LINDEX, an End-to-End Landsat-8 Timeseries Index Processing Framework

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Background

- Timeseries index analysis of satellite data can be used to track changes in a variety of physical and ecological parameters over time.
- Major limitations in the use of bulk datasets and satellite image archives are the time intensive data decompression, extent processing, cloud detection, and index analysis.
- LINDEX was developed as a single tool to address these limitation by taking advantage of open-source tools and packages to automate data preparation and analysis. This results in a 94% reduction in analysis time and the ability to tailor the index used to meet unique research goals.

Objectives

1. Create a tool to assist researchers in doing timeseries index analysis by automating the decompression, cropping, and analysis of Landsat data.
2. Create a customizable framework for researchers to deploy any index of interest.
3. Containerize the tool for easy deployment in any local or cloud computing environment and to increase analysis reproducibility.

Table 1: Technologies and Python packages used.

Technologies	Python Packages
Docker	OpenCV
Singularity	GDAL
QGIS	Rasterio
Lat Lon Tools	MoviePy
USGS Earth Explorer	Matplotlib
USGS Bulk Download Application	Xtarfile

Open-Source Code:

https://github.com/Travis-Simmons/LINDEX

Container hosted at:

https://hub.docker.com/repository/docker/travissimmons/lindex

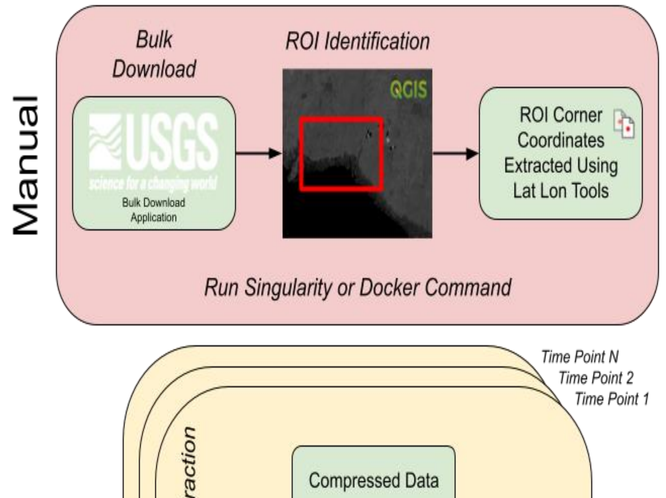

Figure 1: LINDEX deployment workflow.

Table 2: Available indices.

Index	Formula
Normalized Difference Water Index (NDWI)	(NIR-SWIR)/(NIR+SIWR)
Normalized Differencce Vegetation Index (NDVI)	(NIR-RED)/(NIR+RED)
Enhanced Vegetation Index (EVI)	G*((NIR-RED)/(NIR+C1*R-C2*BLUE+L))
Advanced Vegetation Index (AVI)	(NIR*(1-RED)*(NIR-RED))^(1/3)
Soil Adjusted Vegetation Index (SAVI)	((NIR-RED)/(NIR+RED+L))*(1+L)
Normalized Difference Moisture Index (NDMI)	(NIR-SWIR)/(NIR+SWIR)
Moisture Stress Index (MSI)	MidIR/NIR
Green Chlorophyll Index (GCI)	(NIR)/(GREEN)-1
Normalized Burn Ratio (NBR)	(NIR-SWIR)/(NIR+SWIR)
Bare Soil Index (BSI)	((RED+SWIR)-(NIR+BLUE))/((RED+SWIR)+(NIR+BLUE))
Normalized Difference Snow Index (NDSI)	(GREEN-SWIR)/(GREEN+SWIR)
Normalized Difference Glacier Index (NDGI)	(NIR-GREEN)/(NIR+GREEN)
Custom	Custom

```python
def custom_index_template(date_folder):

    # replace the underscores with the band you need, repeat as necissary
    band_ = glob.glob(os.path.join(date_folder, '*B_.TIF'))
    b_ = rio.open(band_[0])

    # After adding in each band you will be using,
    # rename then as their common name eg: nir, red, green ...
    band_name = b_.read()
    band_name = band_name.astype(float)

    # Replace index name with your index
    # do the raster math with the common names
    index_name = (band_name-band_name)/(band_name+band_name)

    # Close all the bands, repeat as necissary
    b_.close()

    # Scroll down and find 'index dict'
    # to add your index to the options before running
    return index_name
```

Figure 2: Custom index template.

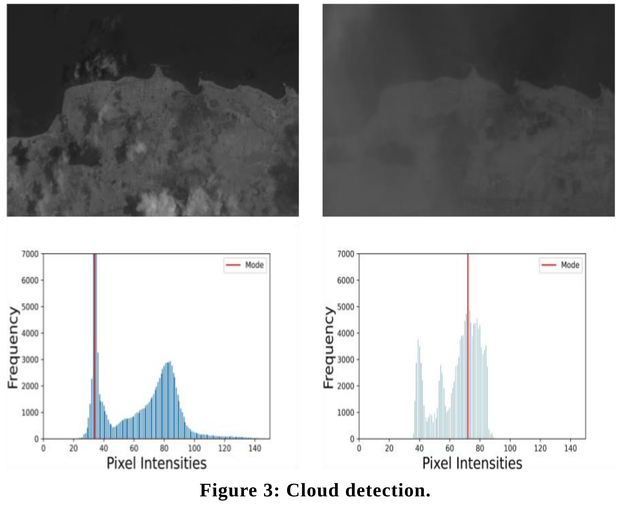

Figure 3: Cloud detection.

Use Cases

- This tool can be used to conduct any index analysis of any region at any time period covered by the publicly available Landsat-8 dataset.
- NDWI can be used to detection of seasonal wetlands and episodic flow.
- NDVI can be used for island migration tracking, crop inventory, and forest canopy tracking.
- NBR can be used for wildfire tracking.
- NDSI and NDGI can be used to track snowfall, sea ice, and glaciers.

Current Limitations

- Refinement of cloud detection approach is needed to increase the accuracy of image sorting.
- LINDEX only has one dependency, Docker or Singularity.

Future Direction

- Create a stand-alone GUI to remove dependencies.
- Extending LINDEX to other satellite datasets.
- Automatic task distribution using Makeflow and Work Queue.
- USGS Machine-to-Machine API integration.

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