



Analyzing patterns of post-monsoon stubble burning in Lakhimpur Kheri, India from 2014-2018

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1. Introduction

Every year across India, farmers light small fires between September and December (post-monsoon season) in a practice called "stubble burning". This burns off the leftover plant material from the harvest and readies the land to be sown again for the next growing season. Since agriculture is still pre-industrialized in India, there is a lack of understanding of the frequency, duration, and effects of these fires. This is where satellite imaging can help.

Research Question:

- How can NBR and dNBR metrics, alongside Landsat imaging, be used to track the patterns and changes in crop-burning across a certain timespan?

2. Methods and Data



- Our study focused on the stubble burning occurring in Lakhimpur Kheri, the largest agricultural district in Uttar Pradesh, India (pictured left).
- Lakhimpur Kheri is an agrarian district, with a gross cropped ranging from 500-700ha, (65-92%) of its total area, with primarily sugarcane, wheat, and rice being grown.

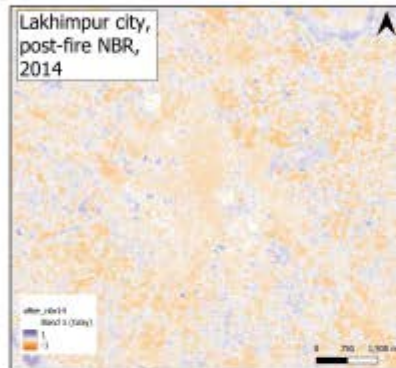
Data:

- Landsat 8/9 OLI/TIRS C2 L2 Imagery (20 images)
- Lakhimpur Kheri district shapefile
- GLAD Global Land Cover and Land Use Change dataset

Methods:

- Image preprocessing done in R Studio
 - Cropping, masking, reclassifying, rescaling
 - Cloud correction using aerosol band
 - Mosaic/merging panels
- NBR and dNBR calculations also done in R
 - NBR equation: $NBR = (NIR - SWIR) / (NIR + SWIR)$
 - dNBR equation: $dNBR = NBR_{pre-fire} - NBR_{post-fire}$
- Classification and visual representation (QGIS)
 - dNBR values classified using USGS burn severity scheme

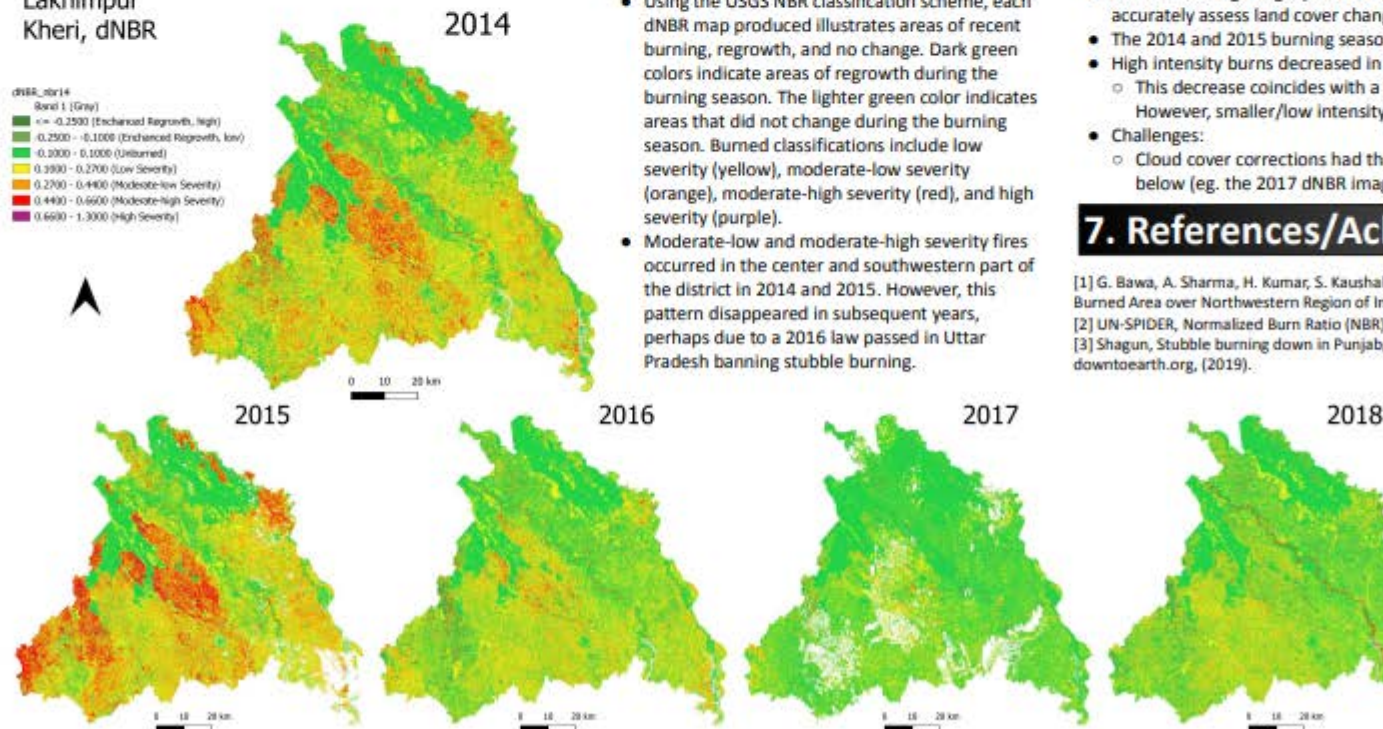
3. NBR Results



- NBR values were found for ten different images: five for pre-fire season images and five for post-fire season images (ie. two images per year from 2014-2018: one pre-fire NBR and one post-fire NBR). Pictured to the left is a cropped sample image where values of 1 indicate vegetation while values of -1 indicate burned areas.

4. dNBR Results

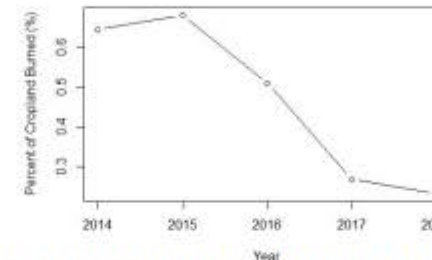
Lakhimpur Kheri, dNBR



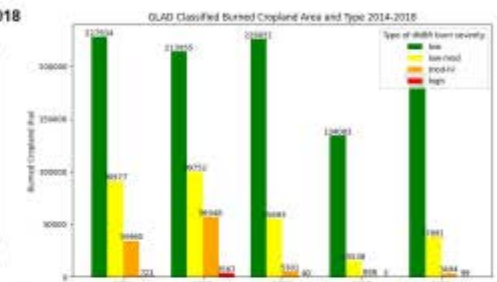
- Using the USGS NBR classification scheme, each dNBR map produced illustrates areas of recent burning, regrowth, and no change. Dark green colors indicate areas of regrowth during the burning season. The lighter green color indicates areas that did not change during the burning season. Burned classifications include low severity (yellow), moderate-low severity (orange), moderate-high severity (red), and high severity (purple).
- Moderate-low and moderate-high severity fires occurred in the center and southwestern part of the district in 2014 and 2015. However, this pattern disappeared in subsequent years, perhaps due to a 2016 law passed in Uttar Pradesh banning stubble burning.

5. Burn Area Estimates Post-2016 Ban On Burning

Percent of GLAD Classified Cropland Burned 2014-2018



GLAD detected 549824 hectares of cropland in 2012-15 and 559961 hectares of cropland in 2016-19. 354092 hectares experienced low-high burn severity in 2014, 374222 hectares experienced burning in 2015, 285342 hectares experienced burning in 2016, 150521 hectares experienced burning in 2017, and 129945 hectares experienced burning in 2018.



6. Conclusions

- Remote sensing imagery and NBR/dNBR metrics may be used to accurately assess land cover change due to extensive cropland burning.
- The 2014 and 2015 burning seasons saw the highest intensity fires.
- High intensity burns decreased in 2016 and following burn seasons.
 - This decrease coincides with a stubble burning ban in Uttar Pradesh. However, smaller/low intensity burns still occurred from 2016-18.
- Challenges:
 - Cloud cover corrections had the potential to obfuscate ground cover below (eg. the 2017 dNBR image).

7. References/Acknowledgements

- G. Bawa, A. Sharma, H. Kumar, S. Kaushal, Trend Analysis in Landsat Based Scheme for Burned Area over Northwestern Region of India, IEE (2022).
- UN-SPIDER, Normalized Burn Ratio (NBR), United Nations, un-spider.org.
- Shagun, Stubble burning down in Punjab, Haryana, UP since 2016: NASA maps, downtoearth.org, (2019).

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