

EO TIME SERIES VIEWER

A QGIS plugin to explore Earth Observation
Time Series Data

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BACKGROUND

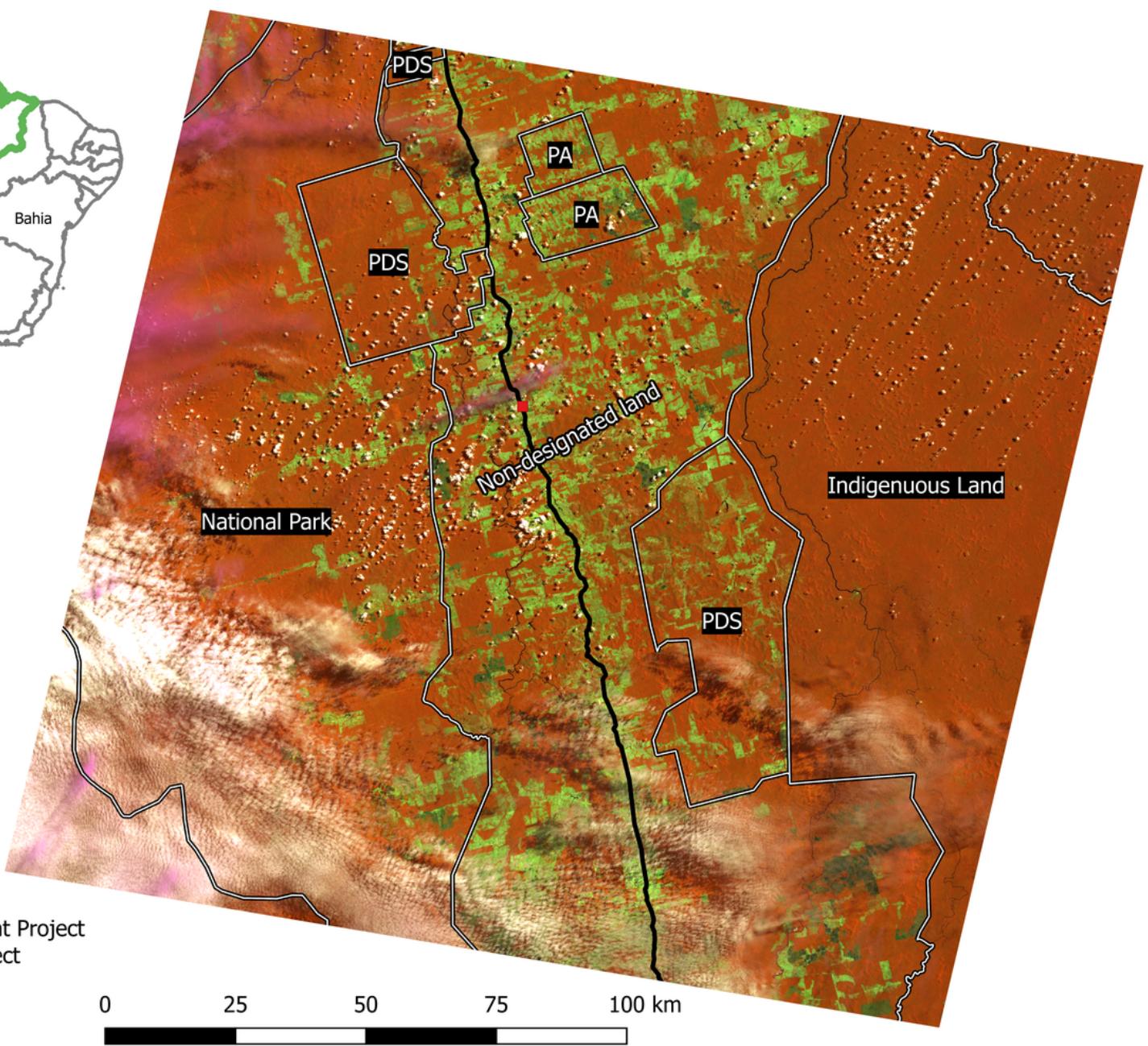


Jakimow, B., Griffiths, P., van der Linden, S. and Hostert, P. (2018): "Mapping pasture management in the Brazilian Amazon from dense Landsat time series." Remote Sensing of Environment 205: 453-468.



Study Region

- Novo Progresso
- BR-163
- Administrative boundaries
- PDS = Sustainable Development Project
- PA = Federal Settlement Project



Landsat 7

2014-07-02



Landsat 8

2014-07-10



Landsat 7

2014-07-18

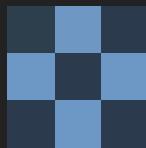


Landsat 8

2014-07-26



- Short visibility of land management
follow up management, clouds, artefacts, ...
- Identification of landcover + burning and tillage events for cal/val



Raster images

80 Landsat (ETM+, OLI), 43 RapidEye, 10 Pléiades, 5 SPOT



Raster images

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Vector maps

GPS positions, official deforestation and land cover maps, administrative units



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Field Data

Camera pictures with locations, personal notes



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Field Data

Camera pictures with locations, personal notes

Problems

- We want to visualize all data available
- Different data types, formats, resolutions

An incomplete and subjective overview on software to visualize EO raster data

GUI	TS	MM	SP	TP	VRT	Notes	
TimeSync	++	++	+	++	-	registration required, Cohen et al. (2010)	
TSTools	++	-		++	++	open source, QGIS Plugin	
	ENVI	++	+	++	++	-	commercial
	SNAP	+	+	++	+	-	open source
	GEE	++	+	+	+		online only, Gorelick et al. (2017)
	ArcGIS	-	+	+	-	+	commercial
	QGIS	-	+	+	-	+	open source

Features: TS = time series is a known concept, MM = multiple maps side-by-side, SP = spectral profiles, TP = temporal profiles, VRT = reads GDAL virtual rasters
Support: basic (+), good (++) , none (-)

GOALS / REQUIREMENTS

- Integrated & interactive visualization
spatial, spectral and temporal dimensions in EOTS

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read data "as-is": tif, bsq, hdf, shp, gpkg, vrt, ...

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- Easy adjustments of visualization settings
apply same render style to multiple observation ...

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- Easy adjustments of visualization settings
apply same render style to multiple observation ...
- Can be used offline
field work in remote areas



EO TIME SERIES VIEWER

Files View Navigation Others

Sensors / Products

	name	nb	n images	wl
0	Landsat	6	28	0.49,0.56,0.66,0.84
1	RapidEye	5	4	undefined

Maps | 2

► Map Properties

▼ Map Views

2 SWIR

Landsat

Style Multibandcolor

Default RGB nIR swIR

R NIR 2501.11 4542.65

G SWIR 984.673 2483.23

B R -81.1823 654.428

Contrast enhancement Stretch to MinMax

Temporal Profiles | 2D

Coordinate Sensor

0	<input checked="" type="checkbox"/> Location 1	Landsat
1	<input checked="" type="checkbox"/> Location 1	RapidEye

DN or Index

Data Value(s)

0% Loaded 1 pixel from 2014-07-18_LE72270652014199CUB00_BOA.tif.

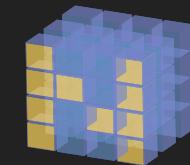
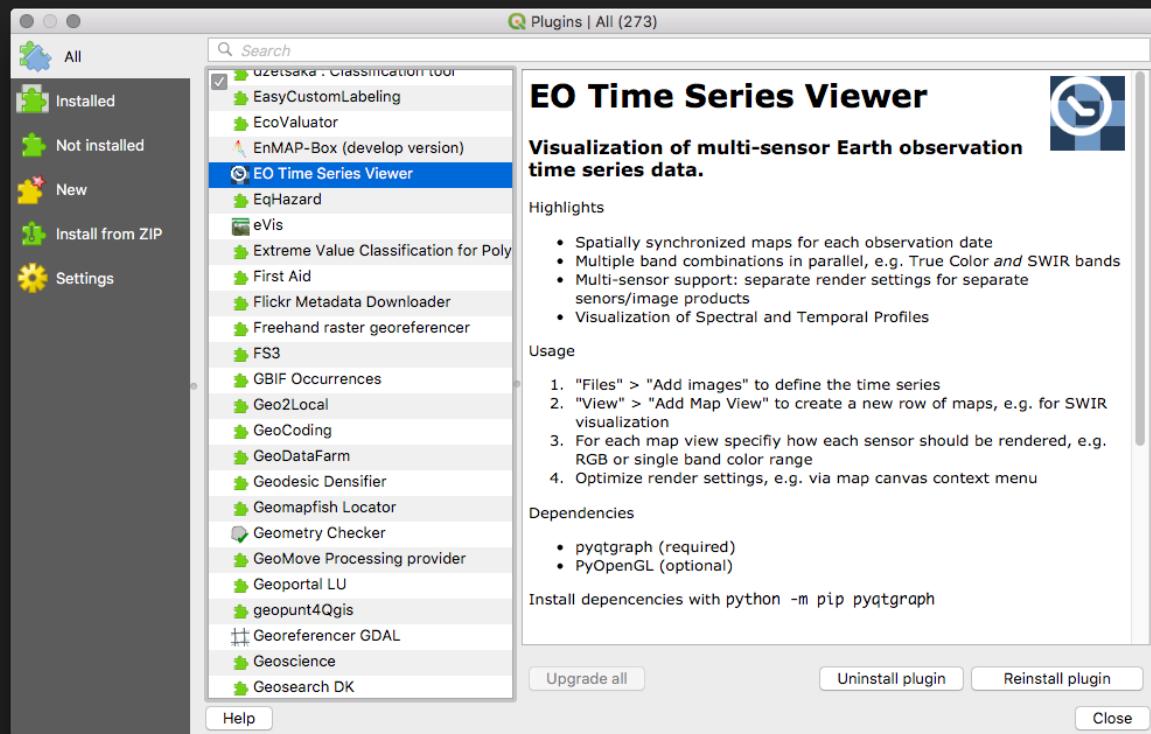
2014-08-03 Landsat 2014-08-11 Landsat 2014-08-17 RapidEye 2014-08-19 Landsat 2014- RapidEye

Spectral Library



Official QGIS 3 plugin

plugins.qgis.org/plugins/timeseriesviewerplugin/



NumPy

PyQtGraph



ADD IMAGES



Time Series								
	Date	Sensor	ns	nl	nb	CRS	Image	
16	<input checked="" type="checkbox"/> 2014-08-03	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-08-03_LE72270652014215CUB00_BOA.tif	
17	<input checked="" type="checkbox"/> 2014-08-11	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-08-11_LC82270652014223LGN00_BOA.tif	
18	<input checked="" type="checkbox"/> 2014-08-17	RapidEye	432	148	5	WGS 84 / UTM zone 21S	re_2014-08-17.tif	
19	<input checked="" type="checkbox"/> 2014-08-19	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-08-19_LE72270652014231CUB00_BOA.tif	
20	<input checked="" type="checkbox"/> 2014-08-20	RapidEye	432	148	5	WGS 84 / UTM zone 21S	re_2014-08-20.tif	
21	<input checked="" type="checkbox"/> 2014-08-26	RapidEye	432	148	5	WGS 84 / UTM zone 21S	re_2014-08-26.tif	
22	<input checked="" type="checkbox"/> 2014-08-27	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-08-27_LC82270652014239LGN00_BOA.tif	
23	<input checked="" type="checkbox"/> 2014-09-04	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-09-04_LE72270652014247CUB00_BOA.tif	
24	<input type="checkbox"/> 2014-09-12		72	24	6	WGS 84 / UTM zone 21N	2014-09-12_LC82270652014250LGN00_BOA.tif	

- Automatic timestamp (ISO 8601) extraction
- Varying projections, grids and spatial extents



ADD IMAGES



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	Date	Sensor	ns	nl	nb	CRS	Image	
16	<input checked="" type="checkbox"/> 2014-08-03	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-08-03_LE72270652014215CUB00_BOA.tif	
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18	<input checked="" type="checkbox"/> 2014-08-17	RapidEye	432	148	5	WGS 84 / UTM zone 21S	re_2014-08-17.tif	
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24	<input type="checkbox"/> 2014-09-12		72	24	6	WGS 84 / UTM	2014-09-12_LC82270652014250LGN00_BOA.tif	

- Automatic timestamp (ISO 8601) extraction
- Varying projections, grids and spatial extents
- Each image get linked to a sensor
- Sensor = (#bands, pixel size, wavelength)

MAP VISUALIZATION

EO Time Series Viewer (0.7.20181109T1551.develop)

Files View Navigation Others

Sensors / Products

	name	nb	n images	
0	Rapideye	5	4	undefined
1	Landsat	6	28	0.49,0.56,0,

2014-06-24 Landsat 2014-06-25 Rapideye 2014-07-02 Landsat

Maps | Sensors / Products

Time Series

	Date	Sensor	ns	nl	nb	CRS	Image
0	2014-01-15	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-01-15_LC82270652014015LGN00_BOA.tif
1	2014-03-20	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-03-20_LC82270652014079LGN00_BOA.tif
2	2014-04-21	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-04-21_LC82270652014111LGN00_BOA.tif
3	2014-04-29	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-04-29_LE72270652014119CUB00_BOA.tif
4	2014-05-07	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-05-07_LC82270652014127LGN00_BOA.tif
5	2014-05-15	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-05-15_LE72270652014135CUB00_BOA.tif
6	2014-05-23	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-05-23_LC82270652014143LGN00_BOA.tif
7	2014-05-31	Landsat	72	24	6	WGS 84 / UTM zone 21N	2014-05-31_LE72270652014151CUB00_BOA.tif

100% 32 scene(s) from 2 sensor(s), 2014-01-15 to 2014-12-17

Time Series Spectral Library Temporal Profiles Coordinates



MAP VIEWS

EO Time Series Viewer (0.7.20181113T0052.develop)

Files View Navigation Others

Maps | 2

Map Properties

Map Views

2 Map View 2

Style Multibandcolor

Default RGB nIR swIR

R Band 3976 12225
G Band 1501 6027
B Band 2892 5975

Contrast enhancer Stretch to MinMax

Min / Max Value Settings

Landsat

Style Multibandcolor

Default RGB nIR swIR

R NIR 2218 4717
G R 116 1034
B G 216 786

Contrast enhancer Stretch to MinMax

Sensors / Products Maps | 2

2014-06-24 Landsat

2014-06-25 RapidEye

2014-07-02 Landsat



TEMPORAL PROFILES

EO Time Series Viewer (0.7.20181113T0052.develop)

Files View Navigation Others

Sensors / Products

	name	nb	n images	wl
0	Landsat	6	28	0.49,0.56,0.66,0.84,1.

Maps | 1

Map Properties

Map Views

1 Map View 1

Default RGB nIR swIR

R: R 129 974
G: G 209 771
B: B 190 472

Temporal Profiles | 2D

Coordinate Sensor Style DN or Index

0	<input checked="" type="checkbox"/> Location 15	RapidEye	<input type="radio"/>	$(b5-b3)/(b5+b3)$
1	<input checked="" type="checkbox"/> Location 15	Landsat	<input checked="" type="radio"/>	$(b4-b3)/(b4+b3)$

DN or Index

0% Loaded 1 pixel from 2014-09-04_LE72270652014247CUB00_BOA.tif.

Temporal Profiles | 2D Time Series Spectral Library

12

The screenshot displays the EO Time Series Viewer software interface. At the top, there's a toolbar with various icons for file operations, navigation, and analysis. Below the toolbar are two main panels: 'Maps' and 'Temporal Profiles'. The 'Maps' panel shows a series of satellite images for different dates: 2014-06-24 (Landsat), 2014-06-25 (RapidEye), 2014-07-02 (Landsat), and others partially visible. The 'Temporal Profiles' panel shows a scatter plot of DN or Index values over Date (from 2014-01-01 to 2015-01-01) for two locations: Location 15 (RapidEye sensor) and Location 15 (Landsat sensor). The RapidEye data is represented by green dots, and the Landsat data by blue dots. A specific data point for the RapidEye sensor is highlighted with a red box, labeled with its DN value (0.22), date (2013-11-24), and DOY (328).



SPECTRAL PROFILES

EO Time Series Viewer (0.7.20181113T0052.develop)

Files View Navigation Others

Maps | 1

Map Properties

Map Views

1 Map View 1

Name Map View 1

Vector Rendering

Raster Rendering

RapidEye

Style Multibandcolor

Default RGB nIR swIR

Sensors / Products Maps | 1

2014-06-24 Landsat

2014-06-25 RapidEye

2014-07-02 Landsat

Spectral Library

x:5.14308
y:-87.56205

Actions fid name source

1 Profile 12 2014-... C:/Users/Think...

2 Profile 15 2014-... C:/Users/Think...

3 Profile 18 2014-... C:/Users/Think...

Temporal Profiles | 2D Time Series Spectral Library

The screenshot displays the EO Time Series Viewer interface. At the top, there's a toolbar with various icons for file operations, navigation, and analysis. Below the toolbar is a map viewer window showing three satellite images: Landsat from June 24, 2014; RapidEye from June 25, 2014; and Landsat from July 2, 2014. To the left of the map viewer is a panel for 'Map Views' where 'Map View 1' is selected. The main workspace contains a 'Spectral Library' plot showing spectral values across five bands. The x-axis is labeled 'X (Bands)' and ranges from 0 to 5. The y-axis is labeled 'Y (Spectral Value)' and ranges from 0 to 4000. A cursor is positioned over the plot at coordinates x:5.14308 and y:-87.56205. To the right of the plot is a table listing three spectral profiles, each with an 'Actions' column containing a trash bin icon, an 'fid' column, a 'name' column, and a 'source' column. The table shows three profiles: Profile 12, Profile 15, and Profile 18, all from 2014 and located at C:/Users/Think... . At the bottom of the interface, there are tabs for 'Temporal Profiles | 2D', 'Time Series', and 'Spectral Library', with 'Spectral Library' currently active.



LABELING REFERENCE DATA

- Identify and describe points / regions of interest
- Create / edit vector geometries + attributes
open for various use-cases and user-preferences



LABELING REFERENCE DATA

- Identify and describe points / regions of interest
- Create / edit vector geometries + attributes
open for various use-cases and user-preferences
- Copy & paste time stamps, DOY, sensor names, ...

The screenshot shows the QGIS application interface. On the left, a context menu is open over a feature in a table. The menu items are: Copy..., Map Coordinates..., Save to..., and Add raster layers(s) to QGIS. The 'Save to...' item is highlighted with a yellow arrow. To its right is another context menu with options: Date, Sensor, Path, and Map. The 'Map' option is also highlighted with a yellow arrow. The main window displays a table titled 'landcover_berlin_point :: Features Total: 5, Filter'. The table has two columns: 'level_1_id' and 'level_1'. The data is as follows:

	level_1_id	level_1
1		2 vegetation
2		4 water
3	2 low vegetation	vegetation
4	0 Unclassified	
5	1 impervious	
	2 low vegetation	
	3 tree	
	4 soil	
	5 water	

A context menu is open over the row where level_1_id is 3. The menu items are: 0 Unclassified, 1 impervious, 2 low vegetation, 3 tree, 4 soil, and 5 water. The '1 impervious' option is highlighted with a blue selection bar.

TO DO'S

Many

- Speed-up labeling
categorical labels, shortcuts to save date/DOY
- Improve spatial, temporal and spectral visualization
background tasks, spectral-temporal surfaces
- Bug fixing

CONCLUSION

The EO Time Series Viewer

- visualizes raster time series data "as-is"
- provides an interactive view on spatial, spectral and temporal data dimensions
- supports labeling of reference data
- is a QGIS Plugin, free and open source



Thanks for your attention

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bitbucket.org/jakimowb/eo-time-series-viewer



The EO Time Series Viewer is developed at Humboldt-Universität zu Berlin. Born in the SenseCarbon project, it was funded by the German Aerospace Centre (DLR) and granted by the Federal Ministry of Education and Research (BMBF, grant no. 50EE1254). Since 2017 it is developed under contract by the German Research Centre for Geosciences (GFZ) as part of the EnMAP Core Science Team activities, funded by DLR and granted by the Federal Ministry of Economic Affairs and Energy (BMWi, grant no. 50EE1529).