



Giwer: Geolmage Workflow Editing Resources

egy ELTE IK-s open sources csomag

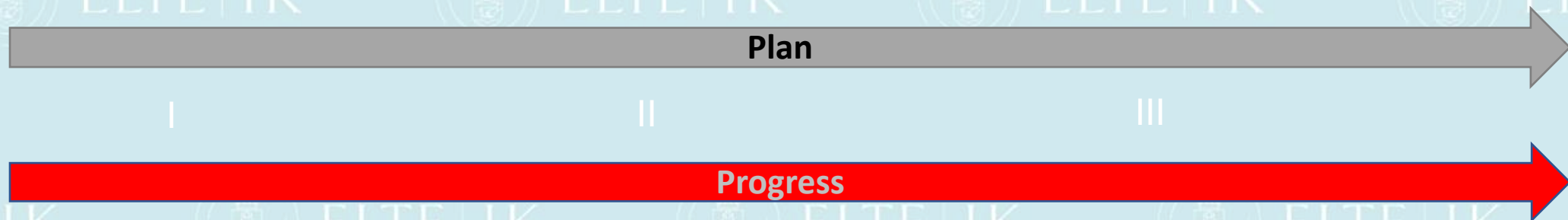
Elek István
ELTE IK

Foszforgézu Konferencia 2023.06.09.

Project no. ED_18-1-2019-0030 (Application-specific highly reliable IT solutions) has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, financed under the Thematic Excellence Program funding scheme..

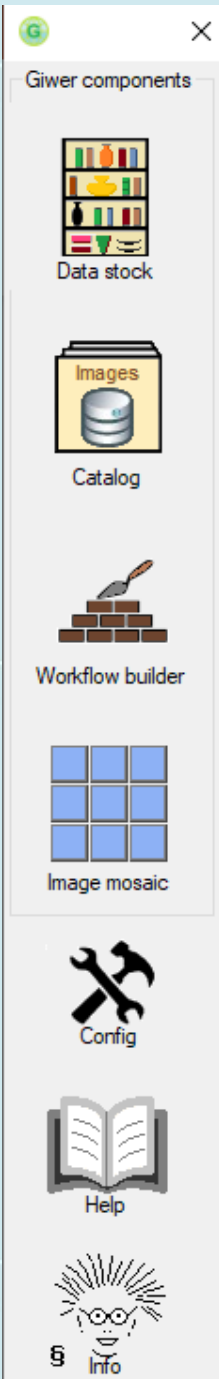
Objective

- I. Create a system for processing images taken from space and air, which can also process images from drones
- II. Users can compound their own workflows from the functions available in Giwer and run them on many images



Sub-systems and modules

1. **Catalog:** It organizes large number of images into a database. The Catalog organizes raw images into a database (Sqlite), which reads and stores many images and image parameters from their exif data, and also provides storage options in interactive fields.
2. **DataStock:** It is an interactive image processing system. We have implemented large number of image processing functions that can be accessed via the menu system
3. **WorkflowBuilder:** This is a workflow editor. From the available functions, arbitrary workflows can be compiled, so the user can create their own processing procedures based on their individual knowledge, experience and creativity.



Difficulties

- A wide variety of non-standard files need to be read
 - Geotif is still the most standard
 - Bil is so diverse that it is already annoying (ESRI bil, ENVI bil, ER Mapper bil)
 - Exif is not standard at all (we need to further develop different exif readers if we want to read the full exif of additional cameras)
- Data from different cameras is not uniform. For example, a DJI RGB camera contains altitude data, but Micasense does not, and the GPS built into the cameras is inaccurate. The RTK GPS built into the drone is accurate, but its data cannot be extracted from it.
- As long as there is no exact height data, we cannot calculate the coordinates of the corner points of the images, therefore it is not possible to display several images in a mosaic-like manner.

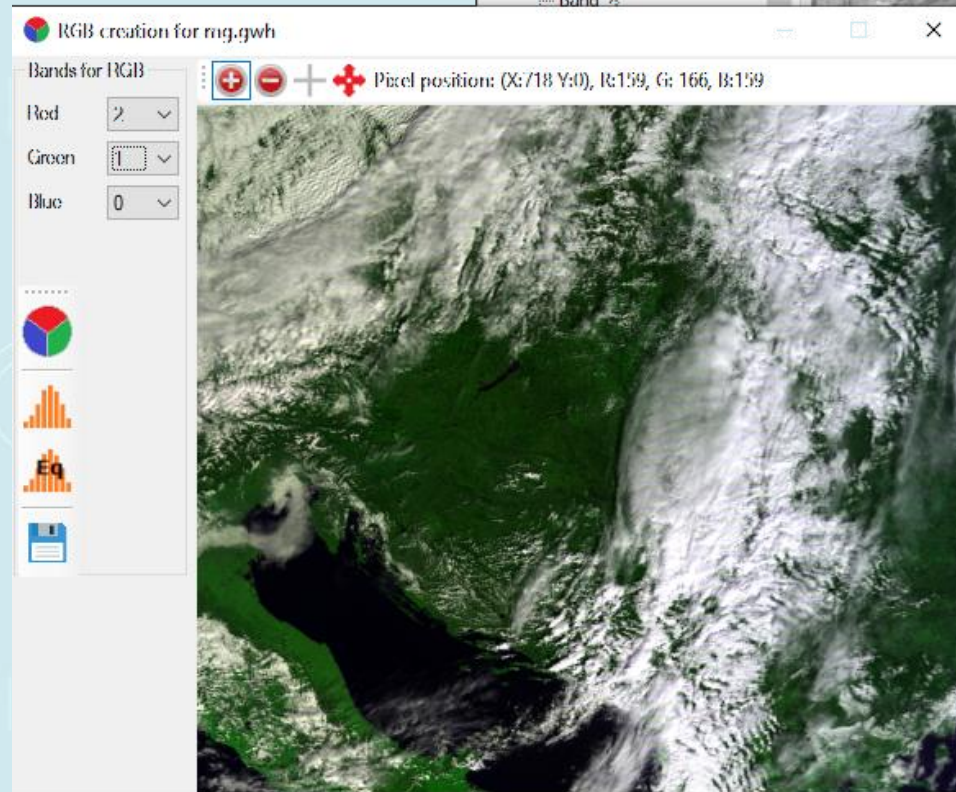
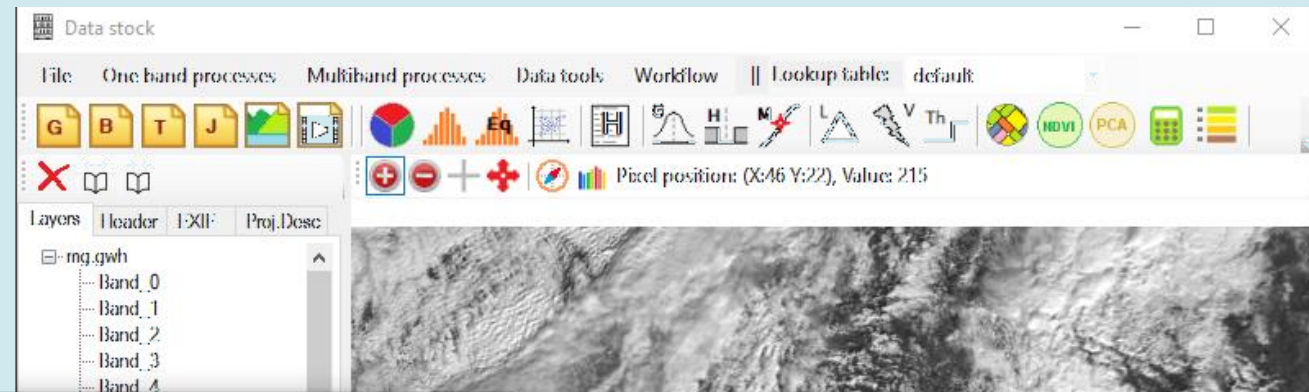
Results briefly

1. DataStock (interactive) is completed (v1.0 completed)
2. Catalog is completed (v1.0 completed)
3. WorkflowBuilder is completed (v1.0 completed)
4. The necessary documentation is being prepared
 - a) users 'guide in Hungarian and English
 - b) Developer docs in English
 - c) Tutorials in Hungarian and English

DataStock

Snapshots from DataStock's operations

- › Loads images from different file format: gwr, bil, ENVI bil, cub, tif, grotif, jpg with 8,16,24,48 bits, with many bands from 3 (RGB) to 250 bands
- › Creates RGB display
- › Displays histogram and equalizes
- › Draws crossplot with any of two bands
- › Displays file header
- › Applies functions of the filter bank
- › Computes NDVI and PCA
- › Loads and displays 3D data (digital terrain modell)
- › Runs the raster calculator (select pixels under the given condition)
- › Classification, clustering
- › Combines images (add, average, exor, subtract, etc)
- › Converts from one format to another
- › Analyses and displays spectrums
- › Extended raster calculator with graphics



Snapshots from DataStock's operations

The image displays three overlapping windows from the DataStock software interface:

- Main Window (Data stock):** Shows a satellite image of a marina. The top menu includes 'File', 'One band processes', 'Multiband processes', 'Data tools', and 'Color palette: default'. A toolbar contains various icons for processing. The 'Layers' panel on the left shows a tree structure for 'DJI_0016.gwh' with sub-items 'Band_0', 'Band_1', and 'Band_2'. A status bar at the top indicates 'Position: (953,232), Value: 101'.
- RGB creation dialog (RGB creation for DJI_0016.gwh):** Overlaid on the bottom left, it shows 'Bands for RGB' with 'Red' set to 2, 'Green' to 1, and 'Blue' to 0. It also shows a color wheel and an 'Eq' (equalize) icon. The status bar indicates 'Position: (2238,368), Values: { R:142, G:134, B:97}'.
- Histogram window (Histogram of DJI_0016.gwh):** Overlaid on the right, it displays three histograms for the RGB bands. The x-axis for all histograms ranges from 0 to 250. The y-axis represents frequency. The histograms show the distribution of pixel values for the Red, Green, and Blue channels. Below the histograms, there is a section for 'Select min/max values for each band' with instructions: 'Left mouse click: set min value' and 'Right mouse click: set max value'. The current values are: RedMinMax: 0,255; GreenMinMax: 0,255; BlueMinMax: 0,255. An 'Equalize' button is visible at the bottom.

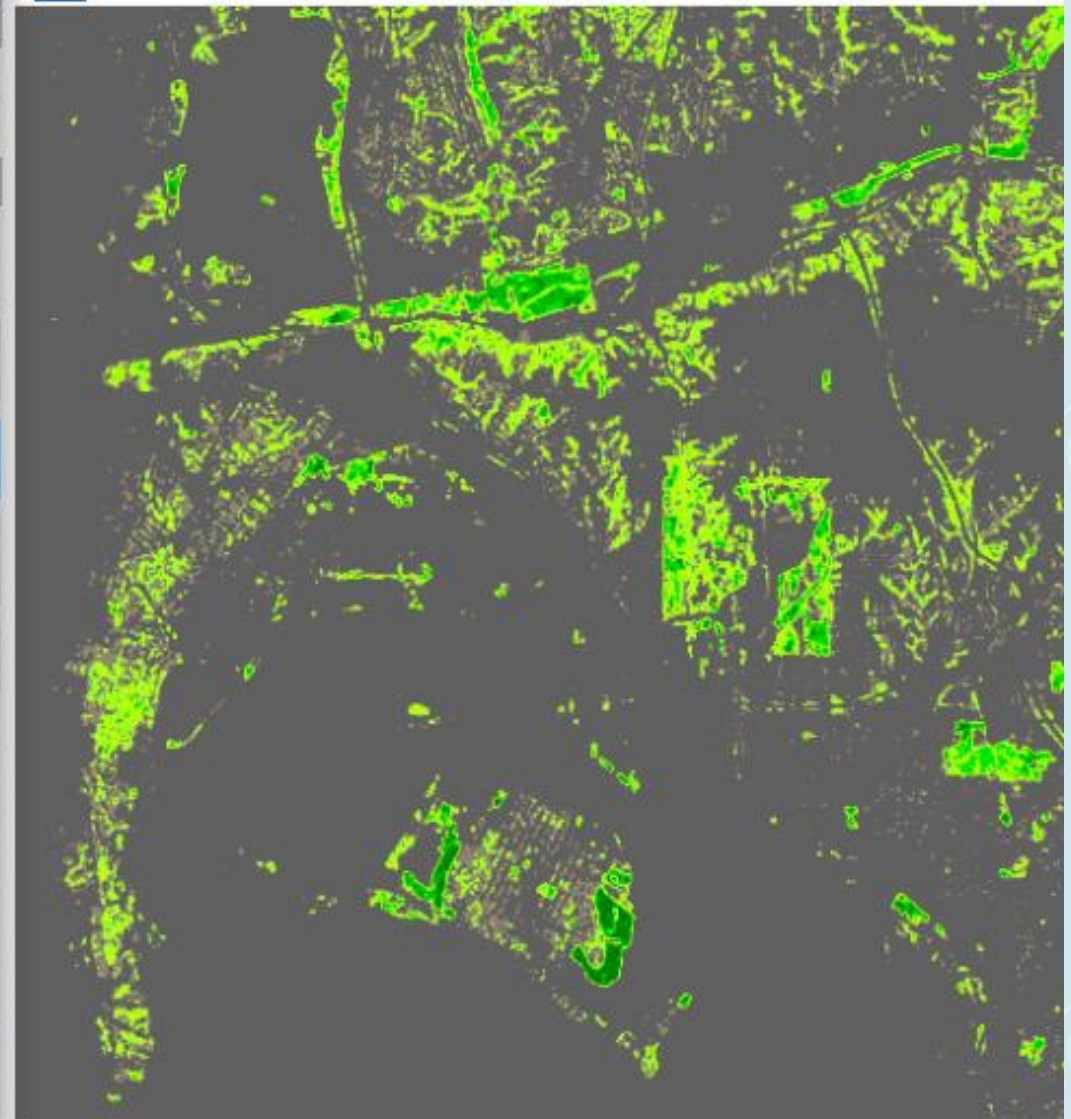
File: DJI_0016.gwh

Snapshots from DataStock's operations

RGB

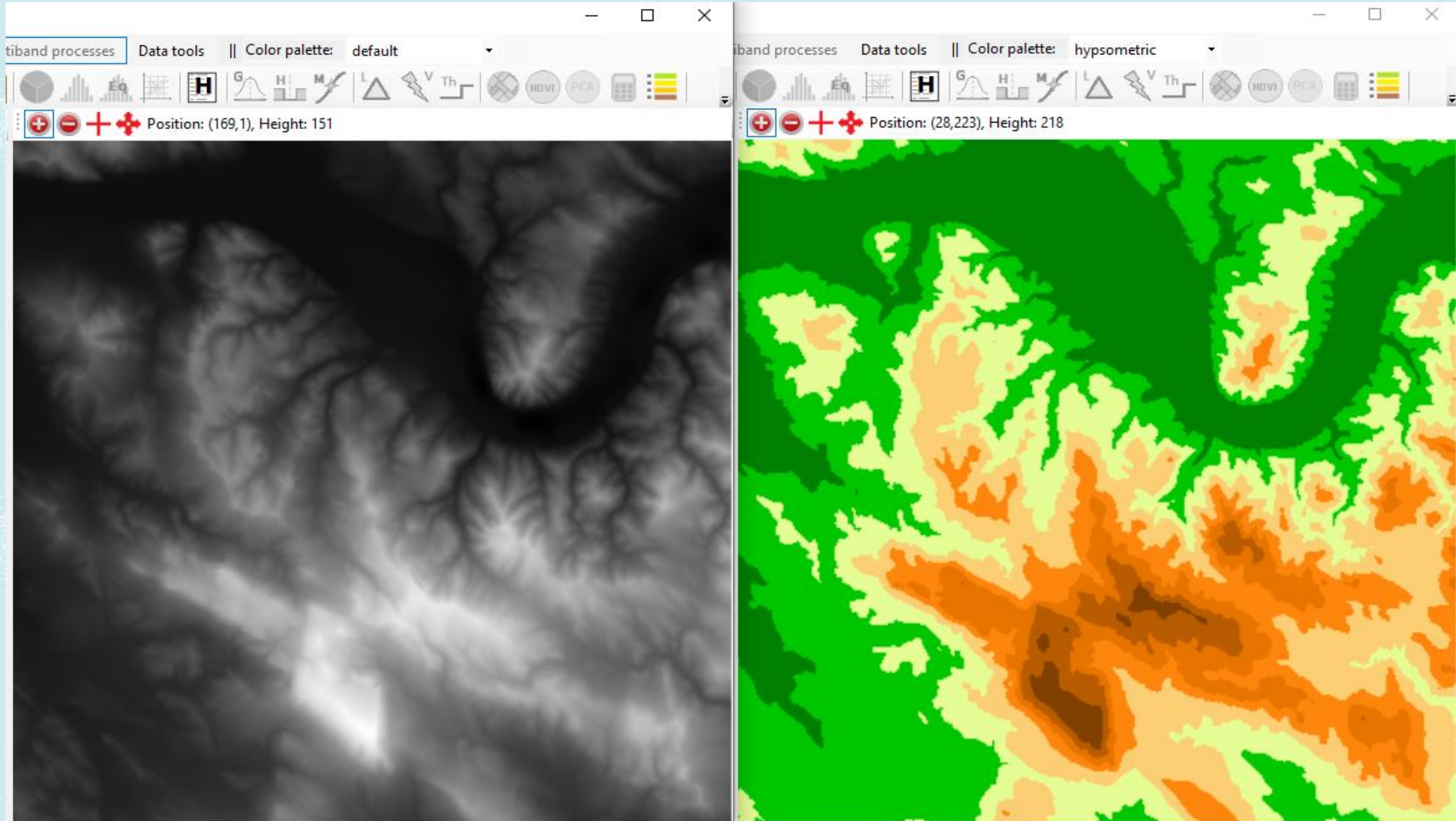


NDVI



Snapshots from DataStock's operations

3D

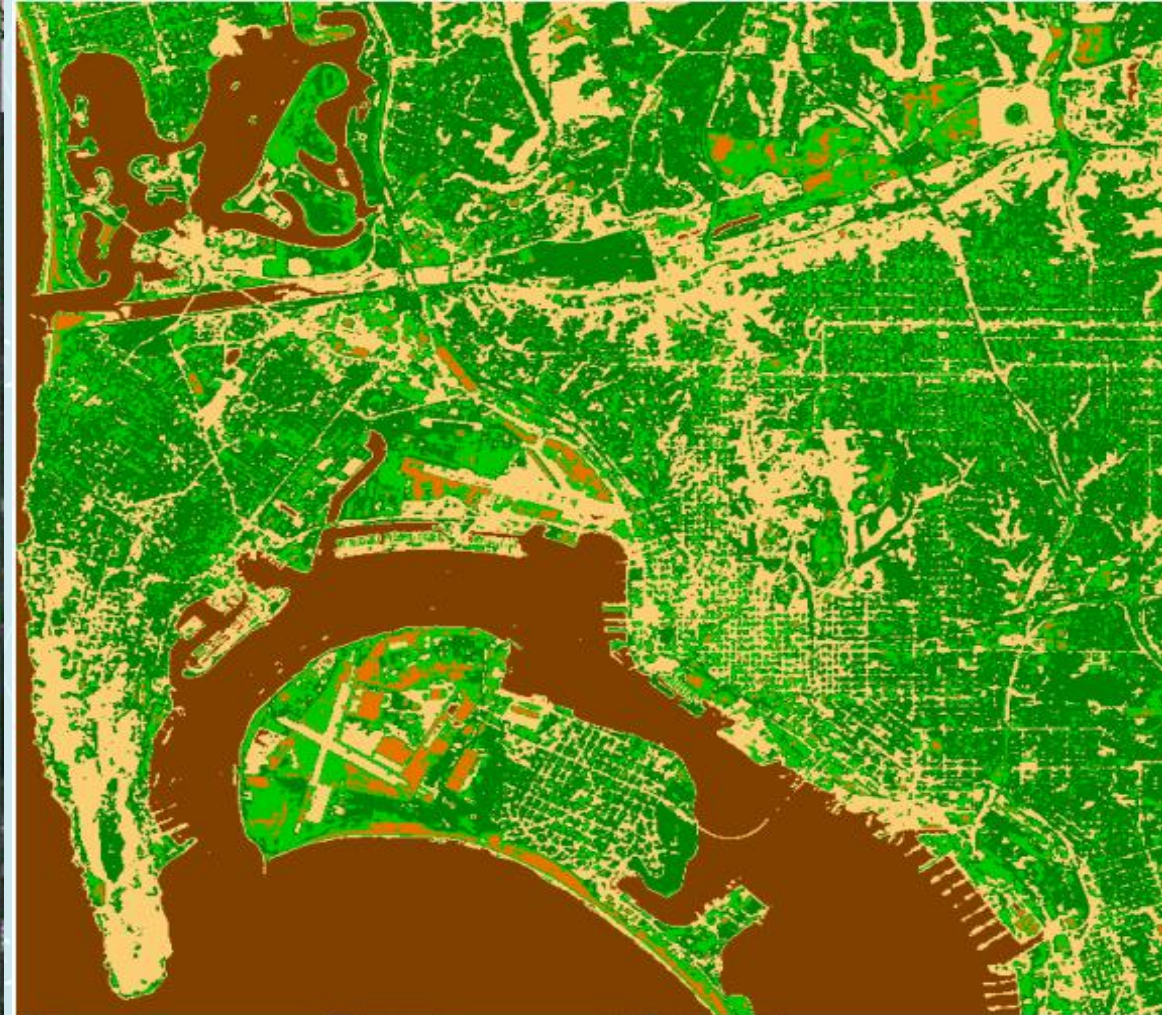


Snapshots from DataStock's operations

RGB

Clustering

SPOT
satellite
image



Snapshots from DataStock's operations

ISODATA clustering

Clustering

Included Bands

Current Band

Current .gwh

Select All

Deselect All

0

1

2

Pixel position: (X:744 Y:386), Value: 252

Clustering Method: ISODATA

Method Parameters

Maximum Iterations: 15

Initial Number of Clusters: 10

Maximum Clusters: 256

Minimum Cluster Size: 100

Standard Deviation Limit: 1,00000

Minimum Centroid Distances: 1000,00

Maximum Merges per Iteration: 10

Color palettes: user

Compute Clustering

Apply Result to Image

Number of clusters found: 10

Done.

Snapshots from DataStock's operations

K-Means clustering

The screenshot shows the 'Clustering' dialog box in a GIS application. The dialog is titled 'Clustering' and has a standard Windows window control bar. It is divided into several sections:

- Included Bands:** Two radio buttons are present: 'Current Band' (unselected) and 'Current .gwh' (selected). Below them are 'Select All' and 'Deselect All' buttons. A list of bands is shown with checkboxes for 0, 1, and 2, all of which are checked.
- Pixel position:** A status bar at the top right of the dialog shows 'Pixel position: (X:739 Y:237), Value: 85'.
- Clustering Method:** A dropdown menu is set to 'K-Means'.
- Method Parameters:** A section containing five parameters with spinners:
 - Maximum Iterations: 15
 - Relative Distortion Threshold: 0,960
 - Minimum Clusters: 2
 - Maximum Clusters: 8
 - Relative Elbow Threshold: 0,240
- Color palettes:** A dropdown menu is set to 'user'.
- Buttons:** At the bottom right, there are two buttons: 'Compute Clustering' (highlighted with a blue border) and 'Apply Result to Image'.

The central part of the dialog is a large preview window showing an aerial photograph of a city with a river. The image has been processed with K-Means clustering, resulting in a color-coded map where different areas are assigned different colors (e.g., red, green, blue, yellow, purple). At the bottom of the dialog, it says 'Number of clusters found: 4' and 'Done.'.

Snapshots from DataStock's operations

Colour palette and lookup table

Color palettes (CP) and lookup tables (LUT)

Available color palettes:

Index	Red	Green	Blue	Alfa	Color
129	255	134	13	255	
130	255	134	13	255	
131	255	134	13	255	
132	255	134	13	255	
133	255	134	13	255	
134	255	134	13	255	
135	255	134	13	255	
136	255	134	13	255	
137	255	134	13	255	
138	255	134	13	255	
139	255	134	13	255	
140	255	134	13	255	

Lookup table

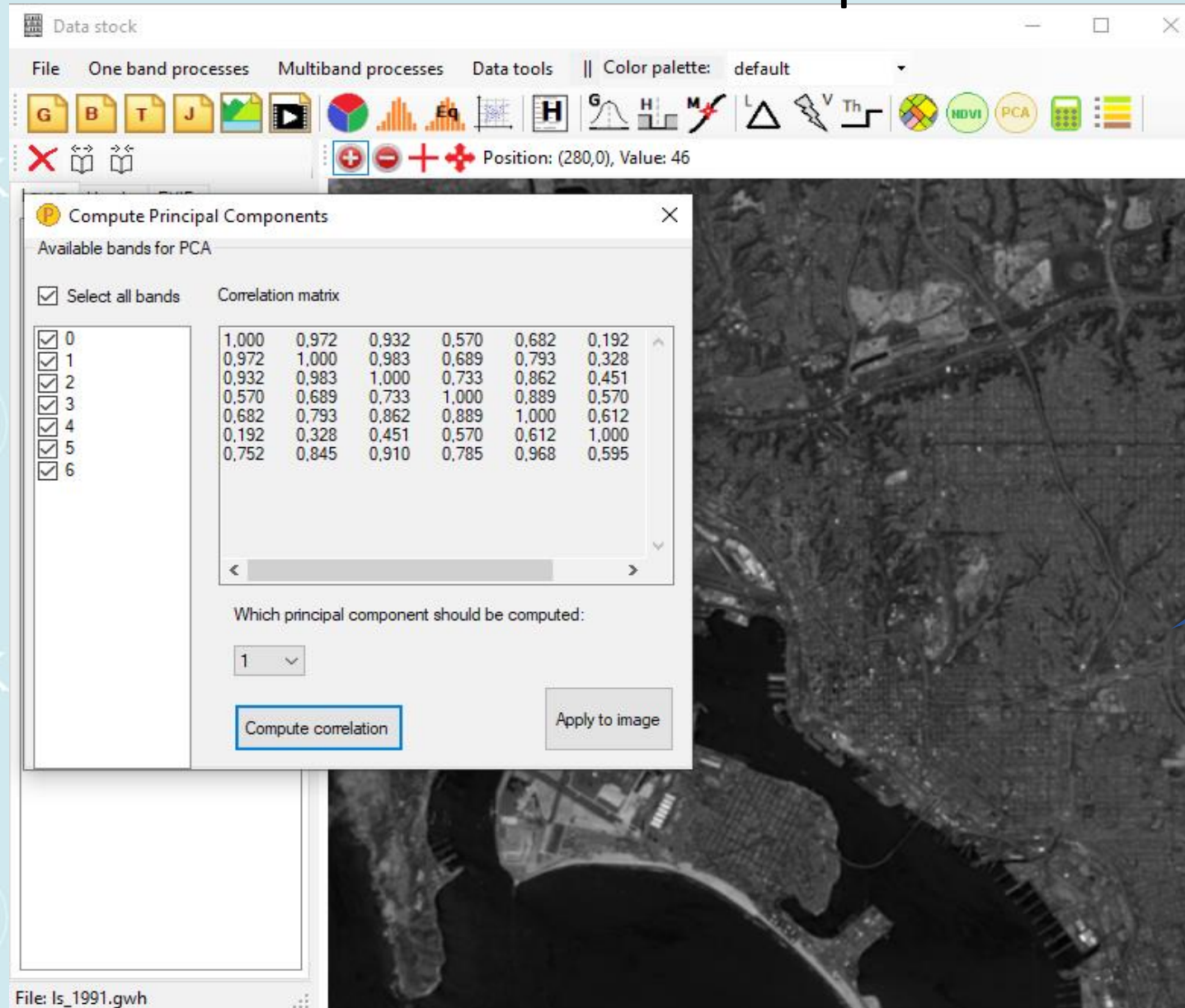
Number of base colors:

Start	Color	Category
0		
32		
64		
96		
128		
160		
192		
224		

Buttons: Create new color palette, Remove selected color palette, Generate palette colors, Save color palette, Save lookup table

Snapshots from DataStock's operations

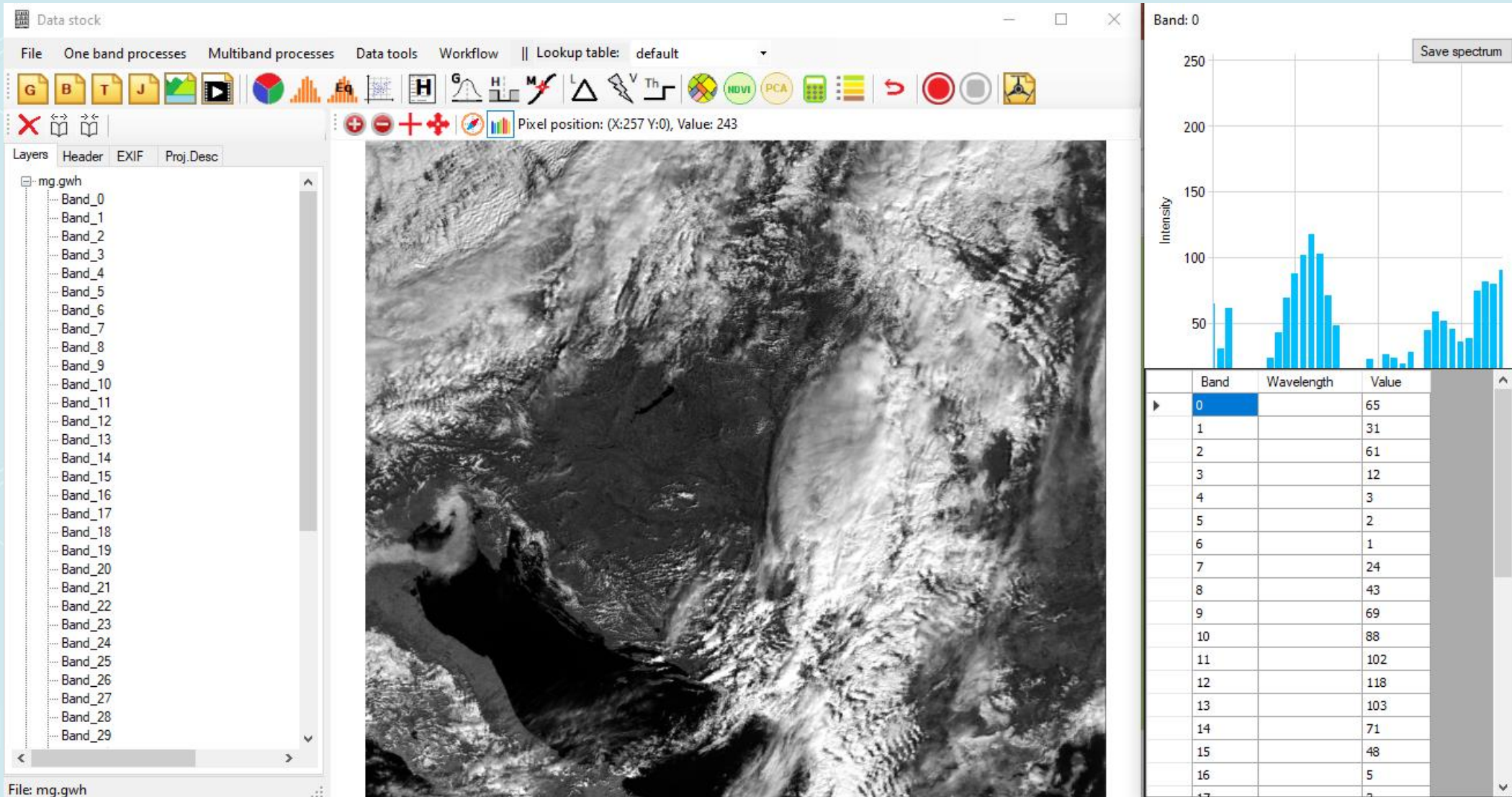
Principal component analysis



PC1

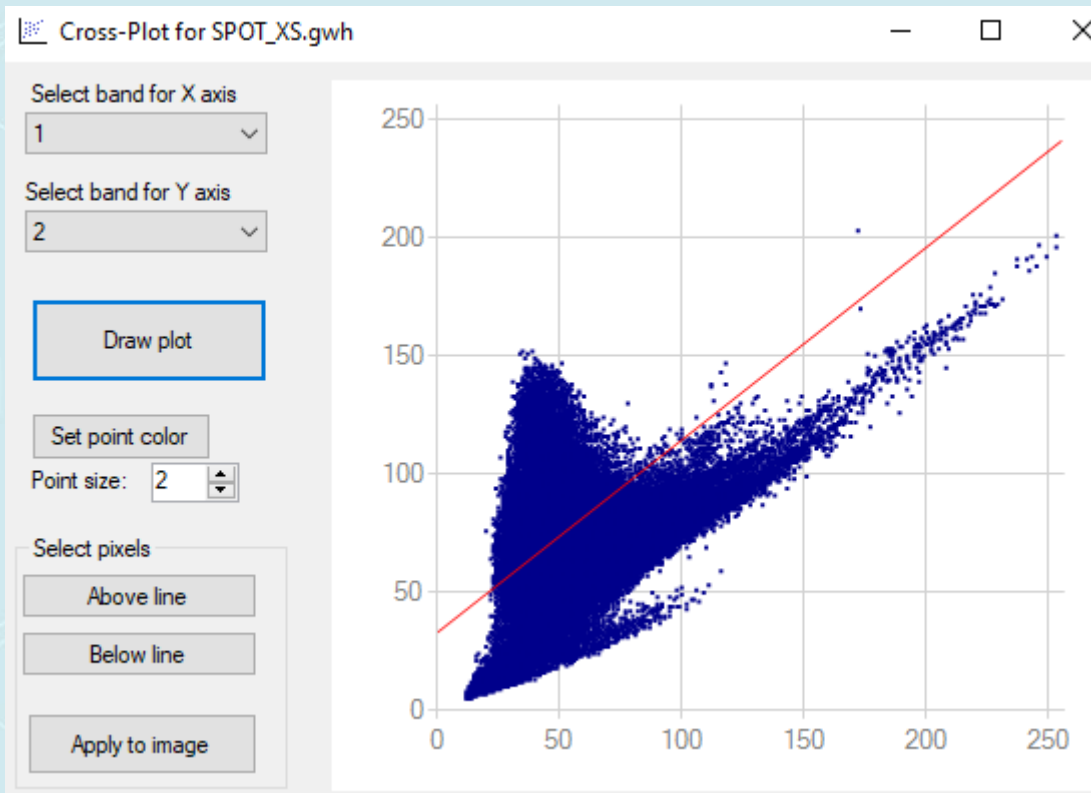
Snapshots from Giwer's operations

Methods for analysing hyperspectral images

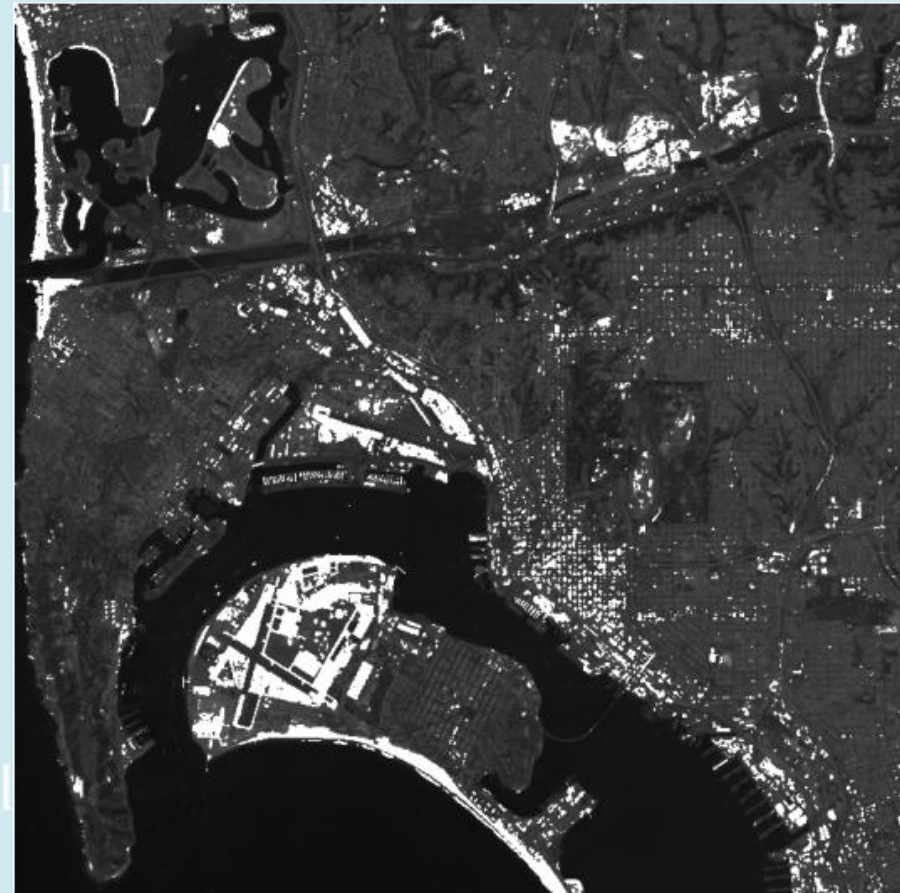


Snapshots from Giwer's operations

Raster calculator

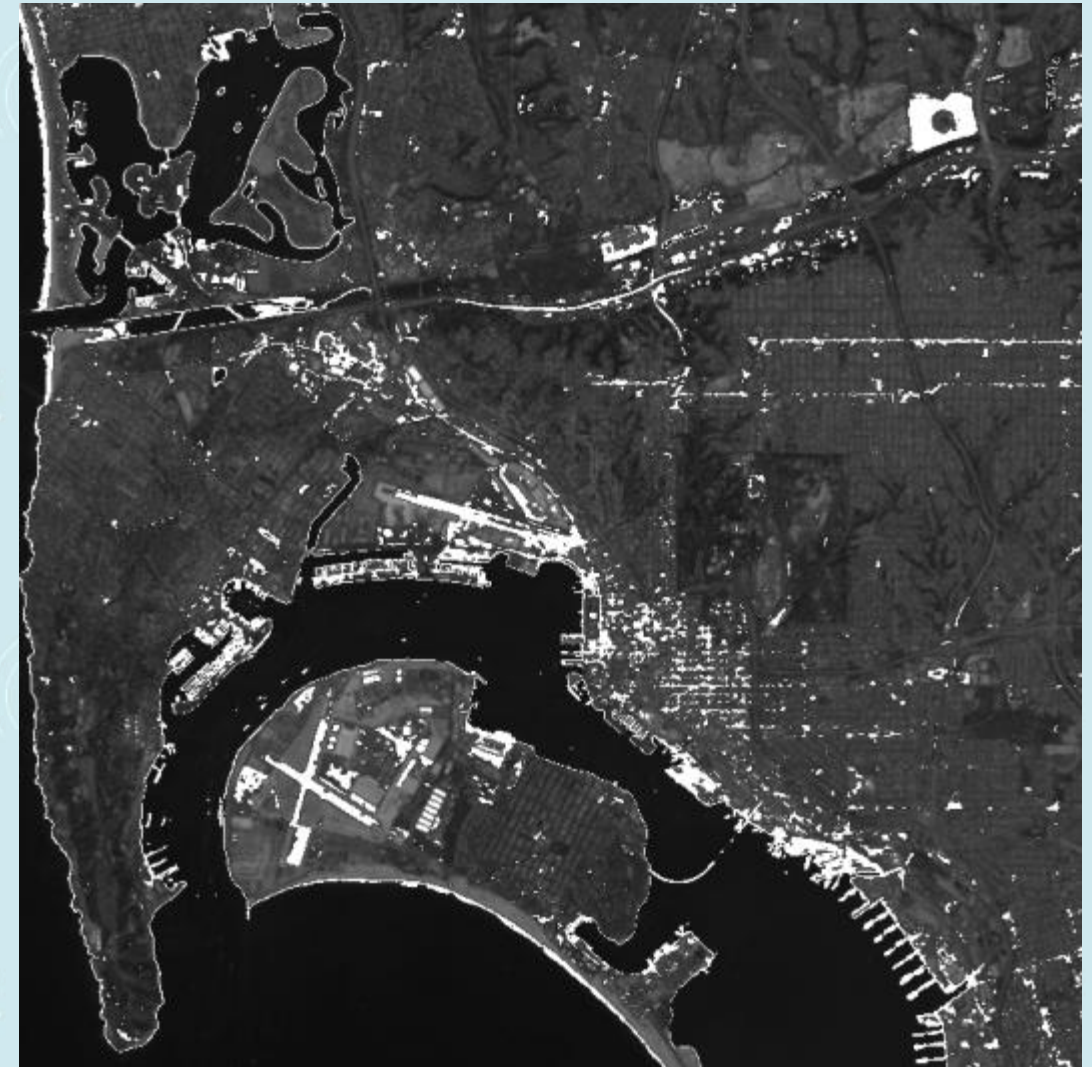
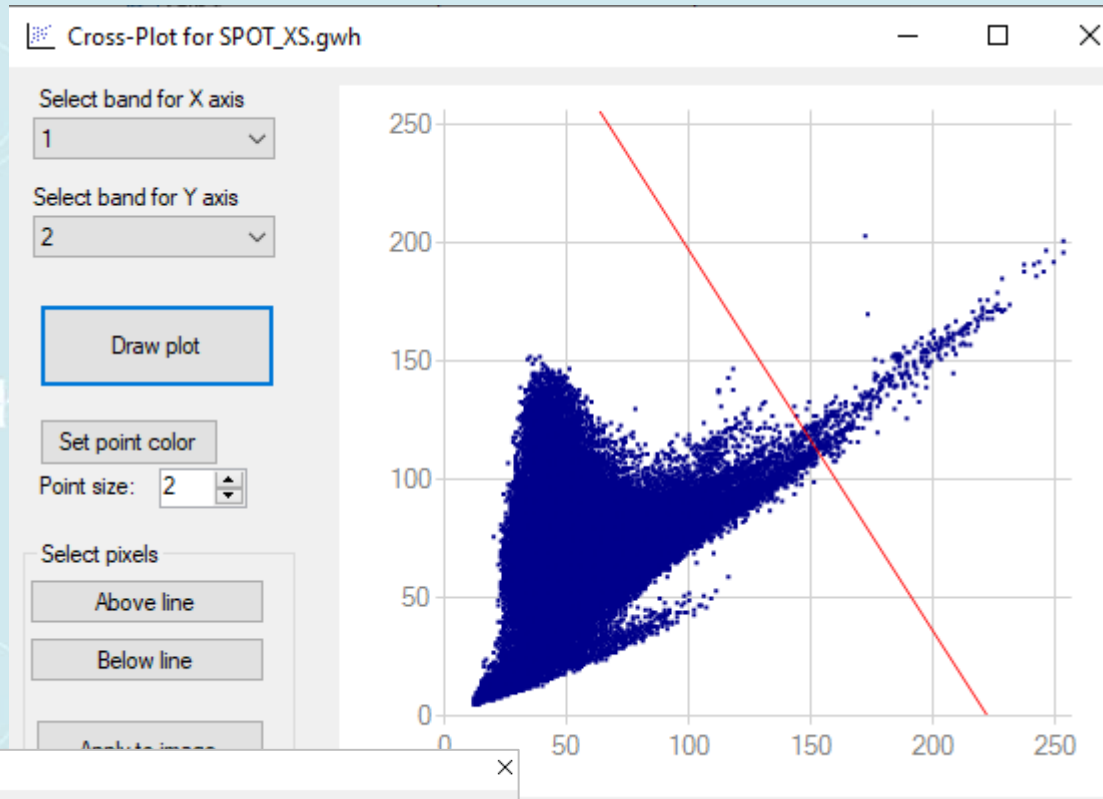


By plotting the intensities of the different frequency bands in a cross-plot, certain areas can be queried by graphical selection. For now, only one arbitrary line is the tool of separation.



Snapshots from Giwer's operations

Rastercalculator



Raster calculator

Single value selection

SELECT PIXELS WHERE Intensity values ARE

Let the selected intensity values be:

else value:

Between value selection

SELECT PIXELS WHERE Intensity values ARE BETWEEN AND

Let the selected intensity values be:

else value:

The image shows a "Raster calculator" dialog box. It has two sections: "Single value selection" and "Between value selection". Each section includes a "Go" button, a field for "Let the selected intensity values be:", and an "else value:" field. The "Single value selection" section has a dropdown menu set to "150". The "Between value selection" section has two input fields for "100" and "200".

Catalog's operations briefly

- Catalog is an SQLite-based program for registering images in the file system and storing their attributes in a data table.
- It allows you to import taken images directly from the drone's media, read their attribute data, and store them in an SQLite data file. We can store data either from the EXIF automatically, some fields can be filled interactively or even a deployment report can be written too.
- The Sql command editor helps you find the images you need.

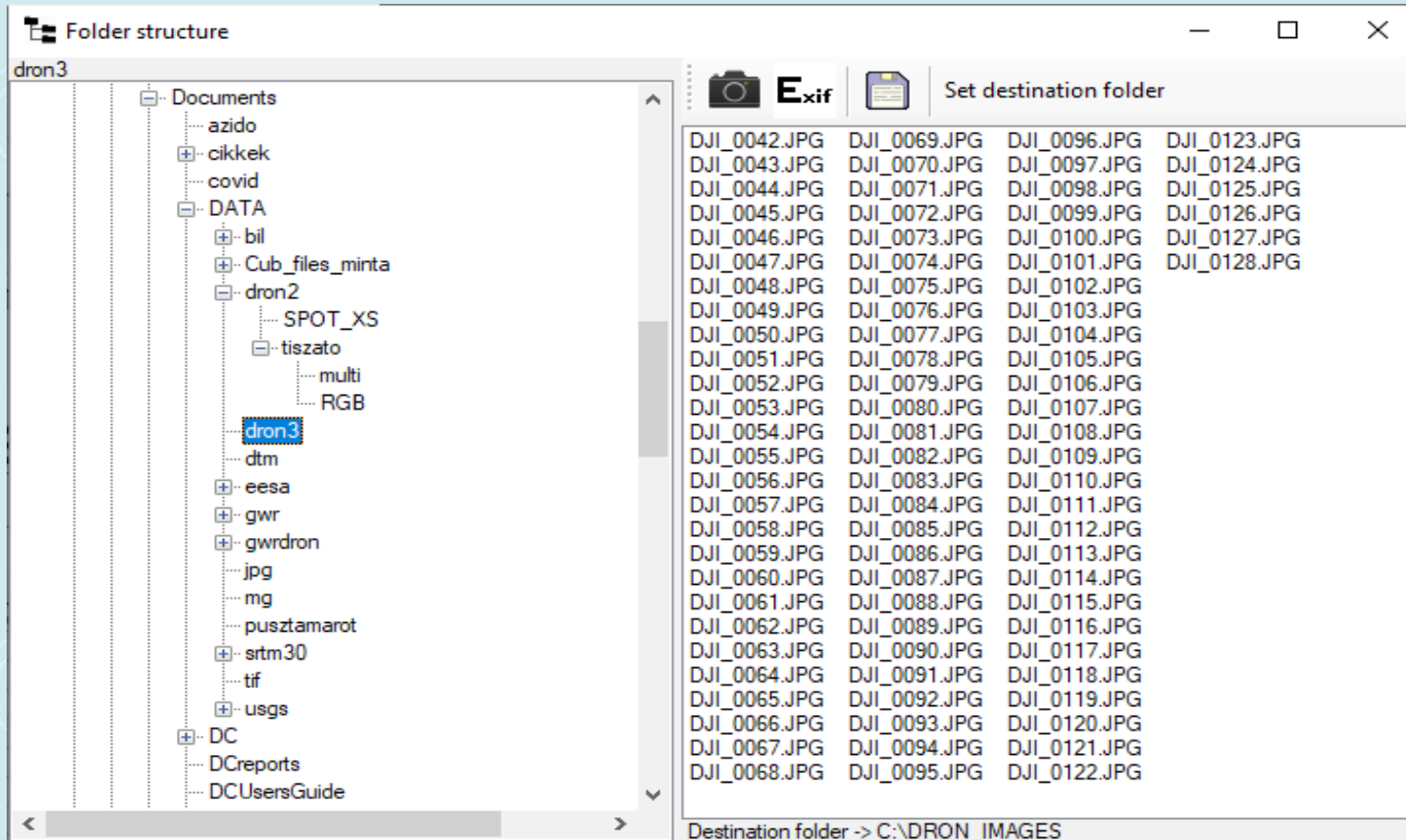
Snapshots from Catalog's operations

id	filename	timestamp	type	bitspersample	samplesperpixel	image_size	file_size	I
1	IMG_0600_1.tif	2020. 09. 10. 11:46	multi	16	1	2064x1544	6382034	T
2	IMG_0600_2.tif	2020. 09. 10. 11:46	multi	16	1	2064x1544	6382008	T
3	IMG_0600_3.tif	2020. 09. 10. 11:46	multi	16	1	2064x1544	6382012	T
4	IMG_0600_4.tif	2020. 09. 10. 11:46	multi	16	1	2064x1544	6382004	T
5	IMG_0600_5.tif	2020. 09. 10. 11:46	multi	16	1	2064x1544	6382018	T
6	IMG_0600_6.tif	2020. 09. 10. 11:46	multi	16	1	160x120	44722	T
7	DJI_0007.JPG	2020. 09. 10. 13:40	RGB	8	3	5280x2970	6799825	T
8	DJI_0009.JPG	2020. 09. 10. 13:43	RGB	8	3	5280x2970	7026657	T
9	DJI_0010.JPG	2020. 09. 10. 13:44	RGB	8	3	5280x2970	6602686	T
10	DJI_0011.JPG	2020. 09. 10. 13:44	RGB	8	3	5280x2970	6592771	T
11	DJI_0014.JPG	2020. 09. 10. 13:45	RGB	8	3	5280x2970	6968375	T
12	DJI_0015.JPG	2020. 09. 10. 13:45	RGB	8	3	5280x2970	6973159	T
13	DJI_0016.JPG	2020. 09. 10. 13:46	RGB	8	3	5280x2970	6972641	T
14	DJI_0019.JPG	2020. 09. 10. 13:50	RGB	8	3	5280x2970	7224836	T
15	DJI_0020.JPG	2020. 09. 10. 13:50	RGB	8	3	5280x2970	7192925	T
16	DJI_0021.JPG	2020. 09. 10. 13:50	RGB	8	3	5280x2970	7014559	T
17	DJI_0022.JPG	2020. 09. 10. 13:50	RGB	8	3	5280x2970	6984827	T

Editable fields

	filename
	timestamp
	type
	bitspersample
	samplesperpixel
	image_size
	file_size
	location
	longitude
	latitude
	dron_type
	camera
	purpose
	operator
	author
	meteo
	content
	public
	comment
	folder

Snapshots from Catalog's operations



Snapshots from Catalog's operations


DJI_0021.JPG

cursor position: 15/19

id	filename	timestamp	type	bitspersample	samplesperpixel	image_size	file_size
1	IMG_0600_1.tif	2020.09.10.11:46	multi	16	1	2064x1544	6382034
2	IMG_0600_2.tif	2020.09.10.11:46	multi	16	1	2064x1544	6382008
3	IMG_0600_3.tif	2020.09.10.11:46	multi				
4	IMG_0600_4.tif	2020.09.10.11:46	multi				
5	IMG_0600_5.tif	2020.09.10.11:46	multi				
6	IMG_0600_6.tif	2020.09.10.11:46	multi				
7	DJI_0007.JPG	2020.09.10.13:40	RGB				
8	DJI_0009.JPG	2020.09.10.13:43	RGB				
9	DJI_0010.JPG	2020.09.10.13:44	RGB				
10	DJI_0011.JPG	2020.09.10.13:44	RGB				
11	DJI_0014.JPG	2020.09.10.13:45	RGB				
12	DJI_0015.JPG	2020.09.10.13:45	RGB				
13	DJI_0016.JPG	2020.09.10.13:46	RGB				
14	DJI_0019.JPG	2020.09.10.13:50	RGB				
15	DJI_0020.JPG	2020.09.10.13:50	RGB				
16	DJI_0021.JPG	2020.09.10.13:50	RGB				
17	DJI_0022.JPG	2020.09.10.13:50	RGB				

Map viewer

Select your map provider --> Bing Satellite Map Provider

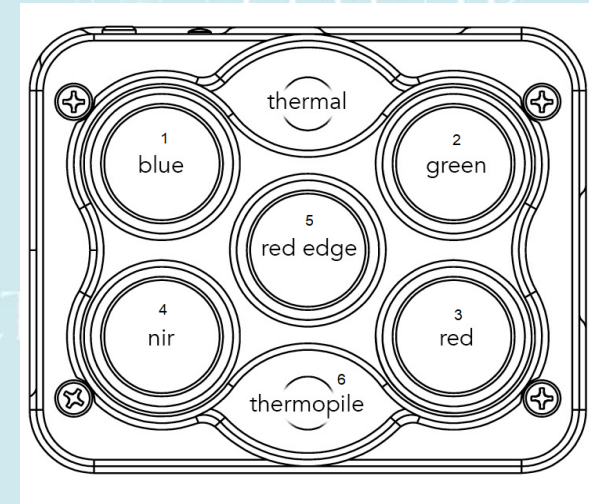


Long: 20,7160473 Lat: 47,6727974

Problems with drones

Mapping errors in the images of the multispectral camera

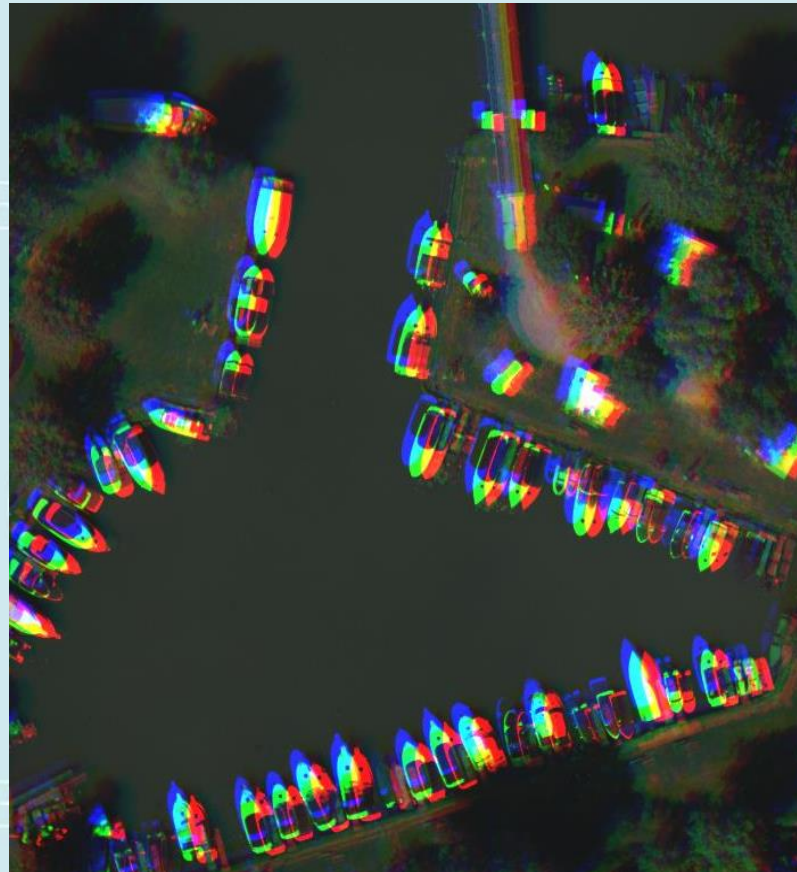
- One image file is generated per frequency band (this would not be a problem yet)
- However, these images do not exactly overlap: 5-25 pixels shift between frequency bands
- The coordinates of the image position given by the GPS built into the cameras are not accurate enough, so flight data and image positions make it difficult to match overlapping images (mosaic)
- Camera distortions make it difficult to fit images. All of the problems above need to be corrected.



Snapshots from Catalog's operations

Micasense camera correction

The correction procedure for shifted individual frequency bands were prepared by Máté Cserép. The process is based on an affine transformation which computes the cross correlation between images, and computes the shifts in this way.



Improve of Catalog's operations

We solved the storage of raw images and header data (Exif, header, etc.). These are raw data only, although it may be necessary to store calculated data in the database, even if these can be calculated from the raw data.

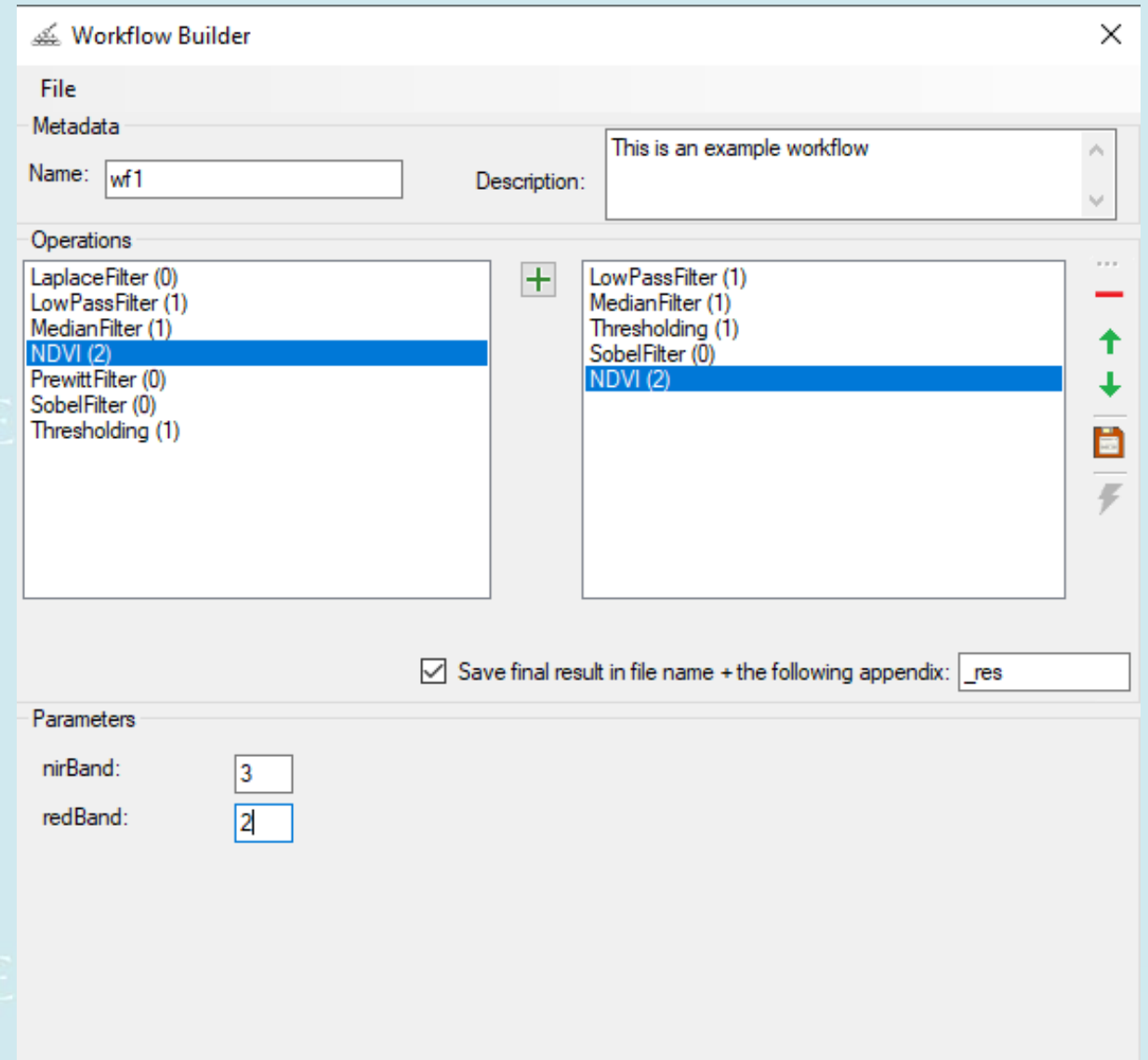
This can be an obvious extension of version 1. The benefit of previous version, despite the wide variety of file formats, is easy to handle these images since they are in known image formats (tif, geotif, jpg, geojpg, bil, ENVI bil, ER Mapper bil, cub, etc.). If you are going to store special remote sensing files too this can be the next task to improve Catalog's functionality. It can be useful for any image processing program, regardless of the Giwer.

Workflow builder

Snapshots from Workflow's operations

From Giwer's functions you can create any workflow that can be saved, edited and run. If an experienced user wants to create their own processing procedures, they can do so with workflow builder. If the task is to do some processing on hundreds of images, the workflow builder is a great tool for that. However, we need to create a project file in advance, which we will use workflow.

Development is complete, but it should be emphasized that this is only the version 1.0.



Snapshots from Workflow's operations

Workflow

```
#Description:  
This is an example workflow  
#Methods:  
LowPassFilter (1)  
3  
MedianFilter (1)  
5  
Thresholding (1)  
50  
SobelFilter (0)  
NDVI (2)  
3  
2
```

Project

```
#Description:  
This project is for reading and handling two  
satellite images (LANDSAT and SPOT)  
#Files:  
C:\Users\eleki\Documents\DATA\gwr\landsat_TM_1985.gwh  
C:\Users\eleki\Documents\DATA\gwr\SPOT_XS.gwh  
#Config_data:  
BilDataFolder, C:\Users\eleki\Documents\DATA\bil  
JpgDataFolder, C:\Users\eleki\Documents\DATA\jpg  
TifDataFolder, C:\Users\eleki\Documents\DATA\tif  
GiwDataFolder, C:\Users\eleki\Documents\DATA\gwr  
3DDataFolder, C:\Users\eleki\Documents\DATA\dtm  
ProjectFolder, C:\Users\eleki\Documents\DATA\projects  
WorkflowFolder,  
C:\Users\eleki\Documents\DATA\projects
```

Publications

1. Istvan Elek: Boundary Detection of Point Clouds on the Images of Low-Resolution Cameras for the Autonomous Car Problem, Intelligent Computing : Proceedings of the 2020 Computing Conference, Volume 2, Cham: Springer, pp 572-581 (2020) (Advances in Intelligent Systems and Computing ; 1229)
2. Elek István – Cserép Máté: Drón képek feldolgozása a nyílt forráskódú Giwer programcsomaggal, GITA, 16. Műszaki Térinformatika online konferencia, 2021. június
3. Istvan Elek – Máté Cserép: Processing drone images with the open source Giwer software package, FTC 2021 - Future Technologies Conference 2021, 28-29 October 2021, Vancouver
4. Nour Naaouf – István Elek: Geospatial Analysis for assessing the Potentials of Large-Scale generation of Solar Energy in SYRIA, Geodézia és Kartográfia, 2022.
5. Istvan Elek: Geolmage Workflow Editing Resources: GIWER, book chapter, New Trends and Challenges in Open Data, IntechOpen, England, 2023, DOI: 10.5772/intechopen.1001297

Be the Giwer open source ?

Yes, let it be. The complete Giwer package has been uploaded to gitHub with minimal documentation (users' guide in Hungarian). Version 1.0 has been completed for all modules.

From May to the end of July, when the TKP is closed, we will write documentation, users' guide (in Hungarian and English), developers' documentation (in English only), and tutorial (in Hungarian and English).

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Thanks for your attention

