Global Forest Disturbance: Detection, Classification and Driver Analysis

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ABSTRACT

Forest is one of the most important surface coverage types. Monitoring its disturbance is of great significance in global ecological environment monitoring and global carbon research. Here, we present an approach, **continuous change detection and classification model based on spectral trajectory breakpoint recognition (CCDC-STBR)**, which is able to work on Google Earth Engine (GEE) for monitoring forest disturbance and forest long-term trends. Next, we select classification samples for 3 disturbance types: logging, fire, and agricultural reclamation, and analyze the temporal variation of the samples. The effects of climate change and human activities on forest structural density were further analyzed. The study shows that **CCDC-STBR can generate high-precision disturbance classification maps** and **detect the occurrence of forest disturbances over a monthly scale**, which was not possible with earlier studies. **Human factors are the second-most important driver of forest structural density.**

CCDC-STBR

The application of the CCDC-STBR algorithm to forest monitoring can be divided into four steps: (1) selection of breakpoint recognition bands or detection indexes; (2) time series fitting with a harmonic model; (3) forest disturbance detection by breakpoint detection method; (4) disturbance type classification and mapping.

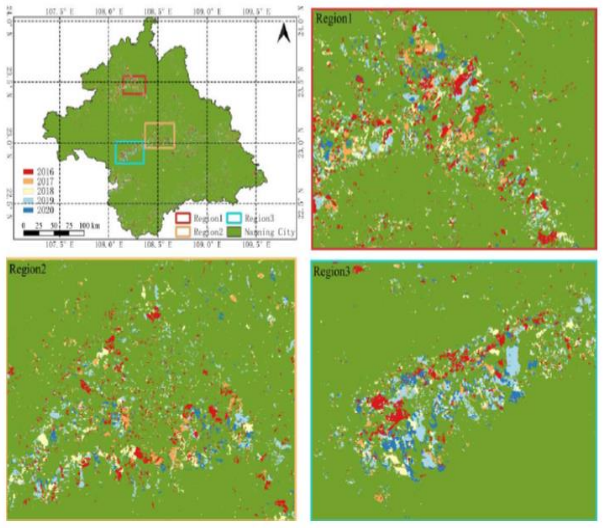
$$\rho(i,t)_{simple} = a_{0,i} + b_{0,i} \times x + a_{1,i} \times \cos\left(\frac{2\pi}{T}x\right) + b_{1,i} \times \sin\left(\frac{2\pi}{T}x\right)$$

$$\rho(i,t)_{simple} = a_{0,i} + b_{0,i} \times x + a_{1,i} \times \cos\left(\frac{2\pi}{T}x\right) + b_{1,i} \times \sin\left(\frac{2\pi}{T}x\right) + a_{2,i} \times \cos\left(\frac{4\pi}{T}x\right) + b_{2,i} \times \sin\left(\frac{4\pi}{T}x\right)$$

$$\rho(i,t)_{simple} = a_{0,i} + b_{0,i} \times x + a_{1,i} \times \cos\left(\frac{2\pi}{T}x\right) + b_{1,i} \times \sin\left(\frac{2\pi}{T}x\right) + a_{2,i} \times \cos\left(\frac{4\pi}{T}x\right) + b_{2,i} \times \sin\left(\frac{4\pi}{T}x\right) + a_{3,i} \times \cos\left(\frac{6\pi}{T}x\right) + b_{3,i} \times \sin\left(\frac{6\pi}{T}x\right)$$

DISTURBANCE DETECTION

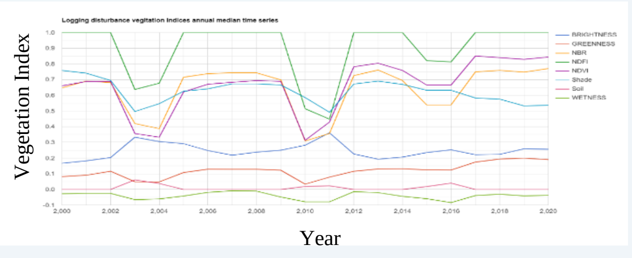
Figure shows forest loss in Nanning, China from 2016 to 2020. The classification accuracy of forest, non-forest and water maps using the optimal classification feature was 95.16%.



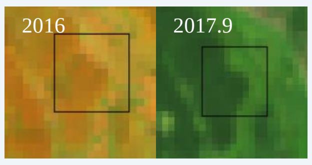
For disturbance detection, our map accuracy is 86.4%。

DISTURBANCE TYPE CLASSIFICATION

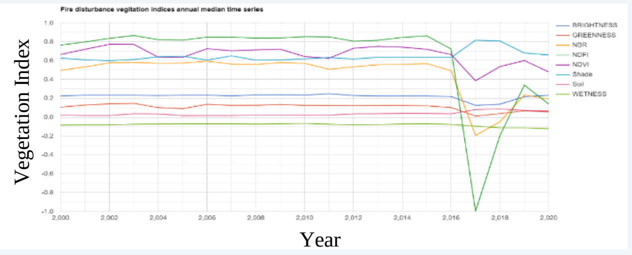
Logging



Fire

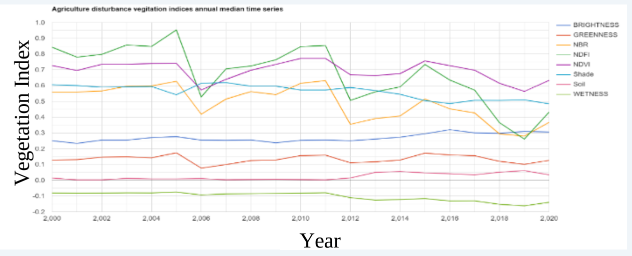


Landsat false color composite figures (Band Information). The fire broke out in August 2017.



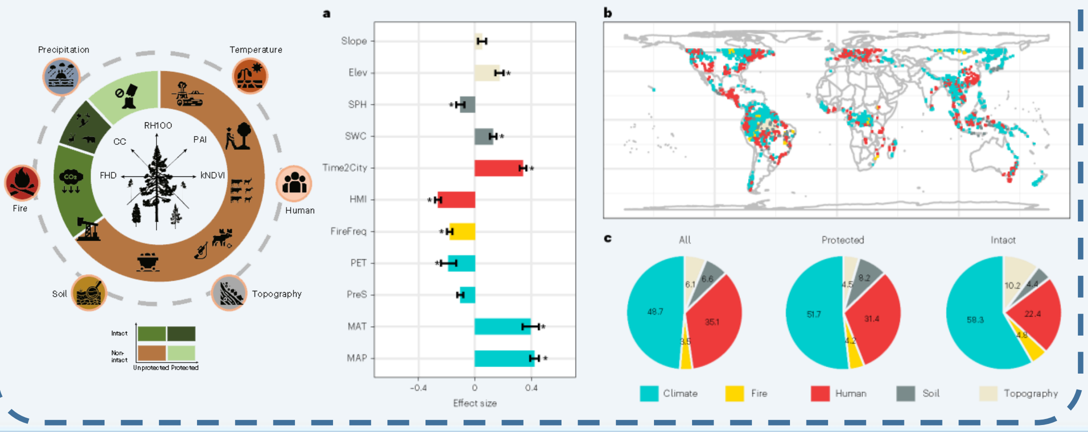
Agricultural Reclamation

In central Africa, forests have been cleared for agricultural purposes.



DRIVERS OF FOREST STRUCTURAL

Climatic factors generally had the highest effect, followed by human factors, both at global (a) and regional (b) scale. However, **human factors were the second-most frequent dominant driver of forest structural density, being the dominant driver in 35.1% of forest grid cells** (c). Besides, strong human impacts on forest structure are widespread even in protected and seemingly intact forests.



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