Satellite TSE: An Opensource Tool to Extract Multi-Sensor Remote Sensing Timeseries Data from Google Earth Engine's Data Catalog

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***Abstract*—Satellite Time Series Extractor (Satellite TSE) tool is a highly generic and interactive tool that can be used to extract satellite time-series data of any opensource sensor available in Google Earth Engine's data catalog. Each version of this tool is dedicated to mapping one environmental/ecological conservation quantifier. The first version (current) is focused on mapping Cyanobacterial Cell Density (CCD). Along with the environmental quantity, the tool can be used to extract True Color Composite as well as False Color Composite imagery of the study area. End output of this tool would be an animated GIF of the study area with user-specified timeframe as well as a plot showing the timeseries variation of the selected environmental quantifier. Developed using Python's interactive *tKinter* GUI package and other opensource geospatial packages viz GDAL, Geopandas, GeeMap with a cloud-based backend facilitated by Earth Engine's API, this tool is completely opensource and freely available to use via GitHub.**

***Index Terms*—time series, remote sensing, google earth engine**

I. Introduction

WITH the advent of climate change and its adversities, more and more remote sensing-based studies are focusing their research on studying ecologies, environment conservation and analyzing the overall change in a wide timescale [1]–[6]. This poses as a strong requirement of quality opensource satellite data which is densely temporal. At this point, not a lot of satellite data is opensource for such long-term time-series analysis. Most of the opensource sensors do not scale back to even a decade – European Space Agency's highly celebrated Copernicus Mission launched its first optical satellite, Sentinel-2 MSI, in July of 2015. While it carries a lot of spatial and spectral information, it becomes a hitch to go back in time while preserving this advantage. To promote such analysis, a cloud based computing engine for satellite data, Google Earth Engine (GEE) [7] was introduced. Along with the computing engine, GEE tied agreements with all satellite data providers and started hosting a data catalogue comprising of opensource as well as otherwise closed source satellite data for educational and research use. This highly helped all the timeseries based studies going on at the time and the remote sensing community saw a sharp rise in the use of GEE and its data catalogue in such studies [8]. GEE now served as a one-stop catalogue for multi-sensor data, but there was still a barrier of technical expertise and Javascript based coding to cross, for anyone who wanted to use multi-sensor timeseries data. Motivated to remove that barrier, this study is aimed at integrating multi-sensor timeseries data extraction into a highly interactive and user-friendly GUI based opensource tool called Satellite Time Series Extractor (Satellite TSE). Satellite TSE does not require one to have any coding knowledge, and it packages the whole process of looking for temporally adjacent sensors and downloading their data separately into a single tool.

II. Methodology

Satellite TSE tool was developed using Python as a base for local processes and Graphical User Interface, and GEE as an uplink for all server-based processes. This makes the tool computationally efficient as well – it does not have a high memory/GPU requirement as all image-based computations are performed on the GEE server. Figure 1 shows the overall methodology of the tool execution. Tool operation happens in two main parts – server-based operations and local operations. Server-based operations are executed on GEE server and cloud storage, and these include calculating median images, doing sensor specific preprocessing which can range from Rayleigh correction and sun-glint removal to a full-fledged atmospheric correction. Local operations mainly involve lightweight tasks such as stitching the monthly images into a mean and plotting a timeseries graph of the ecological quantifier.

A. User Inputs

Satellite TSE is a highly interactive and user-friendly tool, giving user the fine-grained control right from sensor selection to GIF transition time. This tool has the following mandatory user inputs: Sensor name, Region of Interest, Start Date, End Date; and the following optional inputs: Selecting visualizations (True Color Composite or False Color Composite) and tuning the GIF transition speed. By default, none of the two visualizations are selected and the GIF transition speed is set to 2 seconds per frame. A default visualization of a pre-decided ecological quantifier is included

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in every version of this tool.

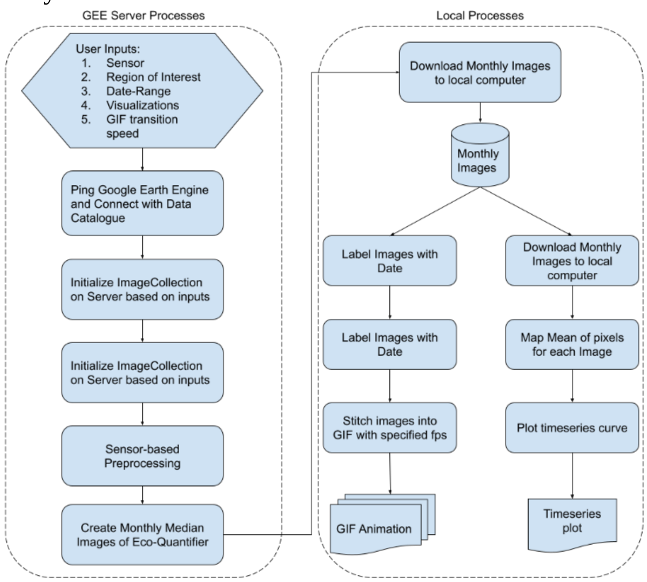

Fig. 1. Overall execution workflow of the Satellite TSE tool

III. Results and Discussion

A. Tool Specifics

This report summarizes the first version of the Satellite TSE tool. Each version of this tool is dedicated to an ecological quantifier. This version, Satellite TSE Tool v0.12, is dedicated to mapping Cyanobacterial Harmful Algal Blooms (CyanoHABs) [9]. CyanoHABs can be a great danger to a nation altogether in terms of economy and are now posing as a global health hazard due to their ability to poison entire waterbodies. Current version of this tool incorporates CyanoHAB mapping my implementing the Cyanobacterial Cell Density (CCD) algorithm [10], which estimates a Cyano-cell count from satellite based reflectance data. Currently, the tool only supports Sentinel-2 and Sentinel-3 sensors.

B. Accessibility and Installation

This tool is opensource and is freely available at https://github.com/Chintan2108/Satellite-Timeseries-Extractor-Tool. To download it, simply clone the repository and follow the instructions in the readme/user manual available on GitHub.

C. Availability and Community Contribution

Distributed under a GPL-3.0 License, there are no restrictions on how this tool is used, modified, or reproduced. Moreover, it will continue to be available on the same GitHub repository, which will host all future releases. Being an opensource paradigm, community/peer contributions are always welcome towards the development of this tool and can be made via "Pull Requests" on GitHub.

D. Demonstration and Functionalities

This subsection discusses the demonstration and functionalities of the Satellite TSE Tool. Figure 2 shows a snapshot of the GUI of the tool. In the top-down order, the functionalities of the tool include: a) A dropdown to select sensors, b) A button to browse local storage and select shapefile for region of interest, c) Text input for start date of timeseries analysis, d) Text input for end date of timeseries analysis, e) Checkboxes to select additional visualizations, f) Text input to specify GIF transition speed, g) A button to browse local storage and select output location, h) Button to Submit Request, (i) Button to Quit the tool and j) A status bar which shows what process is happening in the backend.

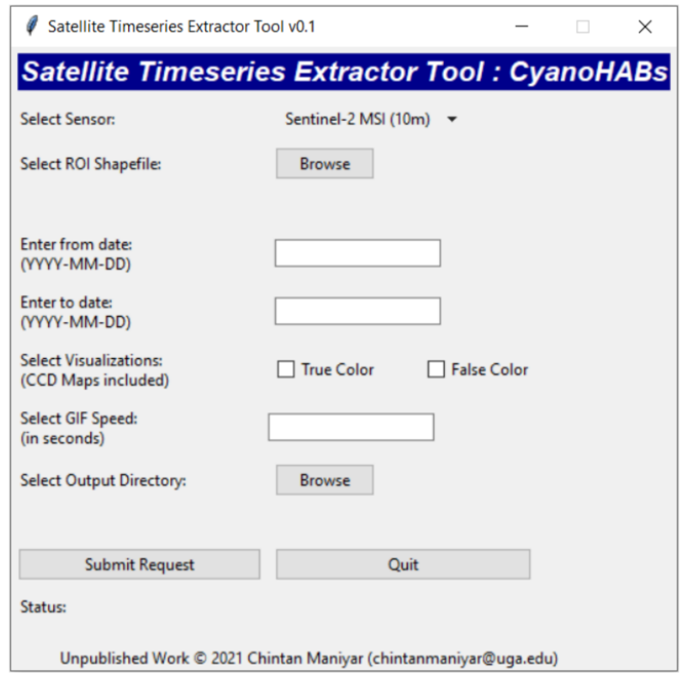

Fig. 2. Graphical User Interface of the Satellite TSE tool

E. Tool Outputs

Upon submitting the request, the tool outputs and animated GIF comprising of the satellite images which are monthly median of the timeseries period. A snapshot of one such labelled image is shown in Figure 3. Each image is labelled with its corresponding timestamp before being stitched into a GIF.

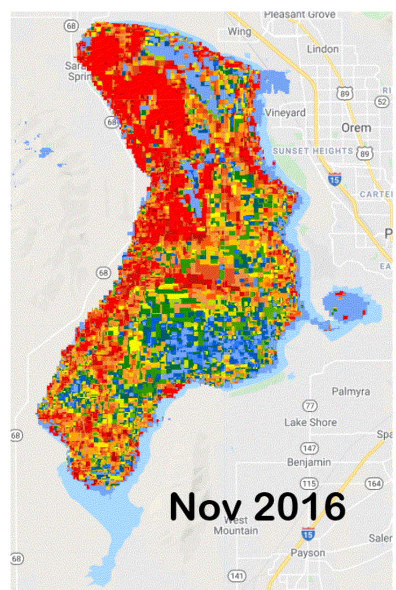

Fig. 3. A snapshot of Utah Lake's CCD Map as downloaded from GEE which serves as a part of the GIF

Apart from the GIF, that could be used for spatio-temporal analysis, viz in this case monitor and analyze the spread and severity of CyanoHABs throughout the surface of the waterbody with time; all the individual images are used to plot a timeseries variation of the ecological quantifier. Each image is used to map a mean function and a mean CCD value for the selected region of interest is determined per month, which is then plotted against time. Figure 4 shows one such timeseries of CyanoHABs at Utah Lake, Utah, from Oct 2016 to Feb 2018.

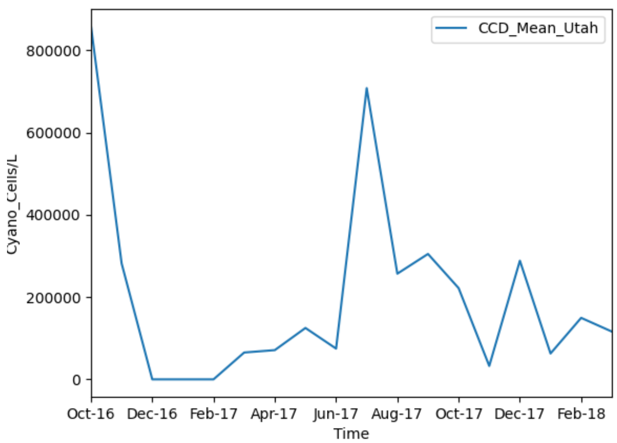

Fig. 4. CCD Timeseries for Utah Lake

IV. Conclusion and Future Work

Satellite TSE tool was proposed with the motivation and aim of having an opensource user-friendly interface which would allow anyone to browse GEE's data catalog without having to code anything at all. The main focus of this tool was to extract timeseries data for a set ecological quantifier in the form of an animated GIF which would enable spatio-temporal analysis, as well as a timeseries plot of the quantifier, which would allow a more detailed analysis across time. While the first version of this tool focuses on CCD, further versions of this tool can focus on any ecological quantifier that can be realized by remote sensing and satellite imagery – for instance NDVI, NDCI, socio-economic variables, health indices etc. Moreover, current version of the tool only includes two sensors namely Sentinel-2 and Sentinel-3. A definite future enhancement of the tool would be by adding more and more sensor support for more rigorous timeseries analysis. For instance, adding Landsat data would enable analysis starting from over a decade back, instead of just 2016 (Sentinel-2).

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VI. References

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