Using Cloud Computing for Mapping Seasonal Landscape Fires in Eastern Zambia

Biological Systems Engineering

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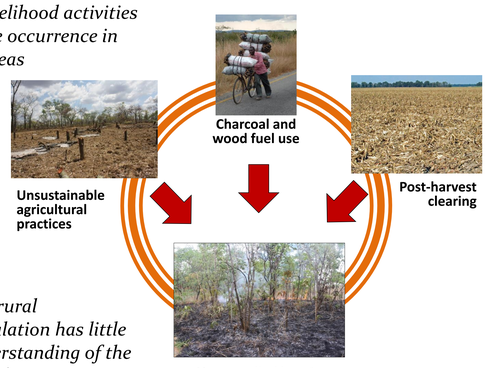
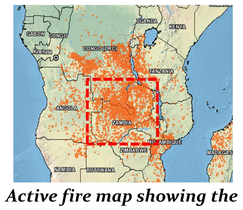
BACKGROUND

- Landscape fire is a major ecosystem disturbance in Eastern Zambia, but budgetary constraints, lack of qualified personnel, and low political will, result in poor fire management.

Rural livelihood activities drive fire occurrence in many areas



The rural population has little understanding of the broader ecosystem impact of landscape burning, and there are no effective cultural or legal deterrents.

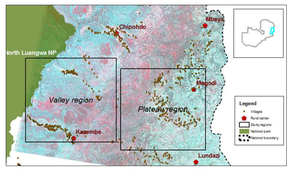


Active fire map showing the extensive burning in Zambia

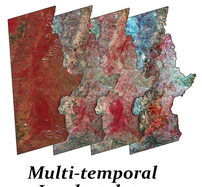
The result -- fires burn out of control over large areas in the dry season.

RESEARCH

- To address the burned area information gap in Zambia, we developed a seasonal burn mapping method using free Landsat data.



Study area in Eastern Zambia showing plateau and valley regions



Multi-temporal Landsat data

We use a multi-temporal analysis approach to gain insight into the temporal as well as spatial patterns in landscape fires in Eastern Zambia.

- Analysis using mid-infrared bi-spectral index (MIRBI) - a burn specific spectral index developed by Trigg and Flasse (2001)

$$MIRBI = 10\rho_{SWIR} - 9.8\rho_{LNIR} + 2.0$$

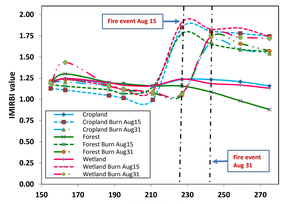
where ρ_{SWIR} and ρ_{LNIR} is band 7 and band 5 in Landsat 7 respectively

Cloud computing

- In addition, we are exploring the utility of cloud computing platforms such as the Google Earth Engine as a way to handle the massive amounts of earth observation data for large areas.

MAPPING BURNED AREAS

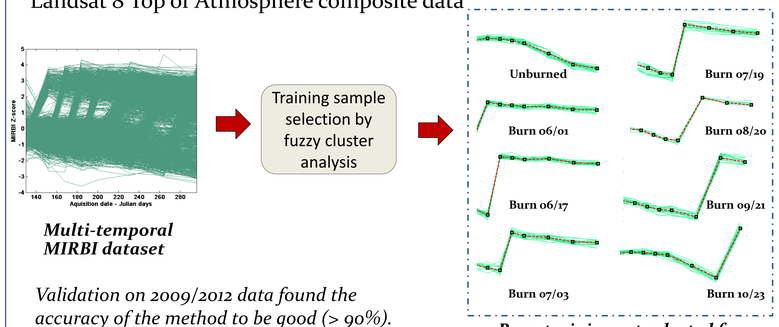
- The new multi-temporal classification algorithm provides an automated method for temporal mapping of seasonally burned areas.



Temporal signatures for burned and unburned samples

The algorithm selects samples of spectral-temporal patterns associated with particular fire events using clustering techniques and applies these clusters to classify all of the study area.

- Training sample selection for 2013 fire season (May 1 – October 23) using Landsat 8 Top of Atmosphere composite data



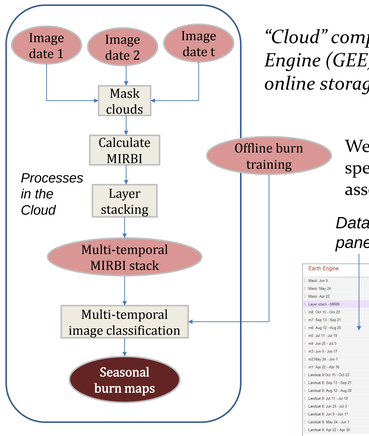
Multi-temporal MIRBI dataset

Burn training set selected from multi-temporal Landsat data

Validation on 2009/2012 data found the accuracy of the method to be good (> 90%).

USING CLOUD COMPUTING FOR BURN MAPPING

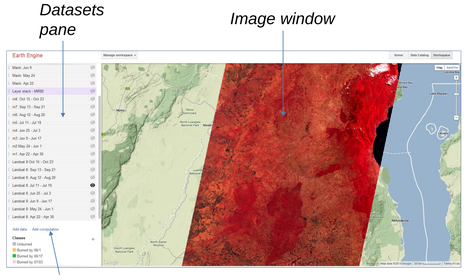
- While Landsat imagery is now free on the internet, the sheer data size presents, downloading, storage and computing difficulties.



Analysis workflow using the Google Earth Engine (GEE)

"Cloud" computing platforms such as the Google Earth Engine (GEE) can help alleviate this problem by providing online storage and superior computing power.

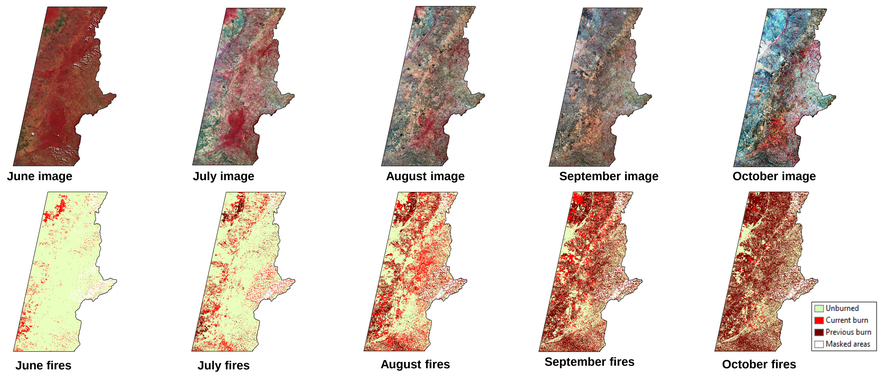
We implemented the new algorithms in GEE to speed up processing, expand the coverage area, and assess broader applicability of the tool.



Google Earth Engine Interface

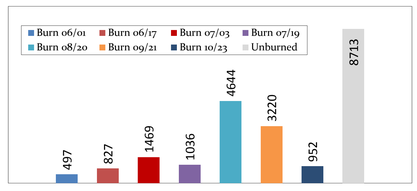
SPATIO-TEMPORAL BURN PATTERNS

- We ran the new burn mapping method on the Google Earth Engine platform to map 2013 season fires (May – Oct) for a 22,637 sq.km area in Eastern Zambia using Random Forests.

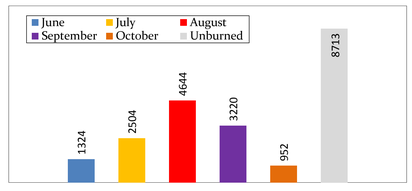


Seasonal fire progression June to October 2013

- The distribution of burned area was derived by summarizing the burned area maps by date and then aggregating by month.

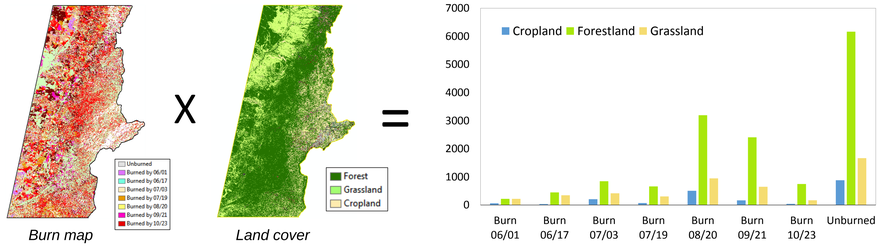


Area burned by mapping date



Area burned by month in 2013.
(Note that over 60% of the area was burned by Oct 23)

- The seasonal fire maps were combined with land cover information to determine the fire distribution by land cover.



Burned area by land cover

CONCLUSIONS

- **By capturing the spatio-temporal progression of fire events, this new method provides better information for fire management. Combining the fire information with land cover data provides detailed information that can be used to guide impact assessment or carbon emission estimates**
- **Assessment of 2013 seasonal fires in Eastern Zambia using Landsat 8 data shows the majority of fires occur in forest and grassland areas, and the progression of burning is similar in all land covers, peaking in August**
- **Misclassifications were observed in cloud and cloud shadow areas that were not successfully eliminated in the masking step. Work is underway to improve the cloud/shadow masking.**

Malambo L. and Heatwole C.D (2014) *Using Cloud Computing for Mapping Seasonal Landscape Fires in Eastern Zambia*. Presented at OGIS Symposium, 4th April 2014, Virginia Tech, Blacksburg, VA USA