



Pacific
Community
Communauté
du Pacifique

GIS TRAINING

Introduction to Remote Sensing

Satellite imagery

Low resolution satellite imagery is generally available for free, while high-resolution imagery must be purchased and licensing usually restrict its distribution

Freely available low resolution multi-spectral & radar satellite imagery

- Landsat 7 ETM+, Landsat 8... : Earth Explorer (<http://earthexplorer.usgs.gov>)
- Sentinel-1,2,3 : Copernicus Open Access Hub (<https://scihub.copernicus.eu>)

Ocean monitoring

- Sea Surface Temperature, Chlorophyll-a (SeaWiFS), MODIS : NOAA/NASA (<https://oceancolor.gsfc.nasa.gov>)

Commercial high-resolution imagery

- IKONOS, GeoEye, QuickBird, WorldView-1,2,3,4
Pléiades,...

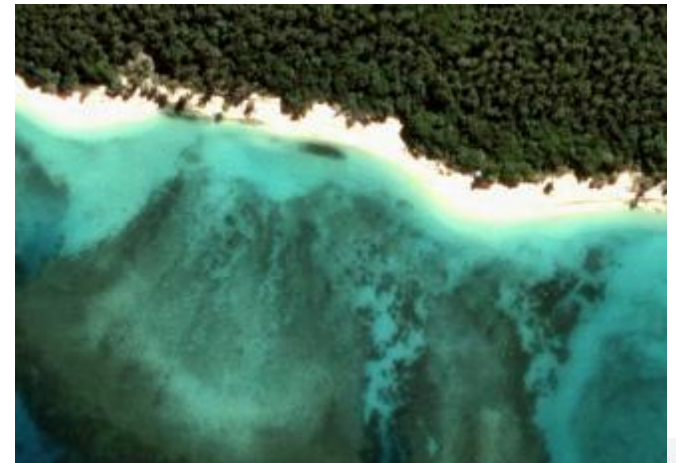


Image acquisition

Karena tidak ada stasiun penerima di Pasifik Selatan, akuisisi citra harus dijadwalkan terlebih dahulu, disimpan di pesawat, dan ditransfer saat berada di atas stasiun penerima.

Akibatnya, tidak banyak gambar yang tersedia untuk area tertentu, dan mungkin berawan

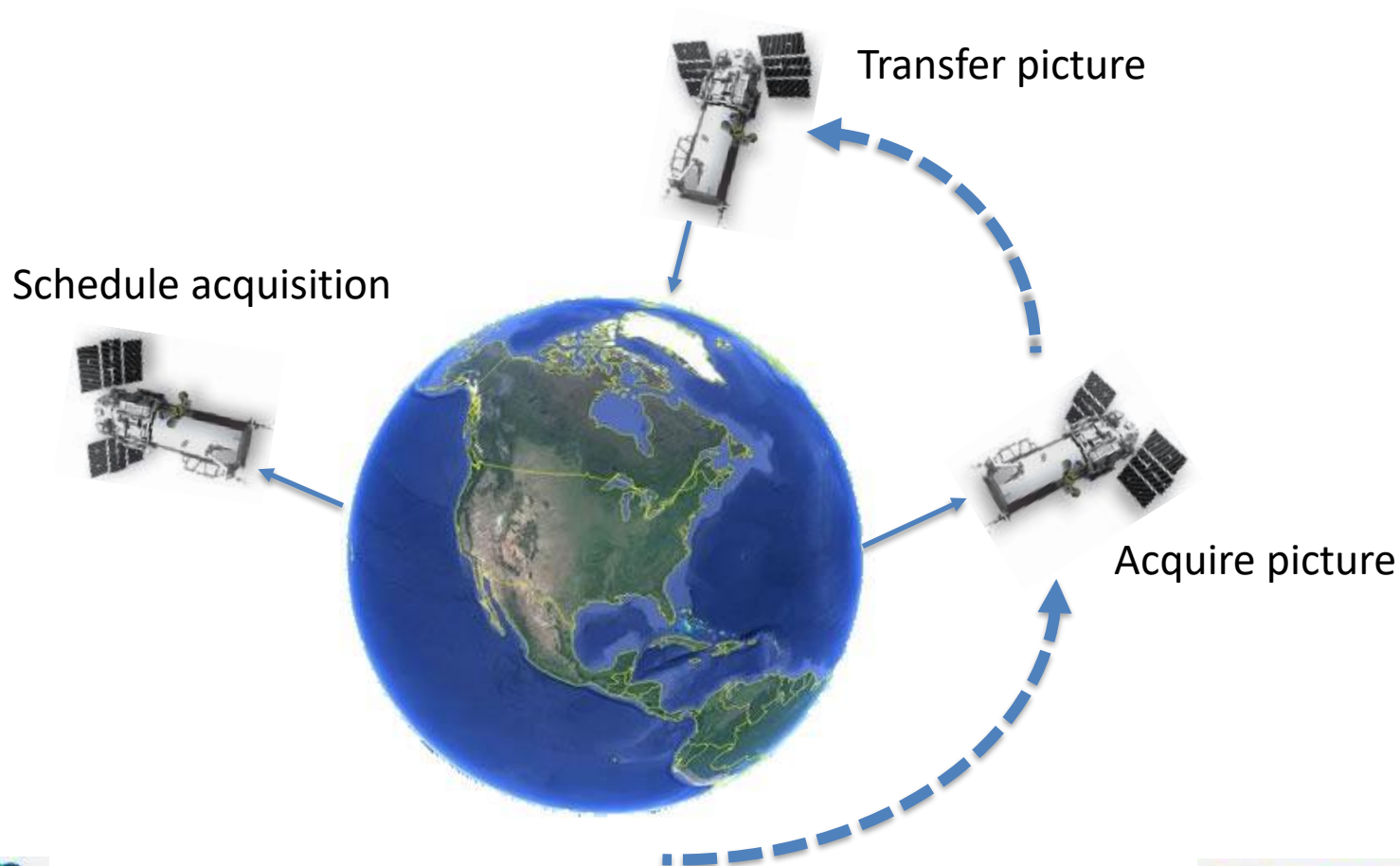
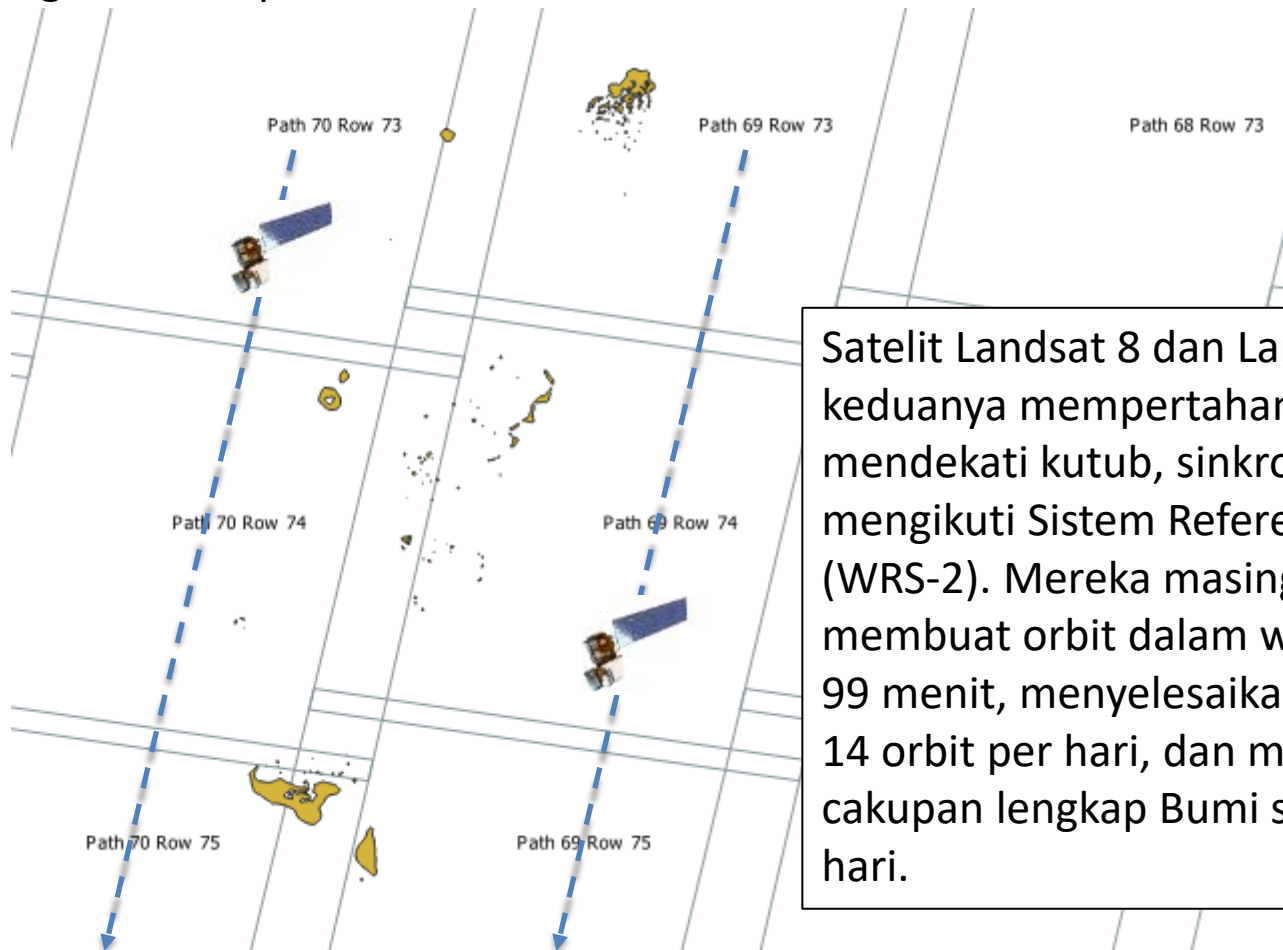


Image acquisition

Pencitraan diperoleh di sepanjang orbit, dan area yang diinginkan mungkin tumpang tindih dengan beberapa orbit



Satelit Landsat 8 dan Landsat 7 keduanya mempertahankan orbit mendekati kutub, sinkron matahari, mengikuti Sistem Referensi Dunia (WRS-2). Mereka masing-masing membuat orbit dalam waktu sekitar 99 menit, menyelesaikan lebih dari 14 orbit per hari, dan menyediakan cakupan lengkap Bumi setiap 16 hari.

Obtaining free imagery

Untuk citra yang tersedia secara gratis (Landsat, Sentinel), Anda cukup menelusuri katalog gambar yang diarsipkan dan memilih satu dengan tidak terlalu banyak awan di atas area yang diinginkan (menggunakan quicklooks sebagai panduan). Kemudian Anda mengirimkan permintaan dan menerima tautan untuk mengunduh gambar. Sebuah gambar biasanya berukuran sekitar 1 GB



Summary

Date: 2019-03-16T21:49:01.024Z

Filename:

S2A_MSIL1C_20190316T214901_N0207_R043_T02LMK_20190316T225905 SAFE

Identifier: S2A_MSIL1C_20190316T214901_N0207_R043_T02LMK_20190316T225905

S2A_MSIL1C_20190316T214901_N02_T02LMK_20190316T225905.SAFE

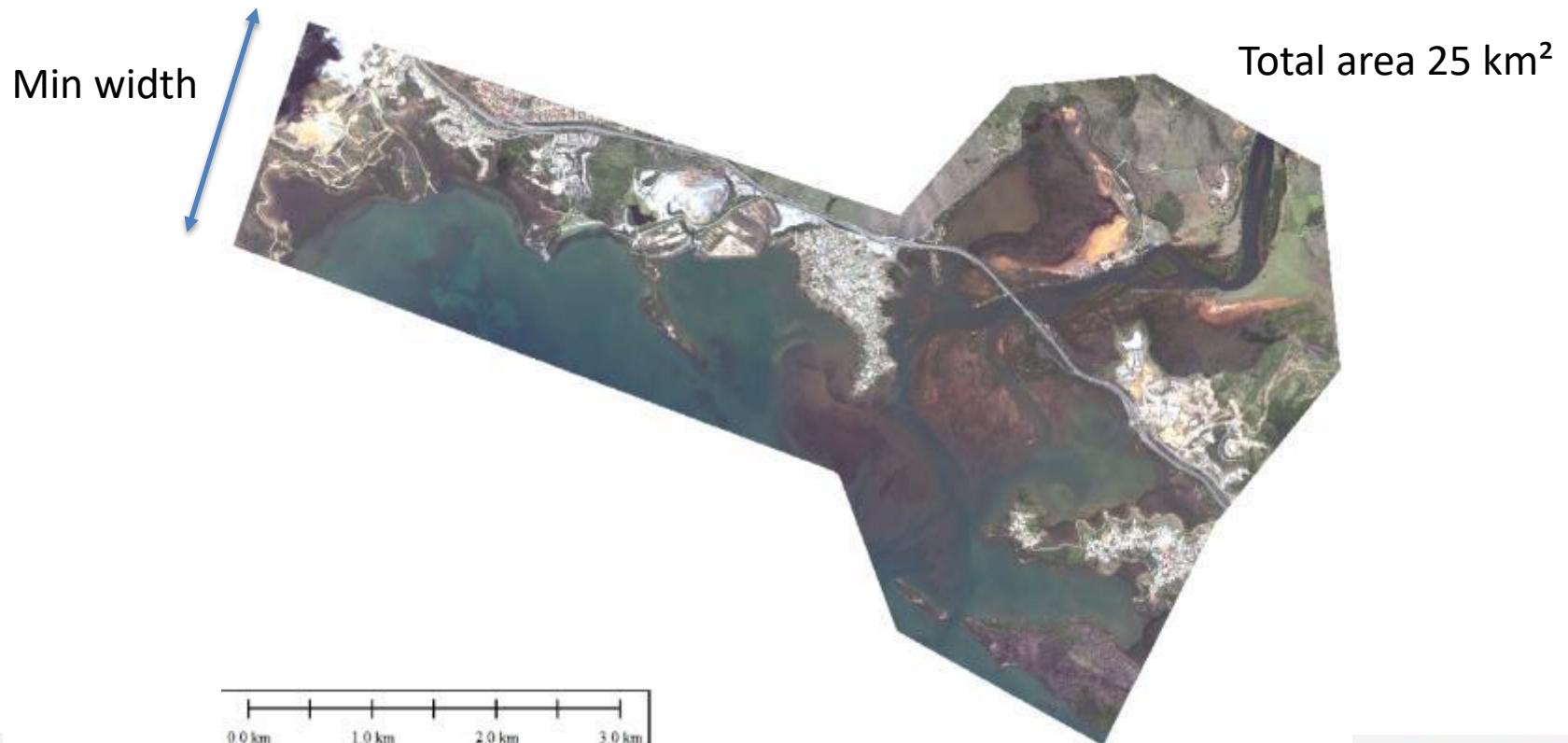
AUX_DATA

DATASTRIP

GRANULE

Ordering commercial imagery

Untuk citra resolusi tinggi, Anda membuat poligon untuk area minat dan membuat query citra yang tersedia untuk poligon tersebut. Karena gambar ditagih per km persegi, Anda hanya memilih area yang Anda butuhkan, namun ada batasan pada bentuk poligon dan area minimum untuk pesanan (25 km² untuk citra WorldView misalnya)



Ordering commercial imagery



Harga per km² tergantung pada resolusi, satelit, jumlah pita (4 atau 8), perizinan dan pemrosesan.

Gambar multi-licensi berharga sekitar USD 50 per km² dengan harga publik

SPC adalah reseller Digital Globe dan dengan demikian mendapatkan harga murah untuk beberapa citra, tetapi lisensi membatasi penggunaan gambar kepada pemerintah tempat gambar tersebut dibeli : (citra komersial yang Anda peroleh melalui SPC umumnya tidak dapat dibagikan dengan pihak ketiga)

Hubungi SPC Geoscience, Energy and Maritime Division (GEM) yang Anda butuhkan untuk mendapatkan akses ke citra yang sudah dibeli atau memesan citra satelit baru.

Banyak citra telah dibeli selama 10 tahun terakhir, Anda mungkin beruntung

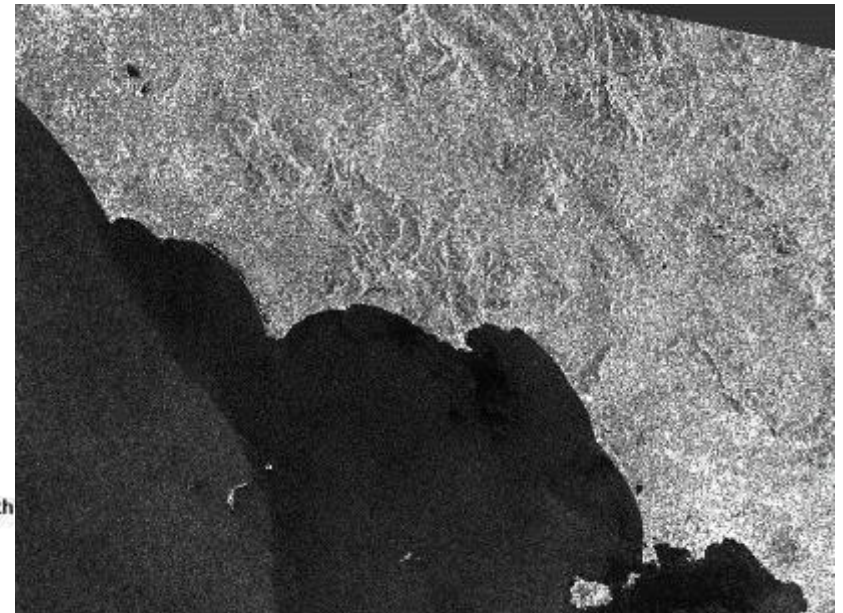
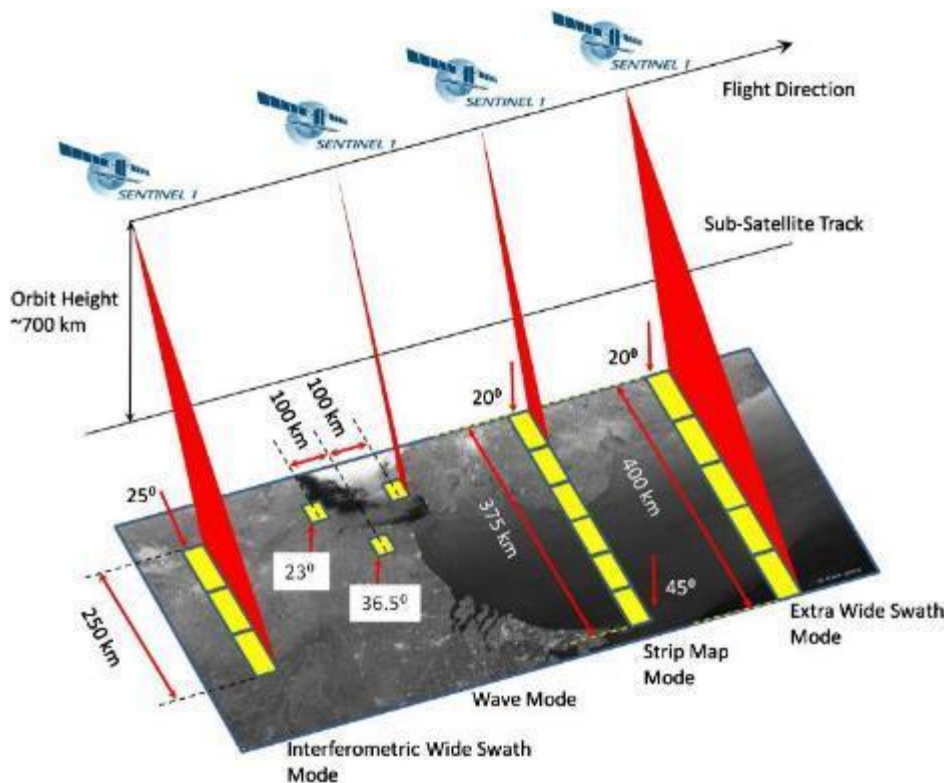
Image mosaic

Karena jalur dan tutupan awan, kombinasi (mosaik) gambar yang diambil pada waktu yang berbeda umumnya diperlukan untuk mencakup area yang luas.



Satellite sensors

Citra adalah output dari sensor satelit, pada resolusi spasial tertentu dengan pita yang sesuai dengan rentang panjang gelombang inframerah yang terlihat (atau panjang gelombang radar untuk satelit radar)

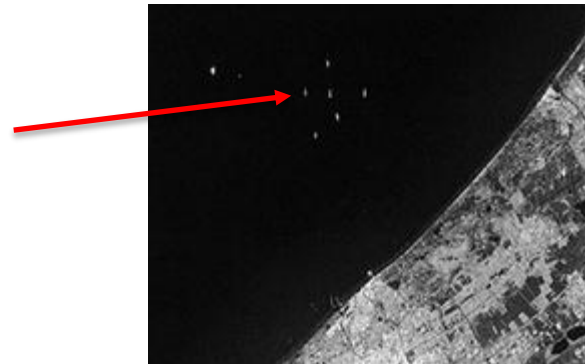


Radar imagery

Air tidak tembus cahaya untuk panjang gelombang radar. Pencitraan radar dapat digunakan untuk mendeteksi kapal, tetapi sulit dan seringkali tidak praktis untuk aplikasi pesisir

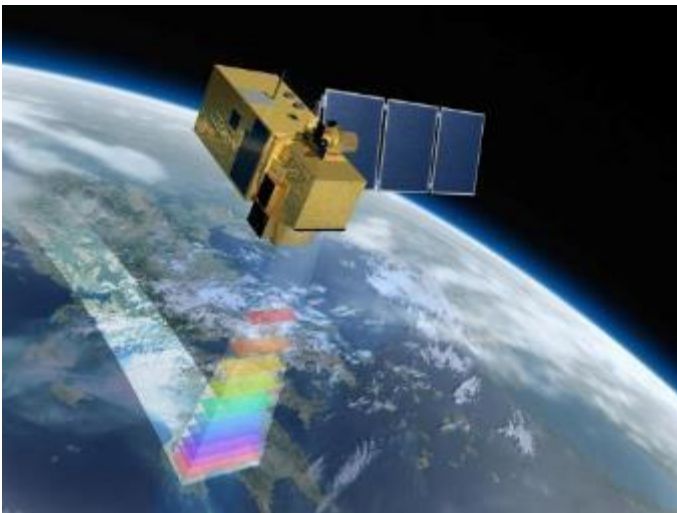
- Sebuah perahu kecil hanya akan menjadi beberapa piksel pada gambar radar
- Gambar tidak diterima secara real time
- Setelah kapal terdeteksi dan ada kecurigaan aktivitas ilegal, Anda masih perlu mengirim pasukan udara dan angkatan laut untuk mengendalikan kapal dan mengumpulkan bukti.

Boats



Multispectral imagery

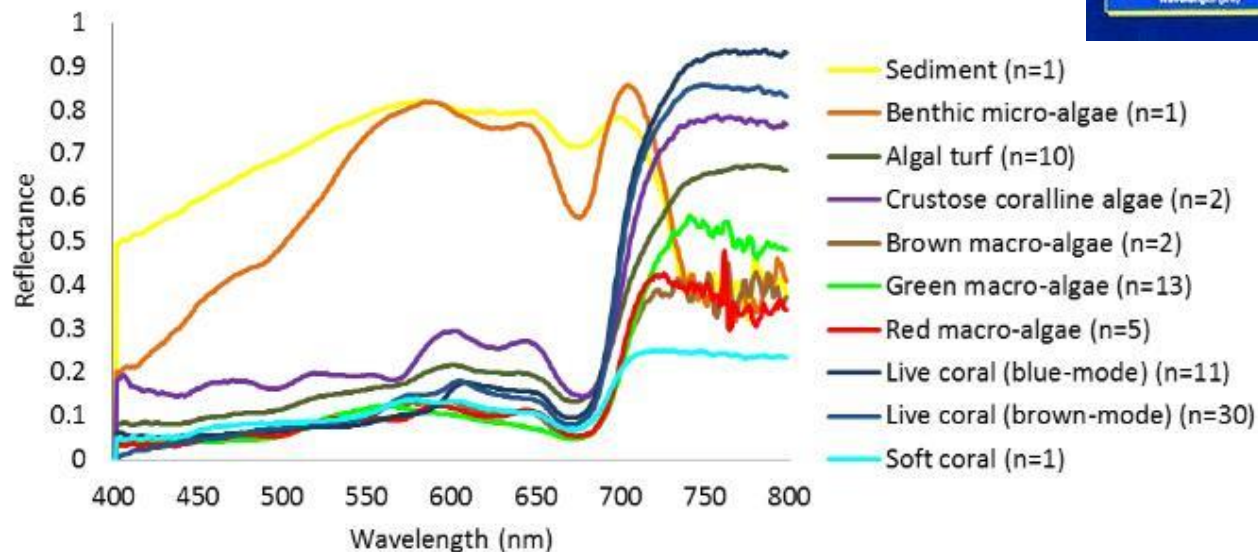
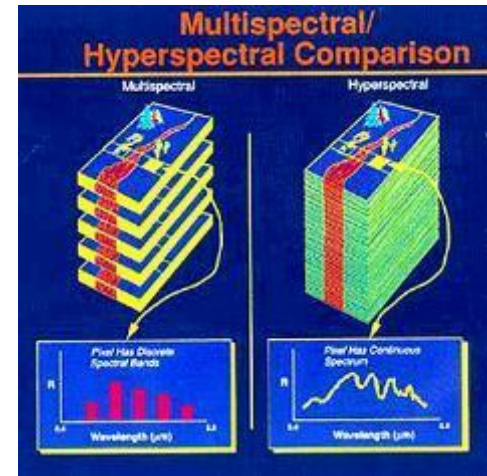
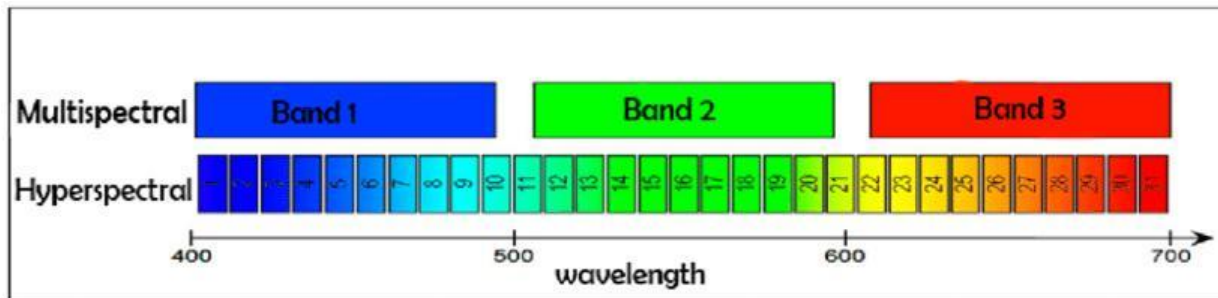
Satellite	Resolution	Bands
Landsat-8	30m/15m	Pan+8 MS +TIR
Sentinel-2	10m-60m	12 bands
IKONOS	4m/1m	Pan+4 MS (defunct)
QuickBird	3m/.7m	Pan+4 MS (destroyed)
GeoEye-1	1.8m/.5m	Pan+4 MS
WorldView-1	.6m	Pan
WorldView-2	2m/.5m	Pan+8 MS
WorldView-3	1.2m/.3m	Pan+8 MS +SWIR+CAVIS



Sentinel-2 Bands	Central Wavelength (µm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

Hyperspectral imagery

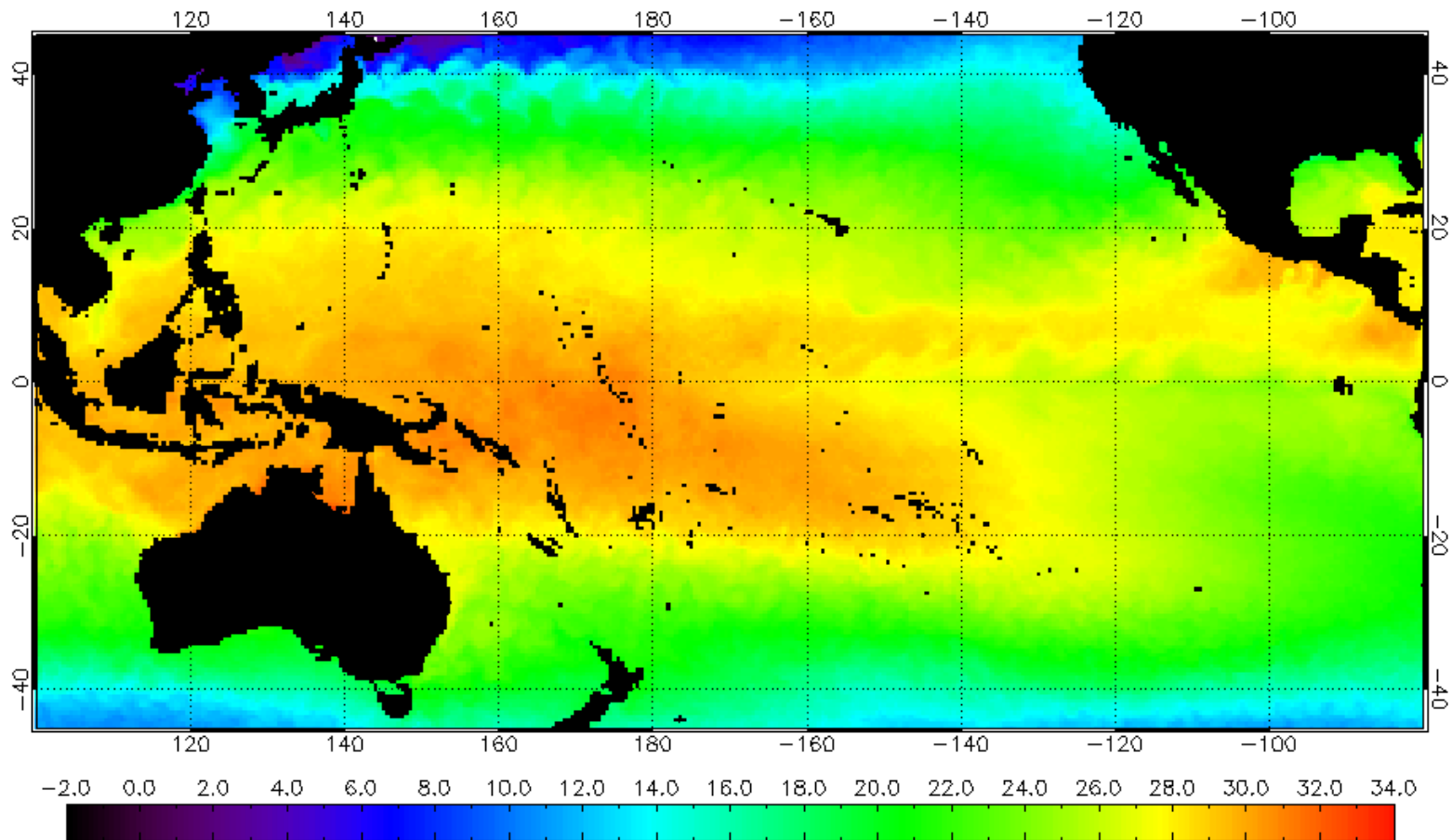
Airborne (AVIRIS, CASI) and satellite (EO-1, HySIS)



Sea surface temperature

https://www.ospo.noaa.gov/Products/ocean/sst/50km_night/index.html

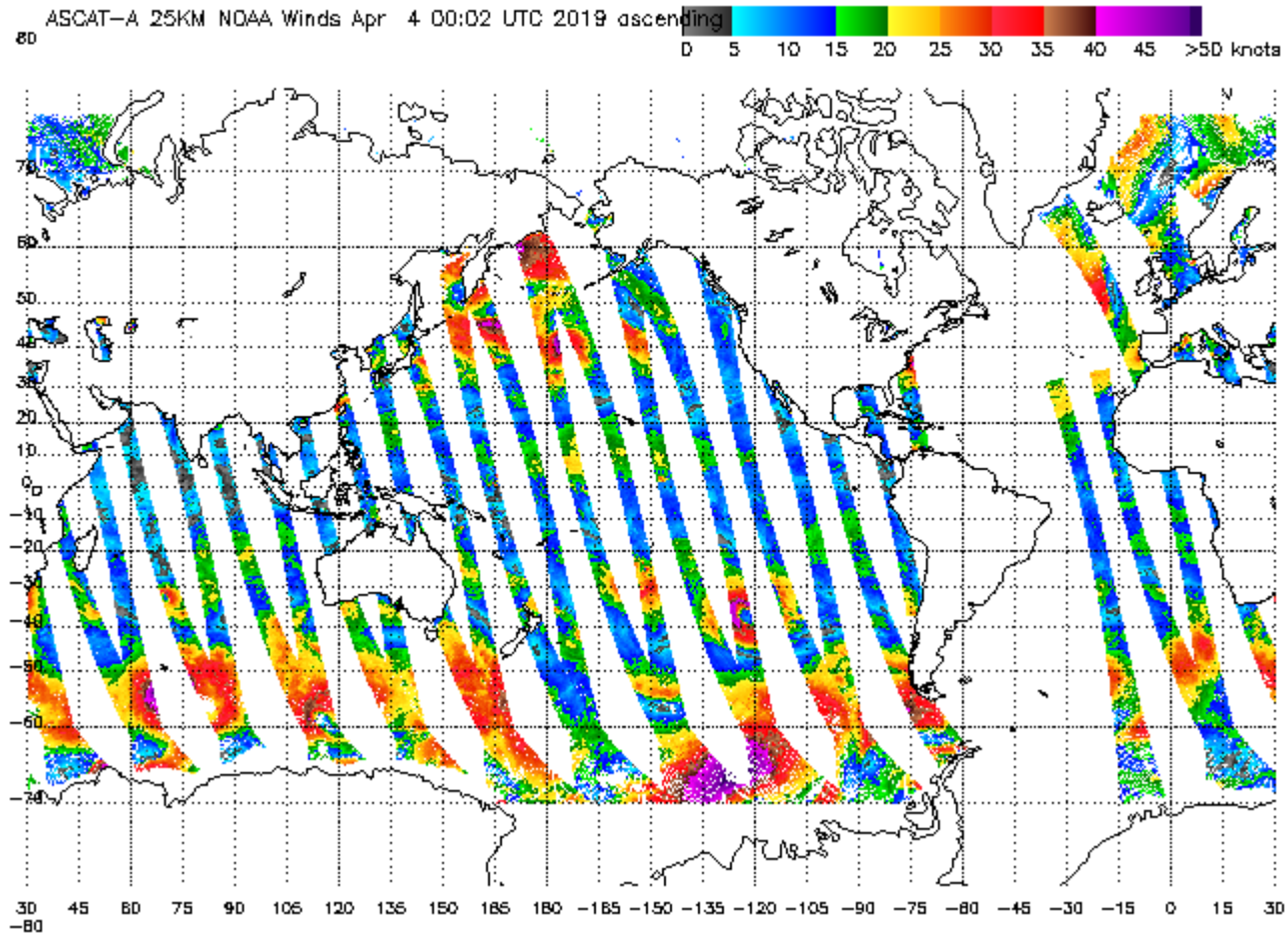
NOAA/NESDIS 50 km Nighttime Sea Surface Temperature (deg C), 1/3/2019



Winds

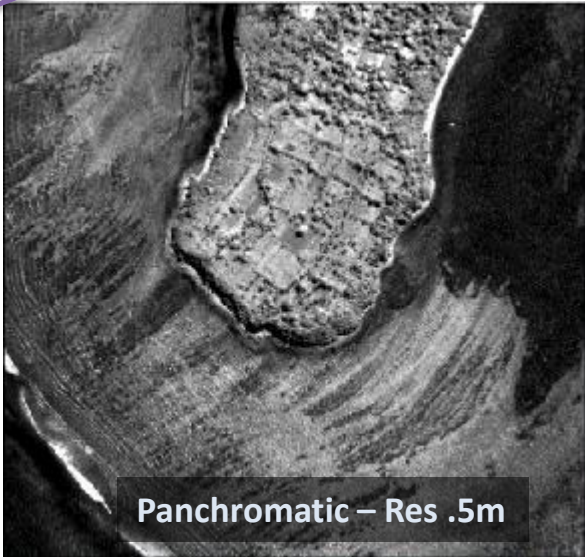
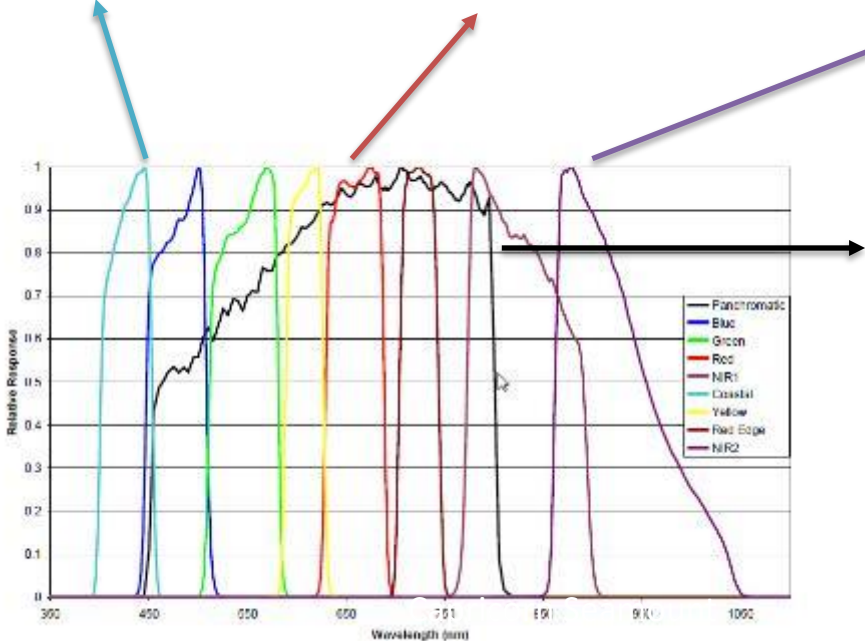
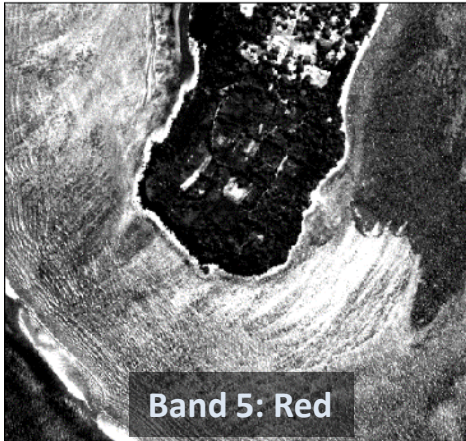
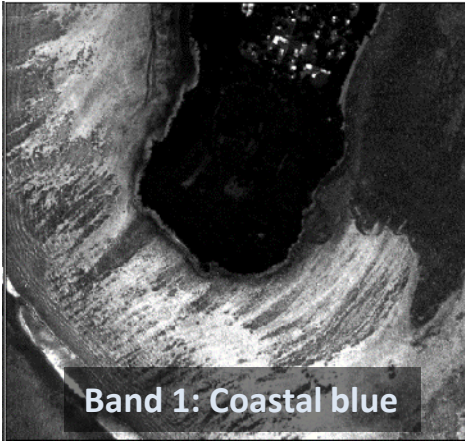
<https://manati.star.nesdis.noaa.gov/datasets/ASCATData.php>

Ascending Pass

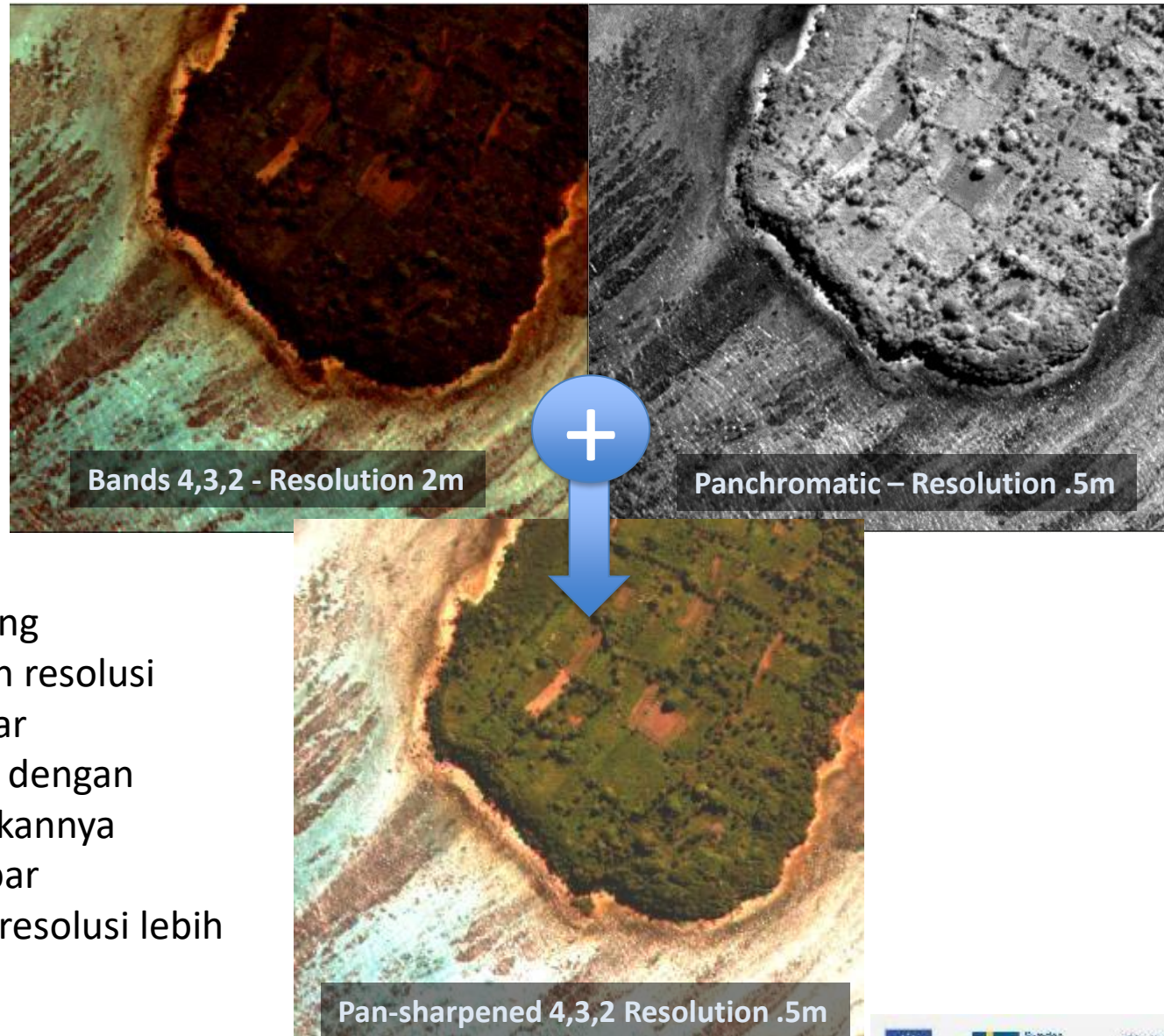


Satellite bands

WorldView-2 : MSS bands 1-8 have a resolution of 2m, while panchromatic is 50 cm



Pan-sharpening



Pan-sharpening meningkatkan resolusi spasial gambar multispektral dengan menggabungkannya dengan gambar pankromatik resolusi lebih tinggi

Image rectification

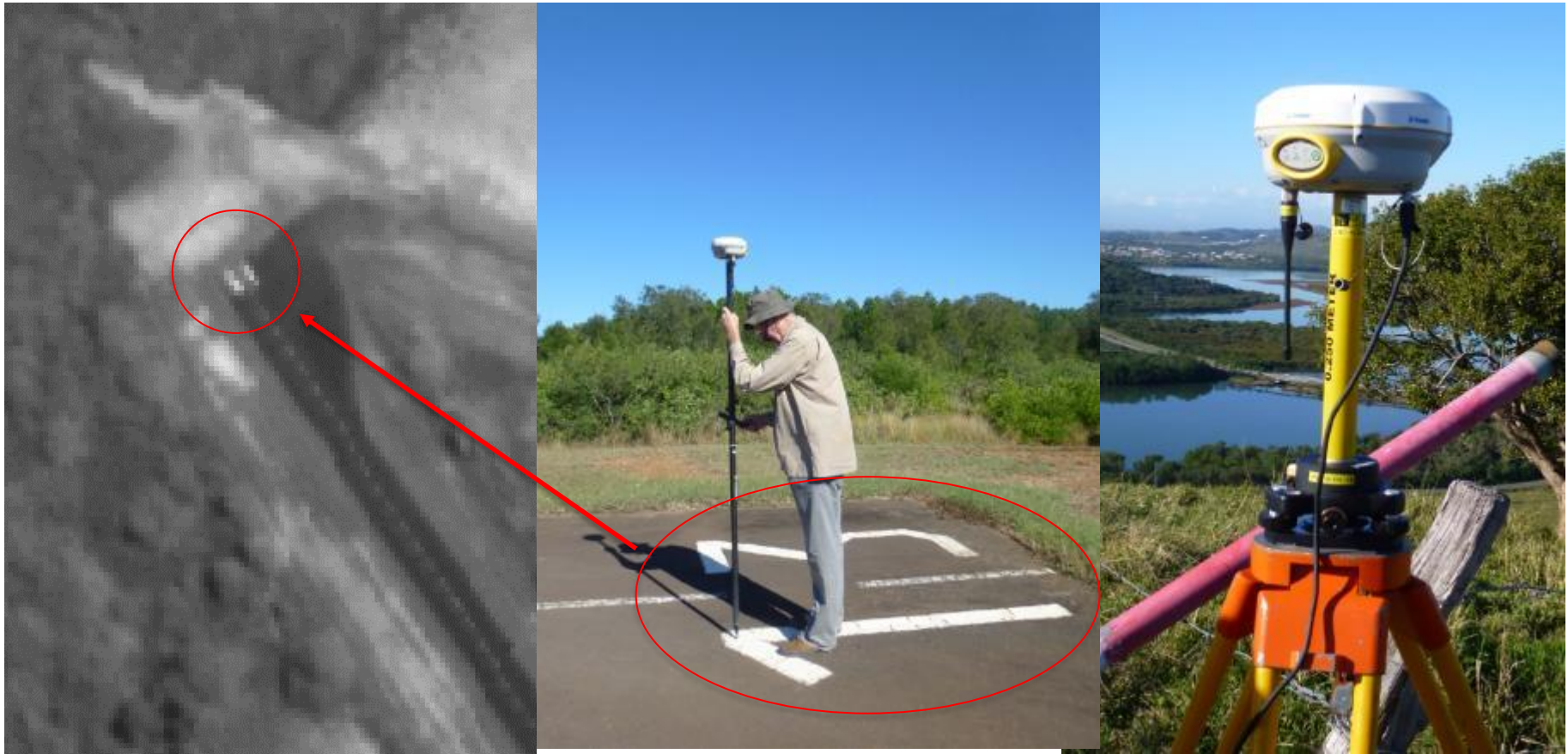


Image rectification



Image rectification



Image enhancement: dehaze



Image classification: isodata

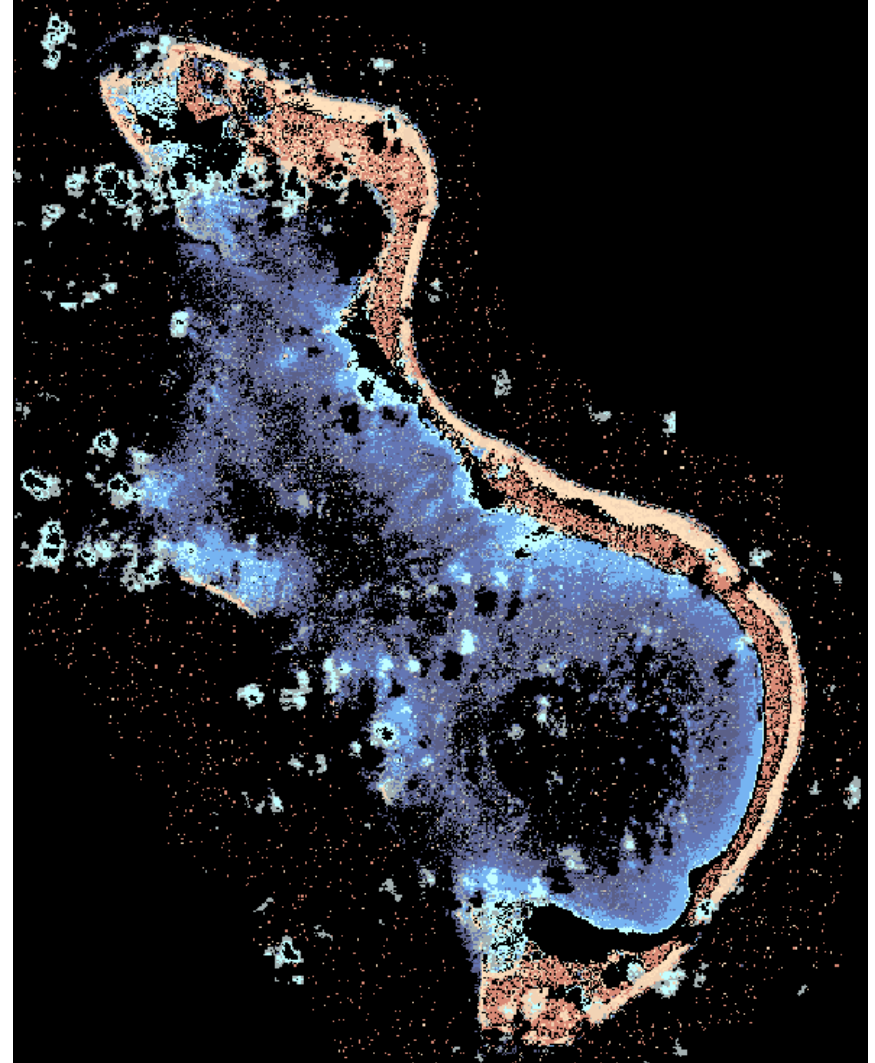
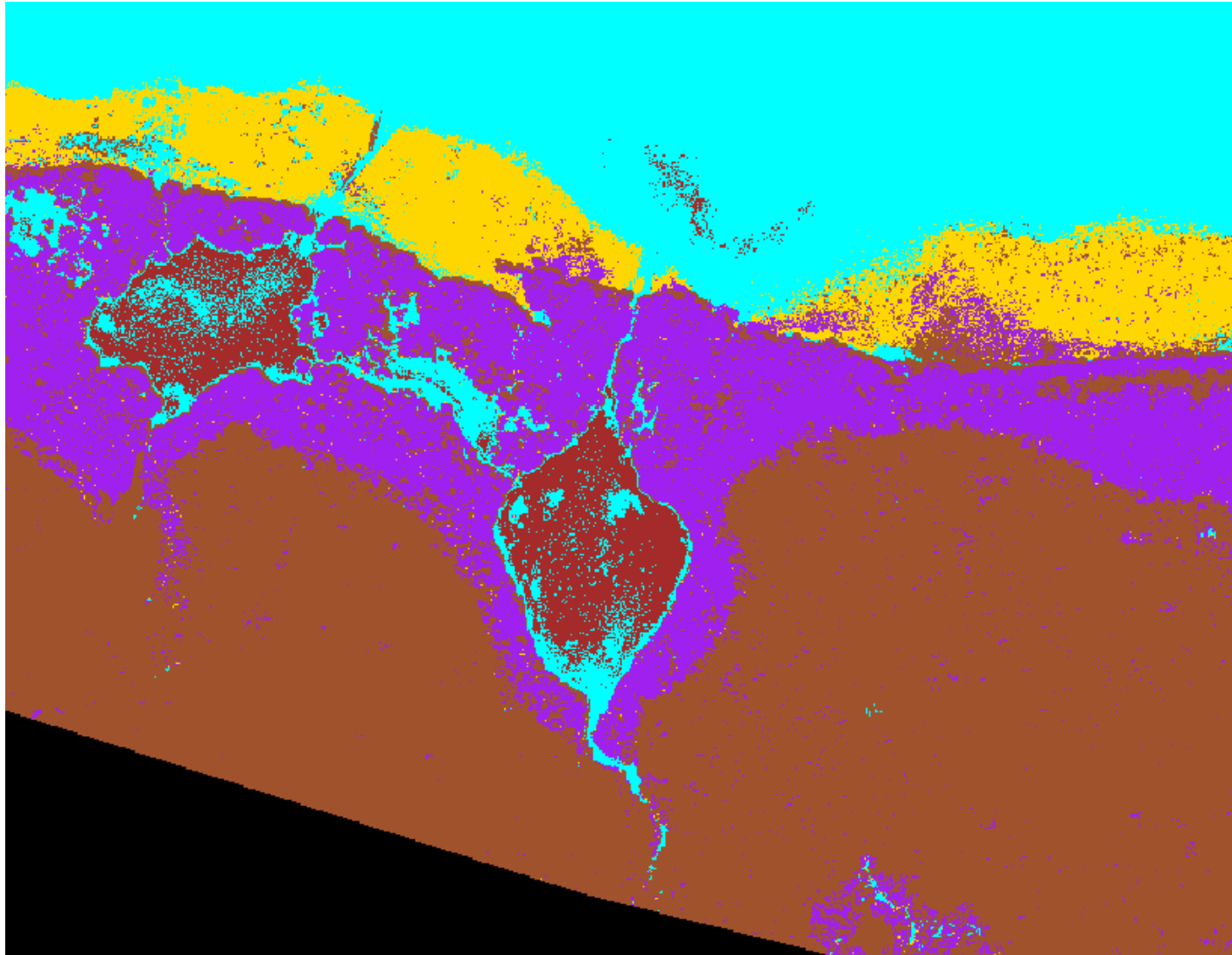


Image classification: k-means



QGIS: Processing Toolbox

Enable the Processing Toolbox panel to access advanced tools

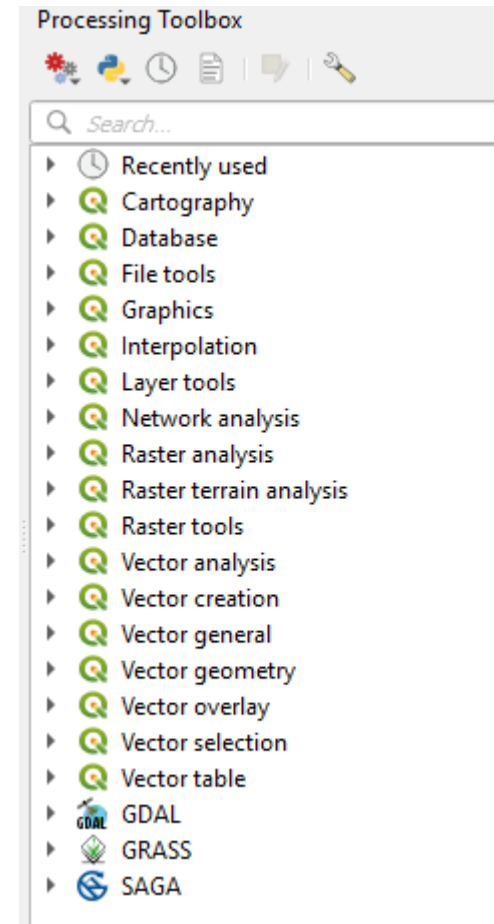
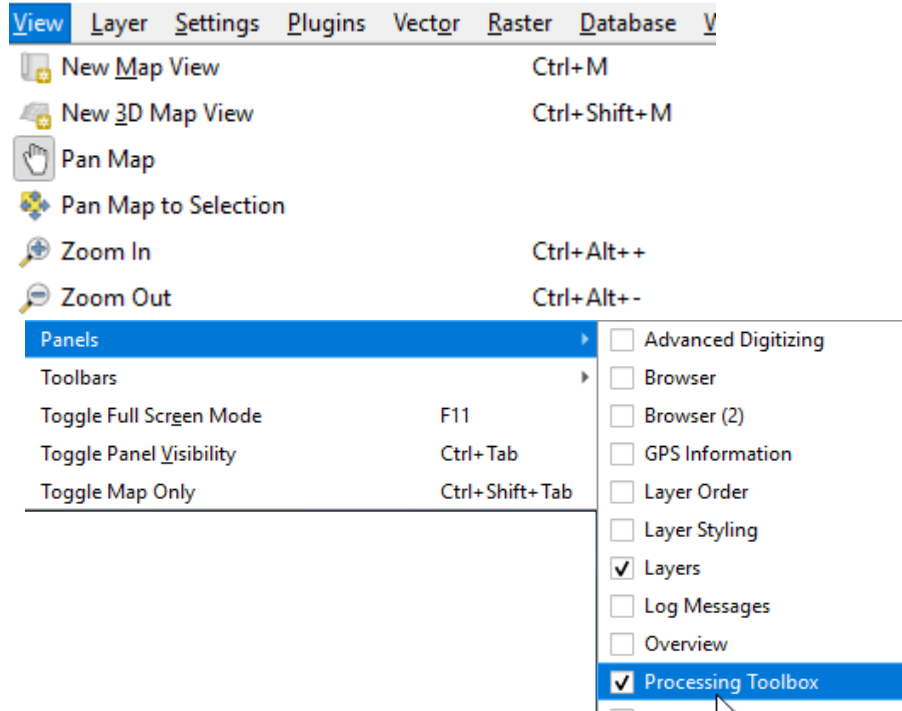
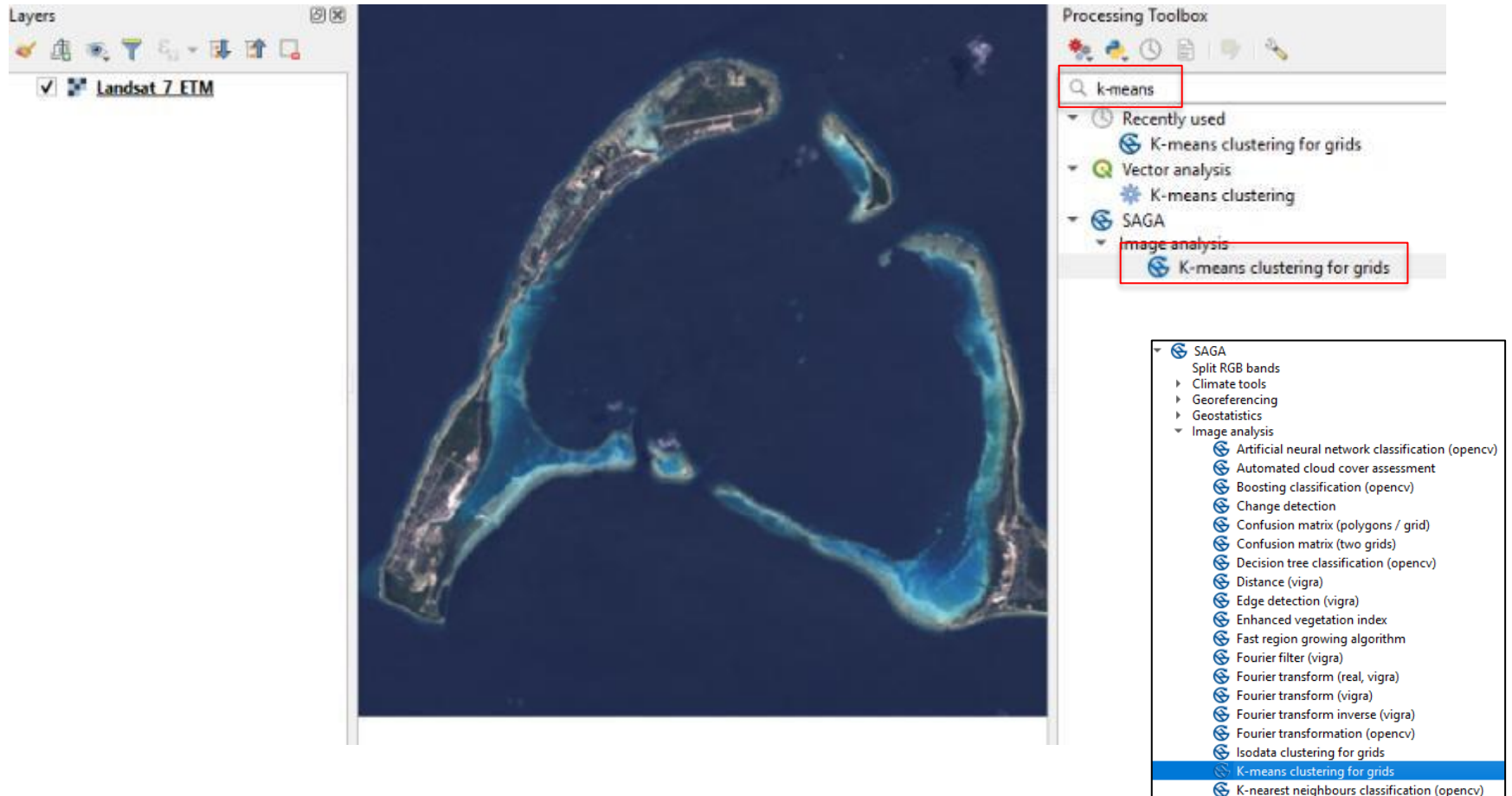


Image classification: k-means

Open the Landsat 7 ETM image and launch k-means clustering from the toolbox



The screenshot displays the QGIS interface. On the left, the 'Layers' panel shows 'Landsat 7 ETM' loaded. The main canvas shows a satellite image of a coastal area. On the right, the 'Processing Toolbox' is open, with a search bar containing 'k-means'. Two tools are highlighted with red boxes: 'k-means' in the search bar and 'K-means clustering for grids' under the 'Image analysis' category. A detailed view of the 'SAGA' toolbox is shown below, listing various image analysis tools, with 'K-means clustering for grids' highlighted in blue.

- Processing Toolbox
 - Search: k-means
 - Recently used
 - K-means clustering for grids
 - Vector analysis
 - K-means clustering
 - SAGA
 - Image analysis
 - K-means clustering for grids

- SAGA
 - Split RGB bands
 - Climate tools
 - Georeferencing
 - Geostatistics
 - Image analysis
 - Artificial neural network classification (opencv)
 - Automated cloud cover assessment
 - Boosting classification (opencv)
 - Change detection
 - Confusion matrix (polygons / grid)
 - Confusion matrix (two grids)
 - Decision tree classification (opencv)
 - Distance (vigra)
 - Edge detection (vigra)
 - Enhanced vegetation index
 - Fast region growing algorithm
 - Fourier filter (vigra)
 - Fourier transform (real, vigra)
 - Fourier transform (vigra)
 - Fourier transform inverse (vigra)
 - Fourier transformation (opencv)
 - Isodata clustering for grids
 - K-means clustering for grids
 - K-nearest neighbours classification (opencv)

Image classification

Image classification can be supervised or unsupervised

	Advantages	Disadvantages
Unsupervised Classification	<ul style="list-style-type: none">- No prior knowledge of the region is required- Allows for minimisation of human error- Spectrally distinct areas presented which may not have been obvious to the human eye	<ul style="list-style-type: none">- Spectral grouping may not correspond to information classes of interest to the analyst- Analyst has little control over the classes
Supervised Classification	<ul style="list-style-type: none">- Analyst has control- Operator can often detect and rectify images	<ul style="list-style-type: none">- Collecting training data is time consuming and costly- There is no way to recognise and represent categories which are not represented in the training data

Image classification: k-means

Select the Landsat 7 ETM image as Grid and set the number of clusters to 12
Run k-means clustering

The image shows two overlapping dialog boxes in QGIS. The 'K-Means Clustering for Grids' dialog box is on the left, and the 'Multiple selection' dialog box is on the right. A blue arrow points from the 'Multiple selection' dialog to the 'Grids' field in the 'K-Means Clustering for Grids' dialog.

K-Means Clustering for Grids

- Parameters | Log
- Grids: 1 elements selected
- Method: [1] Hill-Climbing (Rubin 1967)
- Clusters: 12
- Maximum Iterations: 0
- Normalise
- Old Version
- Update View
- Clusters: [Save to temporary file] ...
- Open output file after running algorithm
- Statistics: [Save to temporary file] ...
- Open output file after running algorithm
- 0% progress bar
- Buttons: Run as Batch Process..., Run, Close

Multiple selection

- Landsat_7_ETM [EPSG:32656]
- Buttons: Select All, Clear Selection, Toggle Selection, Add File(s)..., OK, Cancel

The 'Multiple selection' dialog also displays a satellite image of a forested area with a river, which is the selected grid.

Image classification: k-means

Set render type to palette and classify with random colors. Remove colors corresponding to deep ocean

The screenshot displays the QGIS interface with the 'Layer Properties - Clusters | Symbology' dialog box open. The 'Band Rendering' section is active, showing the 'Render type' set to 'Paletted/Unique values' and the 'Color ramp' set to 'Random colors'. A table lists the classification results:

Value	Color	Label
1	Orange	1
3	Green	3
5	Purple	5
6	Pink	6
7	Yellow-green	7
8	Cyan	8

The 'Color Rendering' section shows 'Blending mode' set to 'Normal', 'Brightness' and 'Saturation' sliders at 0, 'Contrast' slider at 0, and 'Grayscale' set to 'Off'. The 'Resampling' section shows 'Zoomed: in' and 'out' both set to 'Nearest neighbour' and 'Oversampling' set to 2.00.

Image classification: k-means

Compare the classified image with the original image

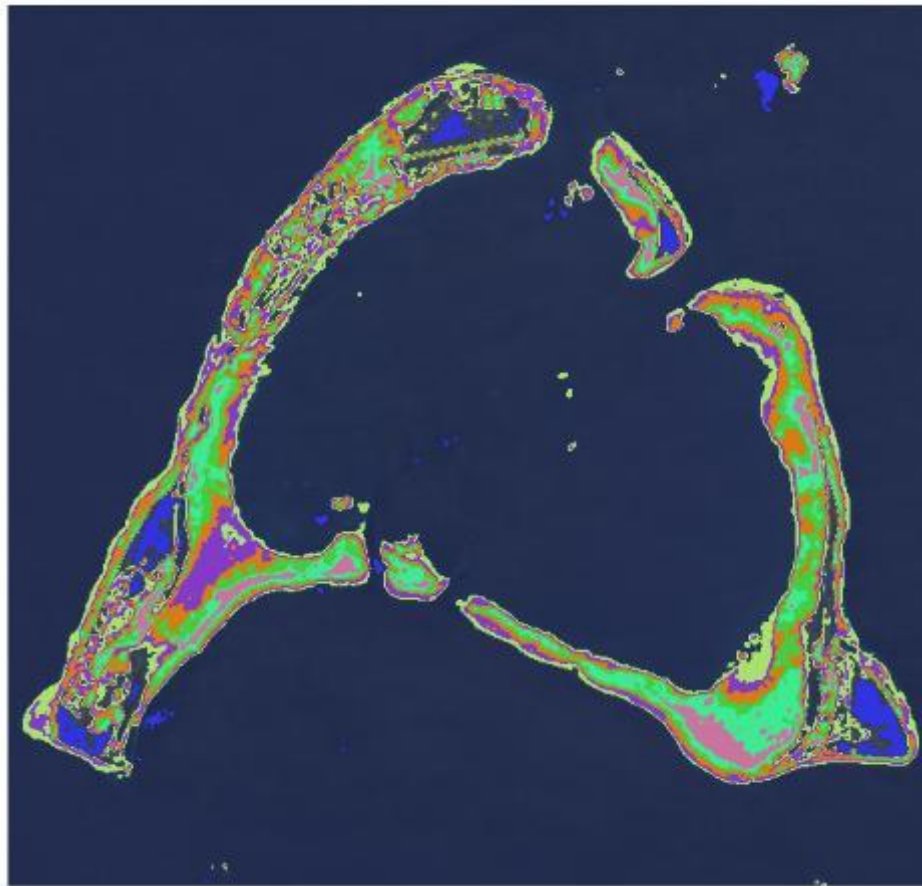
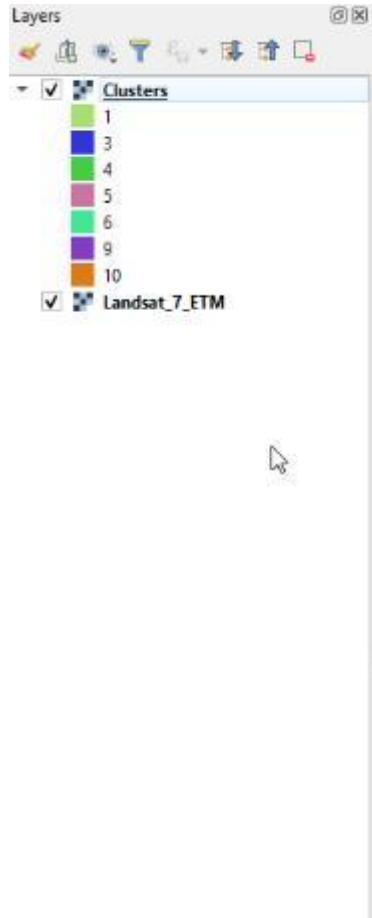


Image classification: raster to vector

Polygonize the clusters image

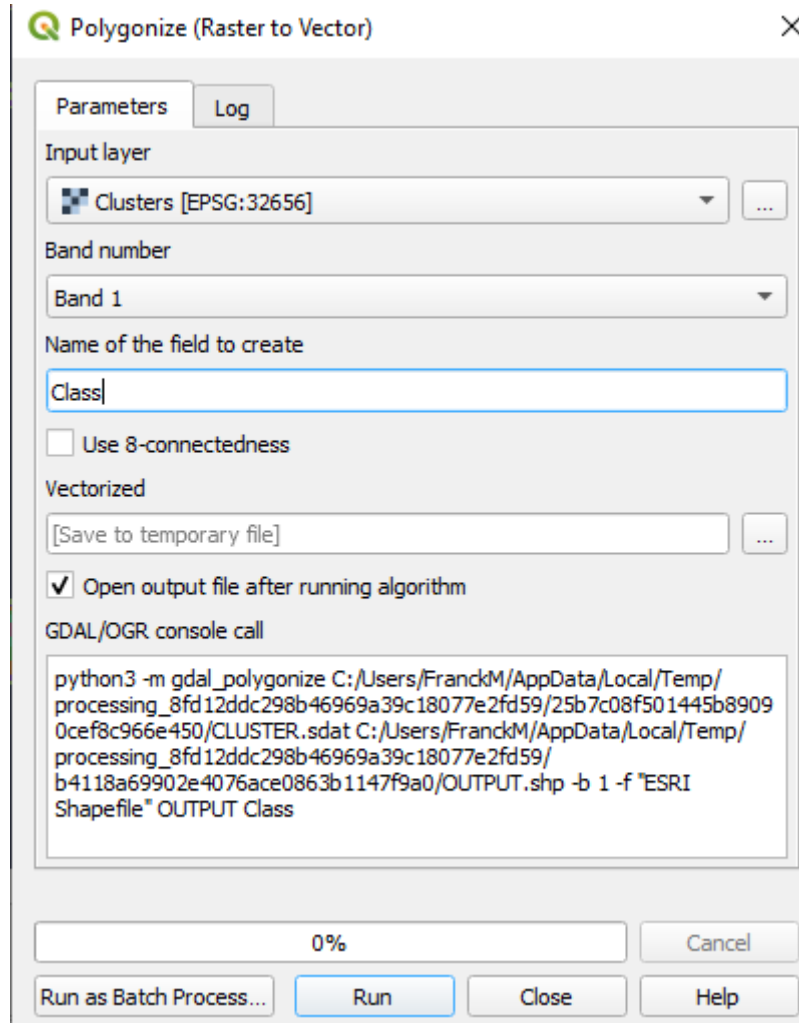
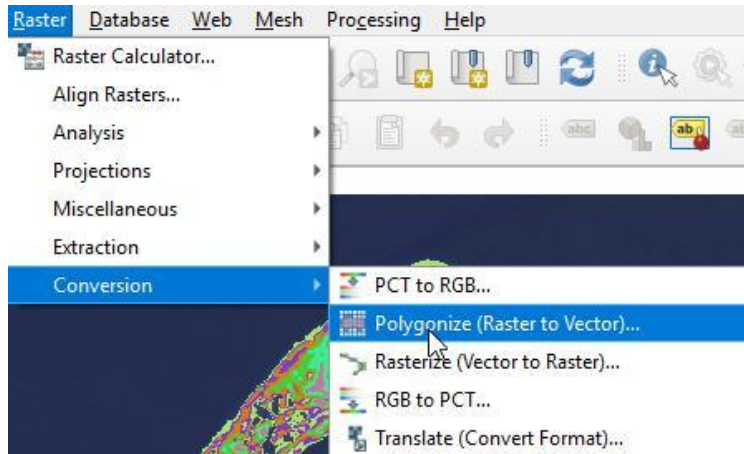
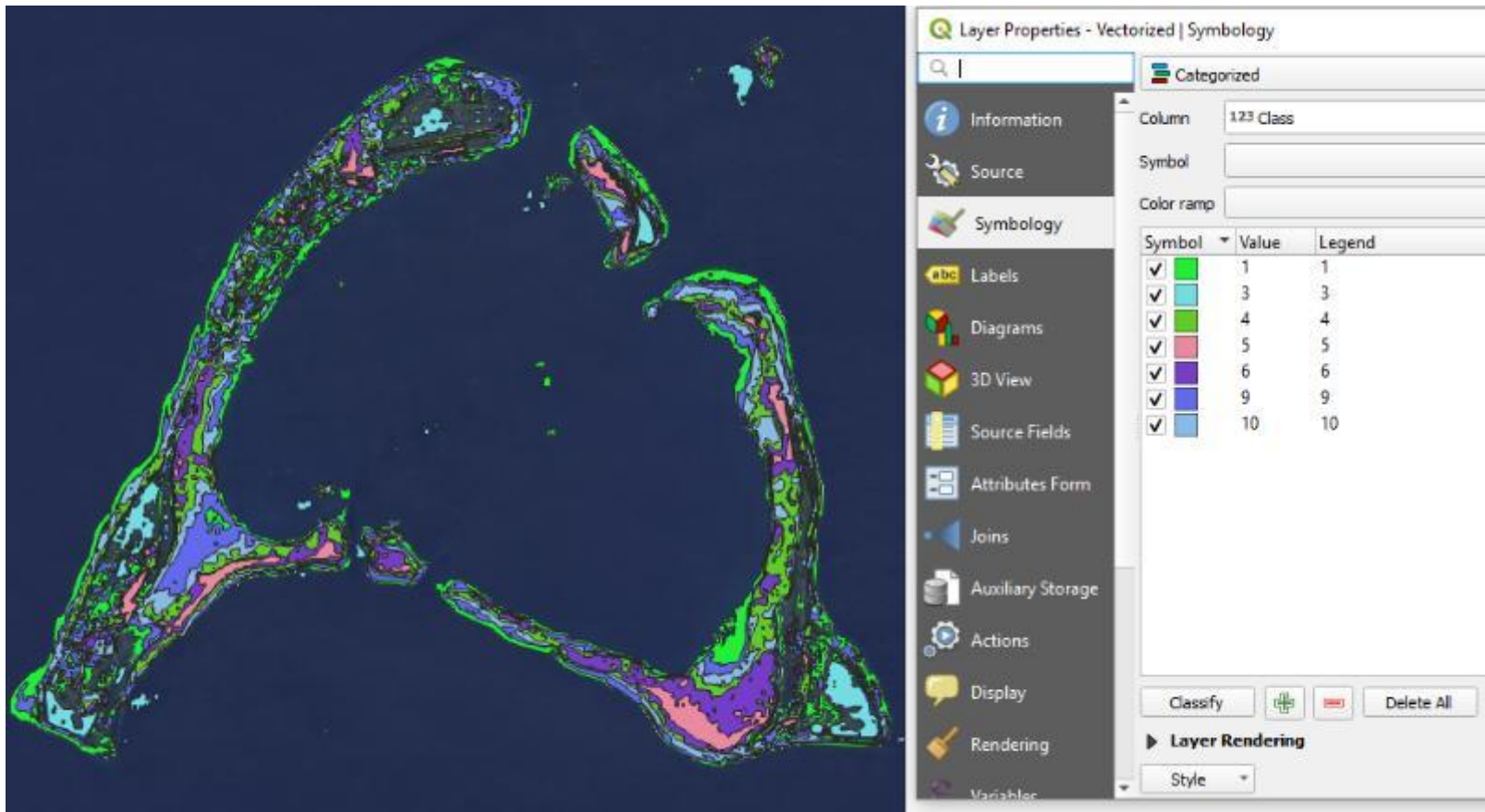


Image classification: raster to vector

Set the symbology and remove classes for deep water



The screenshot displays a GIS application interface. On the left, a map shows a vectorized coastline with various colored regions. On the right, the 'Layer Properties - Vectorized | Symbology' dialog box is open. The 'Symbology' tab is selected, showing a 'Categorized' symbology type. The 'Column' is set to '123 Class'. Below this, a table lists the symbology classes:

Symbol	Value	Legend
<input checked="" type="checkbox"/> [Green]	1	1
<input checked="" type="checkbox"/> [Cyan]	3	3
<input checked="" type="checkbox"/> [Light Green]	4	4
<input checked="" type="checkbox"/> [Pink]	5	5
<input checked="" type="checkbox"/> [Purple]	6	6
<input checked="" type="checkbox"/> [Blue-Gray]	9	9
<input checked="" type="checkbox"/> [Blue]	10	10

At the bottom of the dialog, there are buttons for 'Classify', 'Add' (plus sign), and 'Delete All'. Below these is the 'Layer Rendering' section with a 'Style' dropdown menu.

Image classification: surface areas

Use Group Stats to calculate the surface area by class

Group Stats

Data Features Window Help

1	2
1	Class
2	1
3	1.18381e+07
4	2
5	6.95808e+07
6	3
7	3.04414e+06
8	4
9	8.8788e+06
10	5
11	3.09126e+06
12	6
13	6.9699e+06
14	7
15	1.26649e+07
16	8
17	5.21624e+07
18	9
19	1.17207e+07
20	10
21	1.0385e+07
22	11
23	9.16248e+07
24	12
25	6.05657e+07

Control panel

Layers: Vectorized

Fields:

- Class
- Area
- Perimeter
- average
- count
- max
- median
- min
- stand.dev.
- sum
- unique

Filter: [Empty]

Columns: [Empty]

Rows: Class

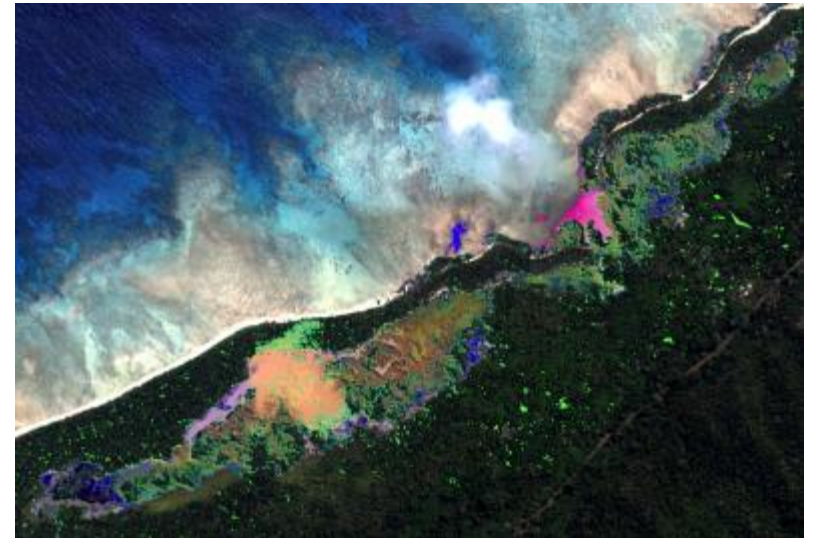
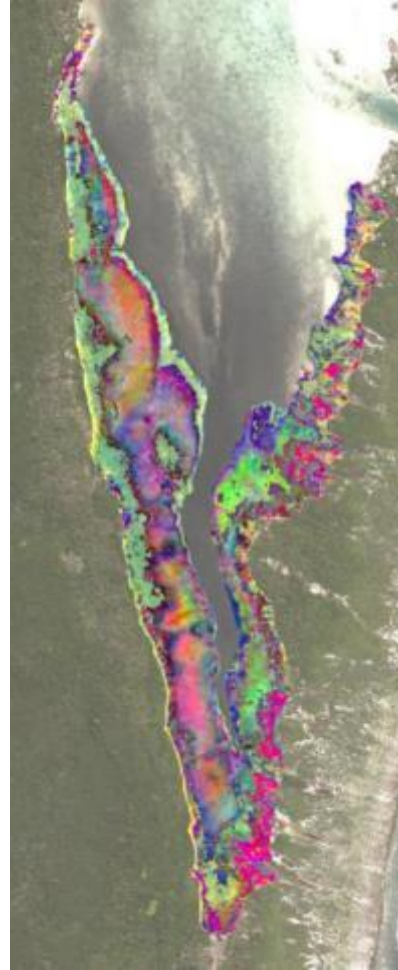
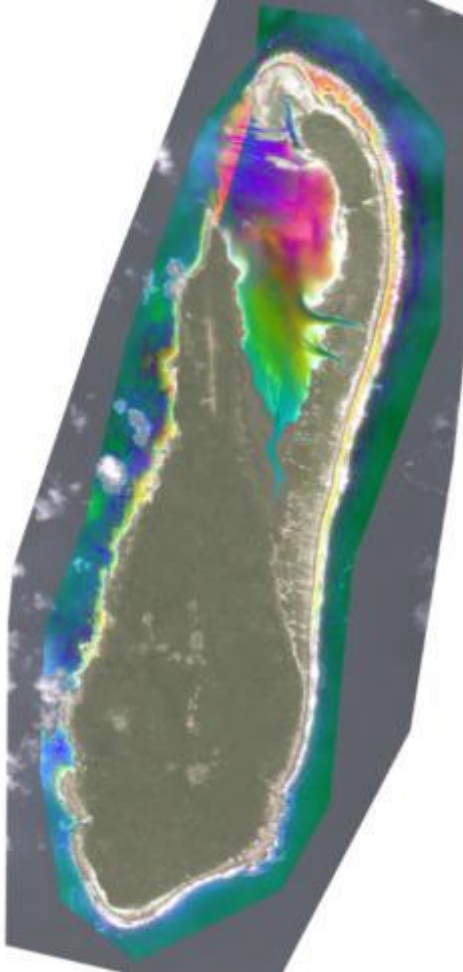
Value: use NULL values

Area

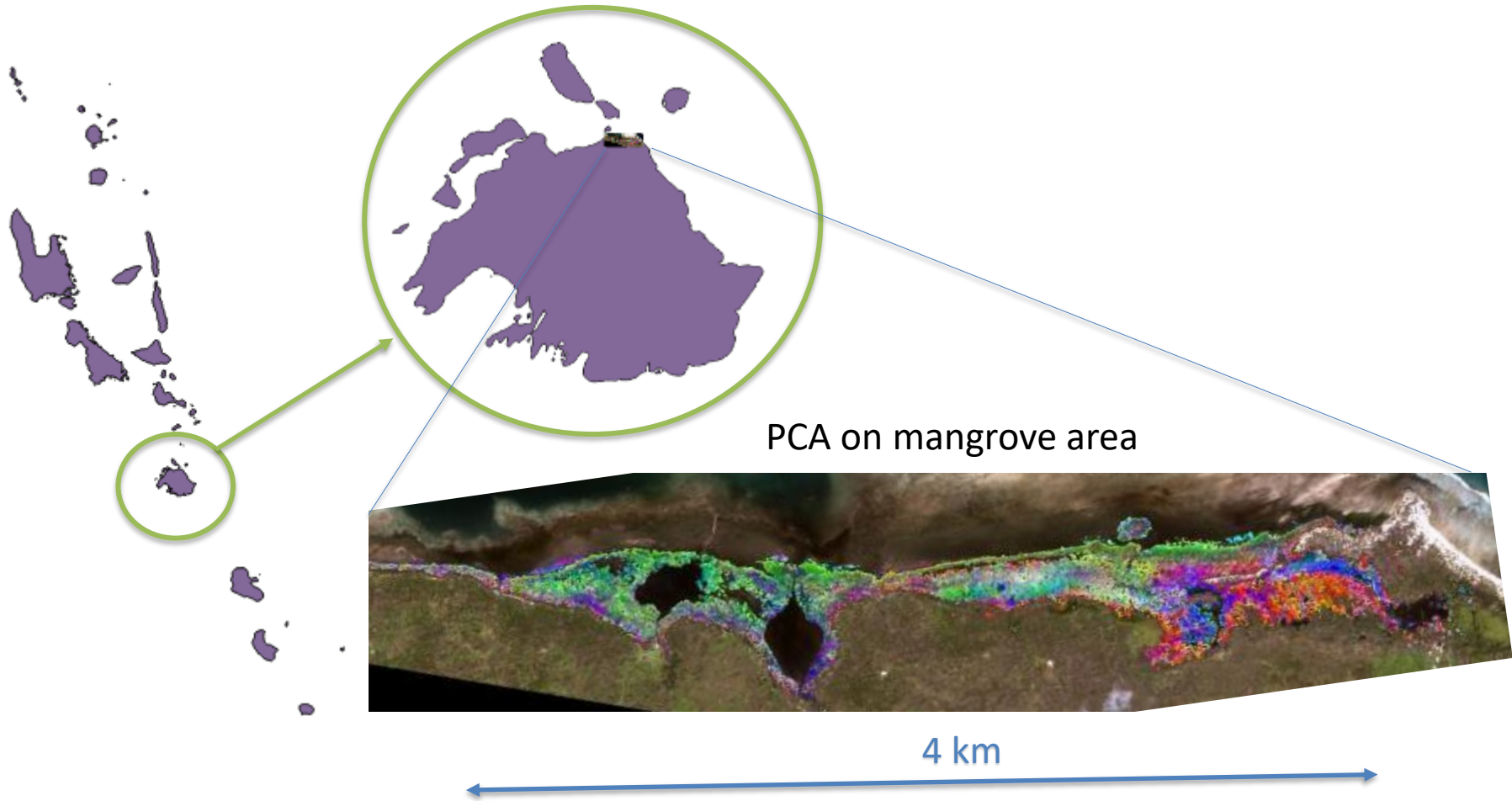
Use only selected features

Calculate

Spectral processing: PCA



Application to North Efate mangrove



Sampling points in the mangrove



Sampled points for the area



Gpx File : Export data :  

Mapping point properties

Survey * Surveyor : Site *

GPS No * Date : * Time :

Waypoint * Longitude : Latitude :

Photo #s separated by

Canopy height (m) Main sediment type :

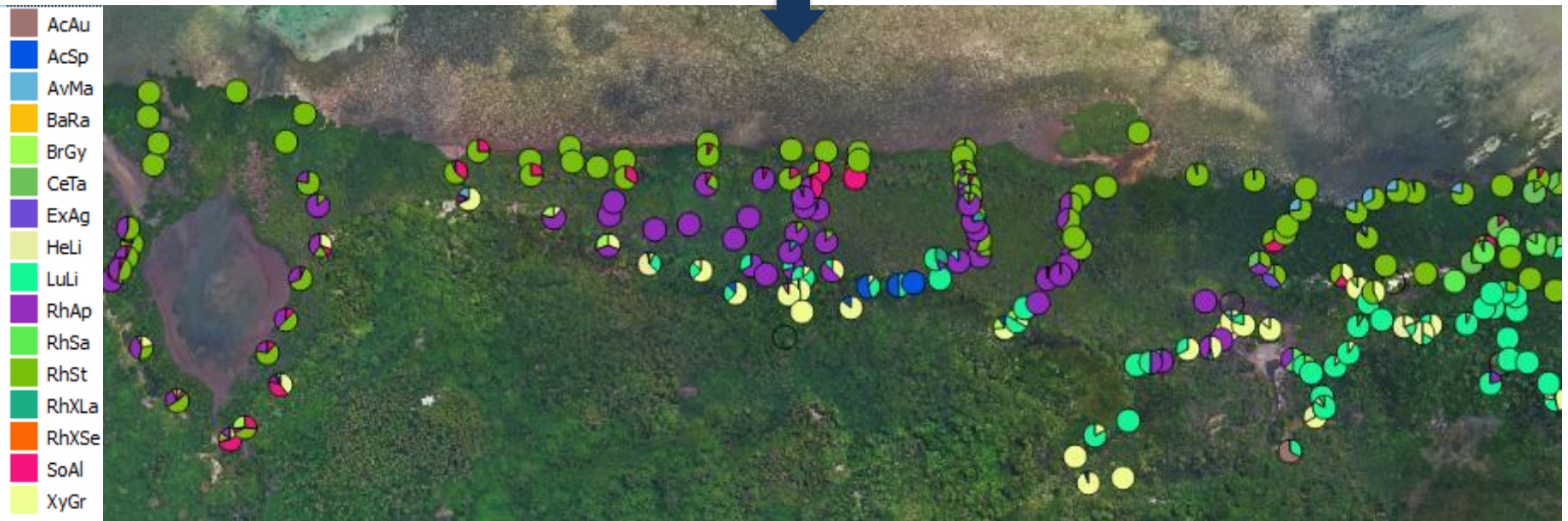
Mangrove species :

Percent cover : Add >>

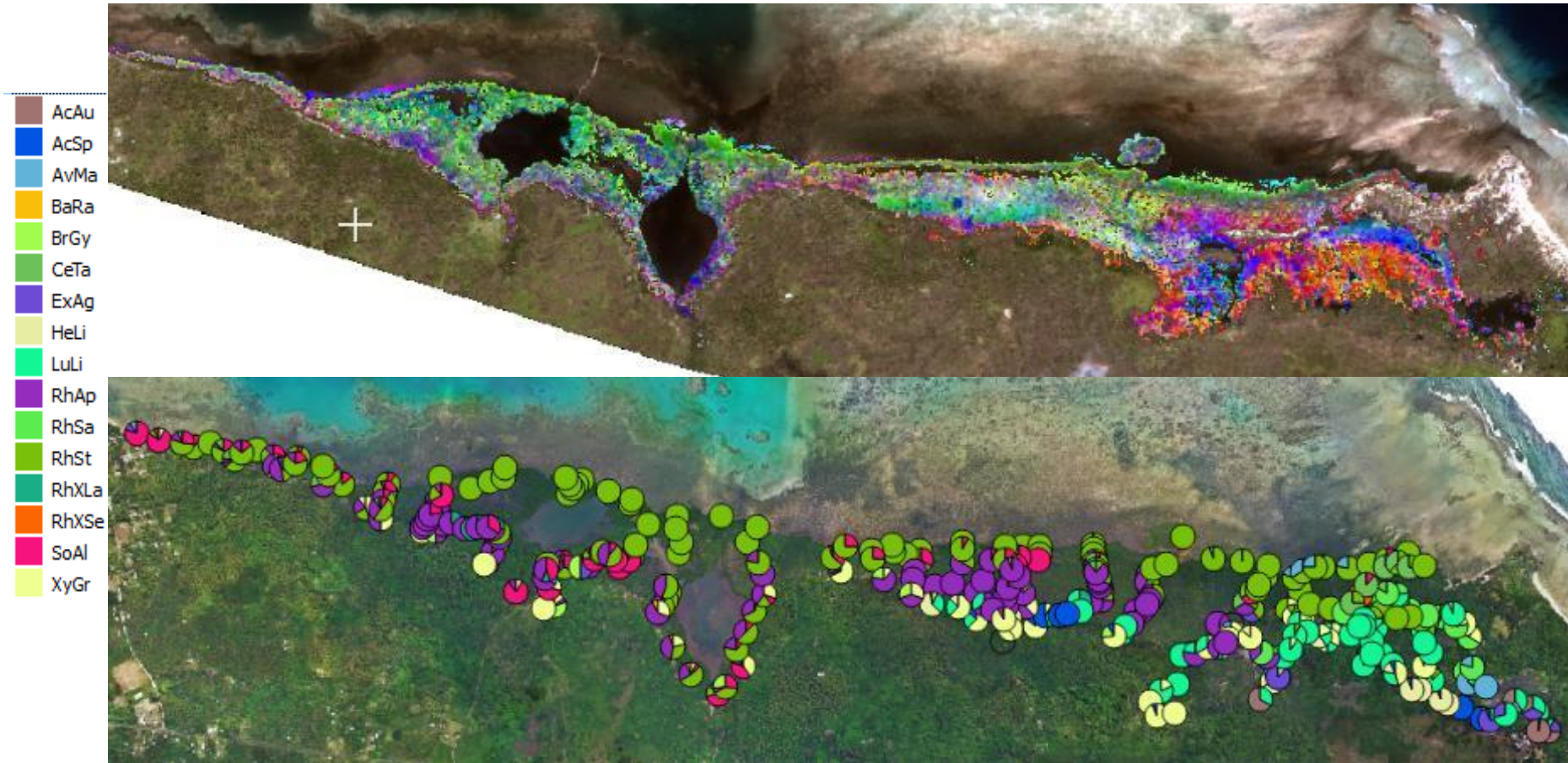
Species	% cover	
Rhizophora samoensis	95	✕
Lumnitzera littorea	1	✕
Total	96	

Web database interface

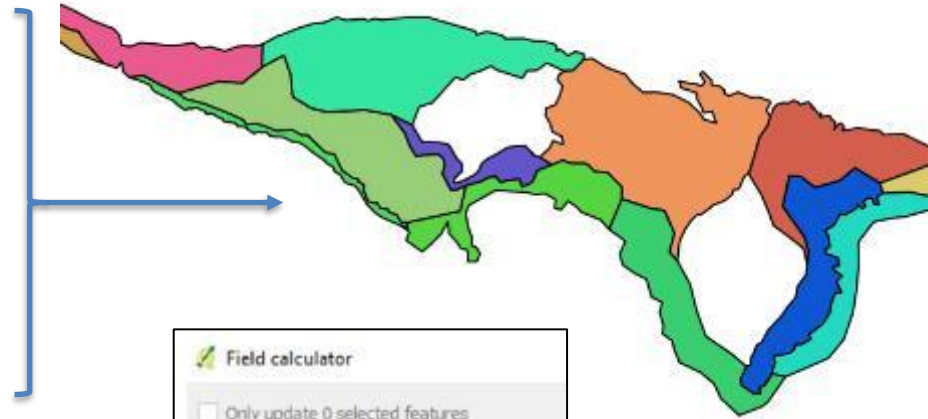
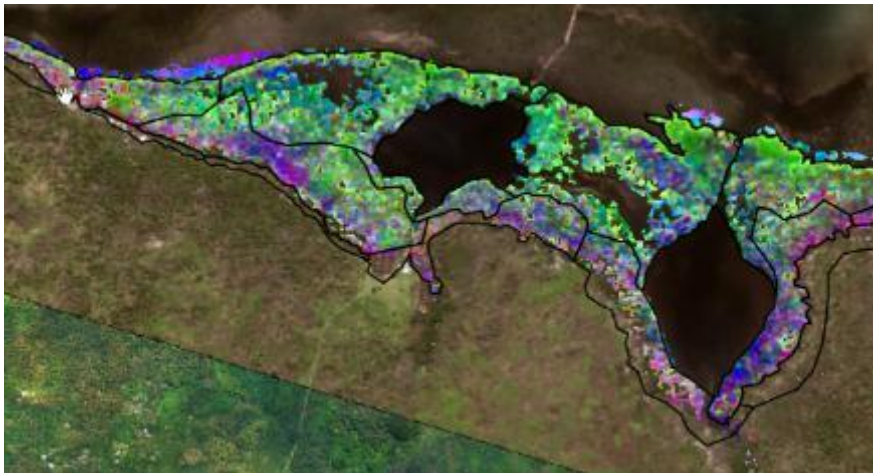
Species composition for sampled points



PCA vs species composition for sampled points



Delineation of zones based on PCA and species composition and extraction of polygon area in Ha



Field calculator

Only update 0 selected features

Create a new field

Create virtual field

Output field name:

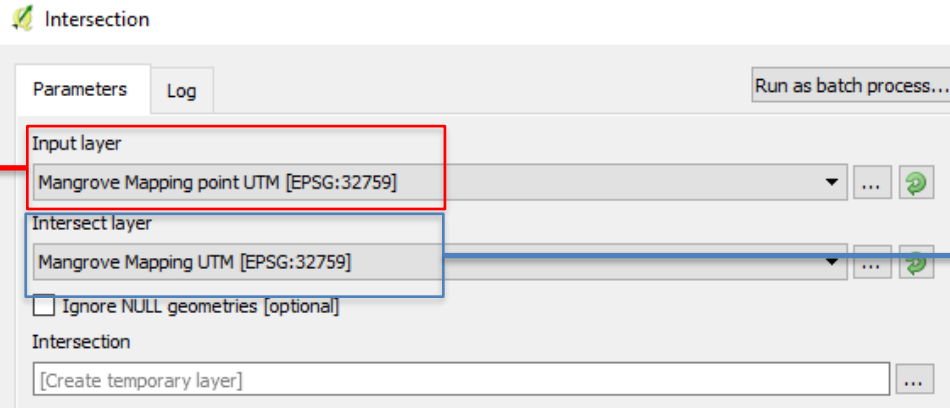
Output field type:

Output field length: Precision:

Expression:

Function Editor

Intersection of mapping points and polygons



AcAu	AcSp	AvMa	BaRa	ExAg	HeLi	LuLi	RhAp	RhSa	XyGr	Poly id	Area Ha
20	0	0	0	5	0	2	0	0	0	14	15.94
90	0	0	0	2	0	0	0	0	0	14	15.94
40	0	0	0	3	0	30	0	0	0	14	15.94
1	0	0	0	1	0	1	0	0	0	14	15.94
2	0	1	0	0	0	2	0	0	0	14	15.94
0	0	0	0	2	0	5	0	0	0	14	15.94
0	0	20	0	0	0	0	0	0	0	14	15.94
0	0	40	0	0	0	0	0	0	0	14	15.94
0	0	20	0	1	0	10	0	0	0	14	15.94
0	0	0	0	0	0	1	0	95	0	13	7.15
0	0	10	0	0	0	0	0	40	0	13	7.15
0	0	0	0	0	0	10	0	30	20	12	0.4
0	0	0	0	10	1	1	0	0	20	12	0.4
0	0	0	0	0	0	0	0	70	20	13	7.15

