives to extract strengths of any / each satellite to complement another platform
- Pilot sites have beta products; begun cal / val coordination with ESA, regional partners (AsiaRice, IRRI, VAST, SERVIR, Ministries,...)

Example Tonle Sap, Cambodia Sentinel-1A Rice Inundation Dynamics Time Series
Towards Near Daily Monitoring of Inundated Areas over North America through Multi-Source Fusion of Optical and Radar Data

Chengquan Huang (PI), Ben DeVries, Wenli Huang, University of Maryland
Megan Lang (Co-I), US Fish and Wildlife Service National Wetland Inventory; John Jones (Co-I), USGS
Irena Creed (International Collaborator), University of Western Ontario, London, ON, Canada

Goals:
- Develop automated inundation mapping algorithms for Landsat, Sentinel-2 and Sentinel-1
- Generate near daily inundation products over US and southern Canada

Progress:
- Algorithm for the automated quantification sub-pixel water fraction (SWF) developed for optical data streams (Landsat-5/7/8 and Sentinel-2) and tested over several sites
- Algorithm for automated classification of water for Sentinel-1 developed and tested over several sites

Benefits of MuSLI inundation approaches:
- Provide needed spatial-temporal details: small water bodies, areas inundated for short periods, rapid inundation changes
- Enable advances in understanding aquatic systems: connectivity, function, carbon, and biodiversity

Time series sub-pixel water fraction (SWF) maps derived using Sentinel-1 (S1), Sentinel-2A (S2) and Landsat-8 (L8) imagery over the Everglades.
Multi-source imaging of infrastructure and urban growth using Landsat, Sentinel and SRTM

C. Small - Columbia Univ. USA  S. Ngheim – NASA/JPL USA  T. Esch – DLR Germany

- Develop continuous index to map built/impervious land cover
- Map changes in settlement extent between 2000 and 2015
- Global Extent – 20 urban-rural gradients in different biomes
- Optical: Landsat + Sentinel 2
- Radar: SRTM + Sentinel 1
- Multi-season – Spectral Stability
- Multi-source – Reflectance + Backscatter
- Multi-decade – Robust WRT sensor & time

- Developed spectral stability index
- Now characterizing reflectance-backscatter relations across biome

Stable Reflectance = Impervious surfaces
High Backscatter = Corner reflectors
Both together = High Infrastructure Density
Multisource Imaging of Seasonal Dynamics in Land Surface Phenology: A Fused Approach Using Landsat and Sentinel-2
Mark Friedl, PI; Josh Gray, Co-I; Boston University
Lars Eklundh, Lund University, Patrick Hostert, Humboldt University,

• Goals:
  • To quantify the timing and magnitude of land surface phenology events ("phenometrics") at moderate spatial resolution, and
  • To generate gap-filled time series of spectral vegetation indices that characterize the entire seasonal cycle of land surface phenology at fixed time steps.

• Geographic area: Global (but focused on study sites)

• Data used: Landsat 8, S2 (supplemented by Landsat 5, 7 & MODIS)

• Advantage of MuSLI approach: Time series density

• Up-to-date progress:
  • Ongoing international collaboration with Lund University and Humboldt University, Berlin (BU Team visiting Berlin & Lund in Nov., 2016)
  • Manuscript in prep., AGU presentation, analyzing phenology algorithms
  • Data set development focused on Cal/Val data for core test sites.
  • Manuscript in prep describing Kalman Filter algorithm to fuse OLI and MSI.
  • Analysis of phenology algorithms based on HLS data (see figure at right)
Prototyping a Landsat-8 Sentinel-2 Global Burned Area Product

David Roy, Haiyan Huang, Lin Yan, Hankui Zhang, Jian Li, (GSCE, South Dakota State University, USA), Luigi Boschetti (Idaho, USA); International Collaborators: Jose Gómez-Dans & Philip Lewis (UCL, London, U.K), Emilio Chuvieco (Alcala, Spain), Kevin Tansey (Leicester, U.K)

- **Goal:** Prototype global 30m burned area product to meet user needs for
  - improved carbon budget accounting
  - greenhouse gas and aerosols emissions
  - environmental management
  - post-fire assessment and remediation
  - people - environment - climate - fire research

- **Geographic area:** Africa + global sample

- **Data used:** Landsat-8 and Sentinel-2A/B

- **MuSLI advantage:**
  - Landsat-8 and Sentinel-2A/B together provide needed temporal resolution for time series burn change detection
  - Landsat-8 has improved quantization, signal/noise characteristics, and acquisition coverage over heritage Landsat missions
  - Sentinel-2 has Landsat-8 like bands at 10m & 20m with higher acquisition coverage than Landsat

- **Progress:** Sentinel-2 processing under global WELD processing, and Landsat-8 to Sentinel-2 registration, developed and implemented

- **Progress:** Automated sensor-agnostic burned area algorithm for WELD processed time series prototyped
Integrating Landsat 7, 8 and Sentinel 2 data in improving crop type identification and area estimation

PIs: M. Hansen, P. Potapov, University of Maryland
International collaborators: Pierre Defourny, UCL & Carlos Di Bella, INTA

Goals

• Develop and implement a system for defining the required phenological sampling for mapping crop types.
• Determine if Landsat and/or Sentinel 2 acquisitions are sufficient in meeting required sampling frequencies for selected commodity crop type mapping (required best individual date image inputs).
• Compare the performance of single date images and seasonal metrics in mapping crop type at local (per sample block) and regional (all sample blocks at once) scales.
• Given sufficient temporal richness, validate area estimation of crop type for large scale industrial and fine scale smallholder cropping systems.

Scale - National

Data - Primarily Landsat 7 and 8 and Sentinel 2A

Advantage - Crops require more detailed phenologic profiles for characterization

Progress – Testing use of data in Tanzania for corn mapping, waiting for systematic acquisitions over large commodity crop landscapes

South America 2015-2016 growing season soybean cover
Multi-source imaging of time-serial tree and water cover at continental to global scales

PI: John Townshend, Global Land Cover Facility, Department of Geographical Sciences, University of Maryland
Co-Is: Joseph O. Sexton, Min Feng, Saurabh Channan, Global Land Cover Facility, Department of Geographical Sciences, University of Maryland
International collaborator: Christiane Schmullius, University of Jena, ESA GLOBBIOMASS Project

• **Goal:** Develop methodologies for fusing optical and radar imagery into data streams of tree- and water-cover estimates
• **Geographic area:** Global
• **Data used:** Landsat TM, ETM+ & OLI; Sentinel 1 & 2; PALSAR
• **Advantage:** long-term and globally consistent estimates without gaps due to clouds or sensor failure
• **Progress:**
  • Global estimates of tree cover based on Landsat (2010)
  • Development of online portal for collaborative data visualization and progress-reporting
  • Successful first test of incorporating Sentinel-2: filled cloud gaps
  • Unsuccessful first test of incorporating Sentinel-1: weak tree-cover signal
HLS: Harmonized Landsat/Sentinel-2 Products
https://hls.gsfc.nasa.gov
Laramie County, WY

May 4, 2016 August 8 August 17 September 1 October 20

High temporal density of obs. allows individual mowing events to be detected within alfalfa fields.

Seasonal phenology:
Natural Grassland (blue line)
Irrigated Alfalfa (red line)

NDVI
- Sentinel-2
- Landsat-8

Day of Year

0 100 200 300 400

0.0 0.2 0.4 0.6 0.8 1.0

Grassland
Mowing
Alfalfa

Courtesy: Jeff Masek, NASA GSFC
Merging Sentinel-2 and Landsat data streams could provide < 5-day coverage required for Ag monitoring

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

Global ~2-3 day
Global ~5 day coverage
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Ongoing Solicitations

ROSES-2018

Land-Use Transitions in Asia (due date Aug 1 step-1, Mar 1 step-2)
Programmatic Future

- Keep social science component as an integral part of the LCLUC proposals
- Analyse multi-source land imaging (MUSLI) results
- Continue the support of SARI and NEFI through solicitations and meetings
- Revive research on Latin America
- Balance the program thematically and geographically
- Promote our products internally and externally: FB page, webinars, newsletters
- Enhance LCLUC-EARSeL and LCLUC-ESA collaboration
• India Annual Winter Cropped Area, 2001 – 2016
• consists of annual winter cropped areas for most of India (except the Northeastern states)
• from 2000-2001 to 2015-2016.
• NASA’s Moderate Resolution Imaging Spectroradiometer (MODIS) Enhanced Vegetation Index (EVI; spatial resolution: 250m) for the winter growing season (October-March).
• Automated algorithm identifies the EVI peak in each pixel for each year and linearly scales the EVI value between 0% and 100% cropped area within that particular pixel.
• Maps were then resampled to 1 km and were validated using high-resolution QuickBird, RapidEye, SkySat, and WorldView-2 images spanning 2008 to 2016 across 11 different agricultural regions of India.
• The spatial resolution of the data set is 1 km, resampled from 250m.
• The data are distributed as GeoTIFF and NetCDF files and are in WGS 84 projection.

Download Link: http://sedac.ciesin.columbia.edu/data/set/india-india-annual-winter-crop...

Annually-available dataset in Geotiff or netCDF format with 1km spatial resolution in WGS84 projection. For more details please view the product documentation at http://sedac.ciesin.columbia.edu/downloads/docs/india/india-india-annual-winter-crop...
LCLUC in the News: Wards, Media

• Randolph H. Wynne, professor of forest remote sensing in Virginia Tech’s College of Natural Resources and Environment, received a Society of American Foresters award recognizing his research in remote sensing applications that have resulted in significant advances in forestry.

08/15/2017: Dr. Jessica McCarty discussed wildfires and smoke in Greenland on NPR.
Near Future LCLUC-Related Meetings

- SARI events
  - LCLUC regional science workshop: 27-30 May, Manila, Philippines
  - LCLUC Water-Energy-Food Nexus workshop: mid-August, Laos
- ERSeL-LCLUC 3d Joint Workshop: 11-12 July, Greece
- GOFC-GOLD workshop/training events
- PEEX Sep 17-20 Boreal forests
- WHISPERS (Hyperspectral...) Sep 24-26
- ESA Urban conference (ESRIN, Frascati) Oct 30-31
- GLP Open Conference April 24-26
Thank you,
Enjoy Washington in Bloom

Thanks again to
the LCLUC Project Office support and our sponsors