→ EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Urban Development

City Academy: Geospatial Data Applications for Urban Development, Sao Paulo 16.-17.09.2019

Introduction to basic steps in production of Land Use Maps

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urban development eo4sd

GAFAG SIRS gisat DLR egis JOANNEUM RESEARCH NEO GISBOX

Outline of the Presentation

- Data acquisition, how to proceed?
- Data preprocessing, what are the steps?
- Different classification schemes & classifiers
- How can we extract information from satellite data? From images to information

Data acquisition, how to proceed?

Prerequirement

- Clearly define the project and its specifications

- Choose the data adapted to the theme studied?

Example: to map the footprint of buildings in a city, which types of image to choose?

- Choose the appropriate platform to download the image

examples: https://scihub.copernicus.eu/dhus/#/home

Or

https://peps.cnes.fr/rocket/#/search?maxRecords=50&page=1

Data acquisition Platforms

Some image data acquisition Platforms :

https://scihub.copernicus.eu/

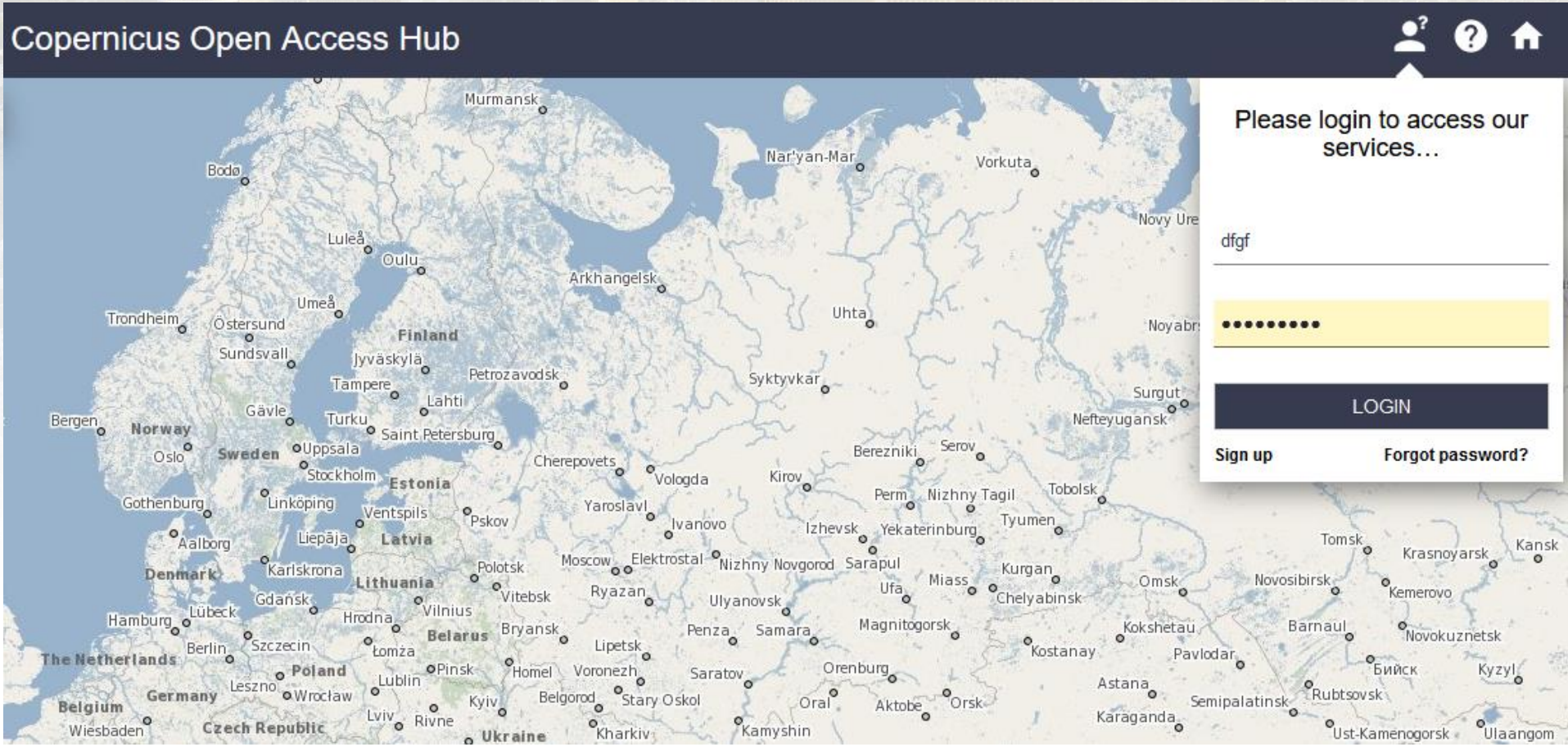
And

https://peps.cnes.fr/

Image credit: https://fr.depositphotos.com/127985826/stock-illustration-gear-setup-machinery-icon.html

Data acquisition, Some platforms: Copernicus hub

Registration



Data acquisition, Some platforms

Advanced Search

The advanced search panel is shown by clicking on the "Advanced Search" icon.

It consists of different search fields. Each search field allows to perform specific queries on the associated parameter. Each search field can be used singularly or in combination with: the others search fields, the full-text search bar and the geographic map tool.

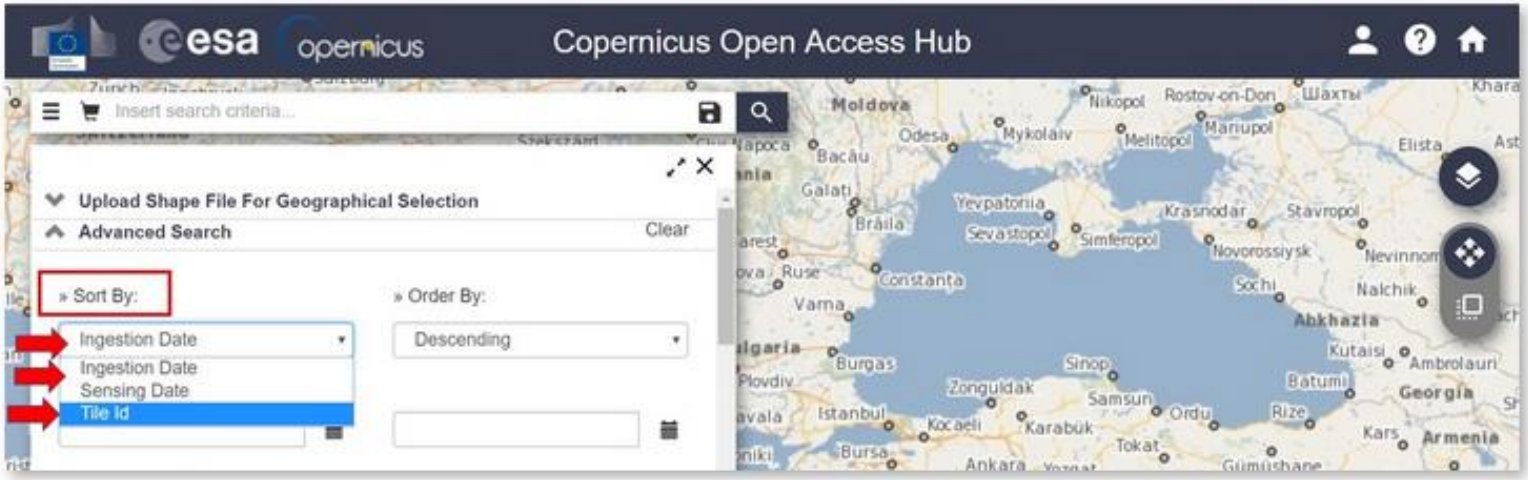
Source: https://scihub.copernicus.eu/userguide/AdvancedSearch

Data acquisition, Some platforms

Advanced Search, Sort by:

Sort by — This field allows to sort search results by:

- ***Ingestion date*** (represents the time when the product is indexed in the DHuS Service databases. Time is in UTC)
- ***Sensing Date*** ((represents the time when the product has been taken. Time is in UTC)
- ***Tile id*** (This sorting is meaningful for Sentinel-2 L1C products only. Clicking on this checkbox Sentinel-2 L1C products will be shown in the list)

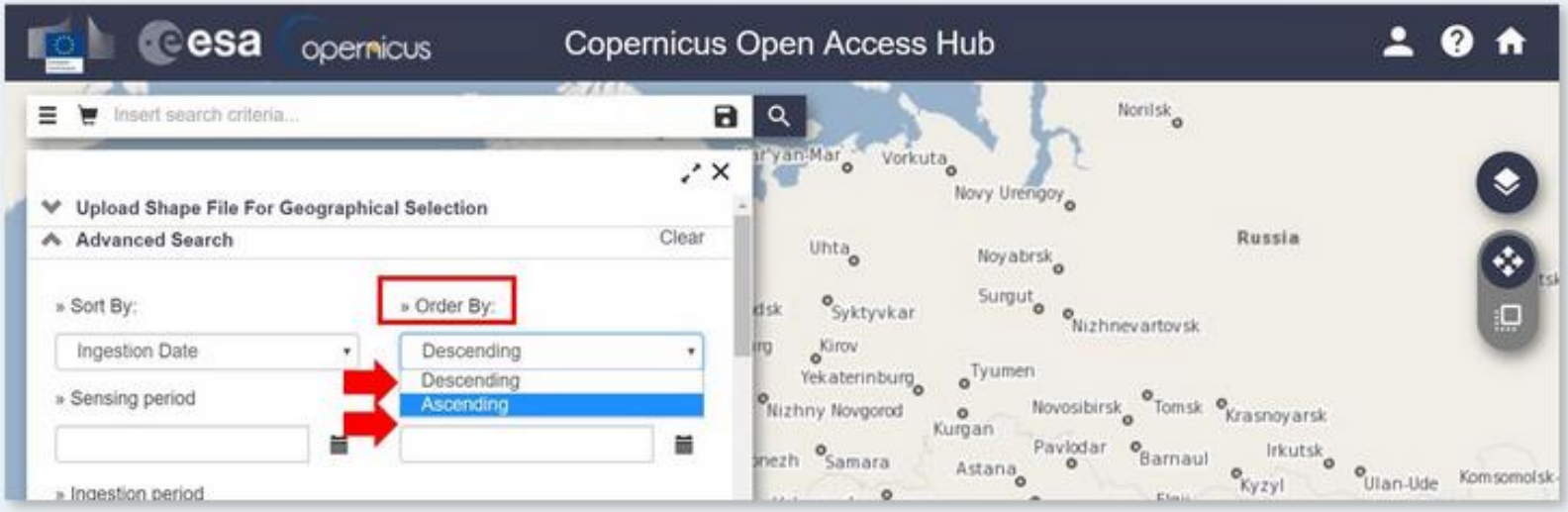


Source: https://scihub.copernicus.eu/userguide/AdvancedSearch

Data acquisition, Some platforms

Advanced Search, Order by:

Order by This field allows to sort search results by ***ascending*** or ***descending*** order.



Sensing Period This search field is composed of two date entries. Dates have to be inserted for both entries. "Pick up date" calendars allow date selection. The query returns all the products whose sensing dates and times are included in the defined period. In particular it returns all the products that respond to both of the following criteria:

Source: https://scihub.copernicus.eu/userguide/AdvancedSearch

Data acquisition, Some platforms

Advanced Search,

Sensing Period: This search field is composed of two date entries. Dates have to be inserted for both entries. "Pick up date" calendars allow date selection. The query returns all the products whose sensing dates and times are included in the defined period. In particular it returns all the products that respond to both of the following criteria:

- sensing start time equal or greater then 00:00:00 (hh:mm:ss) of the first selected date
- sensing stop time equal or less then 23:59:59 (hh:mm:ss) of the second selected date

The Sensing Time corresponds to the time of the satellite on-board acquisition and it is stamped for each line of the acquired image scene. The sensing start and stop times of a product correspond to the time of the satellite on-board acquisition of respectively the first and last line of the image in the product. Click on "Clear date" to remove the search entry. Click on "Today" to select the current date.

Source: https://scihub.copernicus.eu/userguide/AdvancedSearch

Data acquisition, Some platforms

Advanced Search, Ingestion:

Ingestion Period	This search field is composed of two date entries as for ***Sensing Period***. The query returns all the products whose publication dates and times on the Data Hub are included in the defined period. In particular it returns all the products that respond to both of the following criteria: • Publication time equal or greater then 00:00:00 (hh:mm:ss) of the first selected date • Publication time equal or less then 23:59:59 (hh:mm:ss) of the second selected date.

NB: Ingestion date does not correspond to the generation date of the product processed at the ground segment. The ingestion date represents the time when the product is indexed in the DHuS Service databases. Time is in UTC.

Source: https://scihub.copernicus.eu/userguide/AdvancedSearch

Data acquisition, Some platforms

Advanced Search:

Mission Sentinel-1	
Satellite Platform	Search based on the Satellite Platform name regardless of the serial identifier. Accepted entries are: • S1_A* • S1_B*
Product Type	Accepted entries are: • Single Look Complex (SLC) • Ground Range Detected (GRD) • Ocean (OCN)
Polarisation	Accepted entries are: HH, VV, HV, VH, HH+HV, VV+VH
Sensor Mode	Accepted entries are: SM (Stripmap), IW (Interferometric Wide Swath), EW (Extra Wide Swath), WV (Wave)
Relative Orbit Number	Relative orbit number of the oldest line within the image data (the start of the product). Accepted entries are: from 1 to 175
Collection	This field allows searches based on the collections that are available.

Source: https://scihub.copernicus.eu/userguide/AdvancedSearch

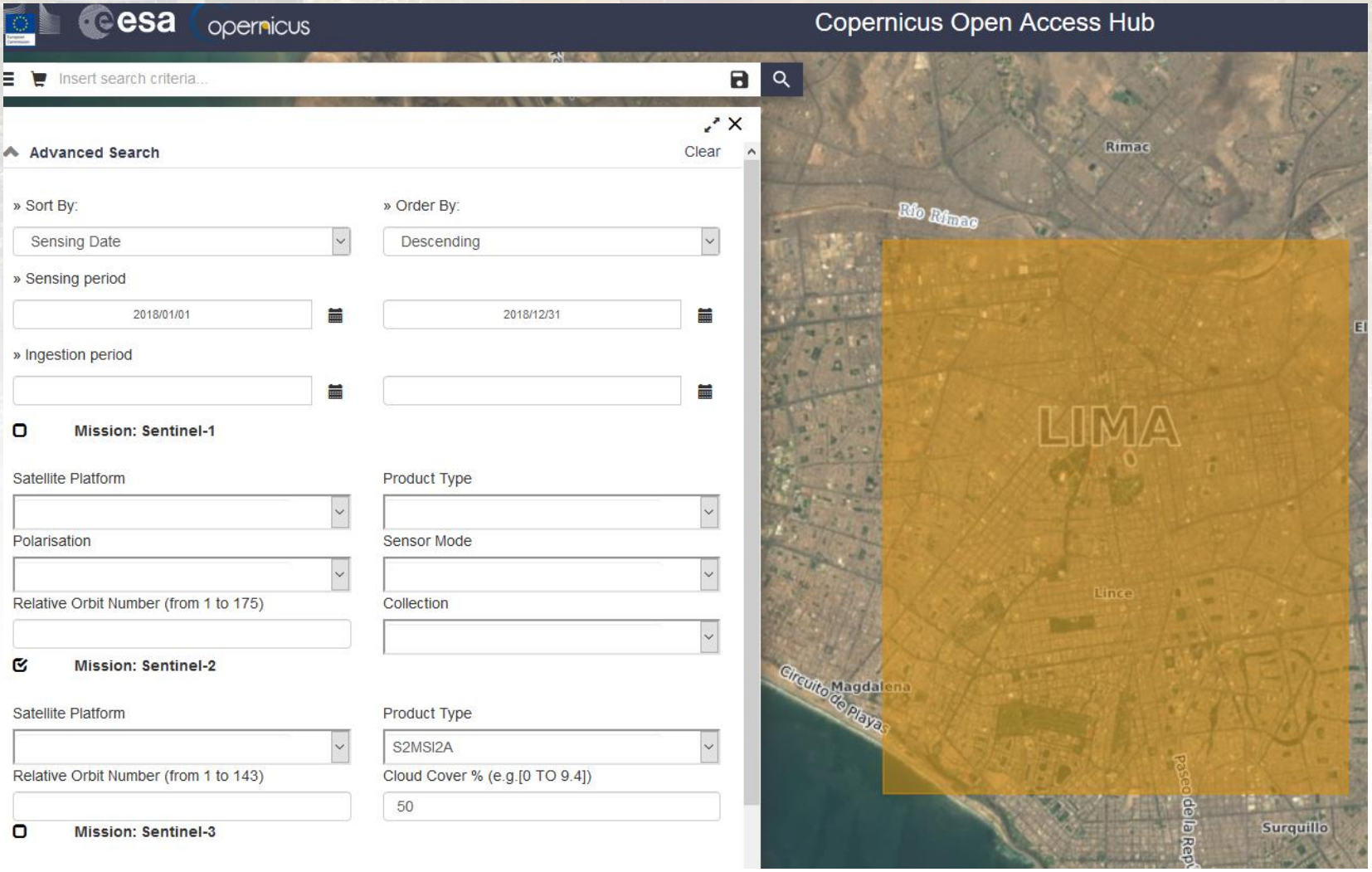
Data acquisition, Some platforms

Advanced Search:

Mission Sentinel-2	
Satellite Platform	Search based on the Satellite Platform name regardless of the serial identifier. Accepted entries are: • S2A_* • S2B_*
Product Type	Accepted entries are: • S2MSI1C • S2MSI2A • S2MSI2Ap
Relative Orbit Number	Relative orbit number of the oldest line within the image data (the start of the product). Accepted entries are: from 1 to 143
Cloud Cover %	It is the percentage of cloud coverage of the product for each area covered by a reference band. Accepted entries are: from [0 TO 100] Example:[0 TO 5]

Source: https://scihub.copernicus.eu/userguide/AdvancedSearch

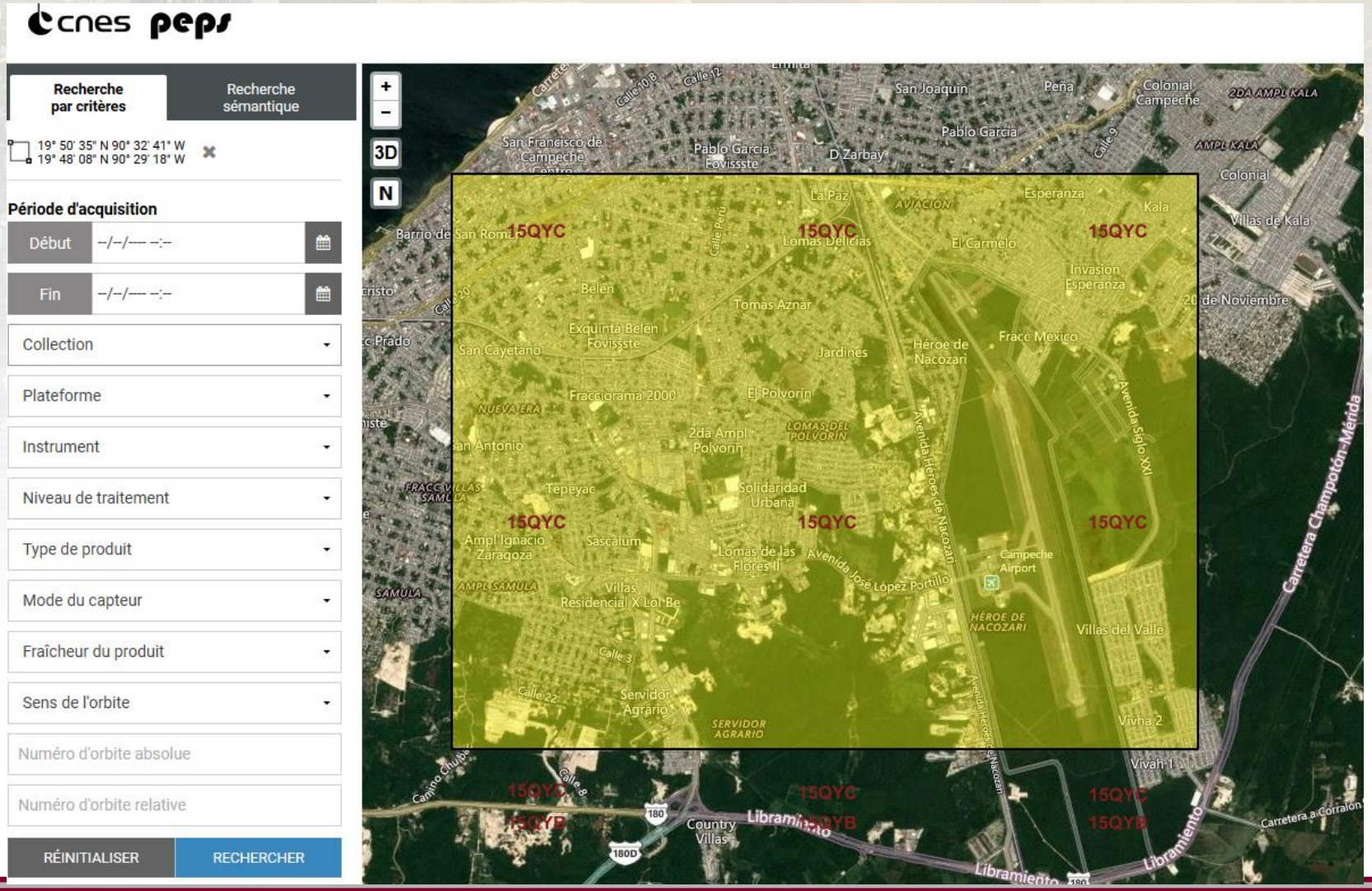
Data acquisition, Some platforms



Data acquisition, Some platforms

Peps.cnes.fr/

Data acquisition, Some platforms



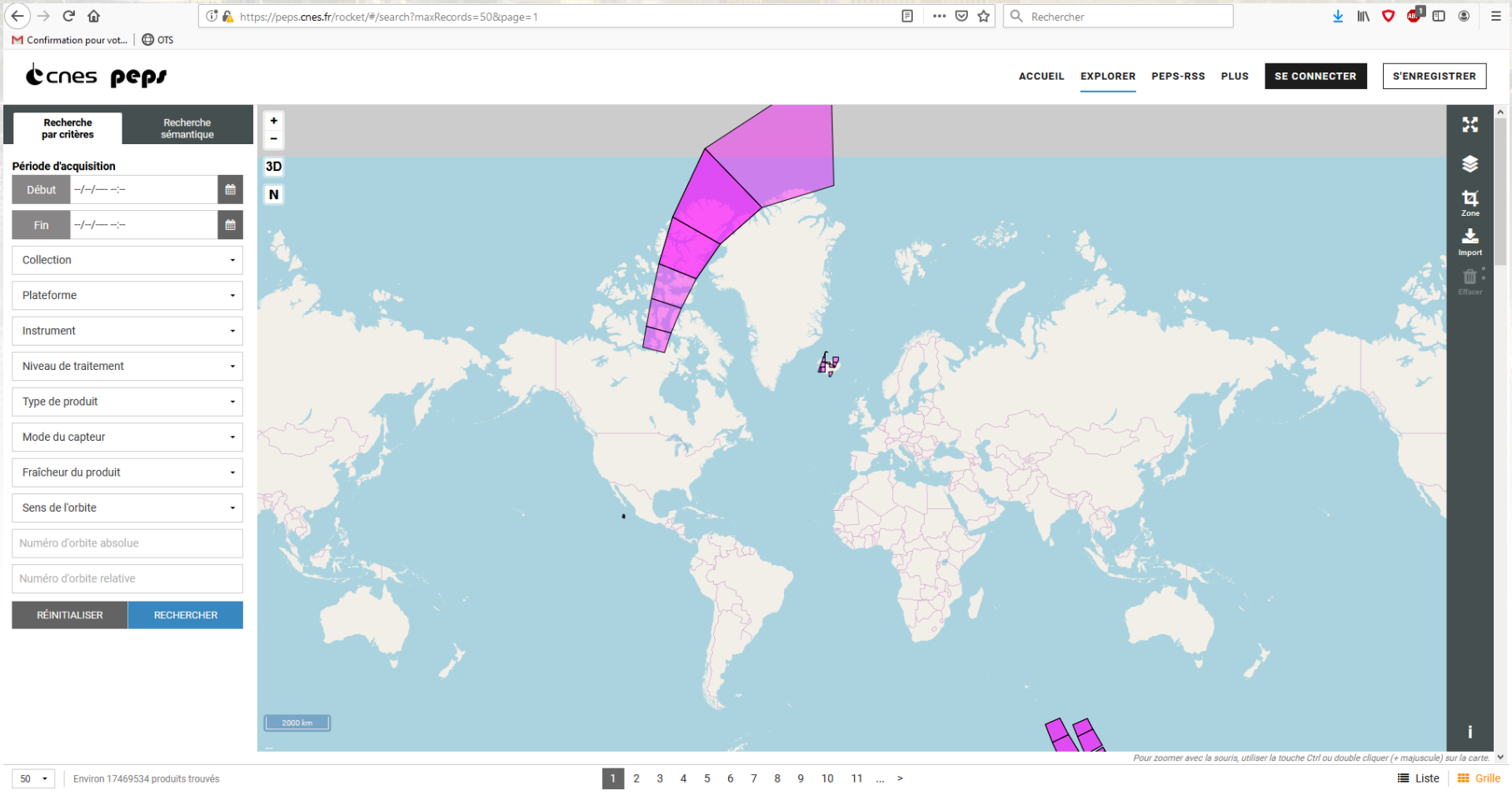
Data acquisition, Some platforms: peps

Peps and its functioning:

- PEPS, the Sentinel Products Operating Platform of the European Copernicus programme, developed by CNES, provides access to Sentinel-1 and Sentinel-2 data.
- Free and easily accessible
- peps offers some online pre-processing features (Atmospheric calibration)
- Possibility to display the image rights-of-way identification grid to facilitate the search
- Acces: https://peps.cnes.fr/rocket/#/search?maxRecords=50&page=1

Data acquisition, Some platforms: peps

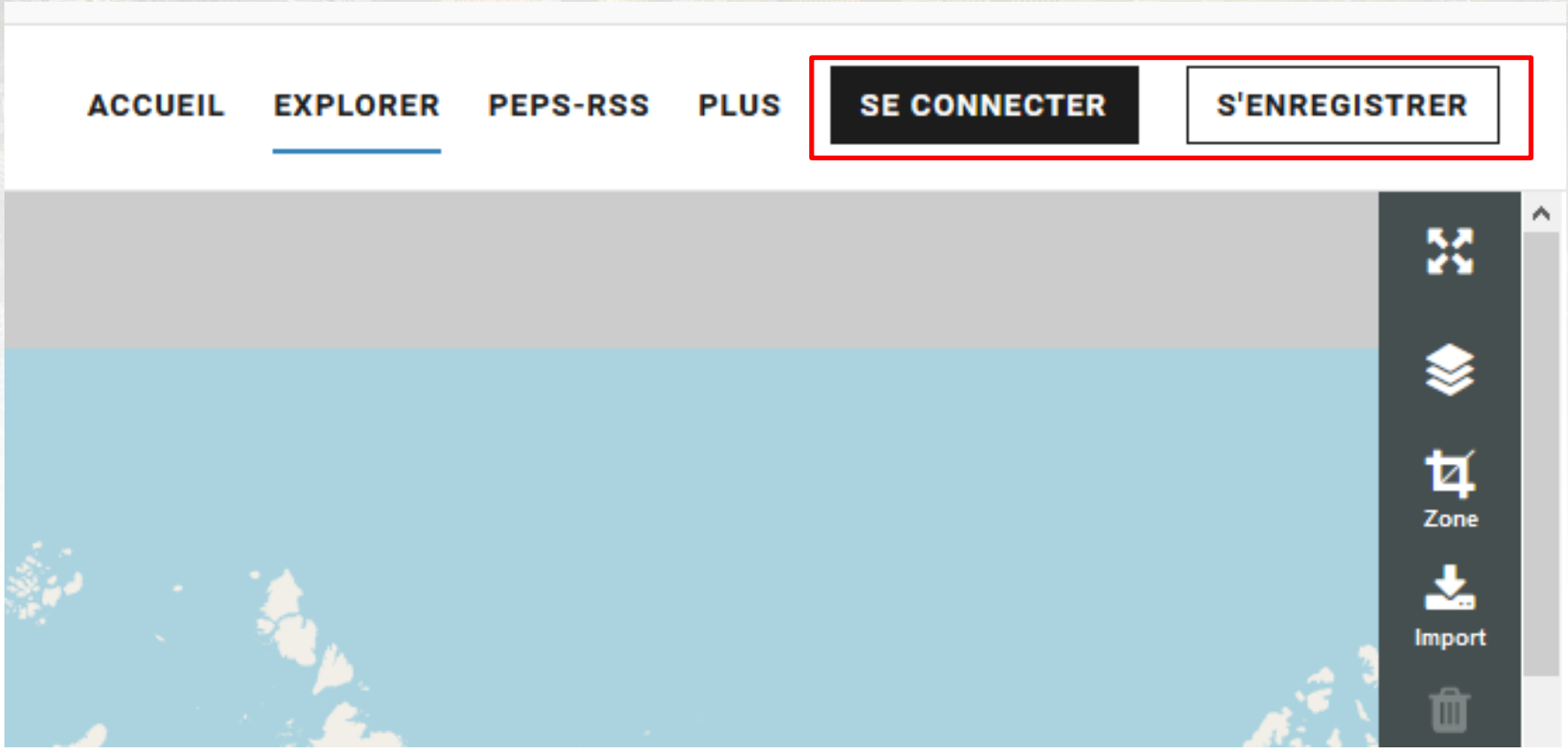
Peps and its functioning:



Data acquisition, Some platforms: peps

Peps and its functioning:

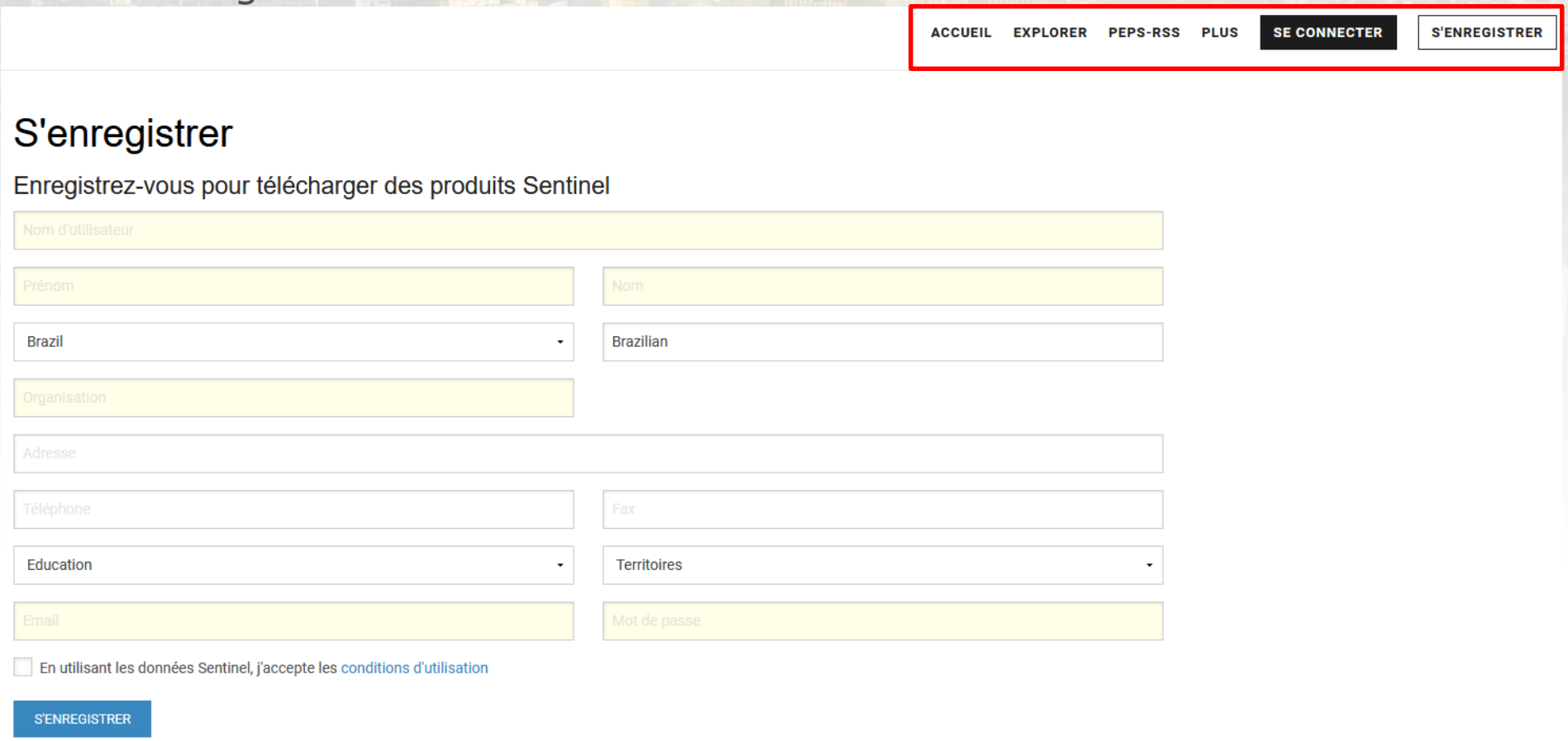
- User Registration:



Data acquisition, Some platforms: peps

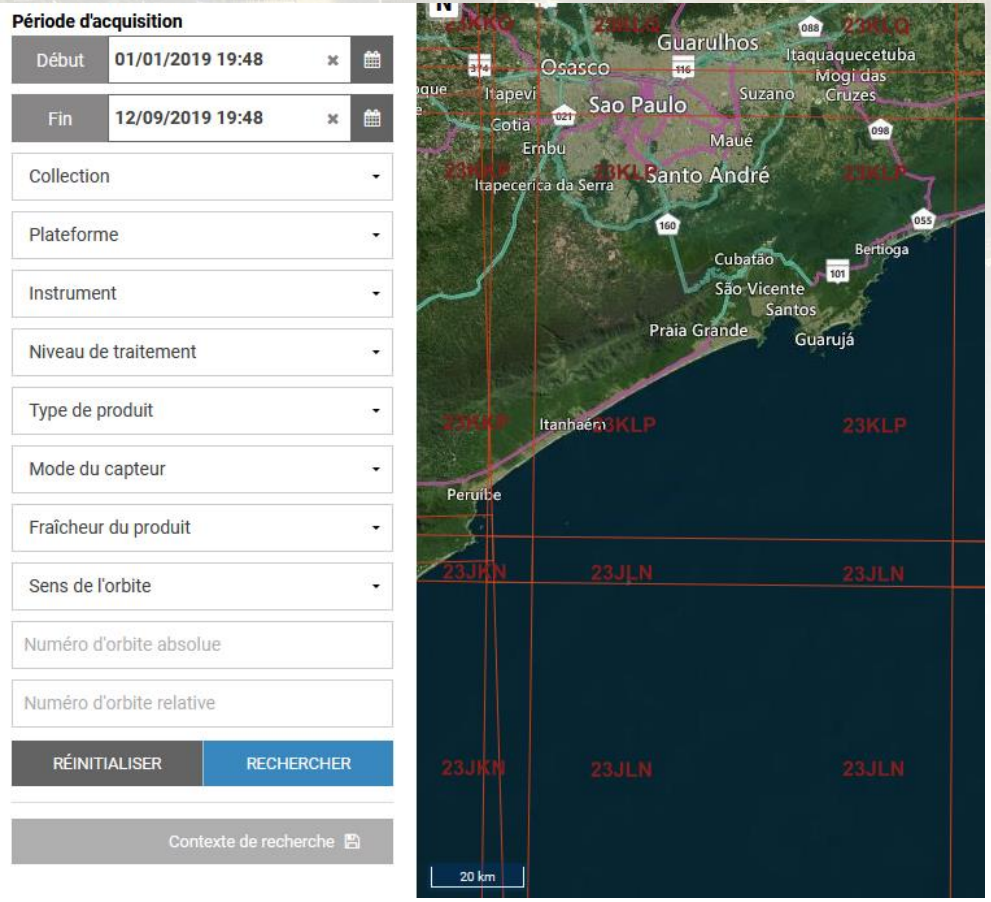
Peps and its functioning:

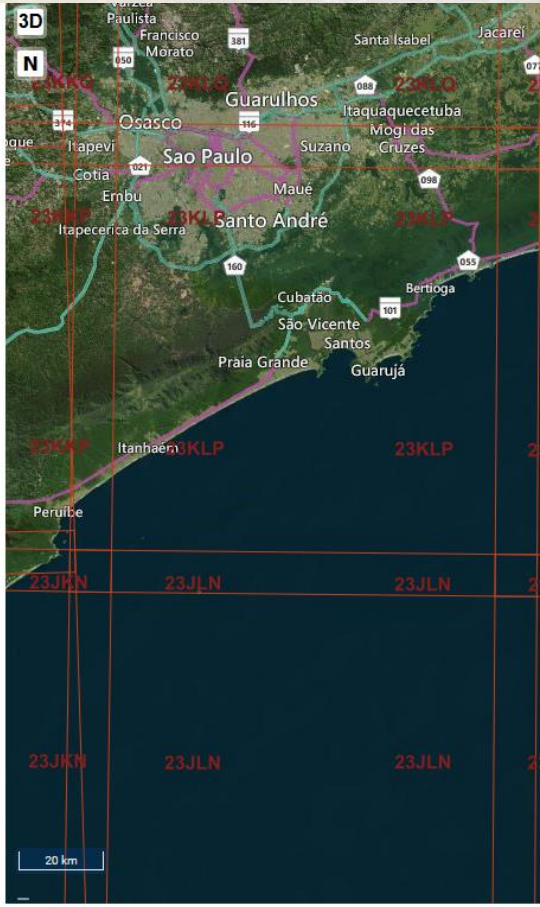
- User Registration :



Data acquisition, Some platforms: peps

Peps and its functioning:





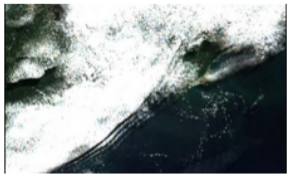
Data acquisition, Some platforms: peps

Peps and its functioning: Preprocessing toolbox

AJOUTER AU PANIER | AJOUTER AU CENTRE DE TRAITEMENT

S2A_MSIL2A_20190601T131251_N0212_R138_T23KLP_20190601T152730

Collection : SENTINEL-2 tuilés | Plateforme : S2A | Numéro d'orbite : 20584
Localisation : Brazil | Instrument : MSI | Niveau de traitement : LEVEL2A
Date : 01 juin 2019 - 13:12:51 | Type de produit : S2MSI2A | Mode du capteur :
Fraîcheur du produit : Nominal

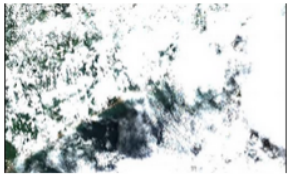


S2A_MSIL2A_20190502T131251_N0211_R138_T23KLP_20190502T153101

Collection : SENTINEL-2 tuilés | Plateforme : S2A | Numéro d'orbite : 20155
Localisation : Brazil | Instrument : MSI | Niveau de traitement : LEVEL2A
Date : 02 mai 2019 - 13:12:51 | Type de produit : S2MSI2A | Mode du capteur :
Fraîcheur du produit : Nominal

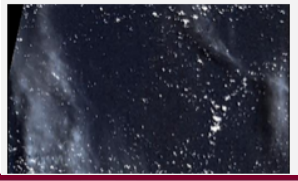
S2A_MSIL2A_20190422T131251_N0211_R138_T23KLP_20190422T170843

Collection : SENTINEL-2 tuilés | Plateforme : S2A | Numéro d'orbite : 20012
Localisation : Brazil | Instrument : MSI | Niveau de traitement : LEVEL2A
Date : 22 avril 2019 - 13:12:51 | Type de produit : S2MSI2A | Mode du capteur :
Fraîcheur du produit : Nominal



S2A_MSIL2A_20190221T131241_N0211_R138_T23KLP_20190221T152523

Collection : SENTINEL-2 tuilés | Plateforme : S2A | Numéro d'orbite : 19154
Localisation : Brazil | Instrument : MSI | Niveau de traitement : LEVEL2A
Date : 21 février 2019 - 13:12:41 | Type de produit : S2MSI2A | Mode du capteur :
Fraîcheur du produit : Nominal

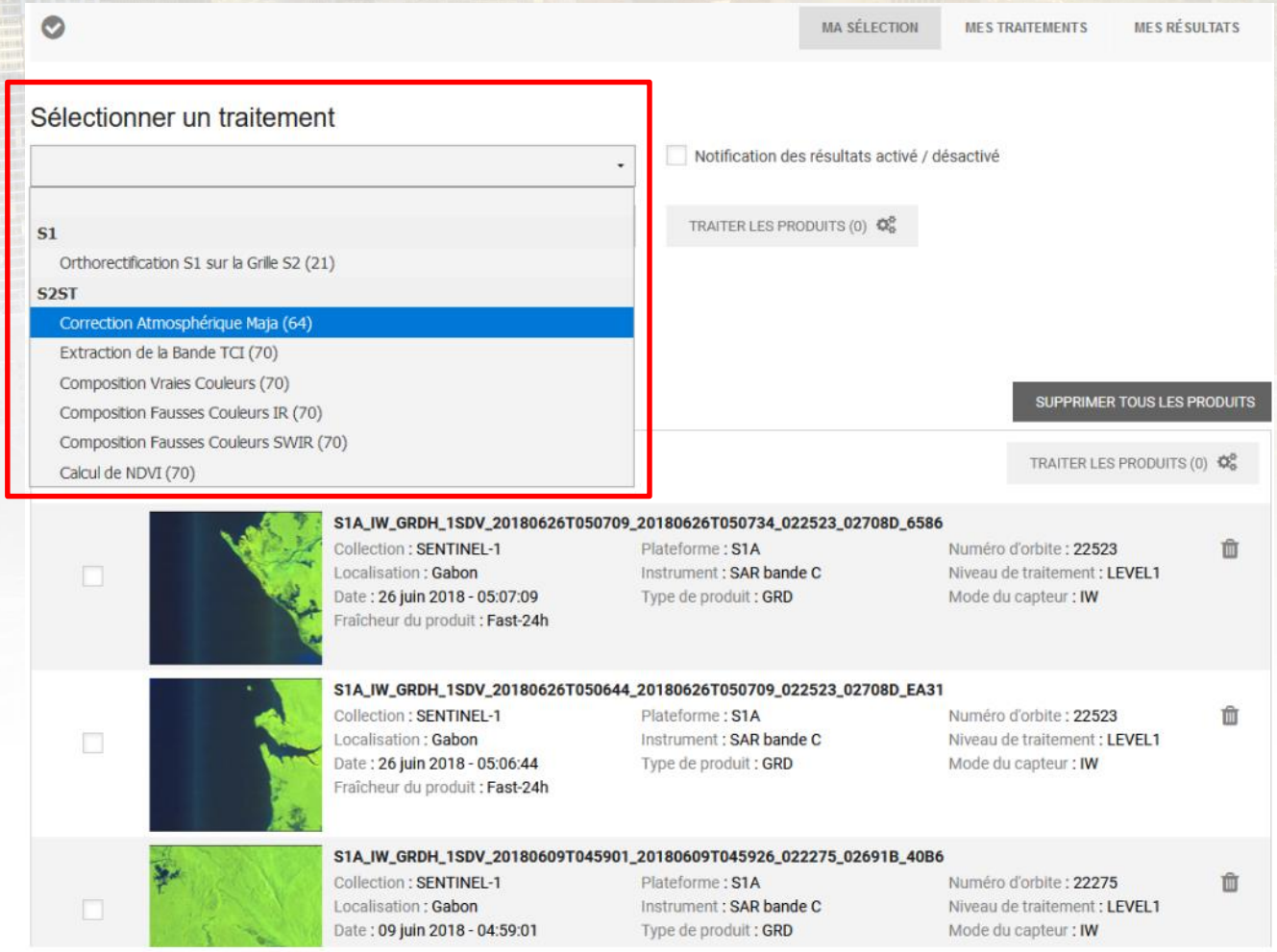


S2A_MSIL2A_20190220T220531_N0211_R129_T01KAP_20190221T001431

Collection : SENTINEL-2 tuilés | Plateforme : S2A | Numéro d'orbite : 19145
Localisation : | Instrument : MSI | Niveau de traitement : LEVEL2A
Date : 20 février 2019 - 22:05:31 | Type de produit : S2MSI2A | Mode du capteur :
Fraîcheur du produit : Nominal

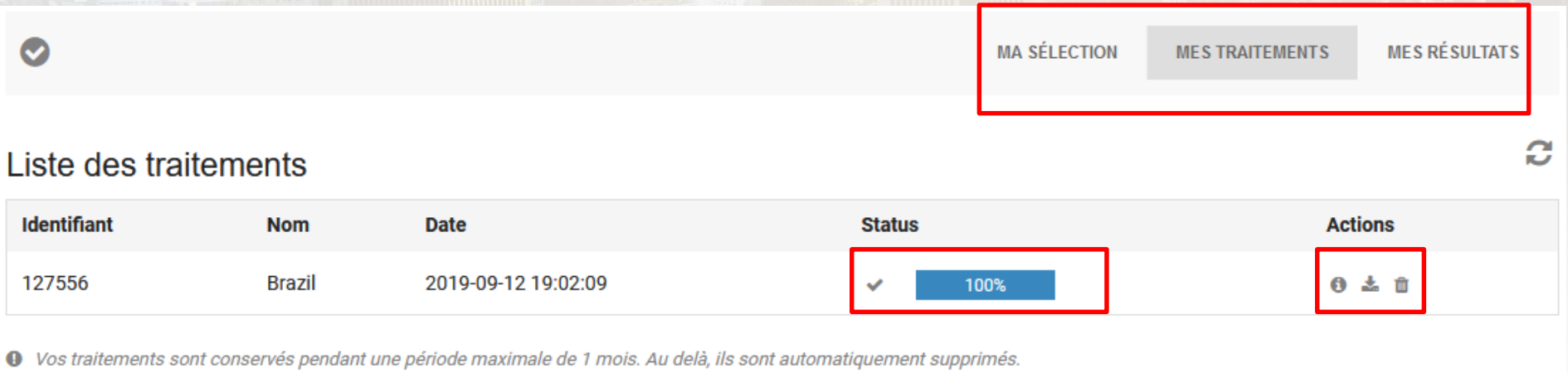
Data acquisition, Some platforms: peps

Peps and its functioning: Preprocessing toolbox



Data acquisition, Some platforms: peps

Peps and its functioning: Preprocessing toolbox



Last operation: download the image and process it

Some ancilliary data acquisition Platforms:

https://www.openstreetmap.org/

And

http://worldpopulationreview.com/

Data acquisition Platforms

Some ancilliary data acquisition Platforms:

https://www.openstreetmap.org/

Initiation date: 2004

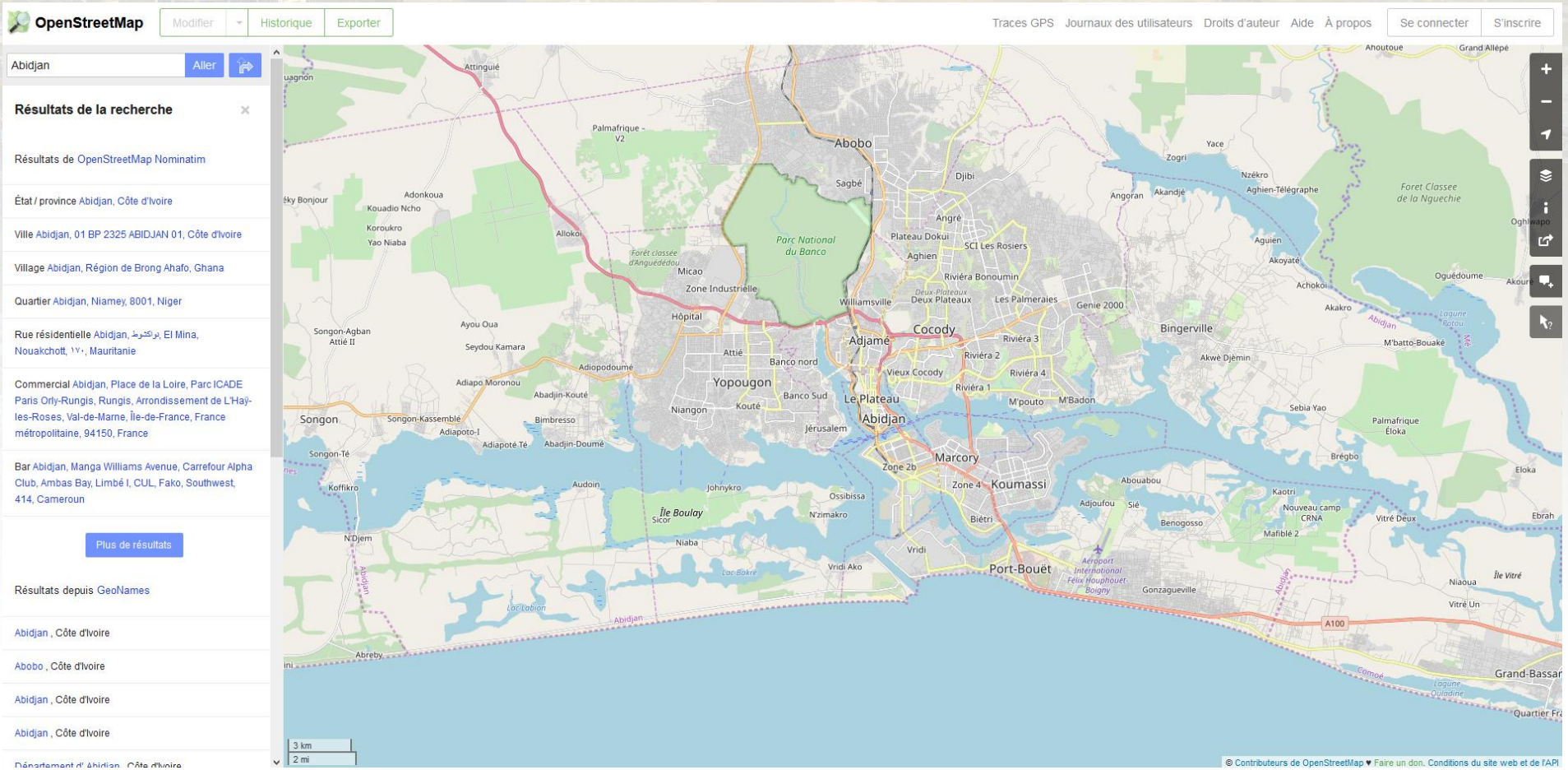
Goal: create a free map of the world

Data provided: geographic data from anywhere in the world.

Data Format: vector with metadata associated
Examples of data: roads, waterways, etc.

Data Cost: free acces

Data acquisition Platforms



Data acquisition Platforms

Some ancilliary data acquisition Platforms:

http://worldpopulationreview.com/

Intiation date: 2013

Goal: Combine the Afropop, AsiaPop and AmeriPop population mapping projetcs to support development, disaster response and health applications.

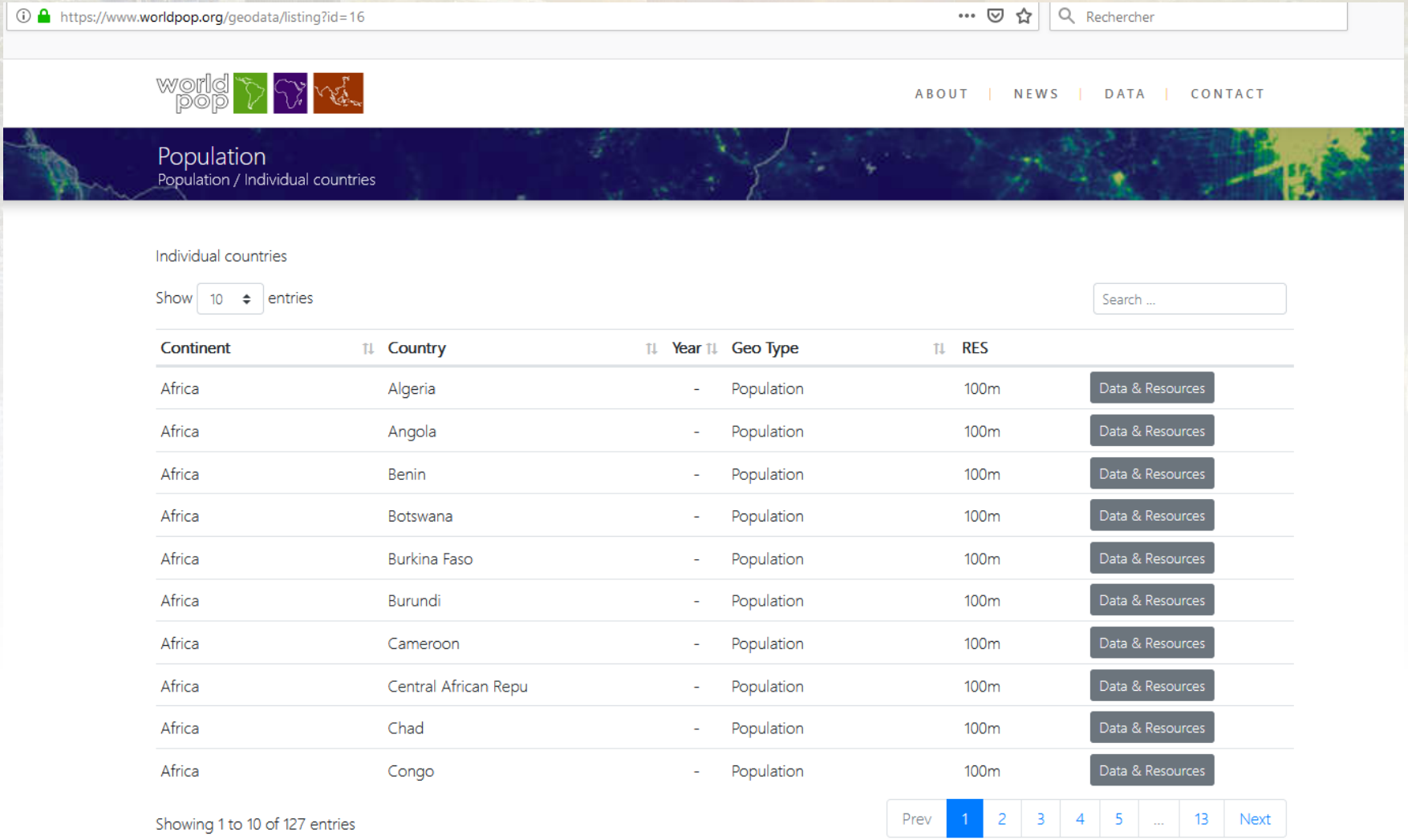
Data on several field: population (number of people, birth, pregrancy, poverty, age structures and population estimates by continent for different years (2000, 2005, 2010, 2015) etc.

Data Format: raster (geotiff), spatial resolution 100m with metadata associated.
Example: Number of people/ pixel.

Data source: national censuses ajusted with UN population estimates (WFP).

Data Cost: free acces

Data acquisition Platforms



Preprocessing of Image data

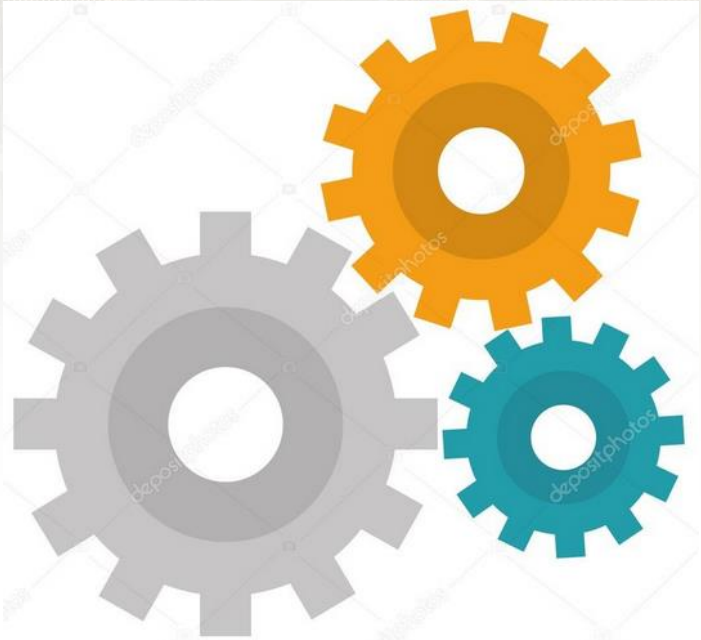


Image credit: https://fr.depositphotos.com/127985826/stock-illustration-gear-setup-machinery-icon.html

Data preprocessing, what is it?

In remote sensing, image acquisition is often disrupted by the interaction between the signal and the atmosphere.

Similarly, perturbations impacting the geometry of the image are also observed when the sensor performs pitch and roll movements during its scanning.

Before any interpretation, the image recorded by the sensors of a satellite must be processed in order to make geometric and radiometric corrections.

Source: http://gsp.humboldt.edu/olm_2015/Courses/GSP_216_Online/lesson4-1/radiometric.html

Data preprocessing, what is it?

How to correct these anomalies?

Radiometric correction

&

Geometric correction

Data preprocessing, what are the steps?

Radiometric Calibration:

- Atmospheric correction is the process of removing the effects of the atmosphere on the reflectance values of images taken by satellite or airborne sensors.

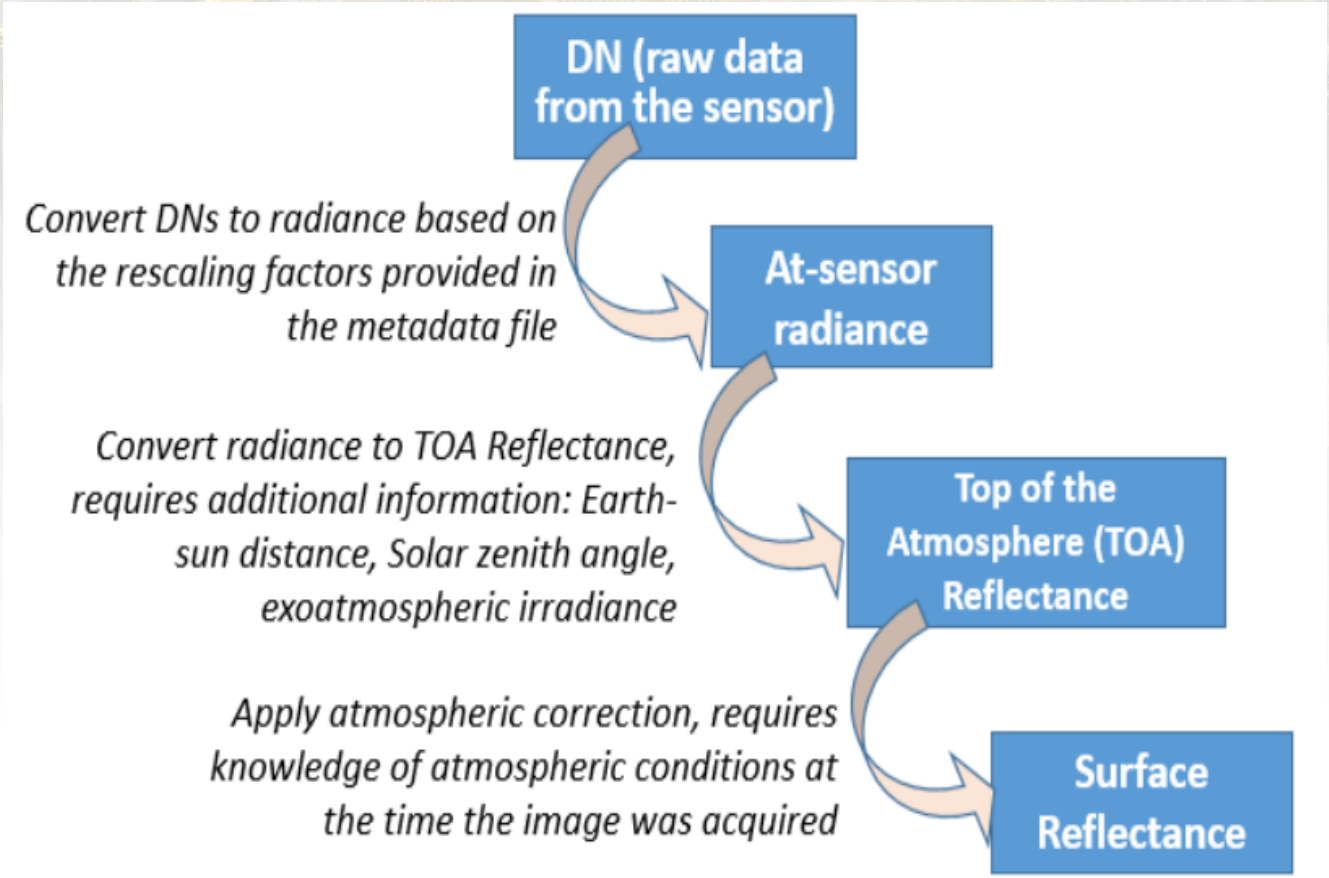
- They are applied to the images to reassign to each pixel a radiometric value as close as possible to that measured in the field.

Source: http://gsp.humboldt.edu/olm_2015/Courses/GSP_216_Online/lesson4-1/radiometric.html

Data preprocessing, what are the steps?

Radiometric Calibration/Atmospheric correction:

- Main steps:



Source: http://gsp.humboldt.edu/olm_2015/Courses/GSP_216_Online/lesson4-1/radiometric.html

Data preprocessing, what are the steps?

Radiometric Calibration

- The different level of products

Table 1: Sentinel-2 product types

Level	High-level Description	Production & Distribution	Data Volume
Level-1C	Top-of-atmosphere reflectances in cartographic geometry	Systematic generation and on-line distribution	600 MB (each 100x100 km2)
Level-2A	Bottom-of-atmosphere reflectance in cartographic geometry	Systematic generation and on-line distribution and generation on user side (using Sentinel-2 Toolbox)	800 MB (each 100x100 km2)

Source: https://sentinel.esa.int/web/sentinel/user-guides/sentinel-2-msi/product-types

Data preprocessing, what are the steps?

Geometric correction

Geometric correction is the process of removing/reducing the geometric deformations that occur when recording the scene.

Geometric deformations come from several sources such as:

- The random variations of attitude of the satellite on its axis of flight (pitch and roll movements)
- The scrolling of the satellite and the inclination of its orbit
- The oblique sights
- The sensor design defects
- The altitude variation on the ground or the discontinuities of the relief
- The shape and rotation of the Earth. This last influence on the orientation of the image.

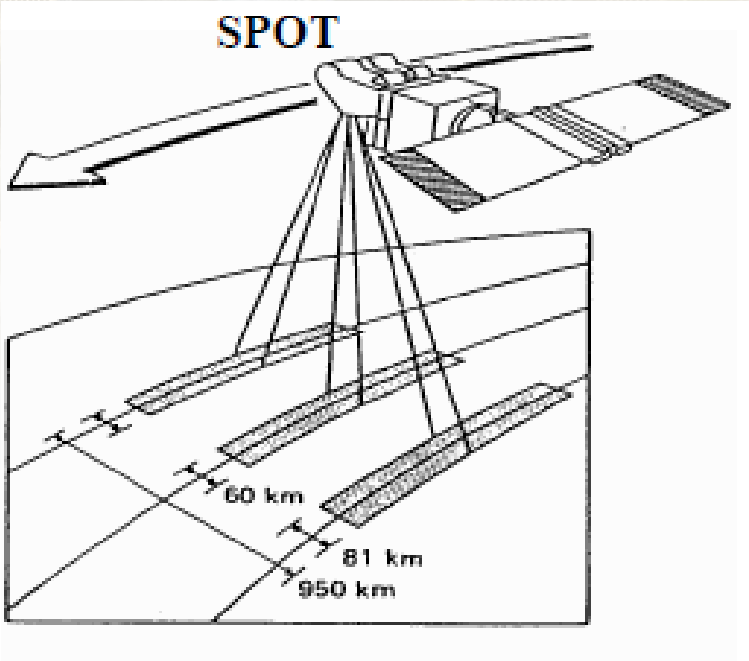
Some deformations, such as the rotation effect of the earth or the oblique sighting effect, are predictable and it is possible to calculate the effect, and therefore to apply systematic corrections.

Data preprocessing, what are the steps?

Geometric correction

Geometric deformations come from several sources such as:

- The scrolling of the satellite and the inclination of its orbit
- The oblique sights



Effect of oblique sighting

Data preprocessing, what are the steps?

Geometric correction

Example of the levels of geometric corrections performed on SPOT Image by the SPOT IMAGE provider:

Level of correction	Geometric corrections	Image Accuracy
1A	Neither	Low
1B	Without terrestrial landmarks	>500 m
2A	Georeferenced but insufficient terrestrial landmarks	±500 m
2B	georeferenced with GCPs, solid terrestrial landmarks	10-30m

Source: https://eduscol.education.fr/obter/principe/acquis/acquis418.htm

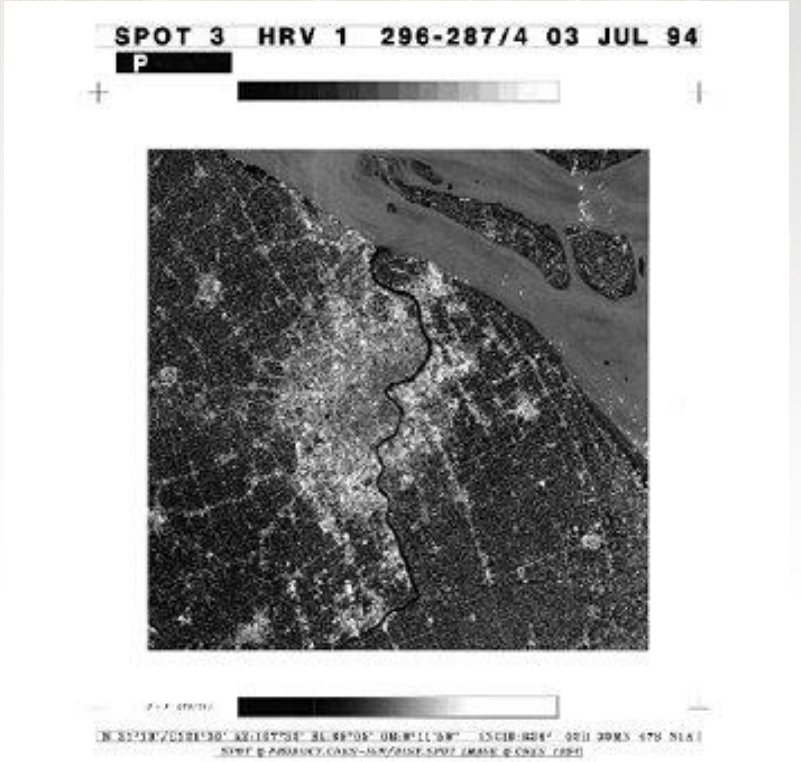
Data preprocessing, what are the steps?

Geometric correction

Example of the levels of geometric corrections performed on SPOT Image by the SPOT IMAGE provider:

Level 1A:

- The image is s**quare-shape**
- Auxiliary data (coordinates of the center of the scene and the four corners) allow the image to be located on the ground with an accuracy of more than 500 m.
- The images are oriented parallel to the satellite's orbit. No geometric corrections are applied. The image is provided as it is acquired, with its raw geometry. It is a grid of pixels.



Source: https://eduscol.education.fr/obter/principe/acquis/acquis418.htm

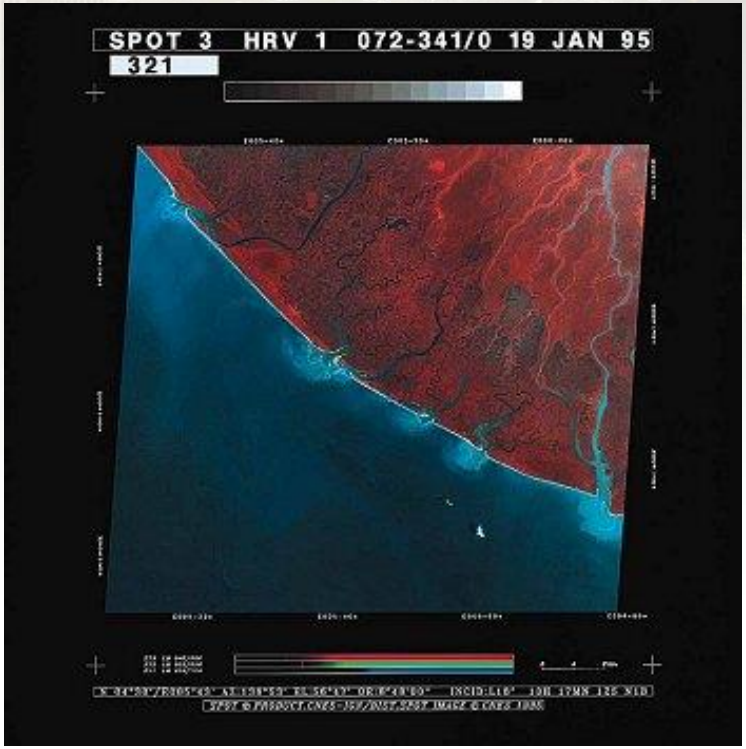
Data preprocessing, what are the steps?

Geometric correction

Example of the levels of geometric corrections performed on SPOT Image by the SPOT IMAGE provider:

Level 1B:

- The image is in the form of **parallellogram**
- The data are resampled and geometric corrections are made to compensate for systematic effects: rotation and curvature of the Earth, deformations induced by angle of view, etc.
- The auxiliary data (coordinates of the center of the scene and the four corners, location model) make it possible to locate the image on the ground with a precision greater than **500 m**.



Source: https://eduscol.education.fr/obter/principe/acquis/acquis418.htm

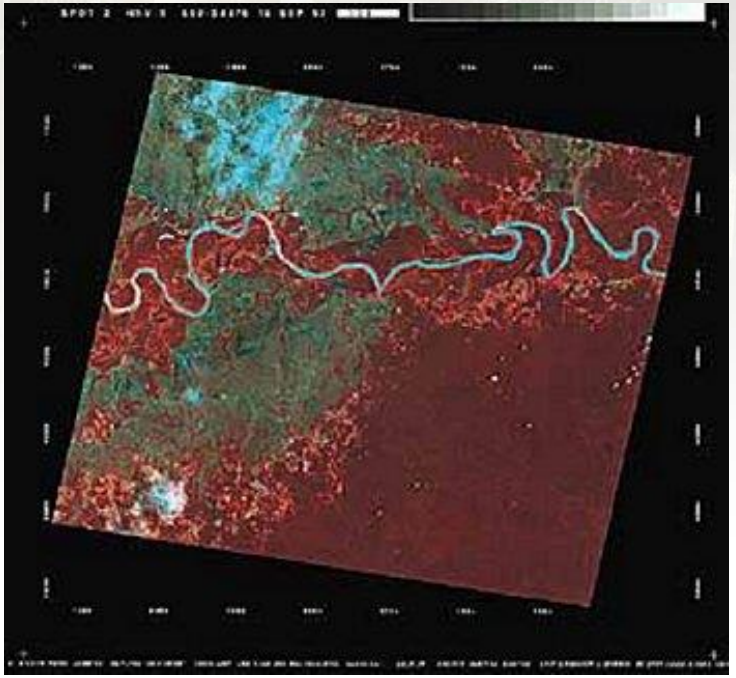
Data preprocessing, what are the steps?

Geometric correction

Example of the levels of geometric corrections performed on Spot 3 by the SPOT IMAGE provider:

Level 2B: ORTHO IMG

- Geometric corrections are also based on geographical or cartographic data.
- This additional information consists of support points whose cartographic or geographical coordinates are measured on a map or on the ground (GPS points).
- This results in a significant improvement in the accuracy of the location of any point in the image, which can range from **10 to 30 m**, depending on the quality of the maps.
- The Spot scene is in the **form** of a **parallelogram** that has been rotated to match the map coordinate system (the image is often oriented northward).



Source: https://eduscol.education.fr/obter/principe/acquis/acquis418.htm

Data preprocessing, what are the steps?

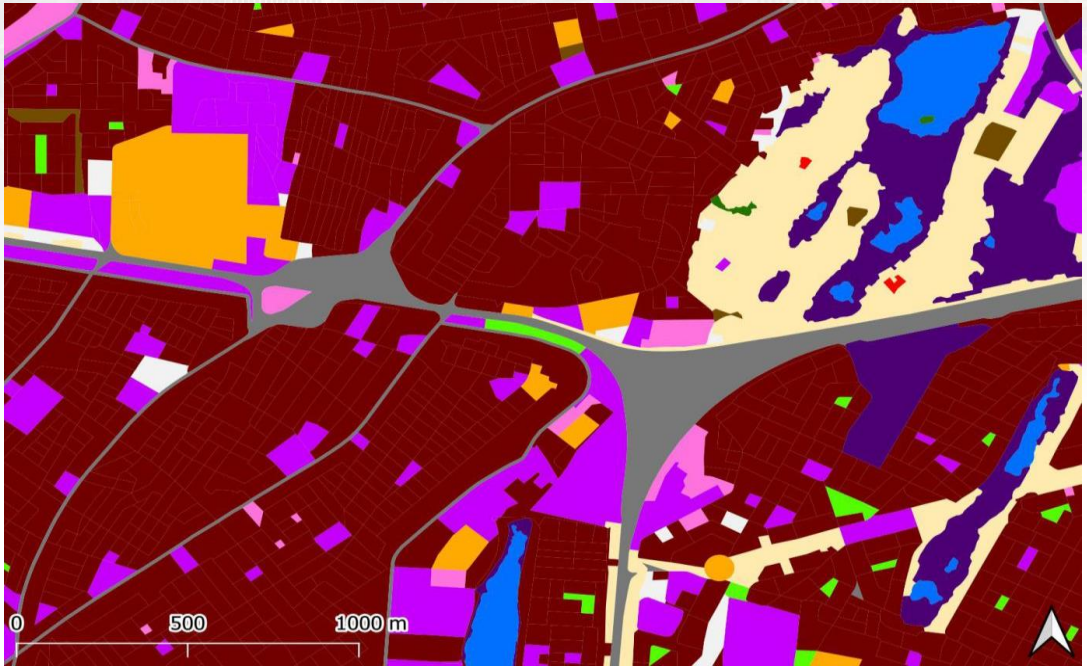
Geometric correction

In most geometric correction operations, we use:

- Digital Terrain Model (DTM) for orthorectification purpose

- GCPs to affine the image or to correct the gap leave by the correction done with DTM/SRTM

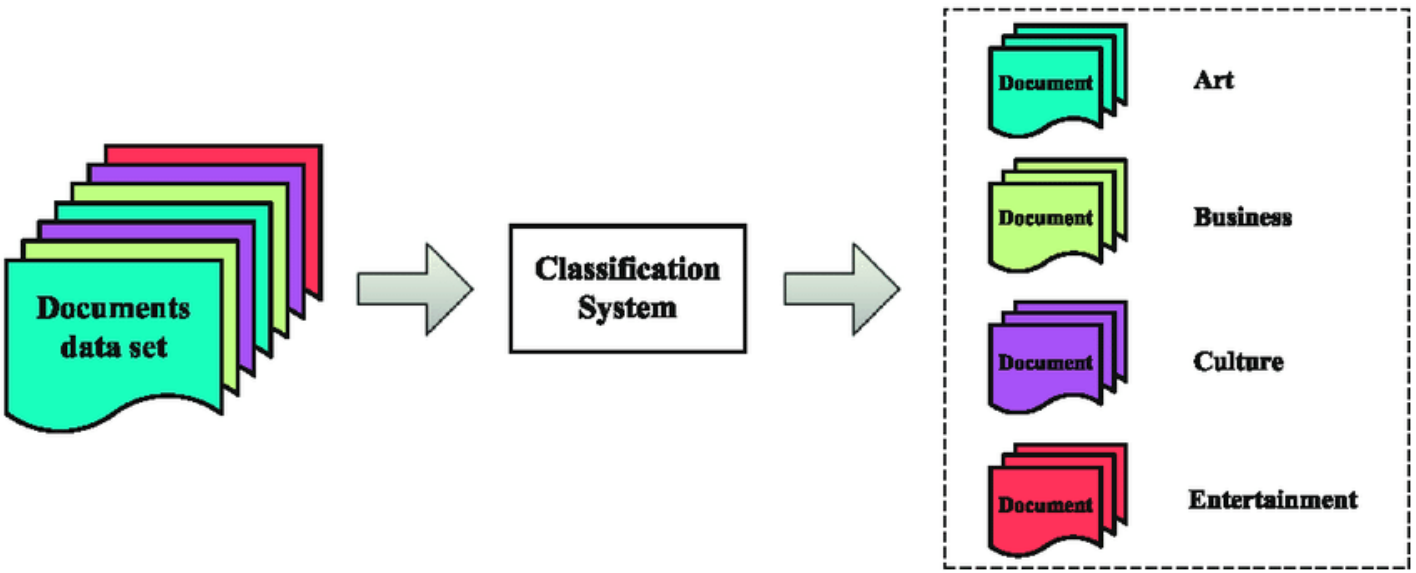
Image classification



Classification, what is it?

Classification in remote sensing consists of grouping the pixels or group of pixels of an image according to their resemblance in relation to the predefined information classes.

When image pixels are the same colour, or nearly the same colour, an image "classification" computer program can recognize this and group such pixels together (nrca).



https://www.researchgate.net/publication/314161864_Instance_Cloned_Extreme_Learning_Machine

Classification, what is it?

Classification

Some elements to be taking in account when classifying an image:

- The Spectral value
- The Shape
- The texture (smooth or rough)

Classification, what is it?

Some classification prerequisites:

1- The selection of the best channels necessary for the classification based on physical and statistical criteria and in relation with the studied theme. Eg: *NIR* and not *Blue* channel for vegetation extraction. .

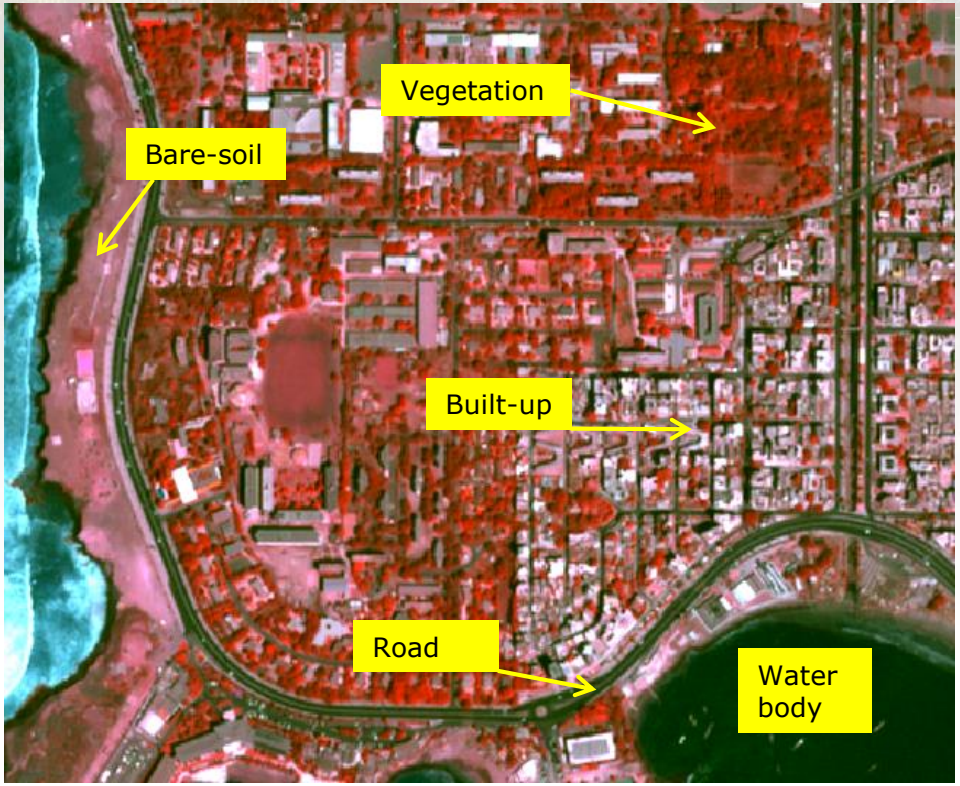
Band	Band	Central wavelength (nm)	Bandwith (nm)	Spatial resolution (m)	Objective
B1	VNIR	443	20	60	Aerosol Correction
B2		490	65	10	Aerosol Correction, Land Measurement Band
B3		560	35	10	Land Measurement Band
B4		665	30	10	Land Measurement Band
B5		705	15	20	Land Measurement Band
B6		740	15	20	Land Measurement Band
B7		783	20	20	Land Measurement Band
B8		842	115	10	Water Vapor Correction, Land Measurement Band
B8a		865	20	20	Water Vapor Correction, Land Measurement Band
B9		945	20	60	Water Vapor Correction
B10	SWIR	1380	20	60	Cirrus Detection
B11		1610	90	20	Land Measurement Band
B12		2190	180	20	Aerosol Correction, Land Measurement Band

Fig: **Sentinel-2 nomenclature and their applications**
(*Image credit: http://spaceflight101.com/copernicus/sentinel-2/*)

Classification, How to do it?

Some classification prerequisites:

2- Make a good thematic analysis of the image to identified the potentials information classes and to establish the nomenclature.



Pléiades: Natural composite bands combination: *RGB=(3/2/1)* *RGB=PIR/Red/Green(4/3/2)*

Classification, How to do it?

Some classification prerequisites:

3- Choose the type of classification to be done:

- Unsupervised

or

- Supervised ?

Unsupervised vs supervised classification

Unsupervised:

- The unsupervised classification proposes groupings according to the structure of the pixels present in the image, without a priori information on the areas to be identified
-
- The interpreter does not define classes from the beginning. It is at the end of the segmentation that the interpreter looks for the different classes found

- The interpreter can choose certain parameters (number of classes, distance between classes, thresholds....

- Computer clusters pixels into spectral classes

Unsupervised vs supervised classification

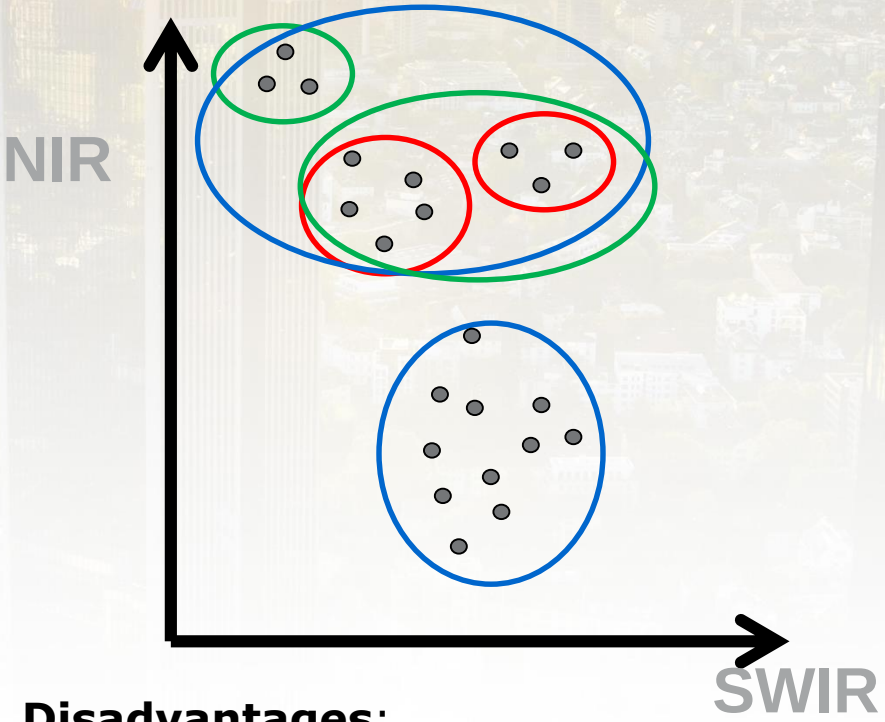
Unsupervised:

- User labels clusters

n=4

n=3

n=2



Advantages:
Good method for pre-classification or when there is not enough field information on the image.

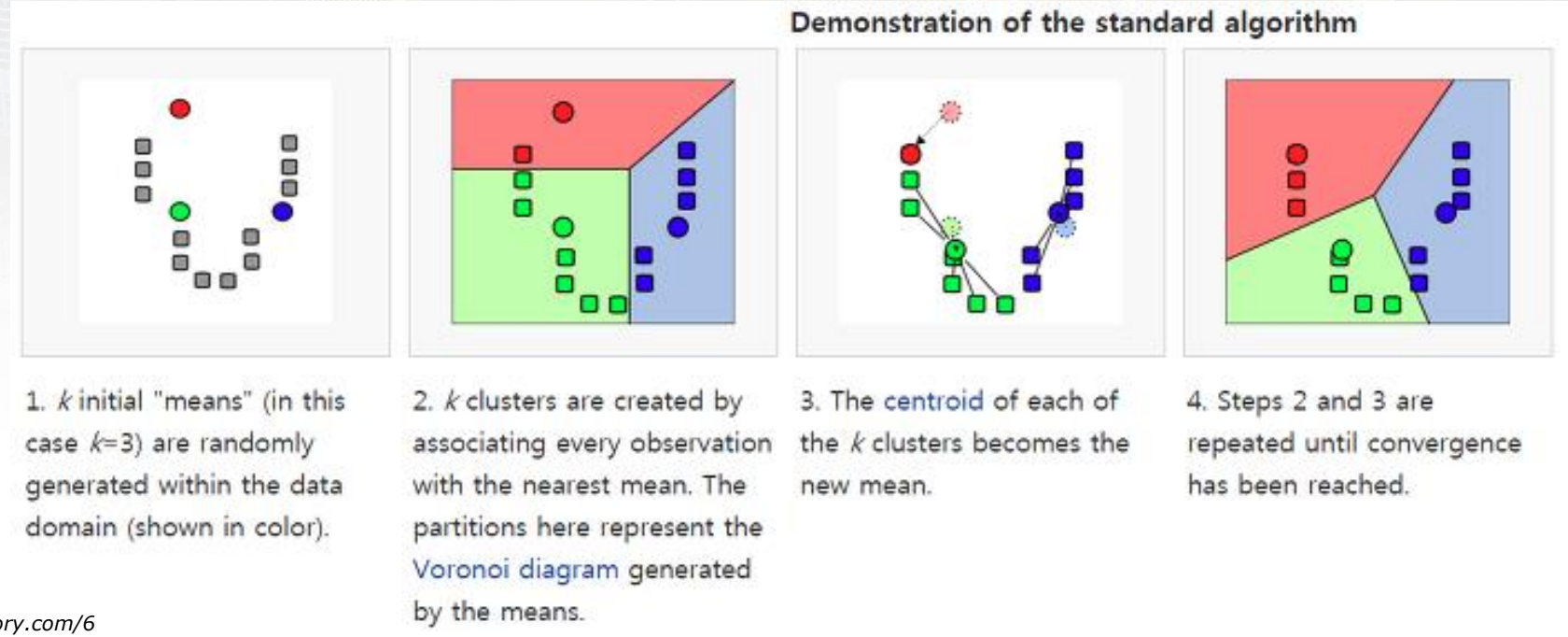
Disadvantages:
The interpretation of the resulting classes is often difficult because it requires a full scan of the image to visualize the result of the segmentation.

Unsupervised vs supervised classification

Unsupervised: some classifiers

Kmeans

- It is one of the most used unsupervised classification algorithms for image processing. It partitions ***n*** observations into ***k*** clusters in which each observation belongs to the cluster with the nearest mean.
- In terms of finding nearest mean, it uses squared Euclidean distance.



https://iancat.tistory.com/6

Unsupervised vs supervised classification

Unsupervised:

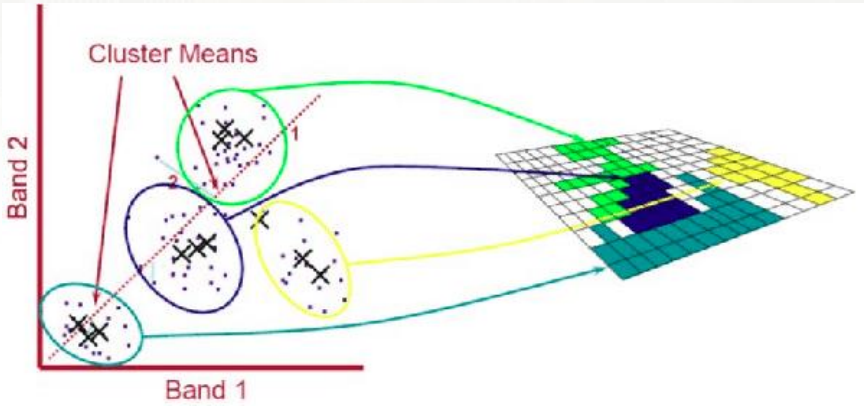
ISODATA: Interative Self organizing Data

- The ISODATA algorithm is a modification of the k-means clustering algorithm (overcomes the disadvantages of k-means)

- ISODATA and k-means algorithm are similar with the distinct difference that the ISODATA algorithm allows for different number of clusters while the k-means assumes that the number of clusters is known a priori.

-It merges clusters if their separation distance in multispectral feature space is less than a user-specified value and the rules for splitting a single cluster into two clusters.

- It Split a Cluster if its standard deviation exceeds its value which is already defined and the No. of pixels are twice the threshold of the minimum number of pixels.



https://www.researchgate.net/publication/306304077_Taxonomy_of_Satellite_Image_and_Validation_Using_Statistical_Inference

Unsupervised vs supervised classification

Supervised Classification

Unsupervised vs supervised classification

Supervised classification/ Learning classification **:**

Supervised classification seeks to assimilate all pixels of the image to pixels of learning areas, defined geographically on the image or radiometrically on its histogram.

It requires the intervention of an operator before, during and after classification trough the following main steps:

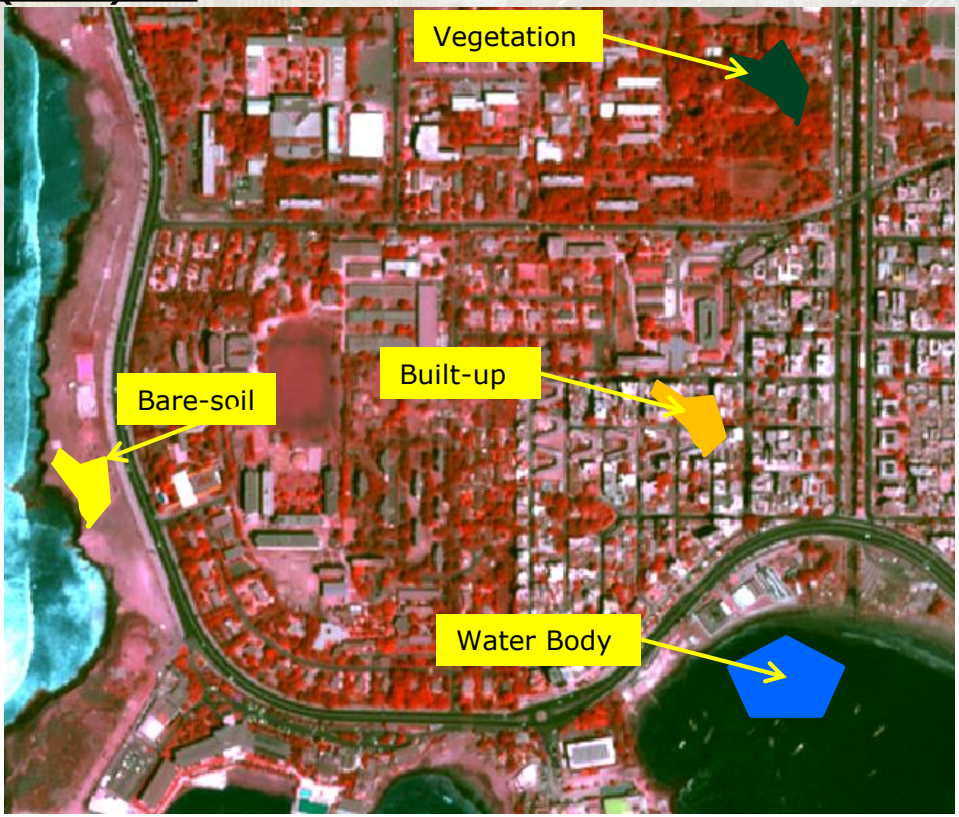
- The creation of Region Of Interest (ROI) according to number of information classes identified in the nomenclature.
- The creation of neo-channels (NDVI, SAVI, etc.) if necessary
- The selection of the best classification algorithm (Minimum Distance, Maximum likelihood, etc.)
- The classification

Classification, How to do it?

Unsupervised vs supervised classification

Supervised classification :

The creation of Region of Interest (ROI) & labels clusters



Dakar: Pléiades 01/03/2018 *RGB (1/2/3)* *RGB (4/3/2)*

Classification, How to do it?

Unsupervised vs supervised classification

Supervised classification :

- The creation of neo-channels (NDVI, SAVI, etc.) if necessary.

- Very white=vegetation
- Medium white = built-up & bare-soil
- Dark= Water & road

Fig: NDVI image on Dakar

Extraction of information by image classification

Supervised classification: some classifiers

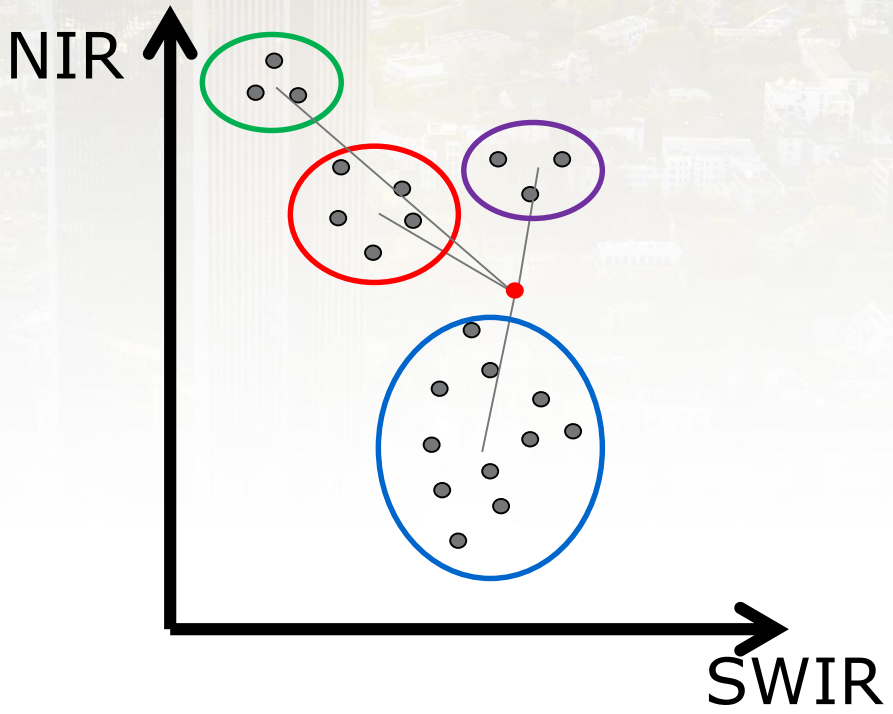
1) Minimum distance to center of potential classes

Class A

Class B

Class C

Class D



Extraction of information by image classification

Supervised classification

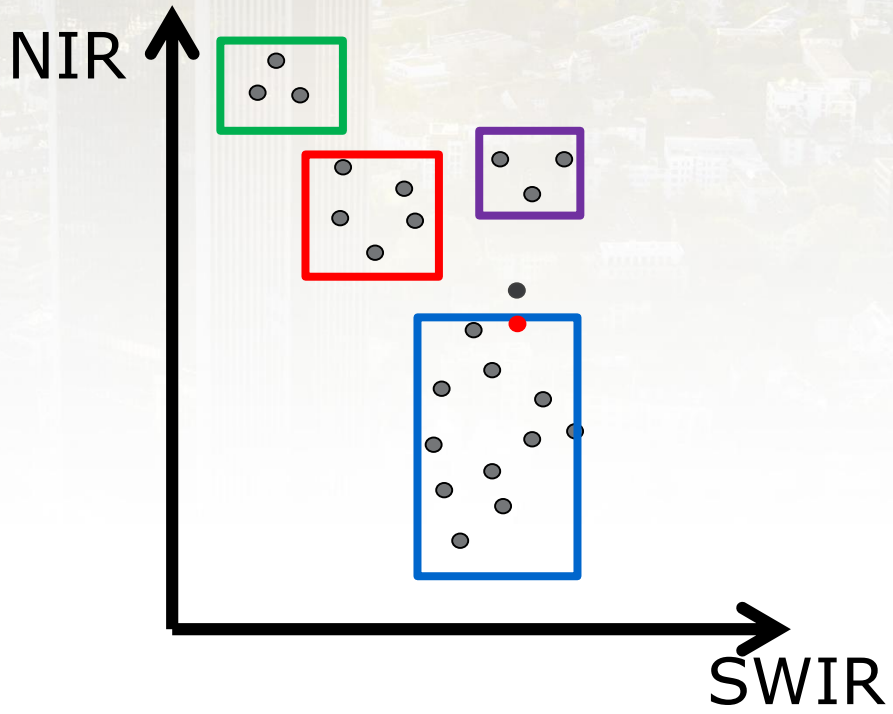
2) Parallelepiped classification:

Class A

Class B

Class C

Class D



Extraction of information by image classification

Supervised classification

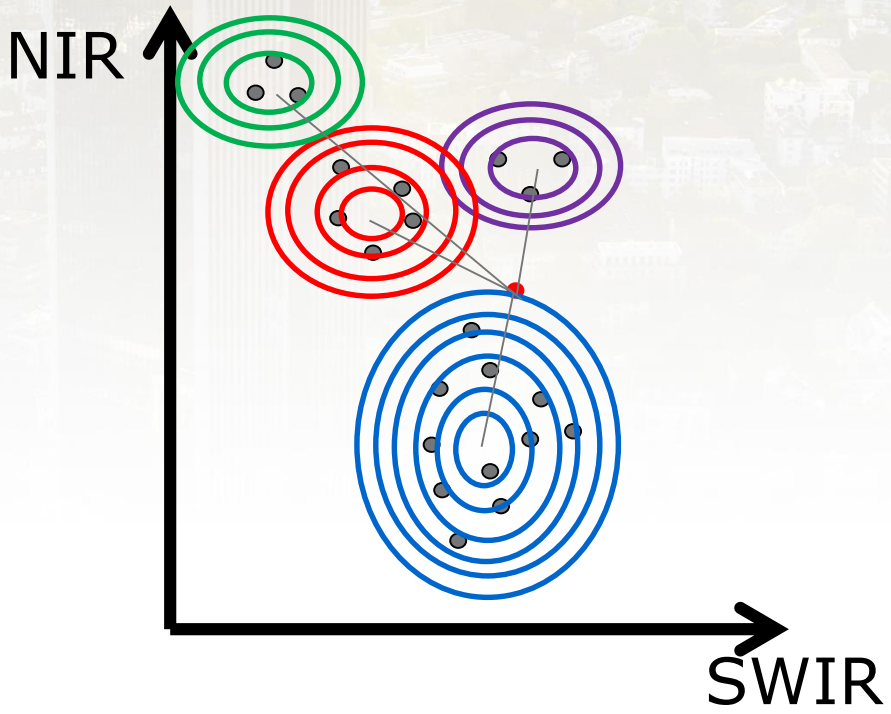
3) Maximum Likelihood – includes the standard deviation of values

Class A

Class B

Class C

Class D

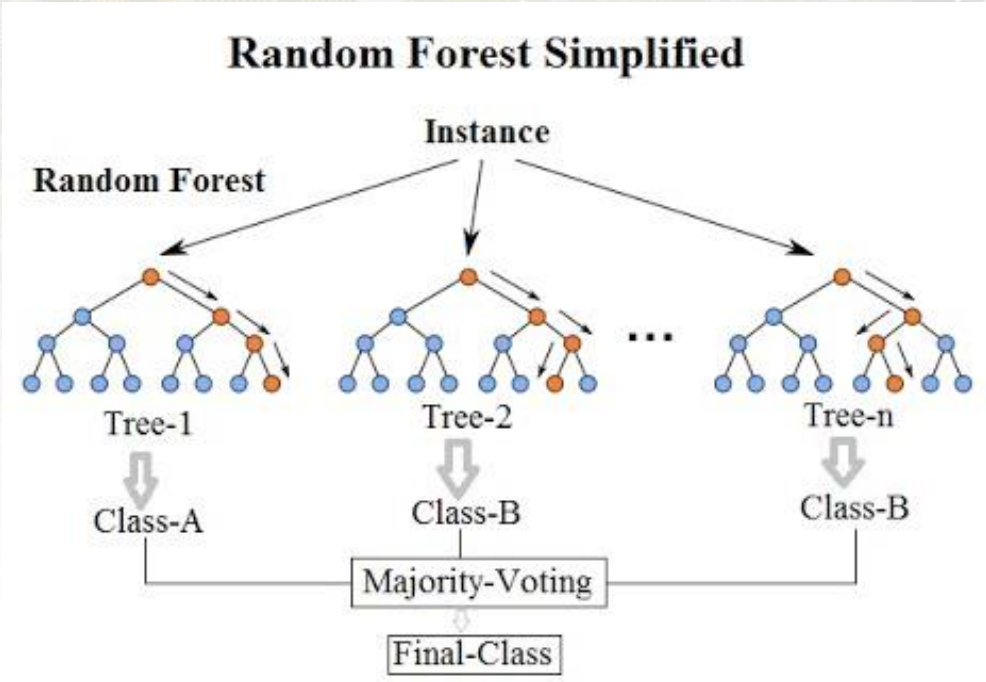


Extraction of information by image classification

Supervised classification
4) Random Forest

Class A

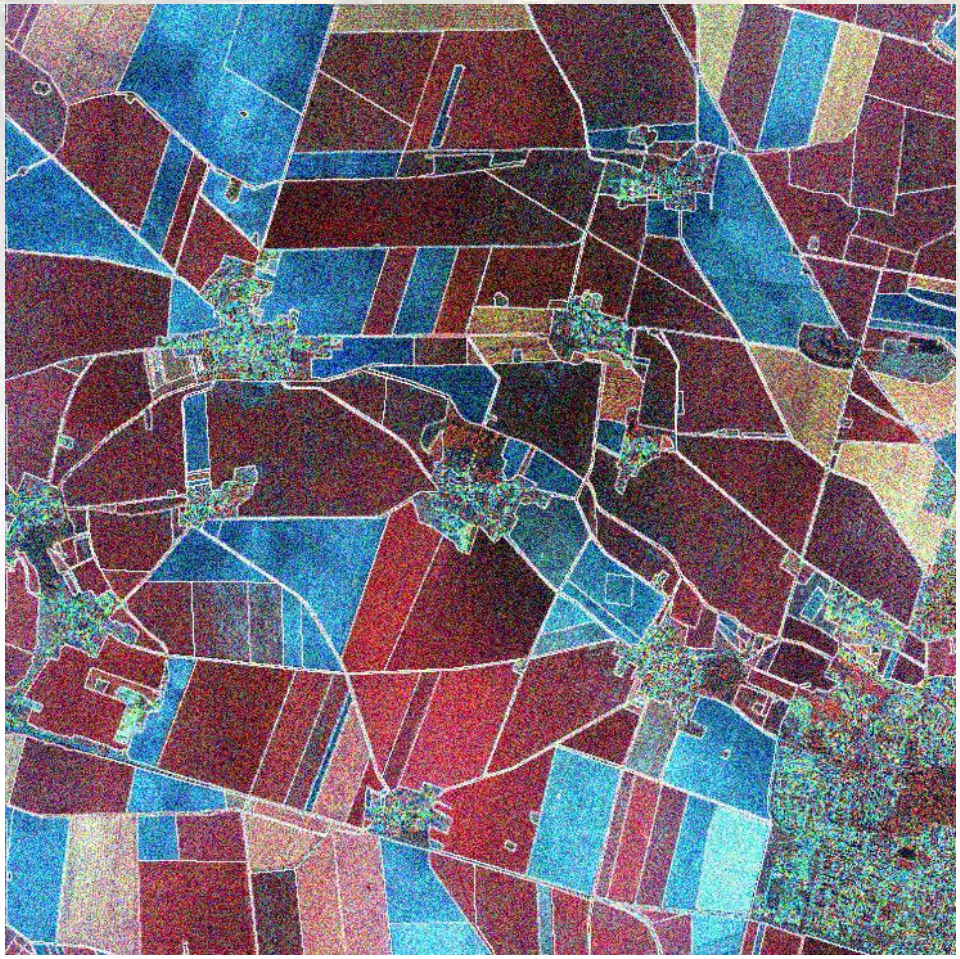
Class B

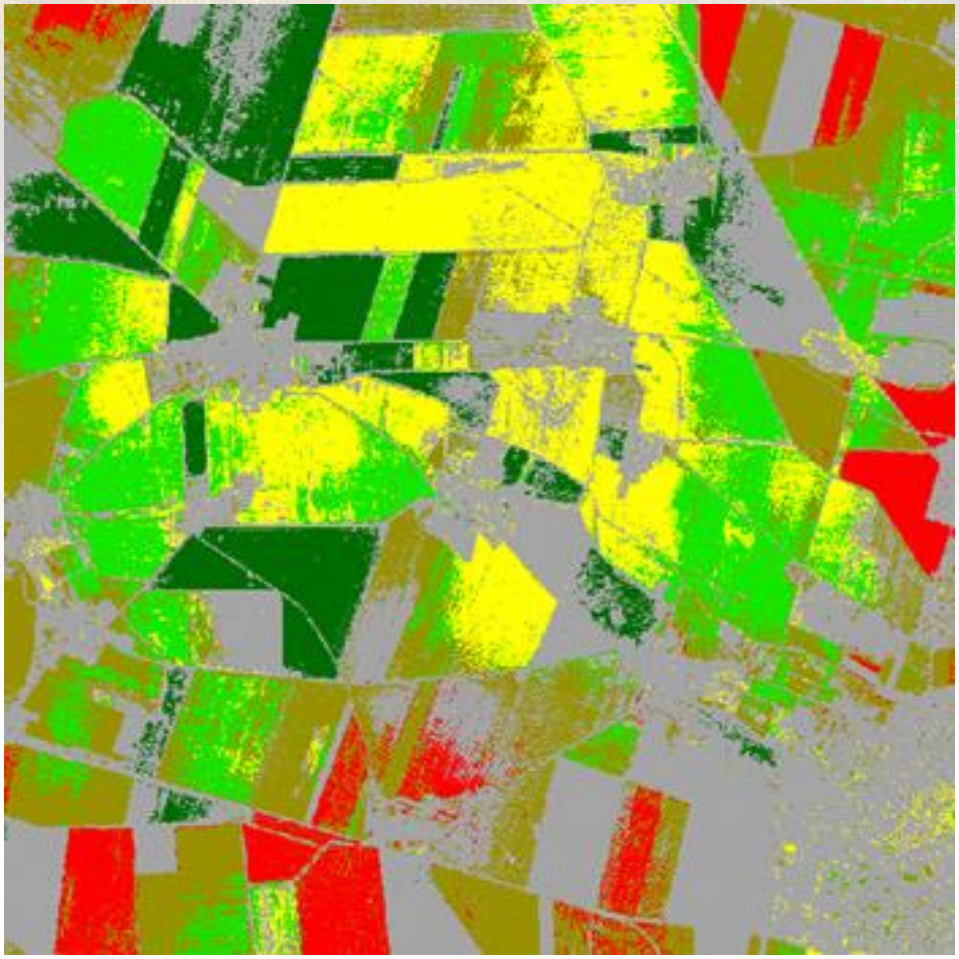


© and more details on
https://www.youtube.com/watch?v=ajTc5y3OqSQ

Classification entity

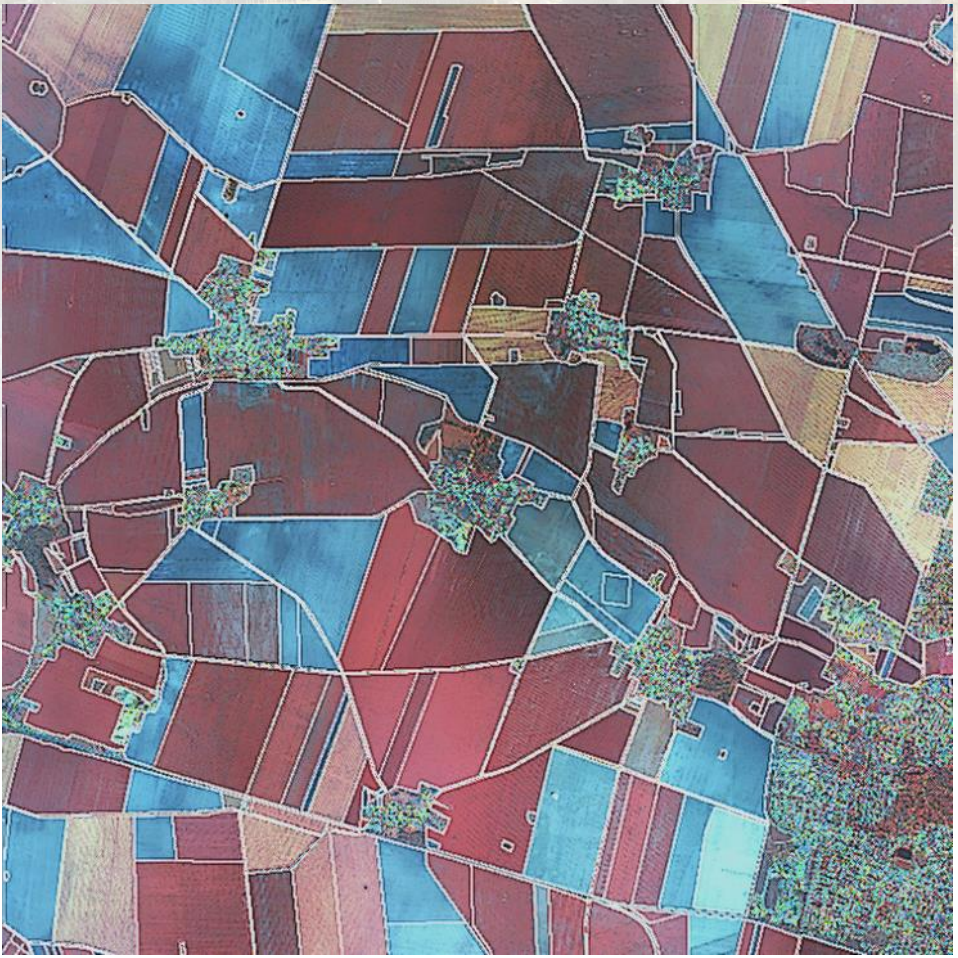
Pixels based classification

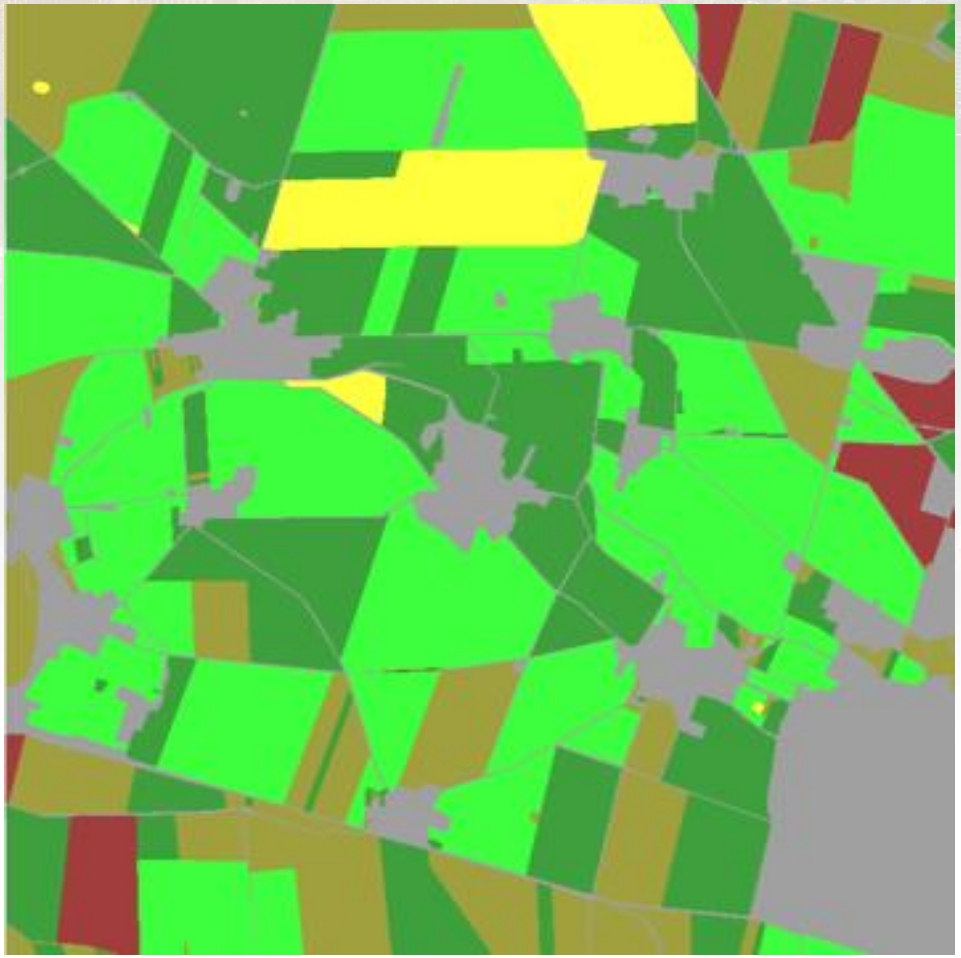




Classification entity

Pixel vs. segments





Accuracy Assessment and Map validation

This operation consists in comparing the produced map with the reference data in order to know the level of accuracy of the map.

Steps to follow:

1- Sampling design

2- Drawing and interpretation of reference samples. Reference data can come from different sources:

- Terrain campaign
- Interpreted on VHR data to have better accuracy
- Other auxiliaries data deemed to be in line with the reality on the field

3- The distribution of samples

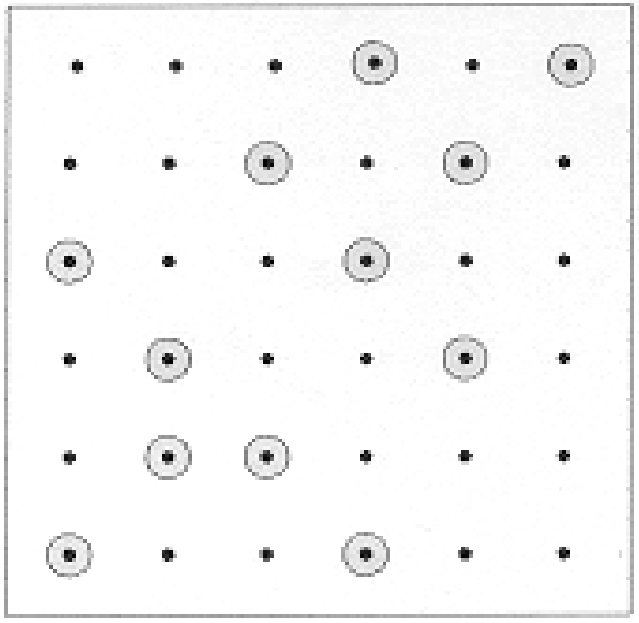
4- The production of statistics and accurary indicators (overall accuracy, kappa index, etc.)

Accuracy Assessment and Map validation

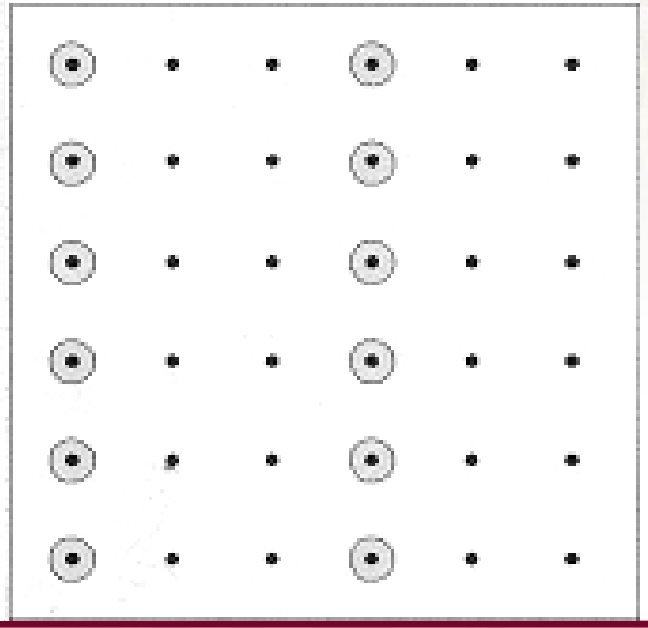
This operation consists in comparing the produced map with the reference data in order to know the level of accuracy of the map.

Sampling designs:

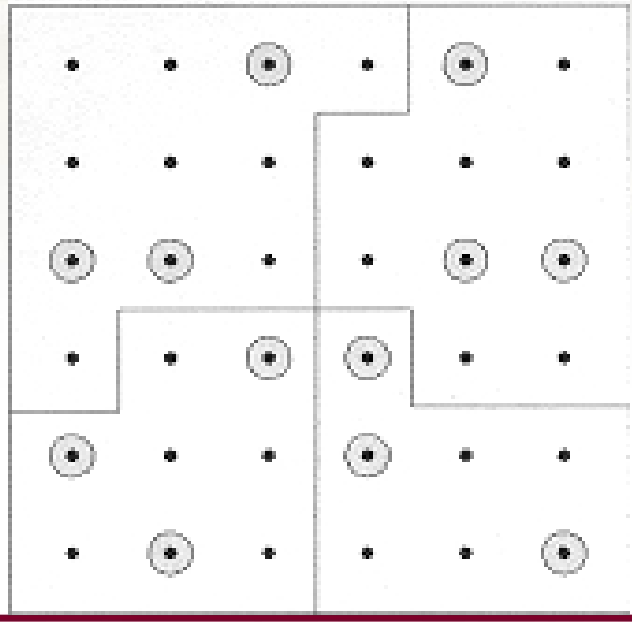
Simple Random sampling



Systematic sampling



Stratified random sampling



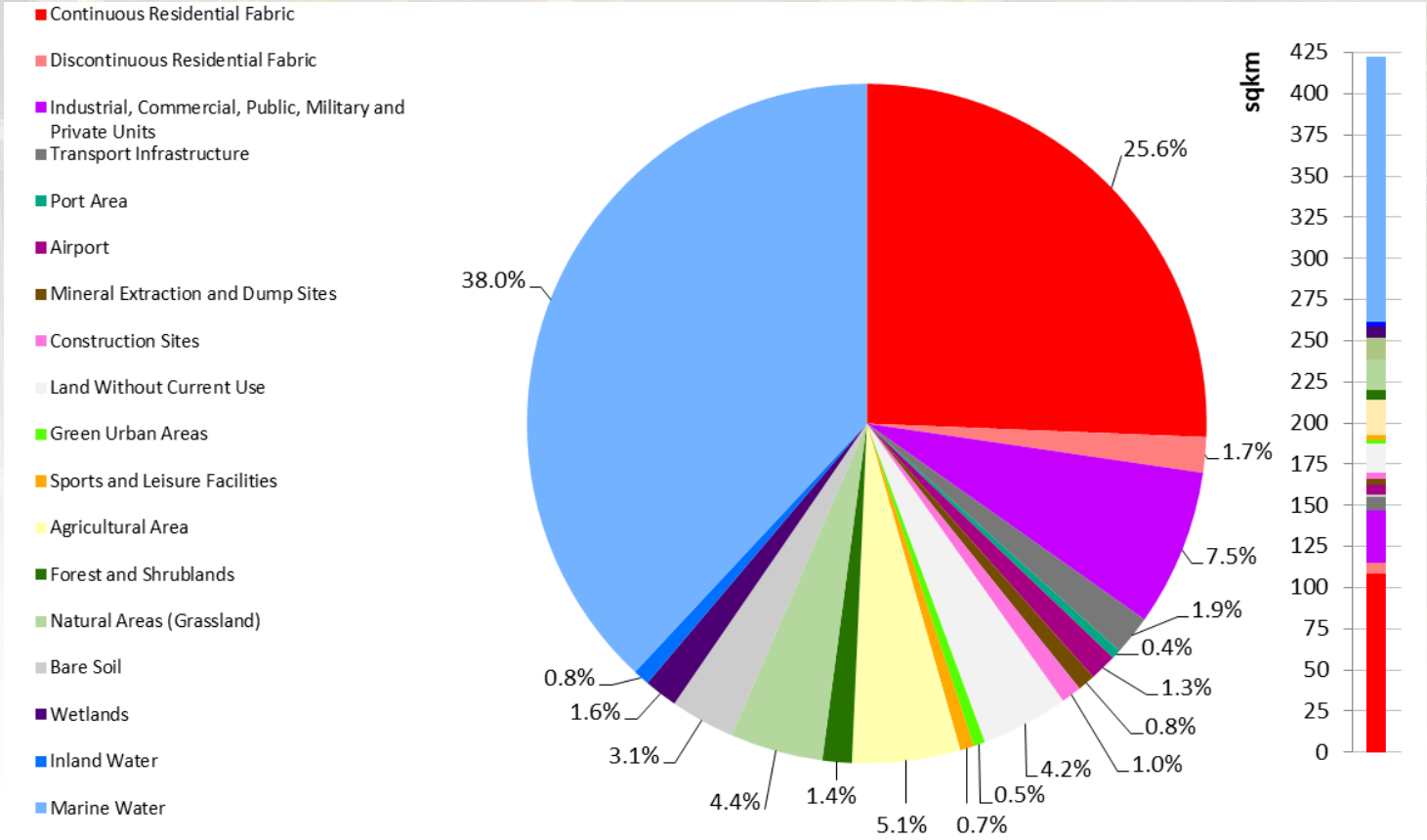
Accuracy Assessment and Map validation

Method use for Eo4SD-Urban LU/LC Products (case of Dakar)=

Stratified random Sampling (*Olofson et al. 2013)*

Preconditions:

1- Know the % of each classes beforehand.



Study case of Dakar

Core City Area - Detailed LU/LC 2018 structure, in % (left) and km2 (right).

Accuracy Assessment and Map validation

Method use for Eo4SD-Urban LU/LC Products (case of Dakar):

Stratified random Sampling

Preconditions:

2- Distribute samples according to the area of each stratum.

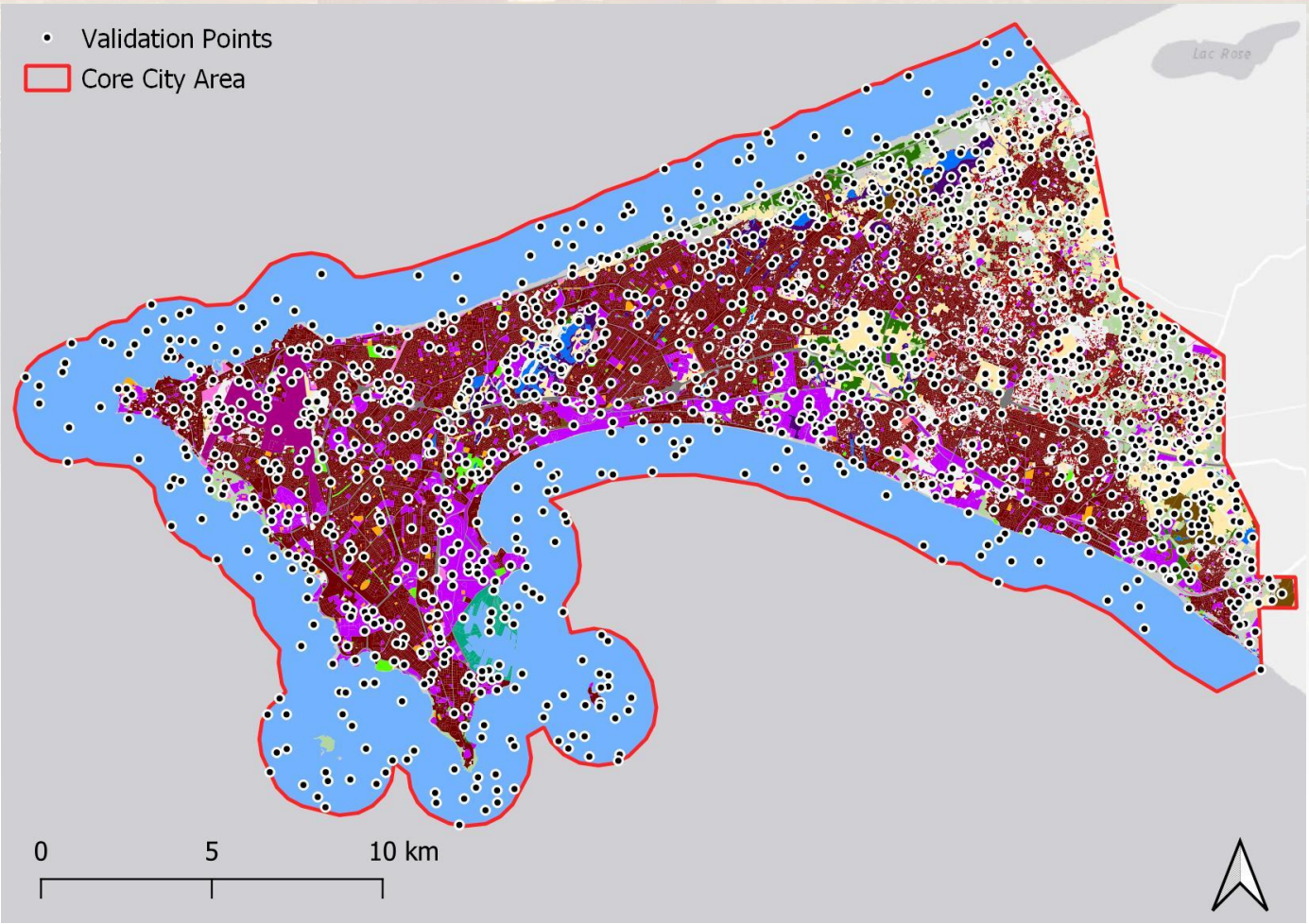
Class Name	Class ID	No. Of Sampling Points	Km² Coverage
Continuous Urban Fabric	**1110**	**196**	**108.2**
Discontinuous Urban Fabric	1120	19	7.1
Industrial, Commercial, Public, Military and Private Units	1210	148	31.4
Transport Infrastructure	1220	31	7.9
Port Area	**1230**	**12**	**1.9**
Airport	1240	24	5.5
Mineral Extraction and Dump Sites	1310	28	3.5
Construction Sites	1330	32	4.1
Land Without Current Use	1340	141	17.3
Green Urban Areas	1410	20	2.3
Sports and Leisure Facilities	1420	20	2.6
Agricultural Area	2000	180	22.3
Forest and Shrublands	3100	40	5.0
Natural Areas (Grassland)	3200	151	18.7
Bare Soil	3300	107	13.2
Wetlands	4000	59	7.3
Inland Water	5100	27	3.3
Marine Water	5200	215	160.7
Total	**-**	**1450**	**422.4**

Number of sampling points for the Core City area classes after applied sampling design with information on overall land cover by class.

Accuracy Assessment and Map validation

Method use for Eo4SD-Urban LU/LC Products:

Stratified random Sampling



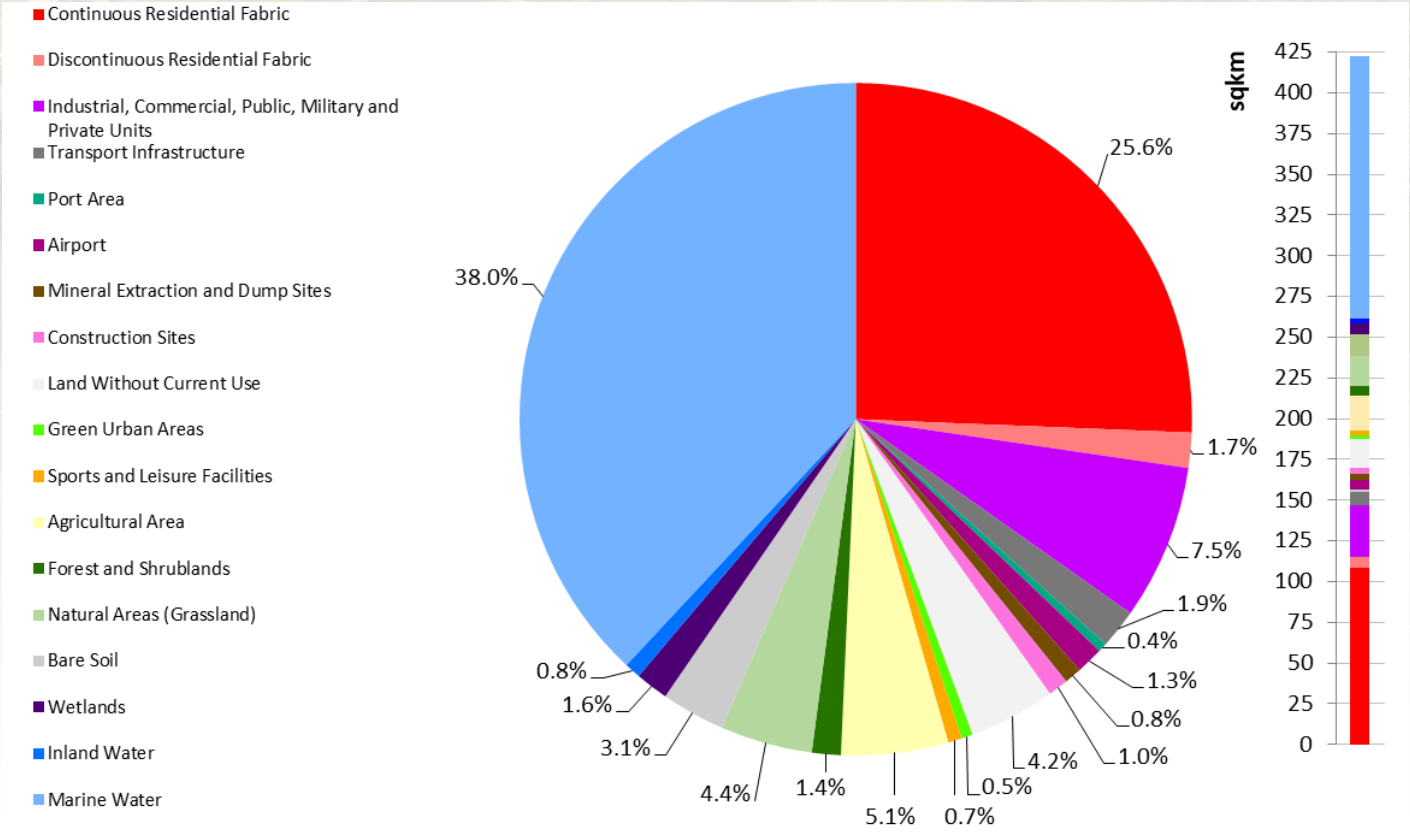
Mapping result of the Core City area of Dakar of the year 2018 overlaid with randomly distributed sample points used for accuracy assessment.

Accuracy Assessment and Map validation

Generation of final maps statistics and interpretation (case of Dakar)

Overall Accuracy= 98.94%

CI ranging from 98.41% to 99.47% at a 95% CI.

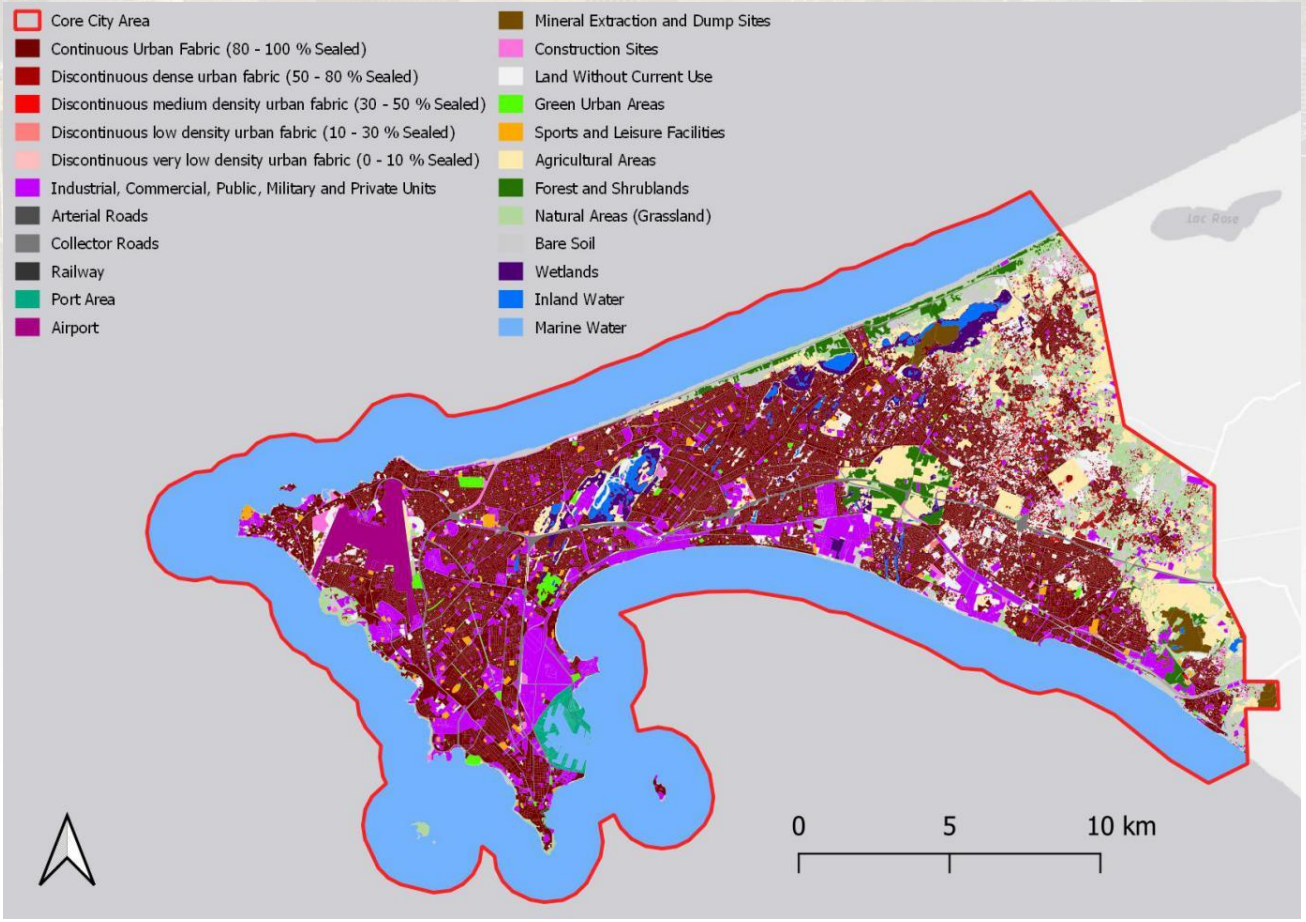


On the LU/LC map, Artificial areas represent in 2018 45% of Dakar's core city area, Water and non artificial areas represent respectively 39% and 16% of the core city area

Classification result and delivery

Classification result
(case of Dakar):

Map ready to be use



Core City Area - Detailed LU/LC 2018 in Dakar

Thank you for your attention!

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