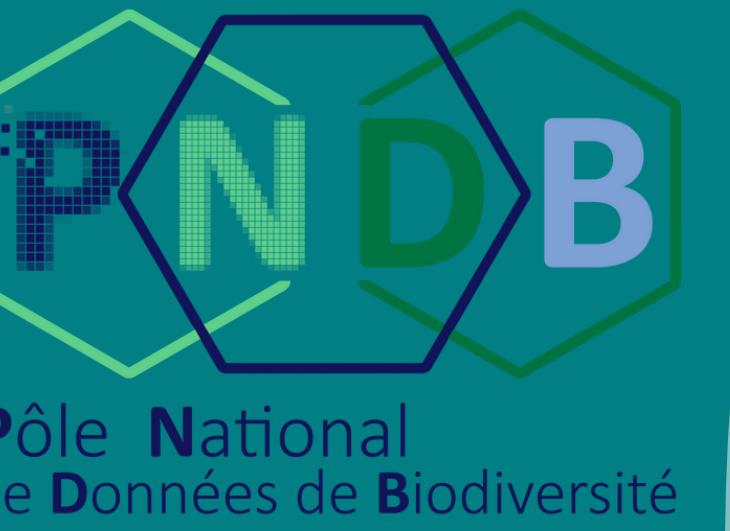


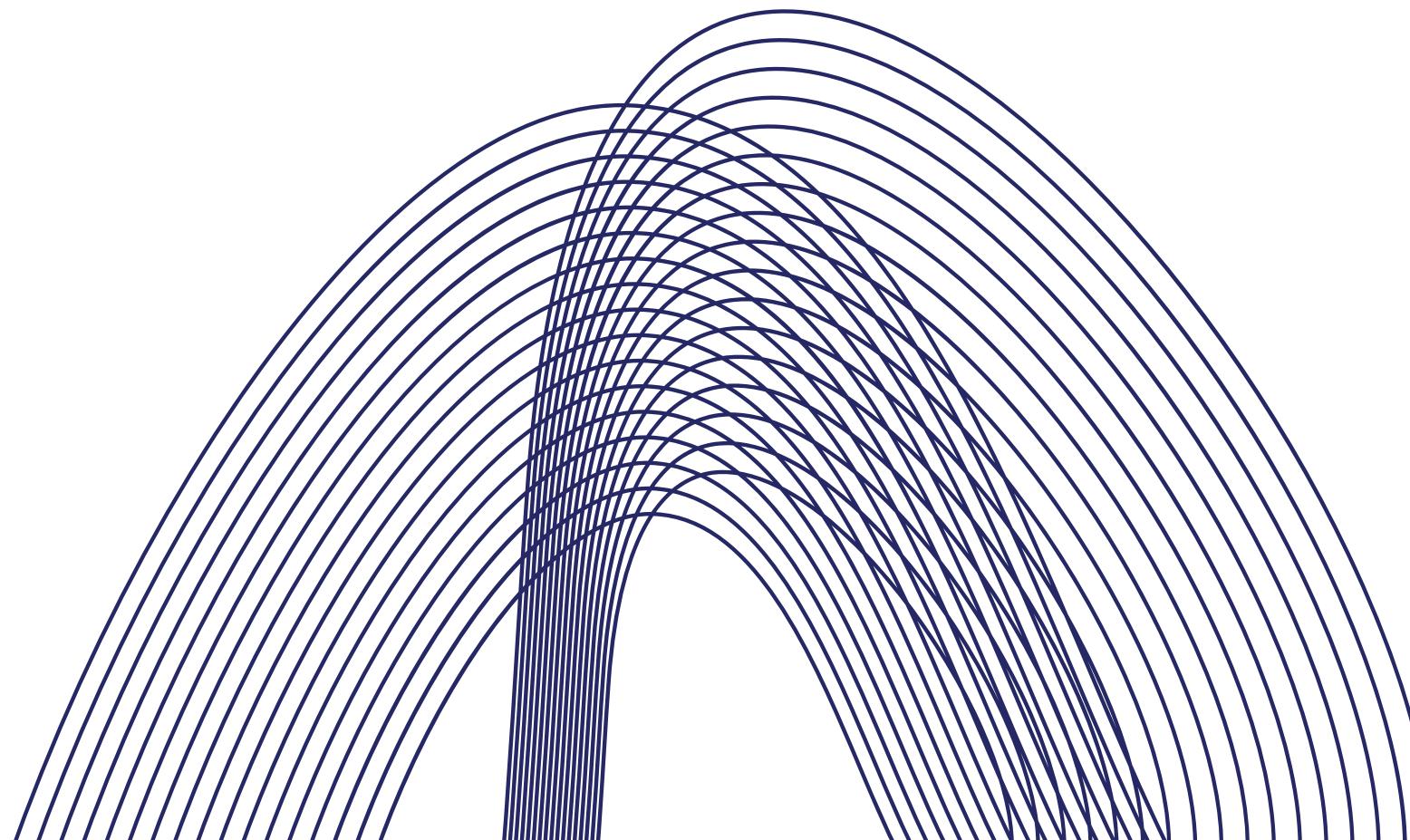
From raw data to biodiversity indicators

Marie Jossé



AGENDA

What are we talking about



01

Remote sensing
with Sentinel 2

02

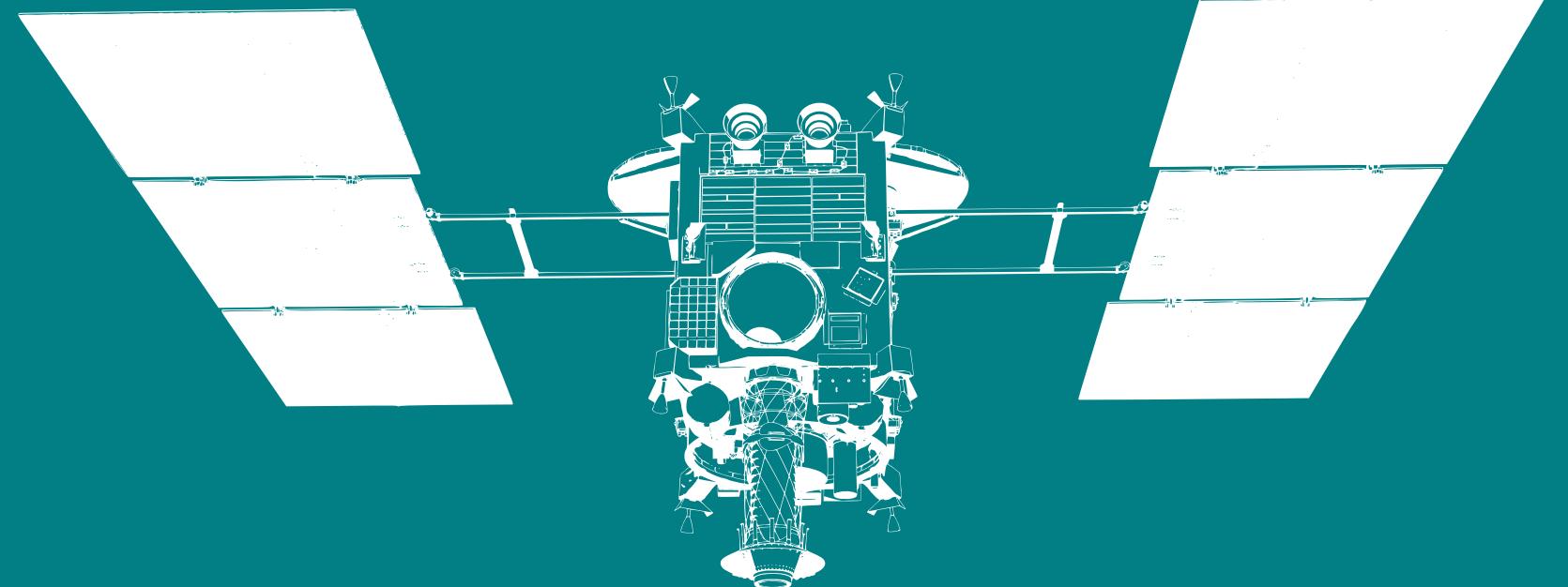
Biodiversity data
exploration an
overview

Context

Remote sensing

For biodiversity indicators

What's the point ?



Download S2 data

Multiple platforms :
Scihub, Peps and Theia



The screenshot shows the Copernicus Open Access Hub interface. On the left, there are search filters for different missions and parameters. The main area features a map of Europe and Central Asia with numerous data points marked across the continent and surrounding seas.

Search Criteria:

- Ingestion period:** Two date input fields.
- Mission: Sentinel-1**
 - Satellite Platform: Selectable dropdown.
 - Polarisation: Selectable dropdown.
 - Relative Orbit Number (from 1 to 175): Input field.
- Mission: Sentinel-2**
 - Satellite Platform: S2A_*
 - Product Type: S2MSI2A
 - Relative Orbit Number (from 1 to 143): Input field.
 - Cloud Cover % (e.g.[0 TO 9.4]): Input field.
- Mission: Sentinel-3**
 - Satellite Platform: Selectable dropdown.
 - Timeliness: Selectable dropdown.
 - Instrument: Selectable dropdown.
 - Product Level: Selectable dropdown.
 - Relative Orbit Start [1-385]: Input field.

Copernicus Open Access Hub

Preparing your data

Prepocess Sentinel 2

Upload your data

Scihub a zip folder

Prepare

The tool reads an give 2
files to use for your
analysis

Raster Bil

Image stored as a
succession of pixels

Metadata

Description of the raster
bil

Envi Bil Format

Quick overview of what the tool looks like

Galaxy Configured by Planemo

Workflow Visualize Bibliothèque de données Admin Aide Utilisateur

Tools

search tools

Upload Data

Upload File from your computer

Compute biodiversity indices from remote sensing data

Compare diversity indicators with remote sensing data

Preprocess sentinel 2 data read, crop, resample and write it as a raster stack.

Compute a PCA raster from remote sensing data

Compute spectral indices as NDVI from remote sensing data

Validate ISO 19139 metadata documents from files or Urls.

Map diversity from remote sensing data

WORKFLOWS

All workflows

Preprocess sentinel 2 data read, crop, resample and write it as a raster stack. (Galaxy Version 0.0.0)

Input data

3: S2A_MSIL2A_20200306T015621_N0214_R117_T51JXN_20200306T034744.zip
2: S2A_Subset_test
1: S2A_Subset_test.hdr

Where does your data come from ?

From Scihub or Peps

Execute

Preprocess Sentinel 2 data

What it does

The goal of this tool (using the package preprocS2) is to provide a common framework for the preprocessing of Level-2A Sentinel-2 images (does not work yet for Level 1C). Sentinel-2 L2A images can be produced or obtained from various data hubs or atmospheric correction methods. PreprocS2 provides a unique function to read, crop, resample the original image directory, and write it as a raster stack.

Input description

A zip folder with Sentinel 2 data. These data can be dowloaded on 3 different platforms:

- Copernicus Open Access Hub, Scihub, which provides complete, free and open access to Sentinel-2 data : <https://scihub.copernicus.eu/dhus/#/home>
- PEPS, la 'Plateforme d'Exploitation de Produits Sentinel' : <https://peps.cnes.fr/rocket/#/search>
- Theia : <https://theia.cnes.fr/atdistrib/rocket/#/search>

For each of those 3 platforms you will need to create an account.

You need to select from where you dowloaded your data in order for the tool to know the format of the folder once it unzips it.

| ZIP | Source |
|------------|-----------|
| folder.zip | Character |
| ... | ... |

Output

A zip folder containing the refelctance data with a raster stack pile in BIL format (no extension), a header with the metadata (.hdr extension) and 2 other files in .xml.

A zip folder containing the cloud mask with the 2 files for the raw data (.RAW) and 2 files containing the metadata (.hdr).

Rasterdiv

Compute biodiversity indicators

Global diversity overview to find the hot spot

| S2A_Subset | longitude | latitude | Shannon | Renyi | Berger-Parker | Pielou | Hill | Prao | CRE |
|------------|------------------|------------------|------------------|------------------|--------------------|--------|------------------|------------------|--------|
| 231 | 13.7119569929834 | 3.17838623784837 | 2.60890630597545 | 2.60890630597545 | 0.16 | 356880 | 13.5841857815757 | 5.1584 | 356880 |
| 231 | 13.7137566357487 | 3.17838849139271 | 2.69060859631006 | 2.69060859631006 | 0.133333333333333 | 357080 | 14.7406442928311 | 5.10888888888889 | 357080 |
| 228 | 13.7155562797955 | 3.17839074178832 | 2.67674384766503 | 2.67674384766503 | 0.142857142857143 | 357280 | 14.5376792458669 | 4.84571428571429 | 357280 |
| 231 | 13.7173559251221 | 3.1783929890352 | 2.67118246534123 | 2.67118246534123 | 0.125 | 357480 | 14.4570540550398 | 4.785 | 357480 |
| 219 | 13.7191555717267 | 3.17839523313333 | 2.7307675777817 | 2.7307675777817 | 0.111111111111111 | 357680 | 15.3446607213507 | 5.04691358024691 | 357680 |
| 223 | 13.7209552196075 | 3.1783974740827 | 2.78790610193132 | 2.78790610193132 | 0.111111111111111 | 357880 | 16.2469646722969 | 5.26024691358025 | 357880 |
| 230 | 13.7227548687627 | 3.17839971188331 | 2.86114692117586 | 2.86114692117586 | 0.111111111111111 | 358080 | 17.4815654206707 | 5.32543209876543 | 358080 |
| 233 | 13.7245545191906 | 3.17840194653513 | 2.87277465770396 | 2.87277465770396 | 0.111111111111111 | 358280 | 17.6860228423754 | 5.67703703703704 | 358280 |
| 240 | 13.7263541708893 | 3.17840417803817 | 2.86114692117586 | 2.86114692117586 | 0.111111111111111 | 358480 | 17.4815654206707 | 5.71654320987654 | 358480 |
| 229 | 13.7281538238571 | 3.1784064063924 | 2.85359585287384 | 2.85359585287384 | 0.111111111111111 | 358680 | 17.350058061542 | 5.83703703703704 | 358680 |
| 227 | 13.7299534780921 | 3.17840863159782 | 2.77434222019488 | 2.77434222019488 | 0.0888888888888889 | 358880 | 16.0280805797061 | 5.85679012345679 | 358880 |
| 224 | 13.7317531335926 | 3.17841085365442 | 2.77434222019488 | 2.77434222019488 | 0.0888888888888889 | 359080 | 16.0280805797061 | 5.92592592592593 | 359080 |
| 230 | 13.7335527903567 | 3.17841307256218 | 2.92837492698598 | 2.92837492698598 | 0.0888888888888889 | 359280 | 18.6972214448931 | 7.26716049382716 | 359280 |
| 234 | 13.7353524483827 | 3.17841528832109 | 2.98844975483482 | 2.98844975483482 | 0.111111111111111 | 359480 | 19.8548786913162 | 8.05333333333333 | 359480 |
| 236 | 13.7371521076688 | 3.17841750093115 | 2.99600082313684 | 2.99600082313684 | 0.111111111111111 | 359680 | 20.0053717129103 | 8.46617283950617 | 359680 |
| 229 | 13.7389517682132 | 3.17841971039234 | 3.02079455106064 | 3.02079455106064 | 0.0888888888888889 | 359880 | 20.5075795316409 | 9.17728395061728 | 359880 |
| 237 | 13.7407514300141 | 3.17842191670466 | 2.9692709500047 | 2.9692709500047 | 0.111111111111111 | 360080 | 19.4777141909957 | 8.14222222222222 | 360080 |
| 235 | 13.7425510930697 | 3.17842411986808 | 2.91520893559028 | 2.91520893559028 | 0.111111111111111 | 360280 | 18.4526674189673 | 7.52987654320988 | 360280 |

Input

The 2 envi bil files from the first tool

Output

Multiple biodiversity indicators shown in tabular and in graphs



How does it look like?

The screenshot shows the Galaxy Configured by Planemo interface. The top navigation bar includes links for Workflow, Visualize, Bibliothèque de données, Admin, Aide, Utilisateur, and various icons. On the left, a sidebar titled "Tools" lists several options: Upload Data, Upload File from your computer, Compute biodiversity indices from remote sensing data, Compare diversity indicators with remote sensing data, Preprocess sentinel 2 data, Compute a PCA raster, Compute spectral indices, Validate ISO 19139 metadata documents, and Map diversity from remote sensing data. Below this is a "WORKFLOWS" section with a link to All workflows.

The main content area displays a tool titled "Compute biodiversity indices from remote sensing data (Galaxy Version 0.0.0)". It asks for the input format ("In which format are your data?") and specifies "ENVI BIL format". It also asks for the input raster ("Input raster") and header ("Input header"), both set to "S2A_Subset_test". A field for "alpha value" is set to "1". A "Execute" button is present.

Computes global biodiversity indices from satellite remote sensing data

What it does

This tool aims to provide functions to apply Information Theory based diversity indexes on RasterLayer such as Shannon's entropy or Cumulative Residual Entropy (CRE).

Input description

It expects an image file as input, with a specific data format. ENVI HDR image with BIL interleave required. The image is an ENVI raster including :

- A binary file (which has no extension here).
- A header file (with .hdr extension).

The header file is a text file including all necessary metadata which can be read with a text editor. It includes image dimensions, projection, and the name and central wavelength for each spectral band.

In order to get such input we advise to use the tool preprocessing sentinel 2 data. If you did so you can directly enter the "Reflectance" output from this tool and thus select the option "The data you are using are in a zip folder Reflectance".

⚠️ If you do not use this Reflectance folder make sure that your data are respectively in bil and hdr format in the datatypes.

- A number for the alpha indice which used to calculate the following indicators : Renyi, Hill and Prao.

| BIL | ENVI HDR | Number alpha |
|--------------|----------|--------------|
| raster stack | Metadata | 1 |

BiodivMapR

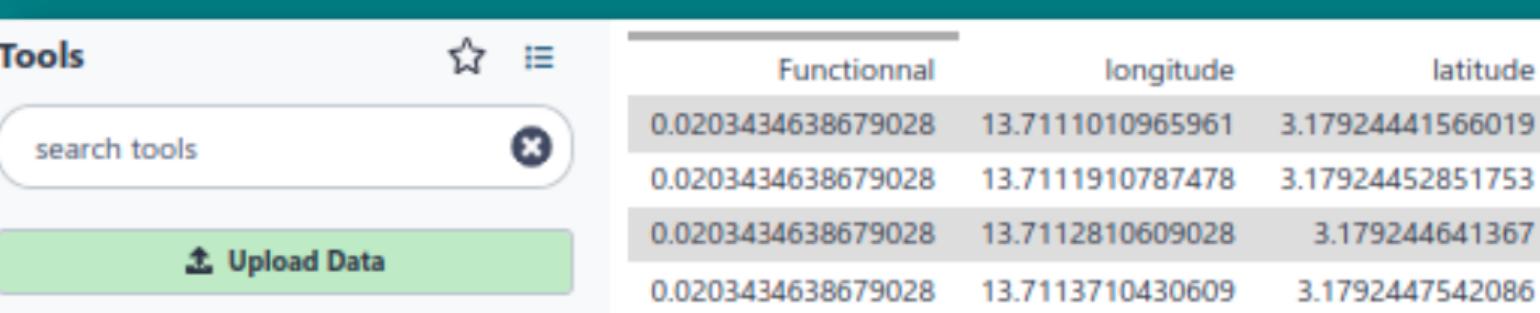
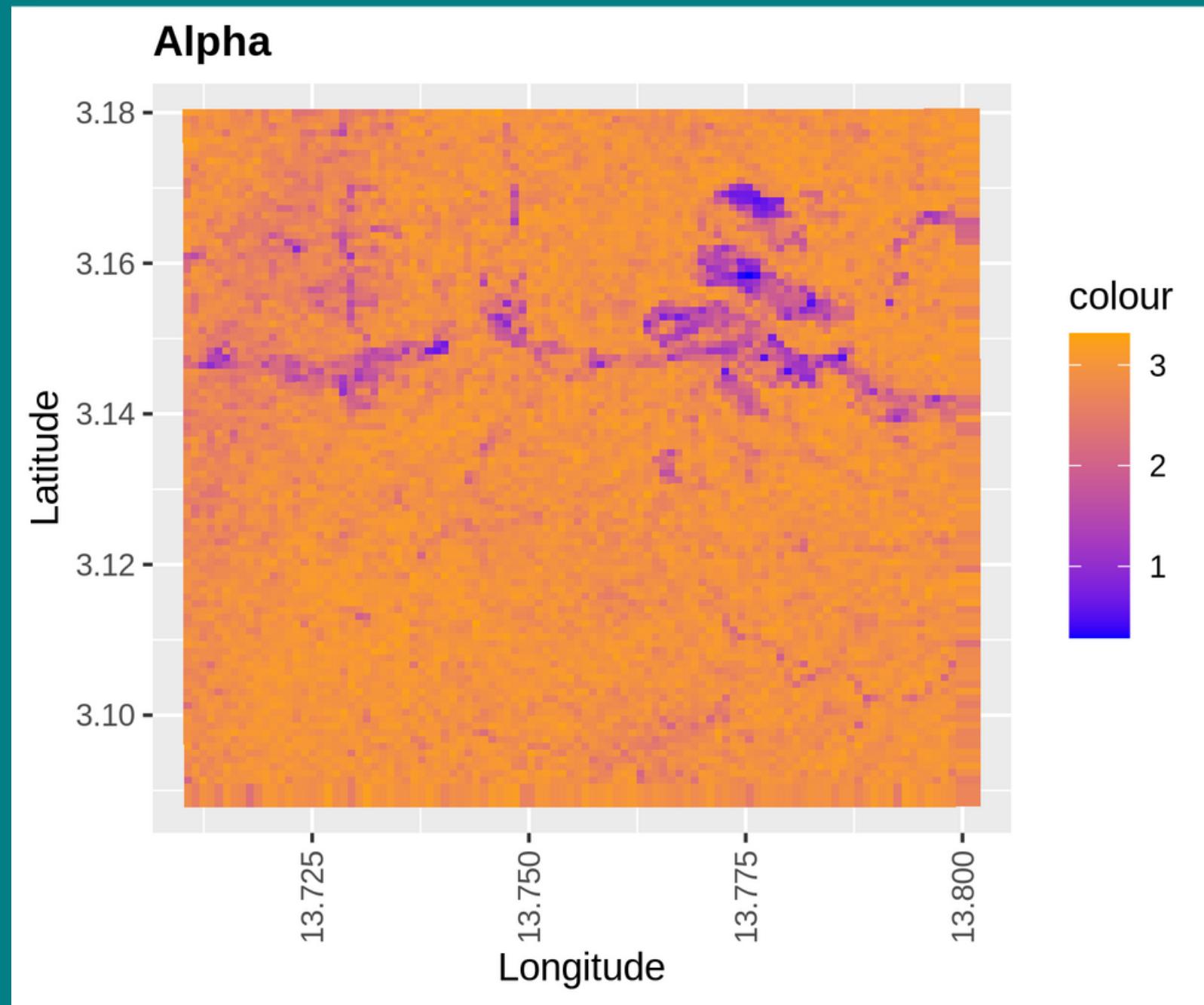
Canopy study :
Map diversity tool

Input

- The 2 envi bil files from the previous tool

Output

- Alpha diversity
- Beta diversity
- Functionnal analysis



How does it look like?

Map diversity

Galaxy Configured by Planemo

Workflow Visualize Bibliothèque de données Admin Aide Utilisateur

Tools

search tools

Upload Data

Upload File from your computer

Compute biodiversity indices from remote sensing data

Compare diversity indicators with remote sensing data

Preprocess sentinel 2 data read, crop, resample and write it as a raster stack.

Compute a PCA raster from remote sensing data

Compute spectral indices as NDVI from remote sensing data

Validate ISO 19139 metadata documents from files or Urls.

Map diversity from remote sensing data

WORKFLOWS

All workflows

Map diversity from remote sensing data (Galaxy Version 0.0.0)

In which format are your data ?

Your already have the files in ENVI BIL format

Input raster

2: S2A_Subset_test

It can be the raw data in bil or the PCA raster layer in bil

Input header

1: S2A_Subset_test.hdr

Do you want to do a PCA or a SPCA ?

SPCA

PCA

If you choose PCA there is no rescaling of the data as opposed as if you choose SPCA

Alpha, beta, functional diversity and comparison plot and map

Alpha diversity map

Beta diversity map

Functional diversity map

All of the above

Execute

Process satellite remote sensing data to produce biodiversity indicators

What it does

Féret and Asner (2014) developed a method for **tropical forest** diversity mapping based on very high spatial resolution airborne imaging spectroscopy.

The goal of this tool using the package biodivMapR is to produce (spectral) diversity maps based on (optical) images.

Input description

It expects an image file as input, with a specific data format. ENVI HDR image with BIL interleave required. The image is an ENVI raster including :

- A binary file (which has no extension here).
- A header file (with .hdr extension).

The header file is a text file including all necessary metadata which can be read with a text editor. It includes image dimensions, projection, and the name and central wavelength for each spectral band.

BiodivMapR

Canopy study : Comparison tool

Input

- The 2 envi bil files from the first tool
- if you want to compare with in situ data you'll also need a shape file

| ID_Plot | Forest_HighDiversity | Forest_LowDiversity | Forest_MediumDiversity | LowVegetation | Forest_HighDiversity | Forest_LowDiversity |
|------------------------|----------------------|---------------------|------------------------|-------------------|----------------------|---------------------|
| Forest_HighDiversity | 0 | 0.592972288569817 | 0.565601439639129 | 0.641352656343501 | 0.553116089728383 | 0.723287828668831 |
| Forest_LowDiversity | 0.592972288569817 | 0 | 0.794954586282086 | 0.781355810742138 | 0.68534833660536 | 0.782484730632053 |
| Forest_MediumDiversity | 0.565601439639129 | 0.794954586282086 | 0 | 0.576192328969609 | 0.497822379593039 | 0.649394360809528 |
| LowVegetation | 0.641352656343501 | 0.781355810742138 | 0.576192328969609 | 0 | 0.523405001569518 | 0.557895945457021 |
| Forest_HighDiversity | 0.553116089728383 | 0.68534833660536 | 0.497822379593039 | 0.523405001569518 | 0 | 0.569242046482229 |
| Forest_LowDiversity | 0.723287828668831 | 0.782484730632053 | 0.649394360809528 | 0.557895945457021 | 0.569242046482229 | 0 |
| Forest_MediumDiversity | 0.994515267618716 | 1 | 0.998625429553265 | 1 | 0.996818499650385 | 0.998657718120805 |
| LowVegetation | 0.94018897315834 | 0.95656976529877 | 0.989232155773878 | 0.994662436357695 | 0.968597398220022 | 0.958651854571807 |
| Forest_HighDiversity | 0.955115603705467 | 0.99864406779661 | 0.968903005991497 | 0.988401708610167 | 0.964193053605717 | 0.97430124627628 |
| Forest_LowDiversity | 0.951684436546145 | 0.998625429553265 | 0.961175350935895 | 0.986886991391772 | 0.959473727734387 | 0.975508315582341 |

Output

- Bray curtis table
- comparison study

How does it look like ?

Galaxy Configured by Planemo

Workflow Visualize Bibliothèque de données Admin Aide Utilisateur

Tools

search tools

Upload Data

Upload File from your computer

Compute biodiversity indices from remote sensing data

Compare diversity indicators with remote sensing data

Preprocess sentinel 2 data read, crop, resample and write it as a raster stack.

Compute a PCA raster from remote sensing data

Compute spectral indices as NDVI from remote sensing data

Validate ISO 19139 metadata documents from files or Urls.

Map diversity from remote sensing data

WORKFLOWS

All workflows

Compare diversity indicators with remote sensing data (Galaxy Version 0.0.0)

In which format are your data ?
Your already have the files in ENVI BIL format

Input raster
2: S2A_Subset_test

It can be the raw data in bil or the PCA raster layer in bil

Input header
1: S2A_Subset_test.hdr

Plots folder zip
8: S2A_T33NUD_Plots.zip

Do you want to compute beta diversity (needs mutliple locations) ?
 Yes
 No

Do you want to do a PCA or a SPCA ?
 SPCA
 PCA

If you choose PCA there is no rescaling of the data as oppposed as if you choose SPCA

Execute

Process satellite remote sensing data to produce biodiversity indicators

What it does

Féret and Asner (2014) developed a method for **tropical forest** diversity mapping based on very high spatial resolution airborne imaging spectroscopy.

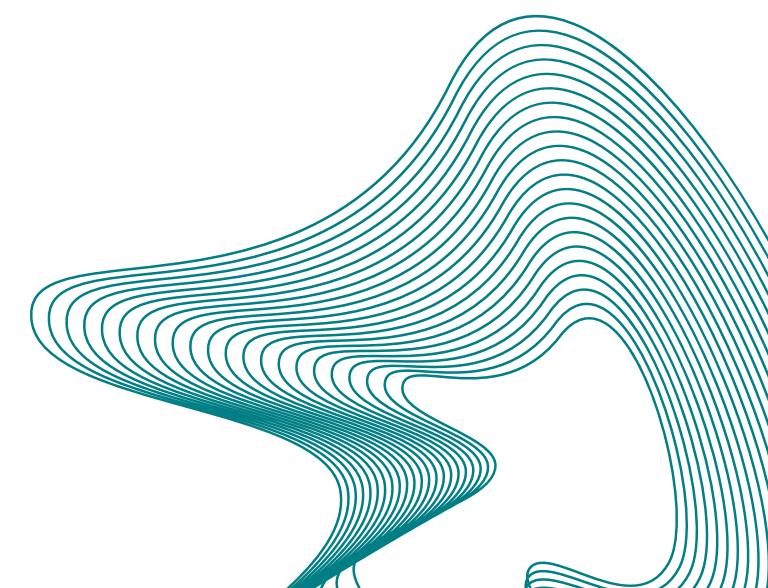
The goal of this tool using the package biodivMapR is to compute diversity indices over each spatial polygon of a shapefile of plots, if available, in order to compare field inventories with diversity indices from remotely-sensed images.

Input description

It expects an image file as input, with a specific data format. ENVI HDR image with BIL interleave required. The image is an ENVI raster including :

- A binary file (which has no extension here).

Compare diversity
indicators



Prosail

Spectral indices

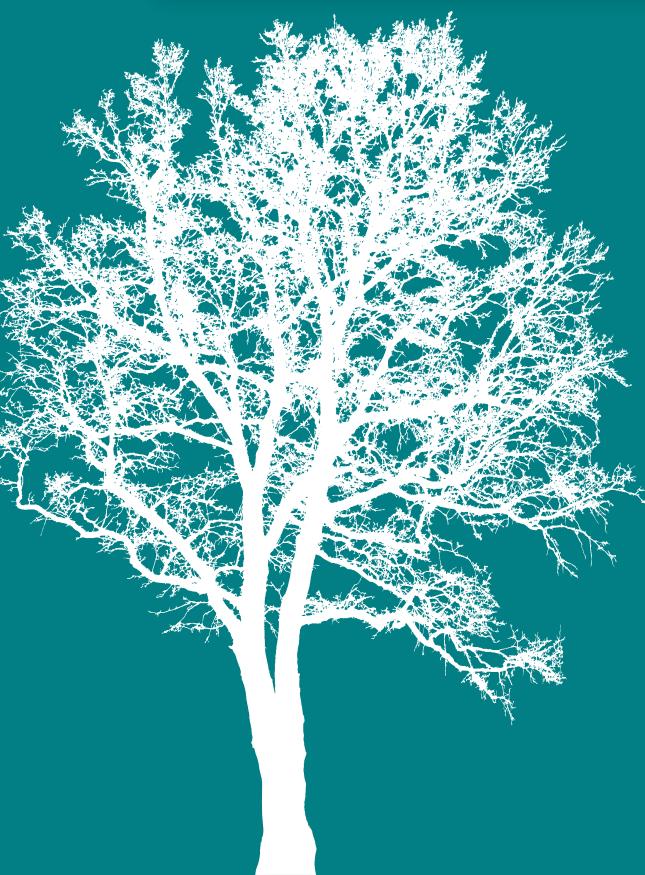
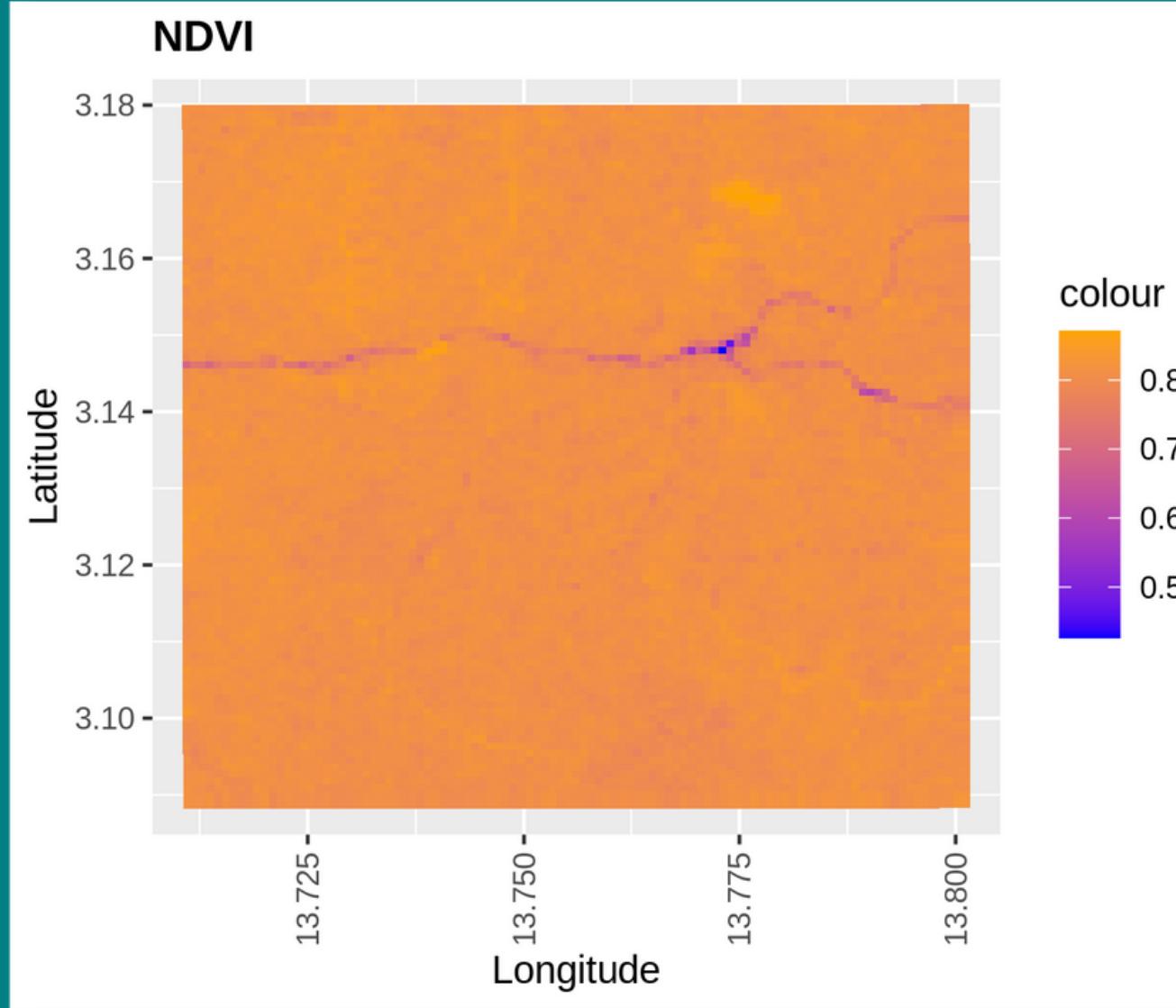
Spectral indices to know more about the well being of the vegetation.

Input

The 2 envi bil files from the first tool

Output

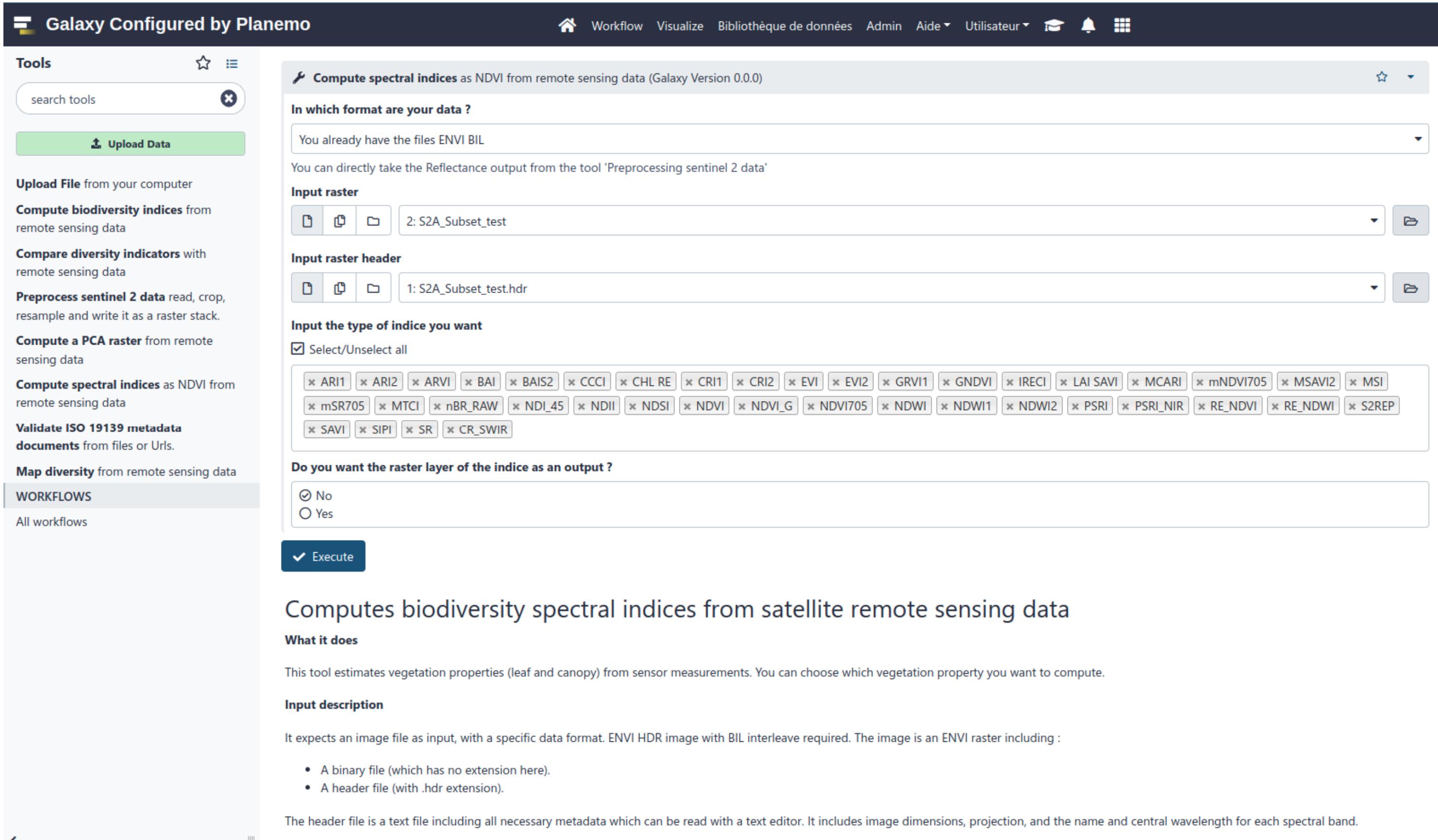
- A tabular on the indice you chose to compute (NDVI, CCCI, ...)
- Graphs on the indices
- The raster layer in envi bil format



| S2A_Subset_test | longitude | latitude | NDVI |
|-----------------|------------------|------------------|-------------------|
| 234.29 | 13.7115065213769 | 3.17883791054367 | 0.809475381273922 |
| 233.06 | 13.7124063428304 | 3.17883903826377 | 0.814533326859802 |
| 231.57 | 13.7133061646046 | 3.17884016519658 | 0.808063813546791 |
| 228.73 | 13.7142059866993 | 3.17884129134209 | 0.814678963045019 |
| 230.6 | 13.7151058091144 | 3.17884241670032 | 0.812649359747791 |
| 228.85 | 13.7160056318495 | 3.17884354127124 | 0.806605795437084 |
| 229.59 | 13.7169054549044 | 3.17884466505487 | 0.810899033966968 |

Remote sensing with Sentinel 2

How
does
it look
like ?

 Galaxy Configured by Planemo

Workflow Visualize Bibliothèque de données Admin Aide Utilisateur

Tools

- search tools
- Upload Data**
- Upload File from your computer
- Compute biodiversity indices from remote sensing data
- Compare diversity indicators with remote sensing data
- Preprocess sentinel 2 data read, crop, resample and write it as a raster stack.
- Compute a PCA raster from remote sensing data
- Compute spectral indices as NDVI from remote sensing data
- Validate ISO 19139 metadata documents from files or Urls.
- Map diversity from remote sensing data

WORKFLOWS

All workflows

Compute spectral indices as NDVI from remote sensing data (Galaxy Version 0.0.0)

In which format are your data ?
You already have the files ENVI BIL
You can directly take the Reflectance output from the tool 'Preprocessing sentinel 2 data'

Input raster
2: S2A_Subset_test

Input raster header
1: S2A_Subset_test.hdr

Input the type of indice you want
 Select/Unselect all

ARI1 ARI2 ARVI BAI BAIS2 CCCI CHL RE CRI1 CRI2 EVI EVI2 GRSI GNDVI IRECI LAI SAVI MCARI mNDVI705 MSAVI2 MSI mSR705 MTCTI nBR_RAW NDI_45 NDII NDSI NDVI NDVI_G NDVI705 NDWI NDWI1 NDWI2 PSRI PSRI_NIR RE_NDVI RE_NDWI S2REP SAVI SIPI SR CR_SWIR

Do you want the raster layer of the indice as an output ?
 No Yes

Execute

Computes biodiversity spectral indices from satellite remote sensing data

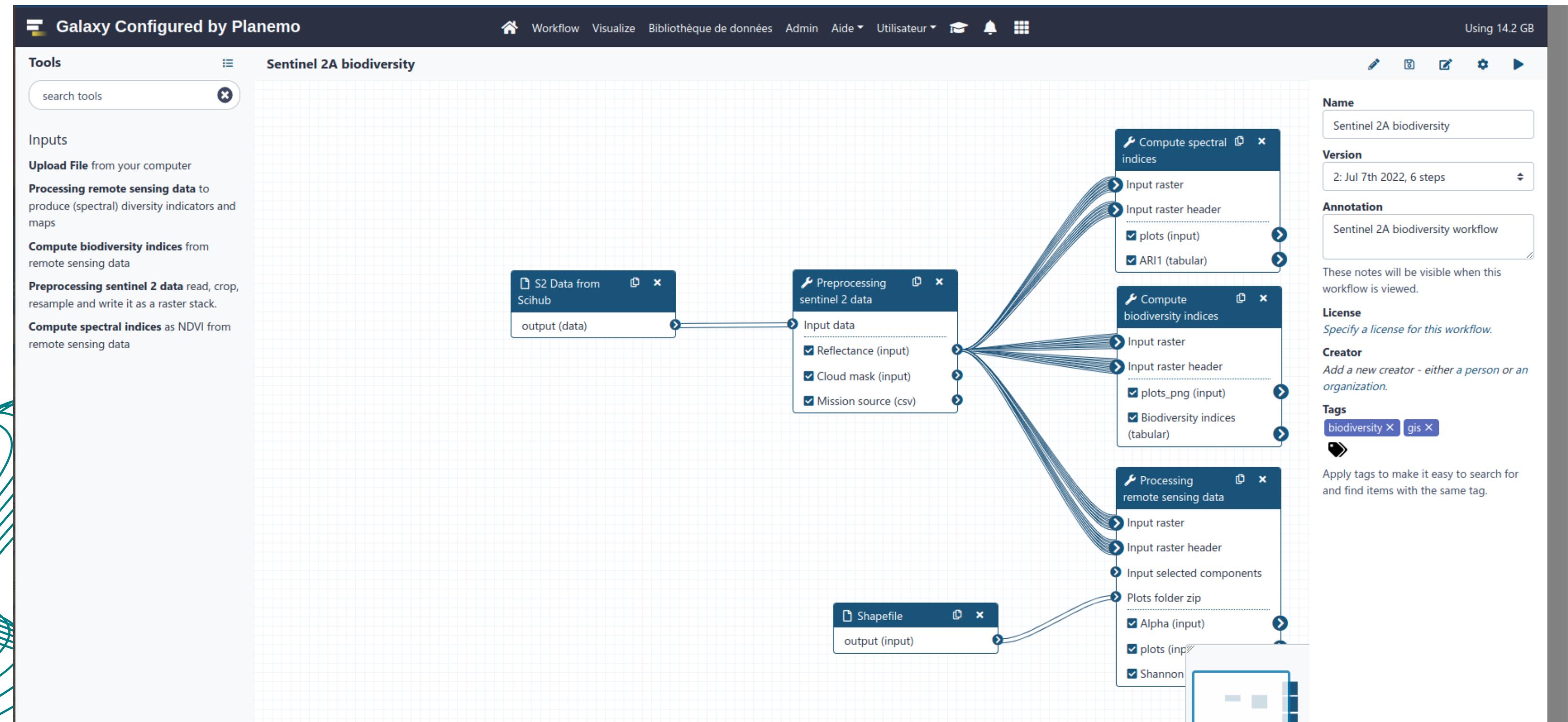
What it does
This tool estimates vegetation properties (leaf and canopy) from sensor measurements. You can choose which vegetation property you want to compute.

Input description
It expects an image file as input, with a specific data format. ENVI HDR image with BIL interleave required. The image is an ENVI raster including :

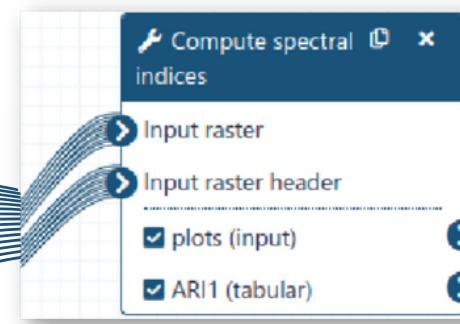
- A binary file (which has no extension here).
- A header file (with .hdr extension).

The header file is a text file including all necessary metadata which can be read with a text editor. It includes image dimensions, projection, and the name and central wavelength for each spectral band.

Sentinel 2 workflow



A tutorial is being developed to explain this workflow for biodiversity



SRS - EBV

Satellite remote sensing essential biodiversity variable

Add some of GEO BON EBV to Sentinel 2 workflow which are similar to spectral indices tool

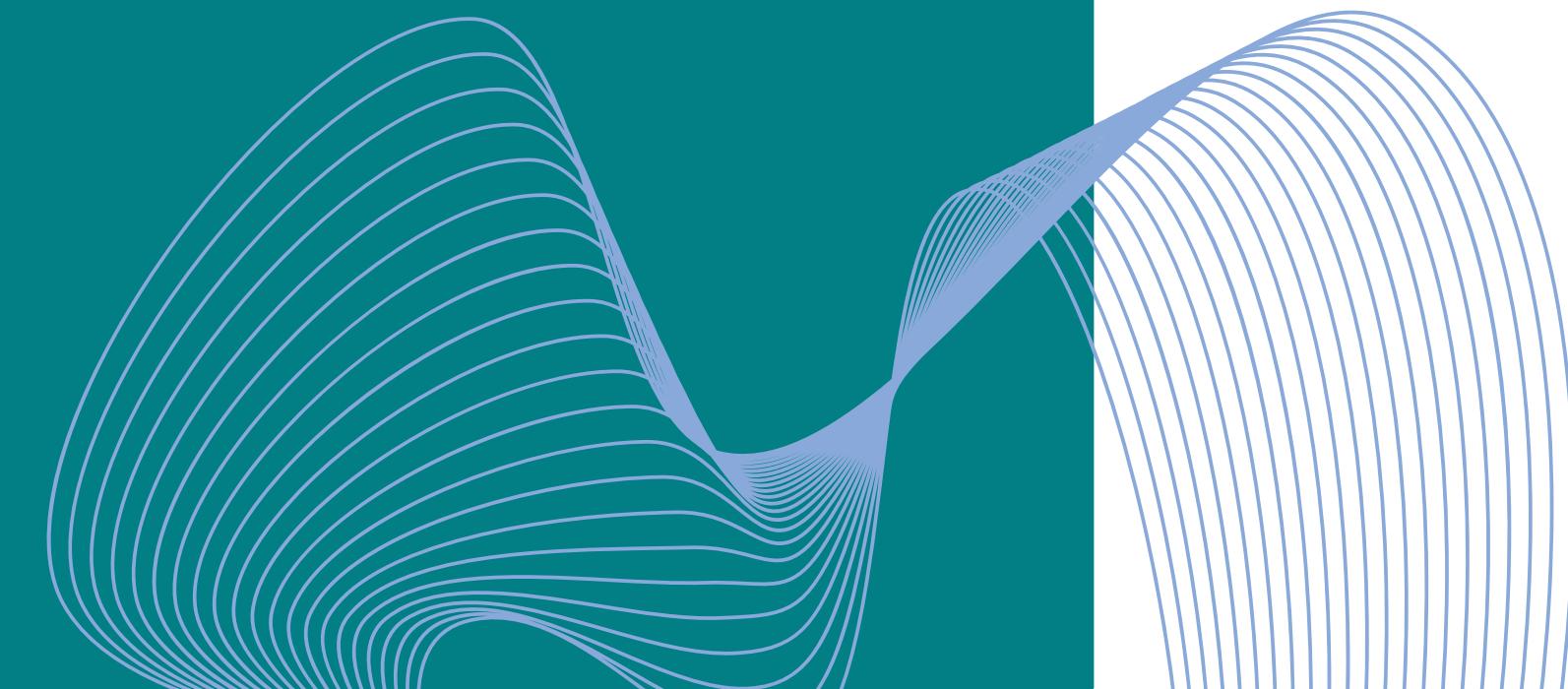
Exemples

- Canopy chlorophyl content
- Vegetation active period
- Red list ecosystem



Sentinel 2 workflow for biodiversity indicators

Still in peer review should be available very soon with its
tutorial



Biodiversity data exploration workflow

A fully operational workflow available on Galaxy-
Ecology

Exploration steps



01 Get and clean in-situ data

02 Presence, absence and abundance

03 Statistics on presence-absence

04 Variables explorations

05 Homoscedasticity and normality

06 LCBD



Biodiversity

In situ data



Spatial

Remote sensing data



Thank you !