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EnMAP-Box 3

What's new in the EnMAP-Box 3.13?

Visualization and Analysis of EnMAP Data



Gefördert durch:



aufgrund eines Beschlusses
des Deutschen Bundestages

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EnMAP-Box – just released v3.13

Optimized for QGIS LTR 3.28 and QGIS Latest 3.32

The screenshot shows the QGIS Plugins window with the 'EnMAP-Box 3' plugin selected. The window title is 'Untitled Project — QGIS [EnMAP-Box Develop]'. The left sidebar shows the 'Plugins | All (1438)' list with 'EnMAP-Box 3' checked. The main panel displays the following information:

EnMAP-Box 3

Imaging Spectroscopy and Remote Sensing for QGIS

The EnMAP-Box is a QGIS plug-in to visualize and process remote sensing data. It has been particularly developed to handle data and products from the imaging spectrometer EnMAP (Environmental Mapping and Analysis Program, www.enmap.org).

Project Website

enmap-box.readthedocs.io

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www.gnu.org/licenses/gpl-3.0

Environmental Mapping and Analysis Program (EnMAP)

www.enmap.org

Acknowledgements

The EnMAP-Box is developed at Humboldt-Universität zu Berlin under contract by the Helmholtz Centre Potsdam GFZ and is part of the EnMAP Core Science Team activities. It is funded by the German Aerospace Centre (DLR) - Project Management Agency, granted by the Federal Ministry of Economic Affairs and Energy (BMWi; grant no. 50EE1923).

★★★★★ 79 rating vote(s), 50785 downloads

Category <https://github.com/EnMAP-Box/enmap-box.git>

Tags raster, analysis, imaging spectroscopy, spectral, hyperspectral, multispectral, landsat, sentinel, enmap, desis, prisma, emit, land cover, landscape, classification, regression, unmixing, remote sensing, mask, accuracy, clip, spectral signature, supervised classification, clustering, machine learning, google earth engine

More info [homepage](#) [bug tracker](#) [code repository](#)

Author [Andreas Janz](#), [Benjamin Jakimow](#), [Sebastian van der Linden](#), [Fabian Thiel](#), [Henrike Dierkes](#)

Installed version 3.13.0

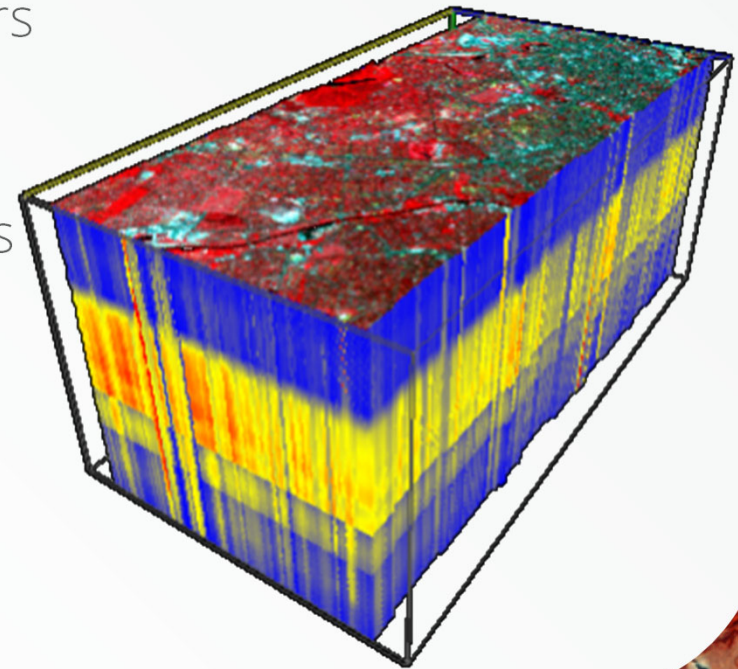
Available version (stable) 3.13.0 updated at Fr Okt 6 04:33:54 2023

Buttons: Upgrade All, Uninstall Plugin, Reinstall Plugin



EnMAP-Box – Motivation and Aims

- ❖ Offer a free and open source environment for visualizing and analyzing EnMAP data together with other EO data
- ❖ Increase the number of EnMAP data users
- ❖ Integrate full GIS functionality with advanced image/spectral processing
- ❖ Application-oriented advanced Workflows (Vegetation, Geology, Soil, Water...)
- ❖ Foster the availability and exchange of state-of-the-art approaches for the analysis of imaging spectroscopy data and spectral libraries





EnMAP-Box – Imaging Spectroscopy in QGIS

❖ EnMAP-Box GUI and Algorithm Provider



The screenshot displays the EnMAP-Box interface. On the left, the 'Data Sources' panel lists various data layers including Spectral Libraries, Raster Data, and Vector Data. The 'Data Views' panel shows two maps: 'Map #1' and 'Map #2'. The 'Processing Toolbox' on the right lists various algorithms. The main window shows a spectral plot with 'Band Index' on the x-axis (0 to 180) and 'Radiance' on the y-axis (0 to 5000). A table of data points is visible at the bottom right of the plot.

fid	name
62	65 sand (playground) 2
63	45 sorghum
64	46 sugarcane 1
65	47 sugarcane 2
66	43 sunflower
67	73 tatar (spots ground)
68	73 water 2
69	74 water1
70	16 white roof material (p...
71	17 white roof material (s...
72	18 white roof material (s...
73	19 white roof material (s...

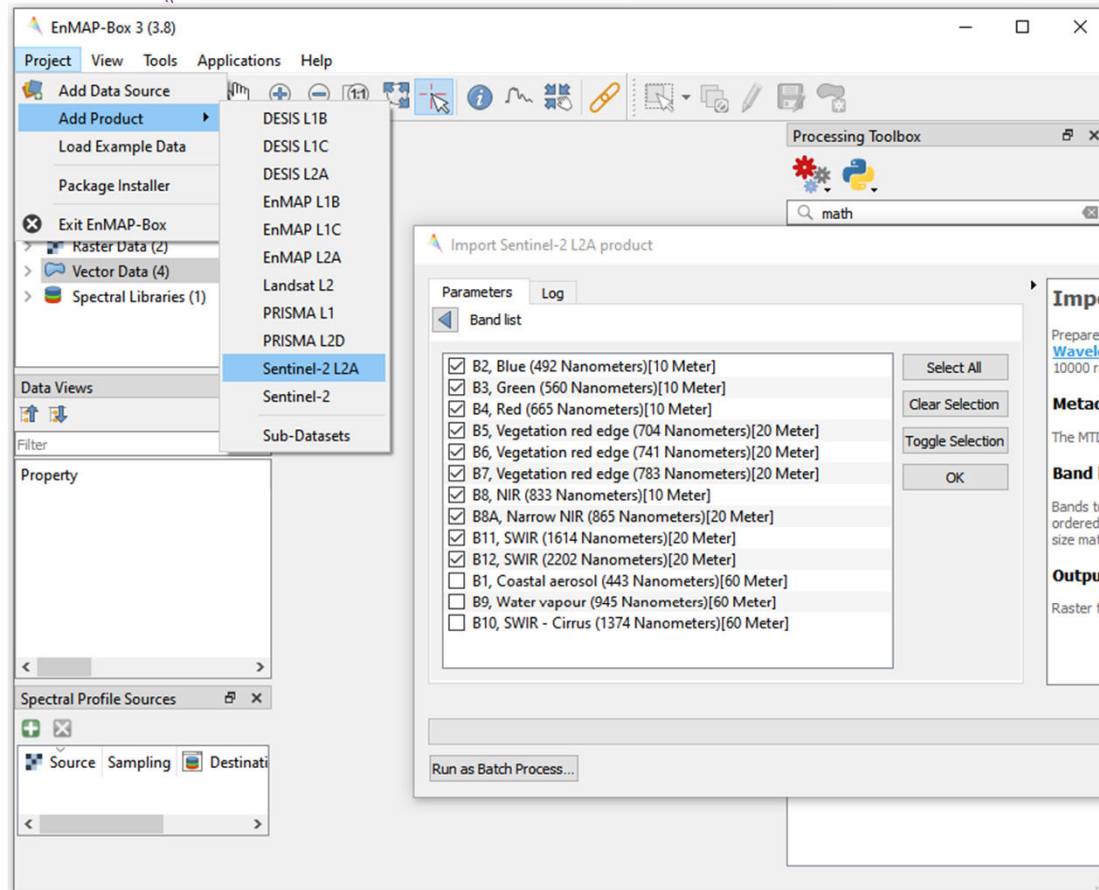
The screenshot shows the QGIS interface with the 'Processing Toolbox' open. The 'EnMAP-Box' folder is expanded, showing a list of algorithms. A red dashed box highlights the EnMAP-Box folder and its contents.

- Vector creation
- Vector general
- Vector geometry
- Vector overlay
- Vector selection
- Vector table
- Vector tiles
- EnMAP-Box
 - Accuracy Assessment
 - Auxiliary
 - Classification
 - Clustering
 - Convolution, Morphology and Filtering
 - Create Raster
 - Create Sample
 - Import Data
 - Masking
 - Post-Processing
 - Random
 - Regression
 - Resampling and Subsetting
 - Testdata
 - Transformation

- ▶ EnMAP-Box
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Create Sensor Synergies



- ❖ Comfortably import multiple optical sensors
- ❖ Create analysis-ready raster data:

- ◆ (convert data)
- ◆ stack bands
- ◆ apply band scale/offset
- ◆ set band names
- ◆ set wavelength/fwhm
- ◆ set spatial reference system and extent



Create Sensor Synergies

EnMAP-Box 3 (3.8.8)

Layer Properties — enmap_potsdam — GDAL Metadata

Band Metadata

Band	Band Name	No Data	BBL	Wavelength	Wavelength Unit	FWHM	Range	Offset	Scale
1	band 1 (418.24 Nanometers)	-32.768	1	418,24	Nanometers	6,99561	414.742 - 421.738	0	0,0001
2	band 2 (423.874 Nanometers)	-32.768	1	423,874	Nanometers	6,6675	420.540 - 427.208	0	0,0001
3	band 3 (429.294 Nanometers)	-32.768	1	429,294	Nanometers	6,42408	426.082 - 432.506	0	0,0001
4	band 4 (434.528 Nanometers)	-32.768	1	434,528	Nanometers	6,25124	431.402 - 437.654	0	0,0001
5	band 5 (439.603 Nanometers)	-32.768	1	439,603	Nanometers	6,13485	436.536 - 442.670	0	0,0001
6	band 6 (444.549 Nanometers)	-32.768	1	444,549	Nanometers	6,06076	441.519 - 447.579	0	0,0001
7	band 7 (449.391 Nanometers)	-32.768	1	449,391	Nanometers	6,01486	446.384 - 452.398	0	0,0001
8	band 8 (454.159 Nanometers)	-32.768	1	454,159	Nanometers	5,98302	451.167 - 457.151	0	0,0001

GDAL/OGR Metadata

Object	Domain	Key	Value	
1	Dataset	IMAGE_STRUCTURE	COMPRESSION	DEFLATE
2	Dataset	IMAGE_STRUCTURE	INTERLEAVE	BAND
3	Dataset	IMAGE_STRUCTURE	PREDICTOR	2
4	Dataset	DERIVED_SUBDATASETS	DERIVED_SUBDATASET_1_NAME	DERIVED_SUBDATASET:LOGAMPLITUDE:D:/source/QGISPlugins/enmap-box/enr
5	Dataset	DERIVED_SUBDATASETS	DERIVED_SUBDATASET_1_DESC	log10 of amplitude of input bands from D:/source/QGISPlugins/enmap-box/enr
6	Dataset		AREA_OR_POINT	Area
7	Dataset		start_time	2022-07-24T10:45:26

comfortably import
multiple optical sensors
create analysis-ready
er files:
(convert data)
stack bands
apply band scale/offset
set band names
set wavelength/fwhm
set spatial reference
system and extent



Create Sensor Synergies

The screenshot displays the EnMAP-Box software interface. At the top left is the EnMAP-Box logo. The main window is divided into several panels:

- Map #1:** A satellite-style map showing a landscape with a red crosshair and a pink circular area.
- Processing Toolbox:** A sidebar on the right containing a search bar with 'emit' and a tree view showing 'EnMAP-Box' > 'Import data' > 'Import EMIT L2A product'.
- Raster Layer Styling:** A panel below the toolbox showing 'emit.2A' selected.
- Import EMIT L2A product dialog:** A central dialog box with the following sections:
 - Parameters:** Includes a 'NetCDF file' field, a checked 'Skip bad bands' checkbox, an 'Output raster layer' field (set to '[Save to temporary file]'), and a checked 'Open output file after running algorithm' checkbox.
 - Log:** A tab for viewing logs.
 - Import EMIT L2A product:** A text area containing instructions: 'Prepare a **spectral raster layer** from the given product. **Wavelength** and **FWHM** information is set and data is scaled into the 0 to 1 range. EMIT website: <https://earth.jpl.nasa.gov/emit/>.' It also defines 'NetCDF file', 'Skip bad bands', and 'Output raster layer'.
 - Progress:** A progress bar at the bottom shows '0%' completion.
 - Buttons:** 'Run', 'Close', 'Help', and 'Apply' buttons are visible.
- Spectral Library #1:** A plot at the bottom left showing 'Spectral Library #1' on the y-axis (ranging from 0.02 to 0.26) and 'Wavelength [nm]' on the x-axis (ranging from 1000 to 2000). The plot shows a green line with several peaks.

Various imaging spectrometers

- ❖ EnMAP
- ❖ PRISMA
- ❖ DESIS
- ❖ EMIT



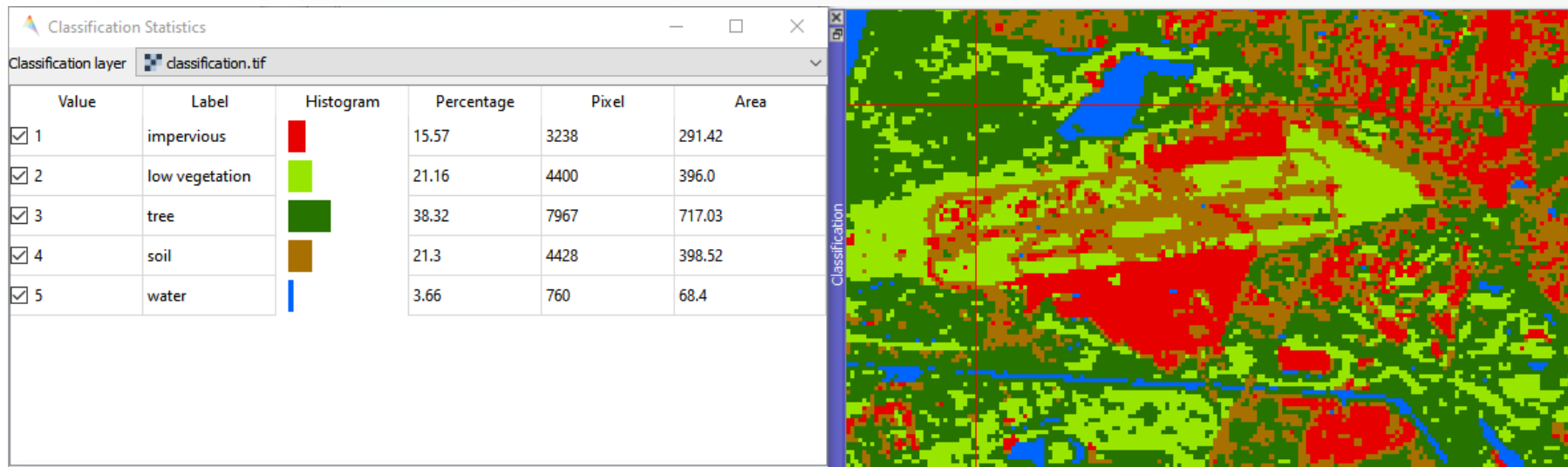
Create Synergies - GEE Time Series Explorer

The screenshot displays the GEE Time Series Explorer interface. At the top left, the 'GEE Temporal Profile Viewer' window shows a scatter plot of data points over time from 2019 to 2021. The x-axis is labeled 'Days' and the y-axis ranges from 0 to 0.4. A blue shaded region highlights the period from 2020-04-03 to 2021-01-06. Below the plot is a map of the region, with a red crosshair indicating the selected location. The map shows various geographical features and labels such as 'Amsterdam', 'Klaipeda', and 'Pilsen'. To the right, the 'GEE Time Series Explorer' window is open, displaying a 'Pixel Quality Filter' panel. This panel contains several sections of checkboxes for filtering data based on aerosol attributes, pixel quality, and cloud/shadow confidence. The 'Aerosol attributes [SR_QA_AEROSOL]' section includes options like 'Fill', 'Aerosol retrieval - valid', 'Water pixel', 'Unused', and 'Interpolated Aerosol'. The 'Pixel quality attributes generated from the CFMASK algorithm. [QA_PIXEL]' section includes options like 'Dilated Cloud', 'Cirrus (high confidence)', 'Cloud', 'Cloud Shadow', 'Snow', and 'Clear'. The 'Cloud Confidence' section includes options like 'None', 'Low', 'Medium', and 'High'. The 'Cloud Shadow Confidence' section includes options like 'None', 'Low', 'Medium', and 'High'. The 'Snow/Ice Confidence' section includes options like 'None', 'Low', 'Medium', and 'High'. The 'Cirrus Confidence' section includes options like 'None', 'Low', and 'Medium'. At the bottom of the interface, there are checkboxes for 'GEE Image', 'ID', 'Date', and 'Bands', along with some utility icons.



Basic Tools – Classification Statistics

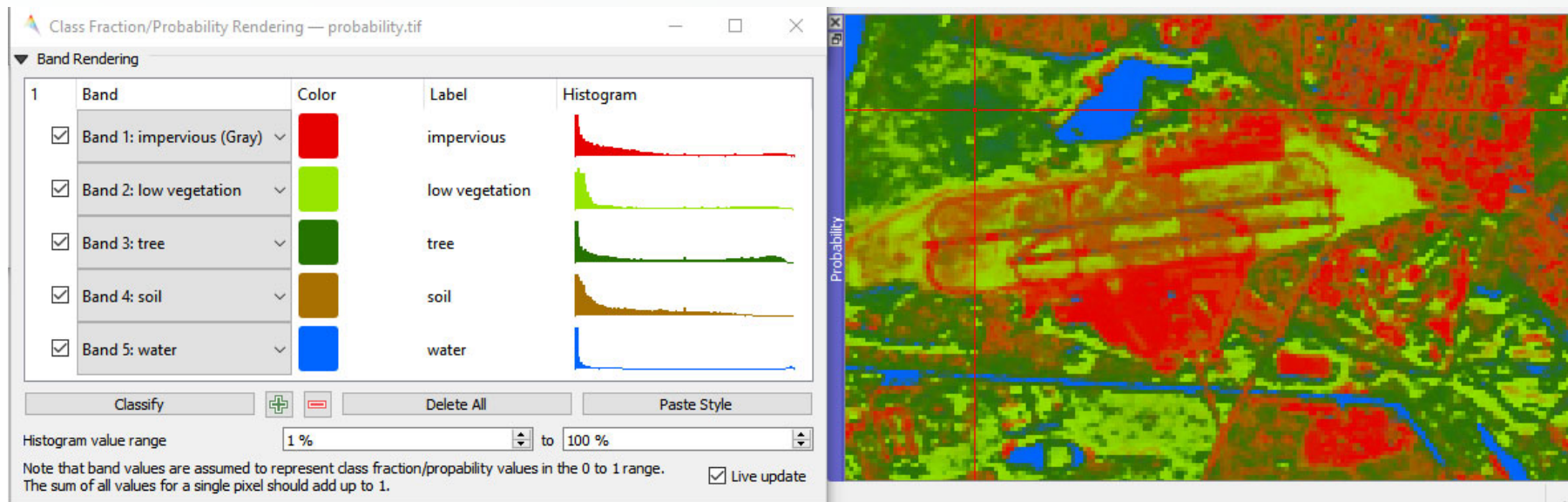
- ❖ General tools with increased functionality, e.g. classification statistics





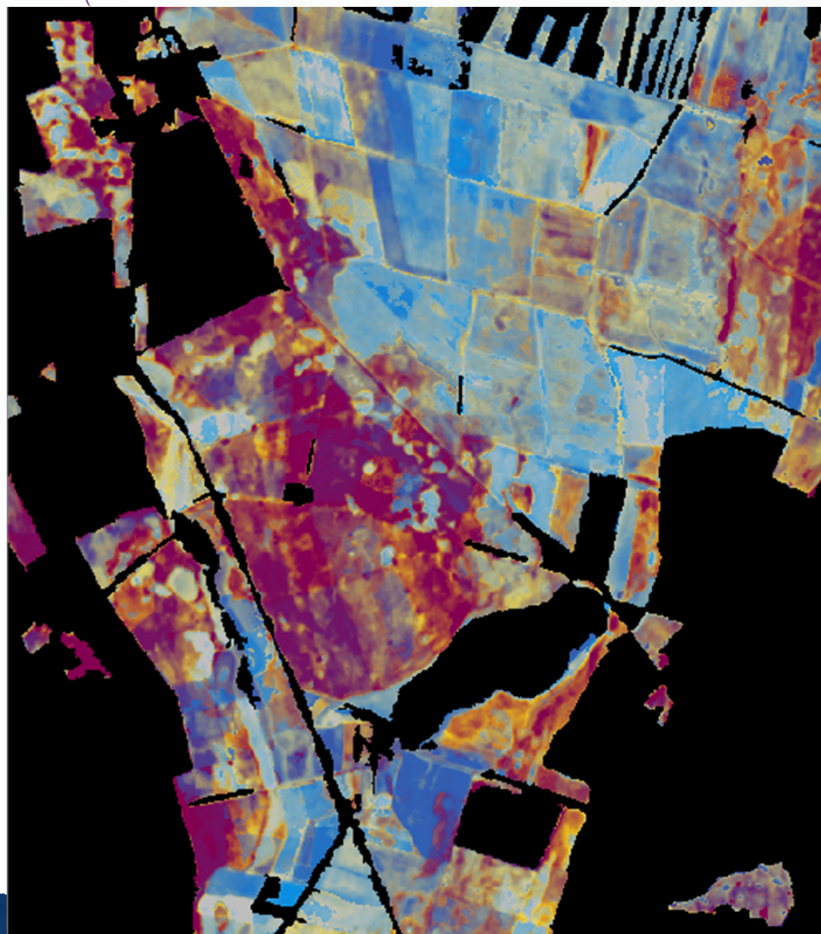
Basic Tools – Class Fraction Statistics

- ❖ General tools optimized for quantitative results from EnMAP products





Basic Tools – Bivariate Color Renderer



Raster layer: NDFI

Band 1: Band 1

Band 2: Band 2

Color plane: ■ ■

▼ Settings

Cumulative count cut: 2,0 - 87,0 %

Extent: Current canvas

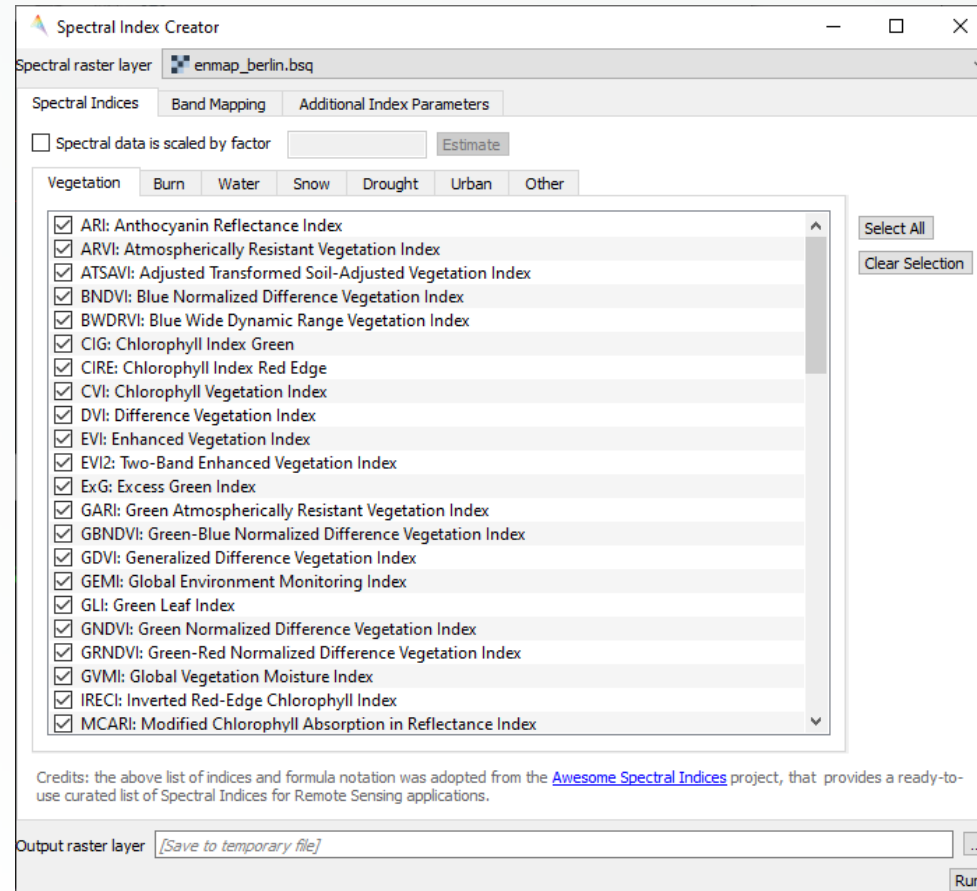
Accuracy: Estimate (faster)

Live update



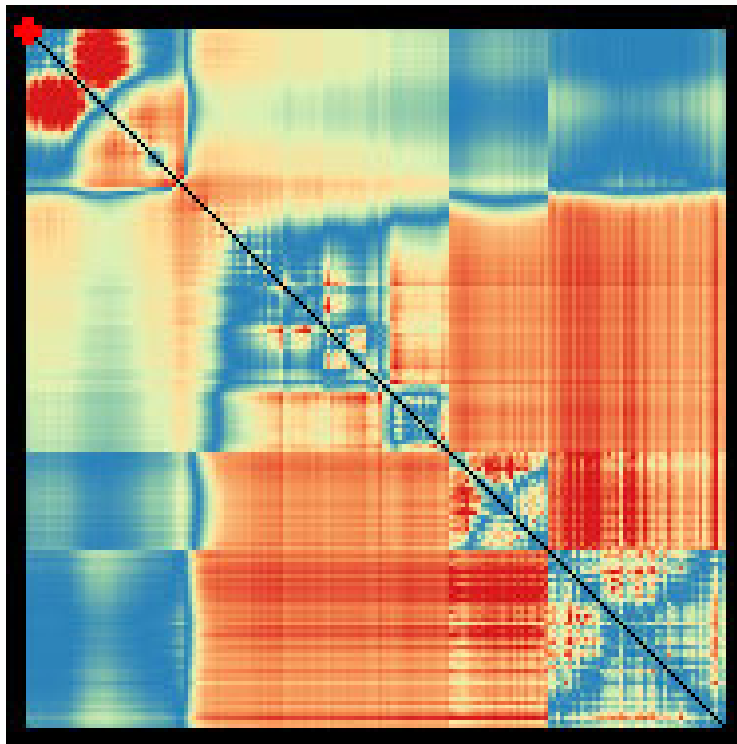
Spectral Tools – Spectral Index Creator

- ❖ Extensive index list taken from *Awesome Spectral Indices* project.





Spectral Tools – Spectral Index Optimizer



Spectral Index Optimizer

Parameters Log

Training dataset

Formular

$(A-B) / (A+B)$

► **Advanced Parameters**

Output score matrix

[Save to temporary file]

Raster Layer Styling

scores2.tif

RGB Gray Pseudo Default Style Linking

Color ramp

Band

- Band 01: roof - RMSE (Gray)
- Band 02: roof - MAE
- Band 03: roof - R^2
- Band 04: pavement - RMSE
- Band 05: pavement - MAE
- Band 06: pavement - R^2
- Band 07: low vegetation - RMSE



Raster Tools – Raster Math

❖ Easy numpy scripting with data IO fully handled

Raster Math

Parameters Log

Code

1

Available data sources Code Snippets

Identifier	Sources
▶ enmap_berlin	enmap_berlin.bsq [EPSG:32633]
▶ hires_berlin	hires_berlin.bsq [EPSG:32633]
▶ landcover_b...	landcover_berlin_point.gpkg [EPSG:32633]
▶ landcover_b...	landcover_berlin_polygon.gpkg [EPSG:32633]
▶ veg_cover_fr...	veg-cover-fraction_berlin_point.gpkg [EPSG:32633]

Operators Data / Metadata Waveband locator

+ - * / () < > == != <= >=

Grid [optional]

Block overlap [optional]

Not set

Monolithic processing [optional]

▶ Advanced Parameters

Output raster layer

[Save to temporary file]

Open output file after running algorithm

0%

Advanced Run as Batch Process... Run Close Help

Raster math

Perform mathematical calculations on [raster layer](#) and [vector layer](#) data. Use any [NumPy](#)-based arithmetic, or even arbitrary Python code.

See the [RasterMath cookbook recipe](#) for detailed usage instructions.

Code

The mathematical calculation to be performed on the selected input arrays.

Select inputs in the available data sources section or use the [raster layer](#) R1, ..., R10 and [vector layer](#) V1, ..., V10.

In the code snippets section you can find some predefined code snippets ready to use.

See the [RasterMath cookbook recipe](#) for detailed usage instructions.

Grid

The destination [grid](#). If not specified, the grid of the first [raster layer](#) is used.

32-bit floating-point inputs



Raster Tools – Profile Analytics App

Profile Analytics

14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000

1997 1998 1999 2000 2001 2002 2003

Date Time (decimal years)

X Axis: Date Time (decimal years)

Map #1

Source type: Raster layer

Profile type: Z-Profile at cursor location (all bands)

Use the map tool to select a locations.

Raster	Band	Style	Scaling
1 1984-2006	Band 001: 1984		0. + 1. * y

Profile Analytics Code Editor

```
D:\source\QGISPlugins\enmap-box\enmapbox\eo4apps\profileanalyticsapp\examples\rbftimeseriesfitting_ufunc.py
12 def updatePlot(profile: Profile, profiles: List[Profile], plotWidget: pg.PlotItem):
13
14     rbfCutOffValue = 0.01 # minimal value considered as weights in convolution (value between 0 and 1)
15     rbfFwhms = [day / 365 for day in [30, 60, 90, 120, 240, 360]] # RBF kernel sizes [decimal years]
16     rbfUserWeights = [20, 8, 6, 4, 2, 1]
17
18     X = np.array(profile.xValues) # X[ndates]
19     Y = np.array(profile.yValues).reshape((1, -1)) # Y[nsamples, ndates]
20
21     X2 = np.linspace(X.min(), X.max(), 1000)
22     Y2 = rbfEnsemblePrediction(X, Y, X2, rbfFwhms, rbfUserWeights, rbfCutOffValue)
23
24     # plot something
25     style = PlotStyle()
26     style.setMarkerSymbol(MarkerSymbol.No_Symbol) # options: Circle, Triangle_Down, Triangle_Up, Triangle_Right, Tri
27     style.markerBrush.setColor(QColor('#ff0000'))
28     style.markerSize = 15
29     style.linePen.setColor(QColor('#ff0000'))
30     style.linePen.setWidth(2)
31     style.linePen.setStyle(Qt.SolidLine)
32     plotDataItem = plotWidget.plot(X2.flatten(), Y2.flatten(), name='RBF Ensemble Fit')
33     style.apply(plotDataItem)
34
```



Spectral Library Tools

Snap to pixel center

search settings

define values for each field

scale profiles

overlay color

sampling

move pixel : CTRL + <Arrow>
Save profile: CTRL + S

show / hide
Plot Plot Settings Form View Table

multiple profile visualizations

name	class	EnMAP	EnMAP3x3Mea
1 forest	Profile	BLOB	Profile
2 forest	Profile	BLOB	Profile
3 forest	Profile	BLOB	Profile
4 cropland	Profile	BLOB	Profile
5 cropland	Profile	BLOB	Profile
6 cropland	Profile	BLOB	Profile

Enhanced Profile Source Panel
Enhanced Plot Settings

Individual / generated labels and colors

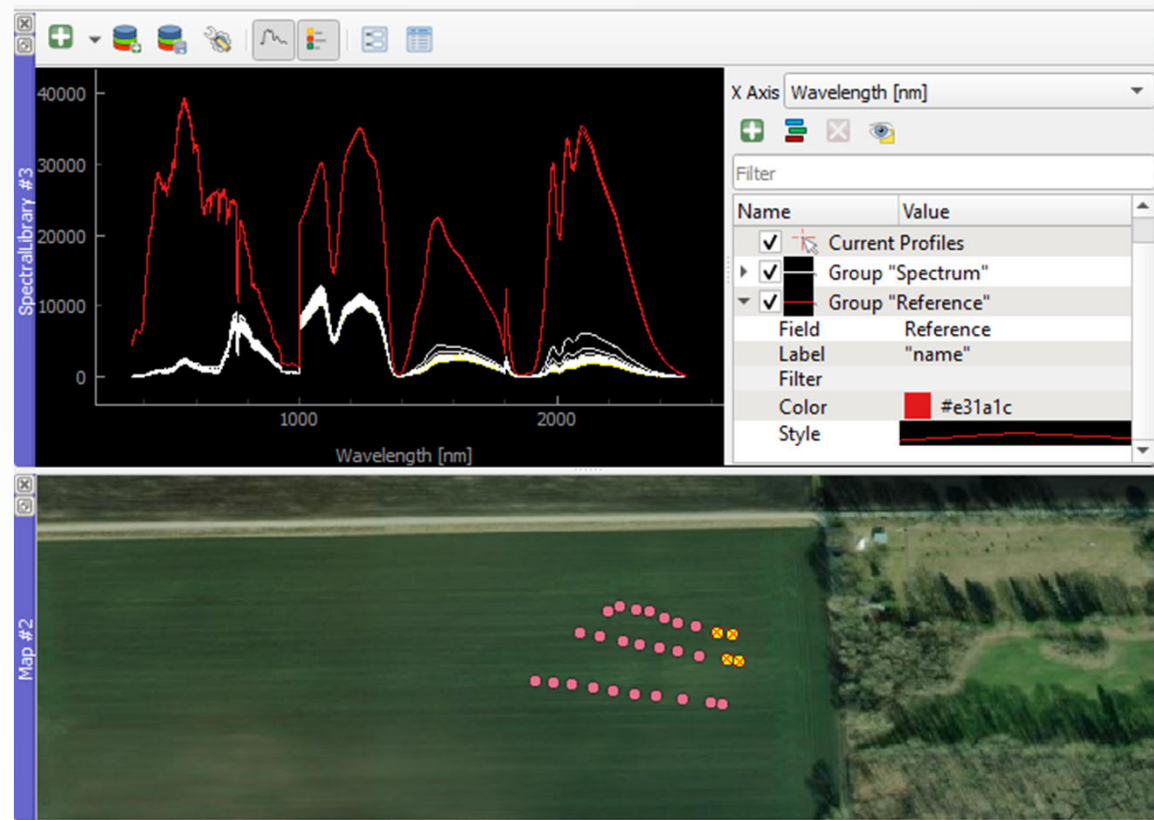
filter profile by attributes

multiple profile fields



Spectral Library Tools – Data Format and Import

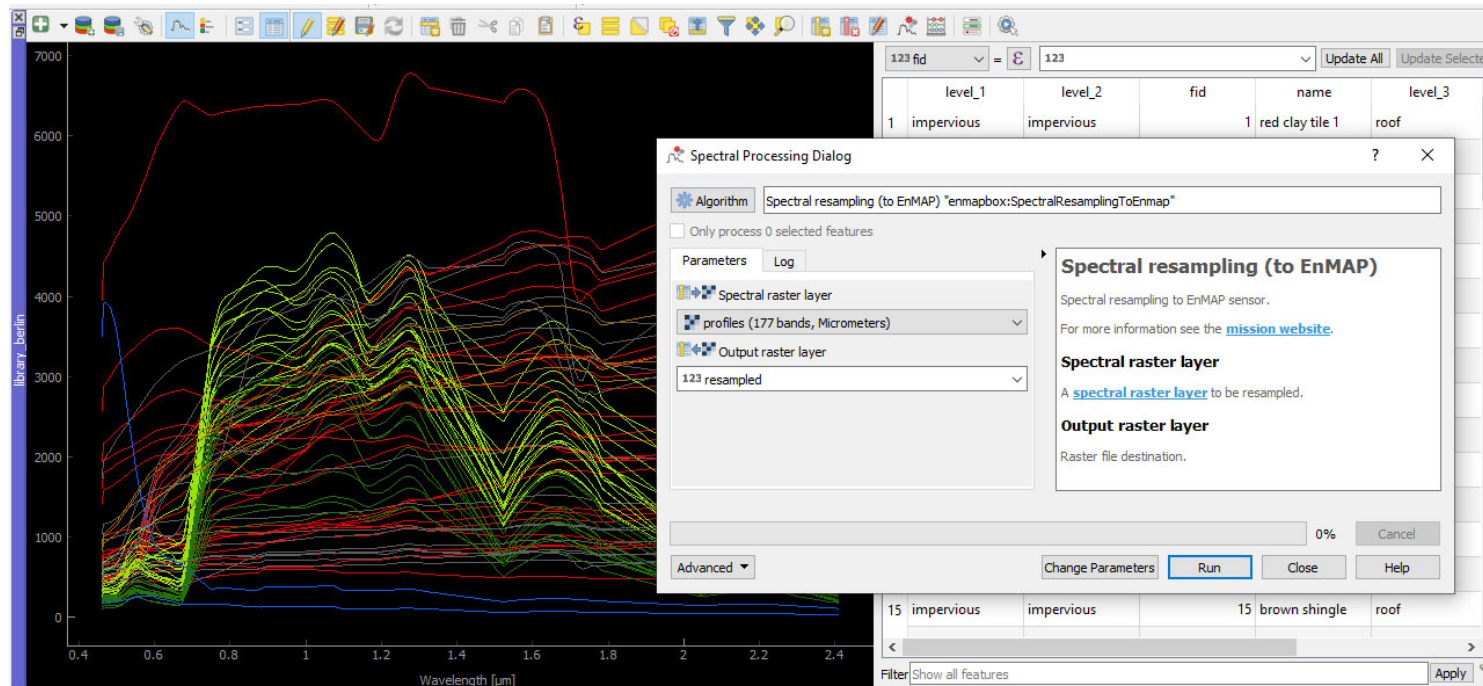
- ❖ Spectral Profiles in Geopackage Format
- ❖ Flexible Attributes stored with Spectra: location, white reference...





Spectral Library Tools – Spectral Processing

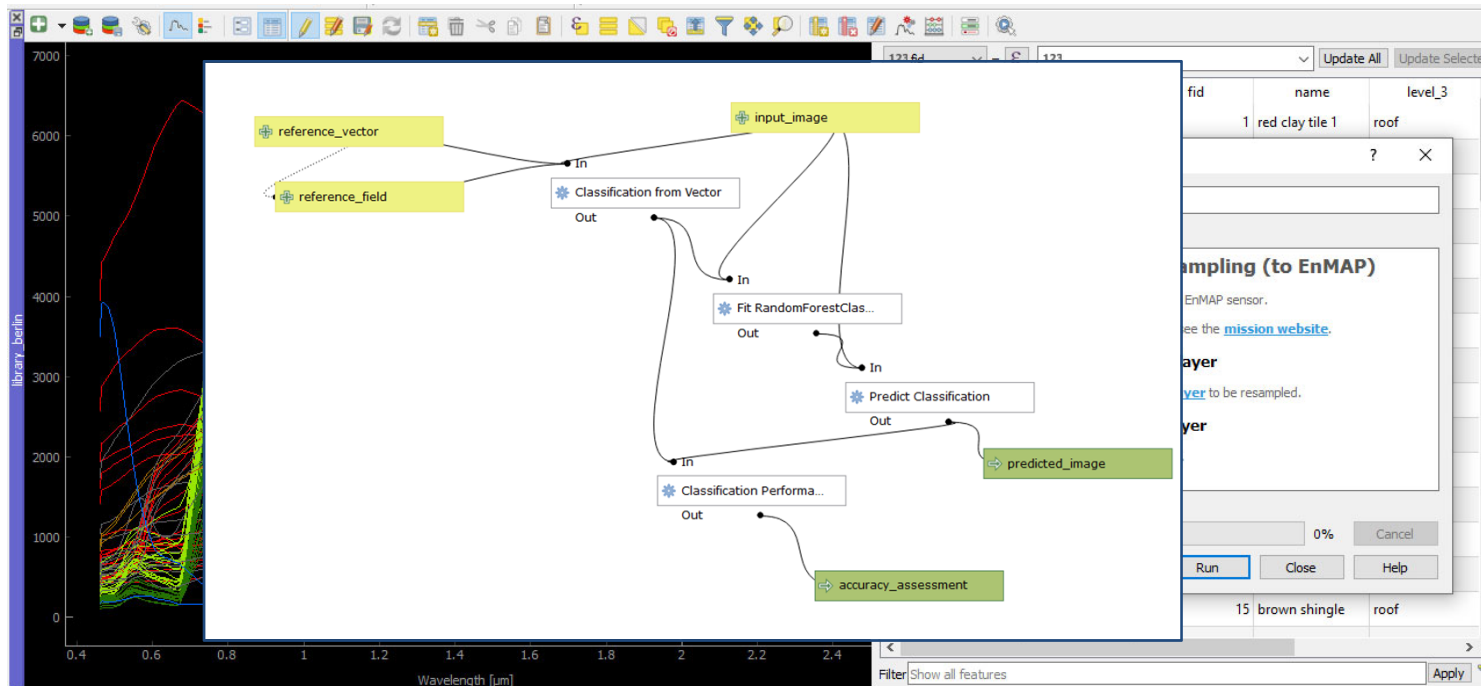
- ❖ all Processing Algorithms are also applicable to Spectral Libraries e.g. *Spectral resampling (to EnMAP)*





Spectral Library Tools – Spectral Processing

- ❖ Spectral Processing is also supporting models from the QGIS Model Designer





EnMAP-Box Publication

- ❖ Jakimow B, A Janz, F Thiel, A Okujeni, P Hostert, S van der Linden (2023). EnMAP-Box: Imaging Spectroscopy in QGIS. SoftwareX, *in review*.

Manuscript File

[Click here to view linked References](#)

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EnMAP-Box: Imaging Spectroscopy in QGIS

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Abstract

Satellite missions like EnMAP and PRISMA generate raster images that describe the Earth's environment with hyperspectral resolution. Such imaging spectroscopy data is of high value for applications in, e.g., ecological

❖ For detailed information, installation, application tutorials have a look at <https://enmap-box.readthedocs.io/en/latest/>

❖ Or write us: enmapbox@enmap.org

