Exploring Land Use Change In Singapore Using Google Earth Engine

Nanki Sidhu[1], Edzer Pebesma[1], Gilberto Camâra[1,2]

ifgi
Institute for Geoinformatics
University of Münster

1.Institute for Geoinformatics, Westfaelische-Wilhems Universitaet, Muenster
2.National Institute for Space Research, Brazil

Abstract

This paper investigates the web based remote sensing platform, *Google Earth Engine*, and evaluates the utility of this platform for performing raster, vector and array manipulations on Landsat, MODIS and GlobCover (2009) imagery. We assess its capacity to conduct space-time analysis over two sub-regions of Singapore, namely Tuas and the central catchment reserve, for *urban* and *wetlands* land use classes. In its current state, this platform has proven to be a powerful tool by providing access to a wide variety of imagery in one consolidated system. Furthermore, it possesses the ability to perform spatial aggregations over global-scale data at a high computational speed. By testing the limits of such a platform, we also examine the challenges that *Google Earth Engine* faces, which are common to most parallel processing, big-data architectures. Supporting both spatial and temporal analysis is not an obvious task. The ongoing refinement of this system makes it a valuable and promising tool for big data analysts from diverse user groups.

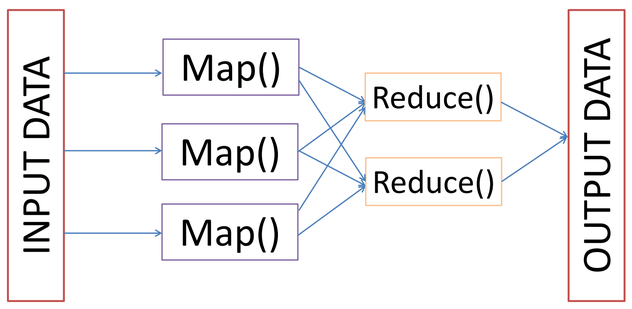
As a use case for exploring *Google Earth Engine*, we are also able to analyze Singapore's land use and land cover. We highlight the change in Singapore's land mass due to the widespread practice of land reclamation, mainly through dredging. Also, within the region of the central catchment reserve, which is a large protected area, we find that the forest cover is not affected by anthropogenic factors, but instead is driven by the monsoon cycles that affect South-east Asia.

Introduction

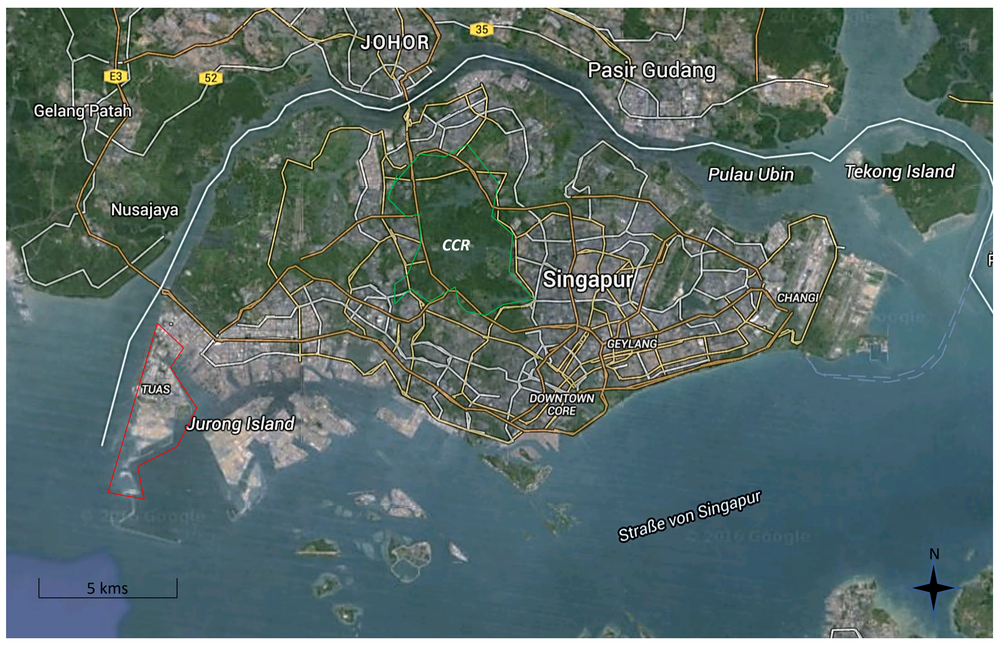
The modification of the planet's terrestrial surface on the local, national and international levels is one of the major anthropogenic factors that contribute to ecosystem change.

Satellite imagery is one of the primary sources of information and analysis when it comes to land use and land cover. **Large amount of earth observation data is available for a wide range of purposes.** This data usually comes with varying characteristics (spatial, temporal, collection). **This gives rise to not only a variety of data, but also makes it imperative to handle these large volumes of data in an efficient manner.**

Presently, ***MapReduce***[1] is a widely utilized method for parallel processing. This method is still used by Google to handle queries for their applications, including Google Earth and Google Maps.

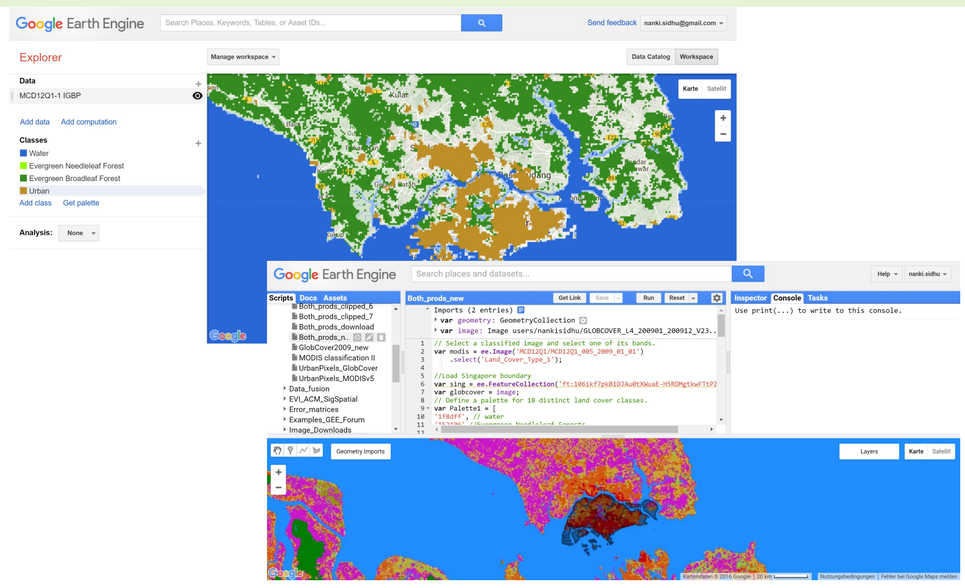


Objectives + Study Site



1) Evaluation of Google Earth Engine (GEE) as a web-based remote sensing platform.
2) Explore the dynamic land cover of Singapore over several years.
3) Testing GEE's ability of performing spatial and temporal aggregations.
4) Analyze if urban growth can be captured using Enhanced Vegetation Index (EVI) signals.
5) Does the *Central Catchment Reserve (CCR)* "change" ?

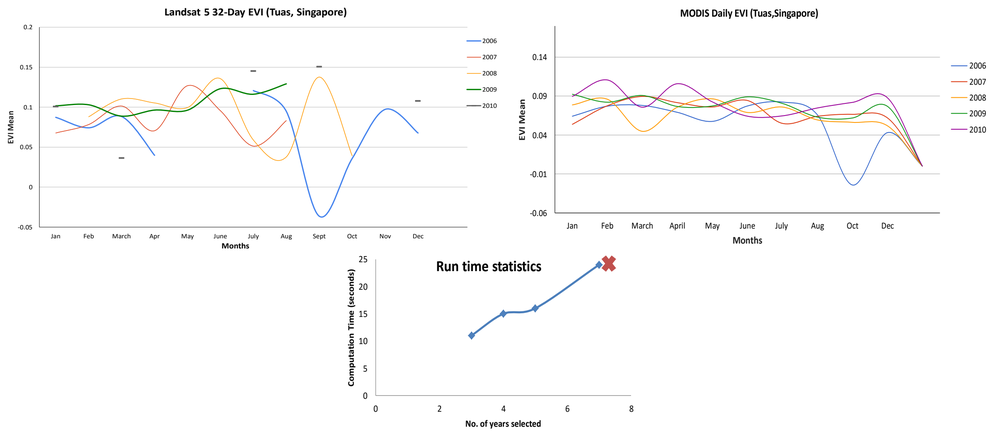
Google Earth Engine



Results

- GEE's *tile-by-tile* algorithm for data processing is highlighted.
- Efficiently scans through image collections for calculating spatial reductions.
- Face "time outs" and computation time increases when generating time series charts for more and more years.
- Temporal approximation is not as obvious as spatial aggregations.
- Changes in boundary in the Tuas industrial area, could be seen in the EVI signals.

Tuas industrial area being developed using Dredging



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