The Sentinel GreenReport Application using Google Earth Engine

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Background

Multi-date composited Normalized Difference Vegetation Index (NDVI) data are commonly used for examining vegetation growth, condition, and composition. NDVI is calculated from the visible and near-infrared light reflected by vegetation (NDVI = (NIR - R) / (NIR + R)). When you have high NDVI values, you have healthier vegetation. When you have low NDVI, you have less or no vegetation (Fig. 1).

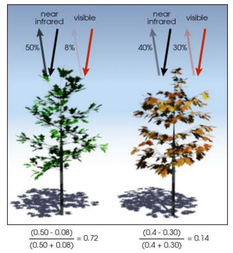


Figure 1 NDVI Overview

Abstract

The Sentinel GreenReport is developed as an application leveraging Google Earth Engine (GEE) to measure and monitor vegetation across the United States (Fig.2). Four maps are created from the Sentinel archive to characterize vegetation greenness for the area of interest: 1) Greenness Map - represents NDVI, which is a surrogate for photosynthetically active plant biomass, for a user-defined composite period; 2) Difference Map 1 - compares NDVI to the previous composite period within the same year to illustrate recent vegetation change; 3)Difference Map 2 - compares NDVI to same period from the previous year to examine year-over-year vegetation change; 4) Difference Map 3 - compares current NDVI to the average NDVI from previous years to examine vegetation change relative to the recent average. Cloud cover is removed based on Sentinel-2 cloud probability dataset and cloud shadow is masked by cloud projection intersection with low-reflectance near-infrared (NIR) pixels. The Sentinel GreenReport is delivered through a GEE Application. As a cloud/browser-based platform, GEE accesses high-quality computing resources for handling massive geospatial datasets without experiencing the computational pains in large-scale geospatial analysis. The published Sentinel GreenReport App makes the data easily accessible to stakeholders, both GIS and

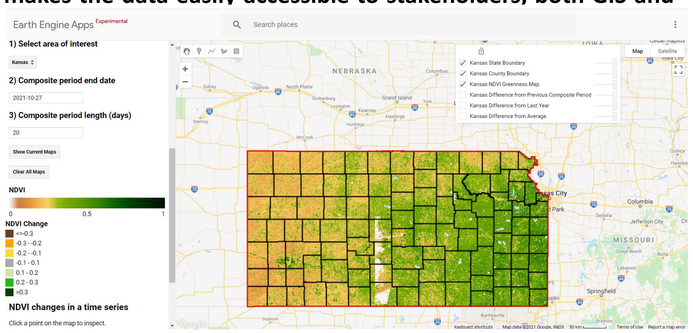


Figure 2 Sentinel GreenReport User Interface

https://water2019.users.earthengine.app/view/greenmapkbsupdated

Advances in Sentinel GreenReport

1) Higher Spatial Resolution: the Sentinel GreenReport is produced using NDVI images derived from 10 m Copernicus Sentinel-2 imagery from 2015-present. Compared with the previous GreenReport that uses MODIS NDVI imagery The GreenReport (ku.edu), the four map products have higher spatial and temporal resolution as indicated in Fig. 3 & 4.

2) Flexible Composite Period: the compositing period can be selected equal or larger than 5 days for a given site. This provides flexibility with regard to local cloud coverage conditions and enables the production of a high-quality information.

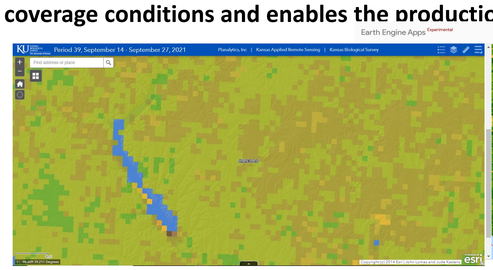


Figure 3 GreenReport that uses MODIS NDVI imagery

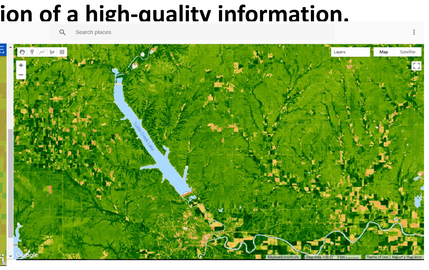
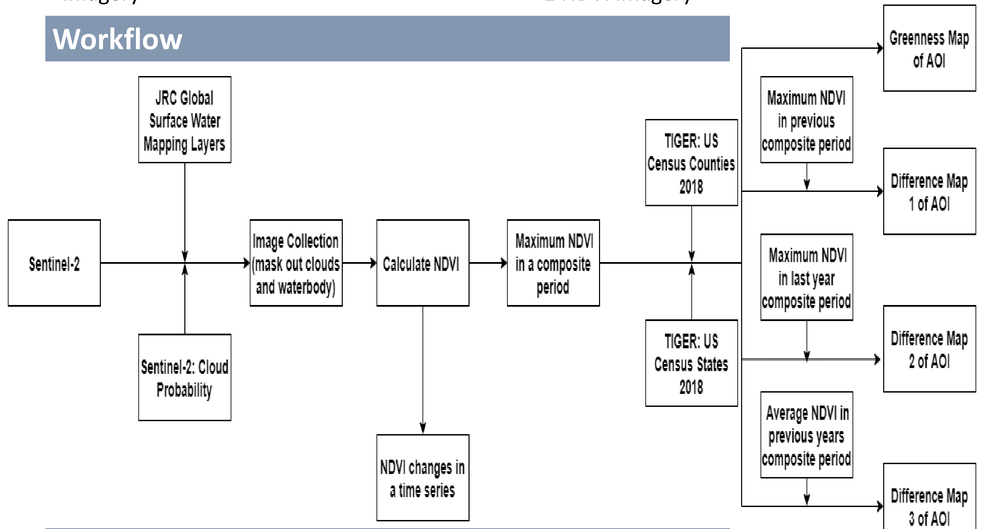


Figure 4 GreenReport that uses Sentinel 2 NDVI imagery

Workflow



Practical Application

1) Crop Monitoring

The Sentinel GreenReport can help with timely identifying the fields on which crops are developing poorly, and to take corresponding management decisions. The multiple circles as indicated in Fig. 5 represent crops: the green color means high water content in vegetation and wider vegetation cover, while the yellow to brown color corresponds to low vegetation biomass and more exposed soil, as crops in central pivots are subjected to irrigation management.

Analyzing the NDVI index by year will help to determine the productive and unproductive fields and this information will help to form a crop rotation optimally. For example, Fig. 6 shows crop rotation near Arkansas River by comparing this year maximum NDVI with the past year NDVI in September: the green color refers to wheat (last year) and corn/soybean (this year); whereas the brown color means the opposite.

2) Investigating Vegetation Damage

The Sentinel GreenReport can help with tracking vegetation damage during and after a disaster, such as flooding, windstorm or natural fire. For example, the flood damages on vegetation in May 2019 in Emporia is detected through the Greenness Map as indicated in Fig. 7B. The yellow color around the Neosho River points out devastated area of vegetation. The brown color on the Difference Map 3 as shown in Fig. 7C also proves the affected vegetation by comparing the maximum NDVI in May 2019 with the average maximum NDVI in May from 2016-2018.

The vegetation damage due to the Derecho Windstorm on Aug 10-11th 2020 in Iowa (Fig. 8a) is identified through the Greenness Map (Fig. 8b): the green inside of the red circle is lighter compared with the surrounding area. Difference Map 3 (Fig. 8c) shows the detail of the right red circle on Fig. 8b, the brown color indicates the vegetation had been destroyed by the storm based on the comparison between the maximum NDVI in August 2020 to the average maximum NDVI in August 2019.

Figure 5 Greenness Map of Garden City, Kansas

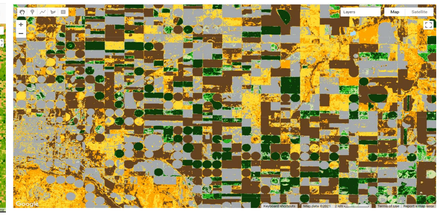
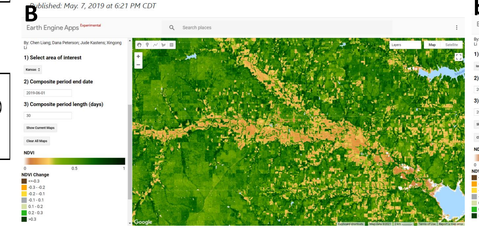


Figure 6 Difference Map 1 of Garden City, Kansas



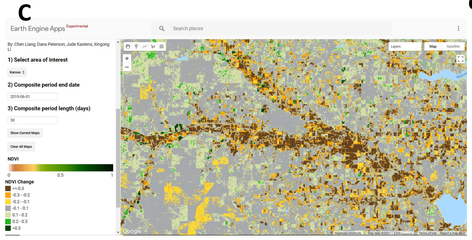


Figure 7 A) Flood in May 2019 in Emporia; B) Difference Map 1 of Neosho River; C) Difference Map 3 Around Neosho River;

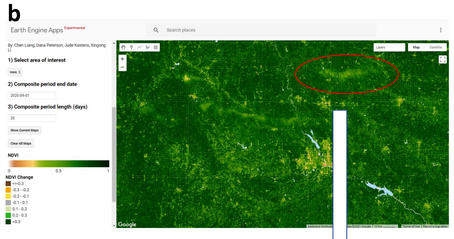


Figure 8 a) Derecho Windstorm on Aug 10-11th 2020 in Iowa; b) Greenness Map of Iowa; c) Difference Map 3 of Garden City, Iowa;