Earth Observations in support of agricultural decisions in Tanzania and Uganda: A STARS East Africa project

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GEO-XII ITC side event: Strengthening regional capacity building initiatives in earth observation

Mexico City, November 9th, 2015
Overall objective:

• Support small holder farmer livelihoods and food security in Tanzania and Uganda

• Through provision of timely, transparent information on agricultural prospects to policy makers in order to inform agricultural decisions and policy including:
  – Export bans & trade regulation
  – Amount of crop to purchase for reserves
  – Mobilization of food aid
  – Planning of grain storage
  – Guiding investments, etc
Challenge and Opportunity

- Government mandated to assess food security, develop policies
- Need **timely, reliable information** at the national scale
- **Long delays** in information collection and aggregation

Remote sensing information can provide:
- Information on **cropland distribution**
- Information on **crop type/system**
- **Crop condition** throughout the growing season
Pathway

Improve timeliness and reliability of information on agriculture using Remote sensing Smart phones/tablets Internet technology

Working with Government & universities to

Inform agricultural decisions and policy, agricultural development initiatives, markets, etc.
Context: Maize Sector in Tanzania

- Close to 50% of national calorie intake
- >80% of farmers cultivate maize, large majority are small holders
- ~ 40% of country’s crop area and grown in all agroecological zones, and traded across all regional markets
- Susceptible to weather- rainfed
- Bi-modal/ uni-modal regions
- Deficit, self sufficient, surplus
- Low yields (avg 1.3T/Ha 2008-2014 relative to global avg. of 5t/ha)
- Regional grain basket: main trade partners Kenya, Malawi and Mozambique
- 5 export bans since 2004
Remote Sensing Tools

- MODIS
- Landsat
- RapidEye/Worldview-2/3
- UAV
- Field Data

Satellite Time Series Pipeline and Archive

Time Series (one season)

Ground-truth land-cover and land-cover dynamics

Relative NDVI / Crop Condition at MODIS and Landsat resolution

Prototype of Agricultural Areas Base Map (Cropland Mask)

Methodologies for classifying:
- Cropland
- Maize production systems
Crop Condition Monitoring: Adapting the GLAM MODIS System

- Free
- Daily coverage
- Near-Real Time
- Spatially explicit and continuous
- Crop condition information
NDVI & seasonality can explain ~35% of price variations in Tanzania

Source: Baffes, World Bank
GLAM East-Africa MODIS NDVI Time Series

2014/15 season:
- Dodoma
- Mbeya: Surplus
- Mwanza: Deficit/bi-modal

2014/15 season: Dodoma
Examples of Prices from 5 different markets across the country (2008-2013)

Surplus region markets tend to have lower prices (green)
Deficit markets tend to have higher prices (red & orange)
Mapping Tanzania Croplands

- Tanzania: 105 Landsat tiles
- Data: Landsat 2010-2013 time series
  - Data composited using cloud free pixels of multi-spectral and thermal Landat 5, 7 and 8 data (Potapov, 2015)
- Methods: decision tree classifiers to relate rank-based multi-spectral, multi-temporal metrics to cropland / no cropland training data.
- Result: A per 30m pixel probability of cropland class membership threshold at >=50%
Landsat – Cropland Extent for Tanzania

SPAM (Spatial Production Allocation Model) dataset map for maize rice and wheat based on land suitability for Tanzania (IFPRI/IIASA).

Tanzania Cropland Extent, 30m resolution
Towards crop type identification with high res time series

Can small holder maize fields be identified?
What are the minimum data requirements for crop type classification
What is actually feasible?
Available RapidEye Data for Kilosa
Aerial UAV Photographs

In support of ground data collection
Field boundary delineation
Crop type identification
Ground truth
Crop condition

Image showing failed sorghum in Rupa-Karamoja
Image collected with supervision by UPDF and approval from COA Moroto District

senseFly eBee UAV imagery, 4 cm resolution Gongoni Ward, Kilosa District, 19. April 2015
Ground data segment:
Crop Measurements; Crop cuts for yield

Variables measured in a 2x2m subplot, 2 in each farm
- Crop height
- Leaf number
- LAI – android app - PocketLAI
- Canopy temp _Infrared Thermometer
- Wet and dry bulb temp psychrometer
- Wind estimation – Beaufort scale
- Crop stage – BBCH code

• In all 3 study sites
• Each of the 2x2m subplots were harvested
• Maize threshed and oven dried to constant weight
Prototype Area Frame- Kilosa
Assessing crop area, conditions, yield

- Statistically representative sample locations (segments)
- Stratified by agricultural intensity
- Stratification based on GeoWiki classification of WorldView-2/3 satellite imagery
Ground Data Collection on Tablets:
Crop Type, Height, Leaf Count, Developmental Stage,

5-Mar-2015
Inflorescence emergence

1-Apr-2015
Development of fruit

30-Apr-2015
Ripening

Njombe District, Ikisa Village, Tanzania
Prototyping a tablet based data collection system

Using the existing paper forms currently used, deployed in Morogoro

Current Ministry forms (WRS 1-5)

1. Crop type, area, production
2. Crop condition, drought, food security
3. Crop pests and diseases
4. Market prices
5. Rainfall
Online ODK Database (ona), example of submitted Crop Condition forms (WRS-2)

https://mafc-tanzania.appspot.com/Aggregate.html#submissions/filter///

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Example of submitted Crop Condition forms: [Full Form](https://mafc-tanzania.appspot.com/Aggregate.html#submissions/filter///)
Min/Max Local Market Prices, District level in Morogoro Region in April 2015 (form 4)
Data are available immediately through the ona online system

Large localized price variability!
Crop Monitor Tanzania
from data to information

• Critical communicate information in succinct direct forms for policy and decision maker community

• Provides real-time information on crop conditions to support decisions such as mobilization of food, grain storage, food reserve purchases, market intelligence that can promote private industry

• Prototype developed at MAFC, Tanzania
Crop Condition Pie charts by Crop and Region
Slice of pie is proportional to production

Conditions:
- Exceptional
- Favourable
- Watch
- Poor
- Out-of-Season
- No Data

Drivers:
- Wet
- Dry
- Hot
- Cool
- Pests
- Disease
- Floods
- Wind
- Extreme Event
- Delayed Planting
- Socio-Political
Crop Monitor Tanzania: user assessment interface
Strong interest from Ministry, Prime Minister Delivery Bureau, and Deputy Permanent Secretary to develop operationally
Uganda: Real-time DATA leading to immediate Informed DECISION

KARAMOJA FOOD SECURITY SITUATION
SEPTEMBER 2015

THE DEPARTMENT OF RELIEF, DISASTER PREPAREDNESS AND MANAGEMENT
OFFICE OF THE PRIME MINISTER

Friday 25th September 2015
Real-time DATA leading to immediate Informed DECISIONS

Food security report presented to Inter-Ministerial Committee September 25, 2015

First trucks of relief food dispatched September 26, 2015
Summary

• Critical need for improved timely, reliable within season monitoring and forecasts for informing ag decisions

• RS methods & GIS technologies are promising for implementation in operational systems to support decisions at national, regional to local scales

• Such data is also highly valuable for private industry
  – (where/when to buy/sell grain, grain storage, regions to invest in, etc)

• Still many challenges, however, RS landscape is advancing
  – Resolution, temporal repeat, quality, processing capabilities, distribution, data policy
Next Steps

• Working with Ministries towards operational monthly bulletins
• Prototyping sampling approach for condition, area and yield
• Expanding digital data collection prototype on tablets
• Working with ministry and TMA towards increasing climate station reporting in Tanzania
• Working with Ministry in Uganda on risk indicator triggers
Thank You
Unmanned Aerial Vehicles (UAVs)

Fixed Wing: senseFly eBee
  Endurance: ~25 to 35 minutes
  Weight: ~700 grams
  Sensors
    Modified canon s100 pocket cameras
    Custom Multispectral camera

Multi-rotor: Geo-Konzept x8000
  Endurance: ~20 minutes
  Sensors
    5 channel Multispectral camera
    RGB camera (Sony Nex 7)
Forest loss
Area Frame Method +
Primary Sample Units and
Ground Segments Selection
Segmentation

*UAV Test Flight Image collected with supervision by UPDF and approval from COA Moroto District
Field Boundary Delineation Using UAV Data

*UAV Test Flight Image collected with supervision by UPDF and approval from COA Moroto District