GC51F-1132: Assessment of a spatially and temporally consistent MODIS derived NDVI product for application in index-based drought insurance

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Abstract

In arid and semi-arid regions of Eastern and Southern Africa, drought can be devastating to pastoralists who depend on healthy vegetation for their herds. The Kenya Livestock Insurance Program addresses this persistent challenge through its insurance program that relies on a vegetation index product derived from eMODIS NDVI (enhanced Normalized Difference Vegetation Index). Insurance payouts are triggered when index values fall below a certain threshold for a Unit Area of Insurance (UAI).

This study produced an updated, cloud-based NDVI product, potentially allowing for earlier payouts which may equip herders to prevent, minimize, or offset drought-induced losses.

This product, named reNDVI (rapid enhanced NDVI), is compared to the existing NDVI product using statistical analyses to test its potential as a suitable replacement. Statistics included correlation, regression analysis, and mean absolute percent difference (MAPD).
Implications in potential payout differences were also evaluated.

The products show good comparability; monthly average NDVI per UAI have correlation values over 0.95 and MAPD under 5% for most UAIs. However, there were moderate differences when assessing year-to-year payout amounts triggered. Because the payouts are currently calculated based on the 20th and 1st percentile of index values from 2003-2016, payouts are very sensitive to even small changes in NDVI. The updated reNDVI product shows promise as a lower-latency vegetation index that could address a pressing drought insurance challenge.

Objectives

- Implement a smoothed NDVI product similar to FEWS NET eMODIS NDVI on the Google Earth Engine (GEE), an open-source cloud-based analysis platform which will allow the index to be calculated simultaneously
- Compare and evaluate the two NDVI time series
- Reduce the latency of the new NDVI product

Acknowledgements

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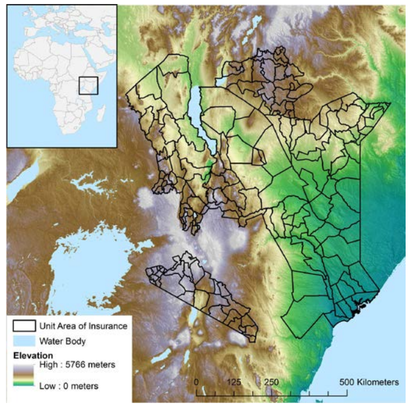
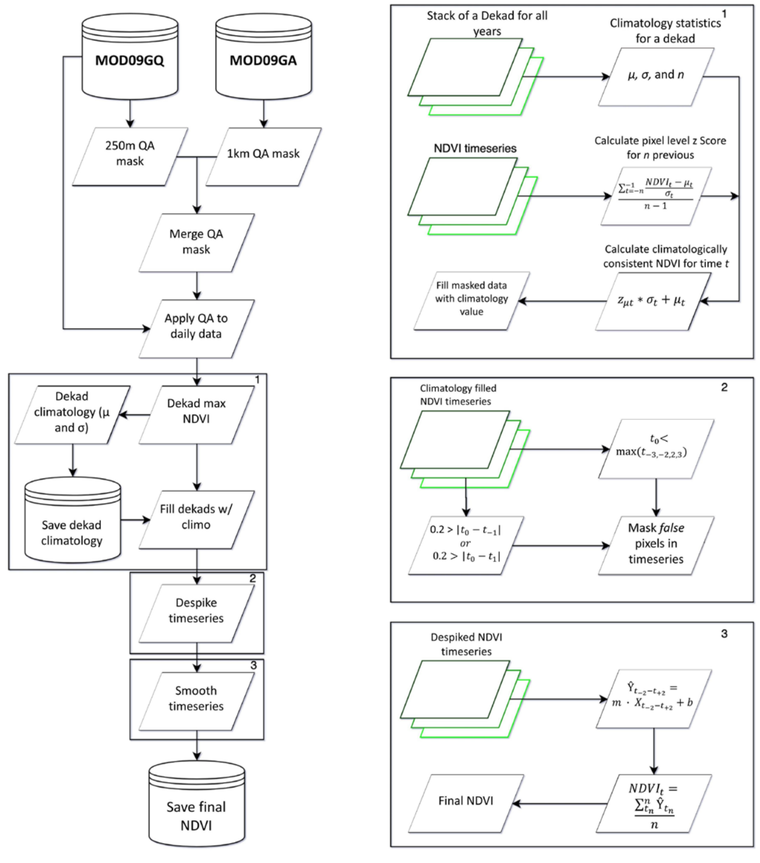
Methodology



Study area showing elevation from the Shuttle Radar Topography Mission (Farr et. al., 2007) and Unit Areas of Insurance.

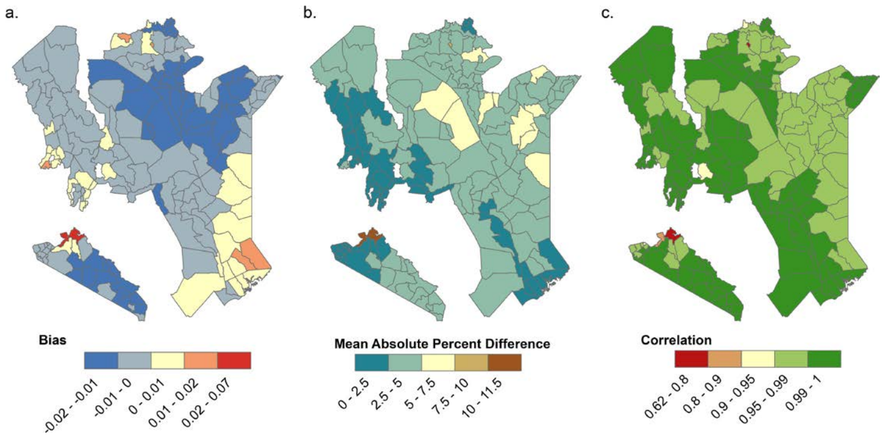
- reNDVI production
  - -Quality masking
  - - Calculate NDVI
  - -Aggregate over dekads
  - -Despike
  - -Smooth
- Evaluate output by comparing to FEWSNET eMODIS NDVI
  - -Calculate bias, mean absolute percent difference (MAPD), and correlation
  - - Compare hypothetical payouts



Flow chart schematic for creating the reNDVI dataset. Overarching flowchart is provided on the left where specific information on component processing is provided on the right

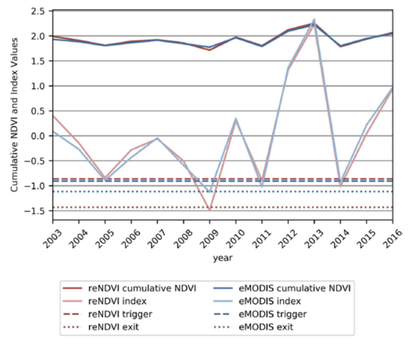
Results

- Statistics at UAI level show good comparability between FEWS NET eMODIS NDVI and reNDVI
- Areas with higher bias, high MAPD, and low correlation correspond with areas of high cloud cover



Bias (a), MAPD (b), and correlation (c) of mean monthly NDVI at UAI level

Payouts were calculated using the z score of cumulative NDVI for each rain season. If the score fell below the 20th percentile of index values from 2003-2016, a payout is triggered. Payouts are calculated as a linear function from the trigger (20th percentile) and exit (1st percentile) of index values.



	eMODIS	sMODIS
2003	0	0
2004	0	0
2005	0	21.51379
2006	0	0
2007	0	0
2008	0	0
2009	100	100
2010	0	0
2011	55.86	0
2012	0	0
2013	0	0
2014	10.46	62.31098
2015	0	0
2016	0	0

Because the difference between 20th and 1st percentiles can be very small for some UAIs, small change in index values can result in a large payout difference, as shown above.

Conclusions

- A replicated cloud solution that mimics FEWSNET process was developed.
- Initial comparisons show promising comparability, however, comparison of calculated payouts shows how sensitive index-based insurance can be to minor changes.
- Differences between products could be due to different filtering processes – reNDVI removes all low quality pixels and allows no data values, whereas eMODIS uses the highest quality pixel available even if it is not a good quality pixel.
- Future work will examine the use of machine learning to produce smoothed NDVI results at reduced latency using Combination of Convolution (space) and Recurrent (time) neural net application and the addition of other remotely sensed inputs to improve the insurance product.

QUESTIONS?
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