

→ 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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- 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

Prerequisite

- 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>

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

Copernicus Open Access Hub



Please login to access our services...

dfgf

.....

LOGIN

Sign up

Forgot password?

Advanced Search

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



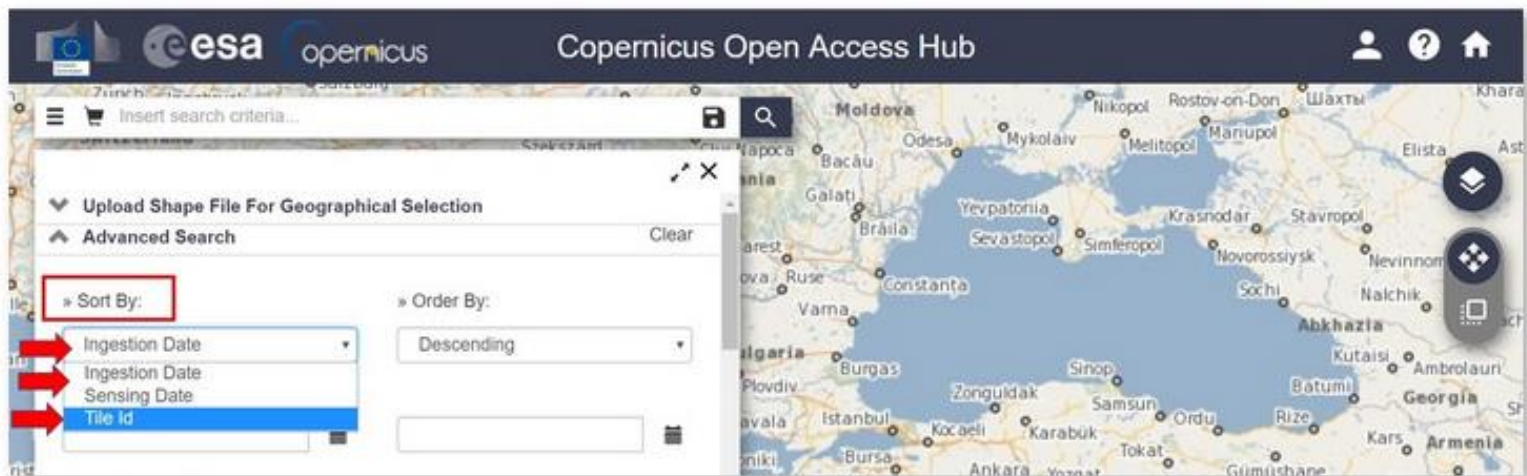
It consists of different search fields. Each search field allows to perform specific queries on the associated parameter. Each search field can be used singularly or in combination with: the others search fields, the full-text search bar and the geographic map tool.

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

Advanced Search, Sort by:

Sort by This field allows to sort search results by:

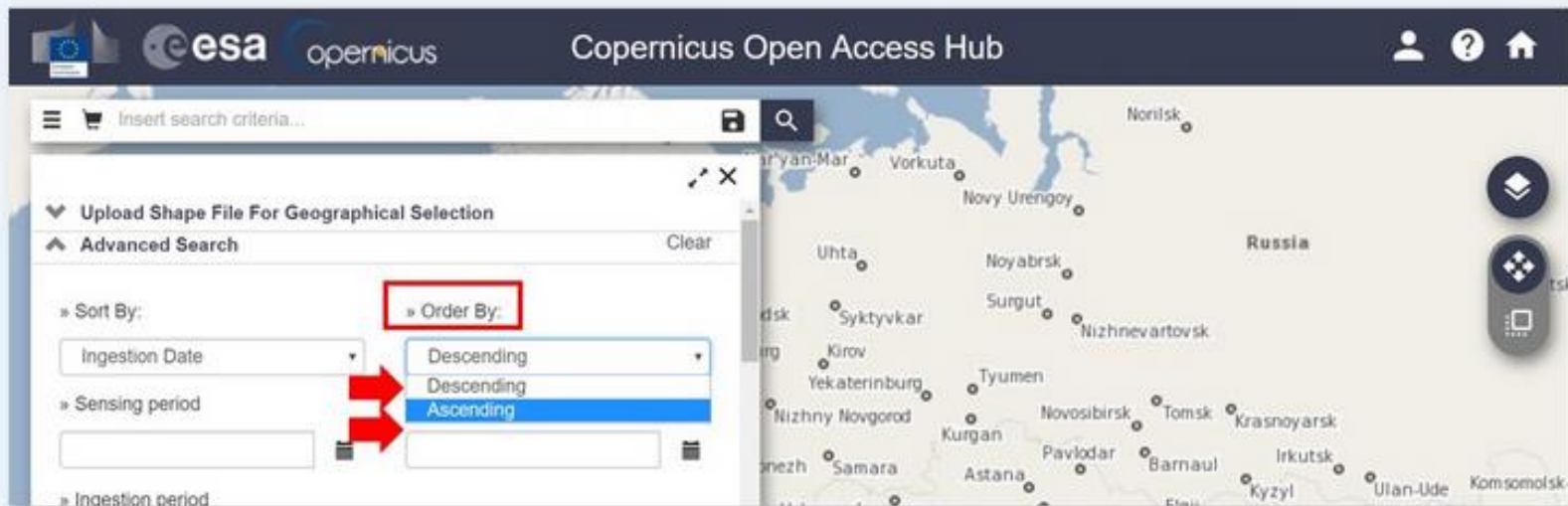
- **Ingestion date** (represents the time when the product is indexed in the DHuS Service databases. Time is in UTC)
- **Sensing Date** (represents the time when the product has been taken. Time is in UTC)
- **Tile id** (This sorting is meaningful for Sentinel-2 L1C products only. Clicking on this checkbox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



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

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>

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>

Advanced Search, Ingestion:

Ingestion	This search field is composed of two date entries as for <i>Sensing Period</i> .
Period	<p>The query returns all the products whose publication dates and times on the Data Hub are included in the defined period.</p> <p>In particular it returns all the products that respond to both of the following criteria:</p> <ul style="list-style-type: none">• 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>

Advanced Search:

Mission Sentinel-1

Satellite Platform	Search based on the Satellite Platform name regardless of the serial identifier. Accepted entries are: <ul style="list-style-type: none">• S1_A*• S1_B*
Product Type	Accepted entries are: <ul style="list-style-type: none">• 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>

Advanced Search:

Mission Sentinel-2

Satellite Search based on the Satellite Platform name regardless of the serial identifier. Accepted entries are:

Platform

- 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



Copernicus Open Access Hub

Insert search criteria...

Advanced Search Clear

» Sort By: Sensing Date

» Order By: Descending

» Sensing period: 2018/01/01 - 2018/12/31

» Ingestion period: []

Mission: Sentinel-1

Satellite Platform: []

Polarisation: []

Relative Orbit Number (from 1 to 175): []

Product Type: []

Sensor Mode: []

Collection: []

Mission: Sentinel-2

Satellite Platform: []

Relative Orbit Number (from 1 to 143): []

Product Type: S2MSI2A

Cloud Cover % (e.g. [0 TO 9.4]): 50

Mission: Sentinel-3

Data acquisition, Some platforms



[Peps.cnes.fr/](https://peps.cnes.fr/)

Data acquisition, Some platforms



Recherche par critères Recherche sémantique

19° 50' 35" N 90° 32' 41" W
19° 48' 08" N 90° 29' 18" W

Période d'acquisition

Début --/--/-- 📅

Fin --/--/-- 📅

Collection ▾

Plateforme ▾

Instrument ▾

Niveau de traitement ▾

Type de produit ▾

Mode du capteur ▾

Fraîcheur du produit ▾

Sens de l'orbite ▾

Numéro d'orbite absolue

Numéro d'orbite relative

RÉINITIALISER RECHERCHER



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

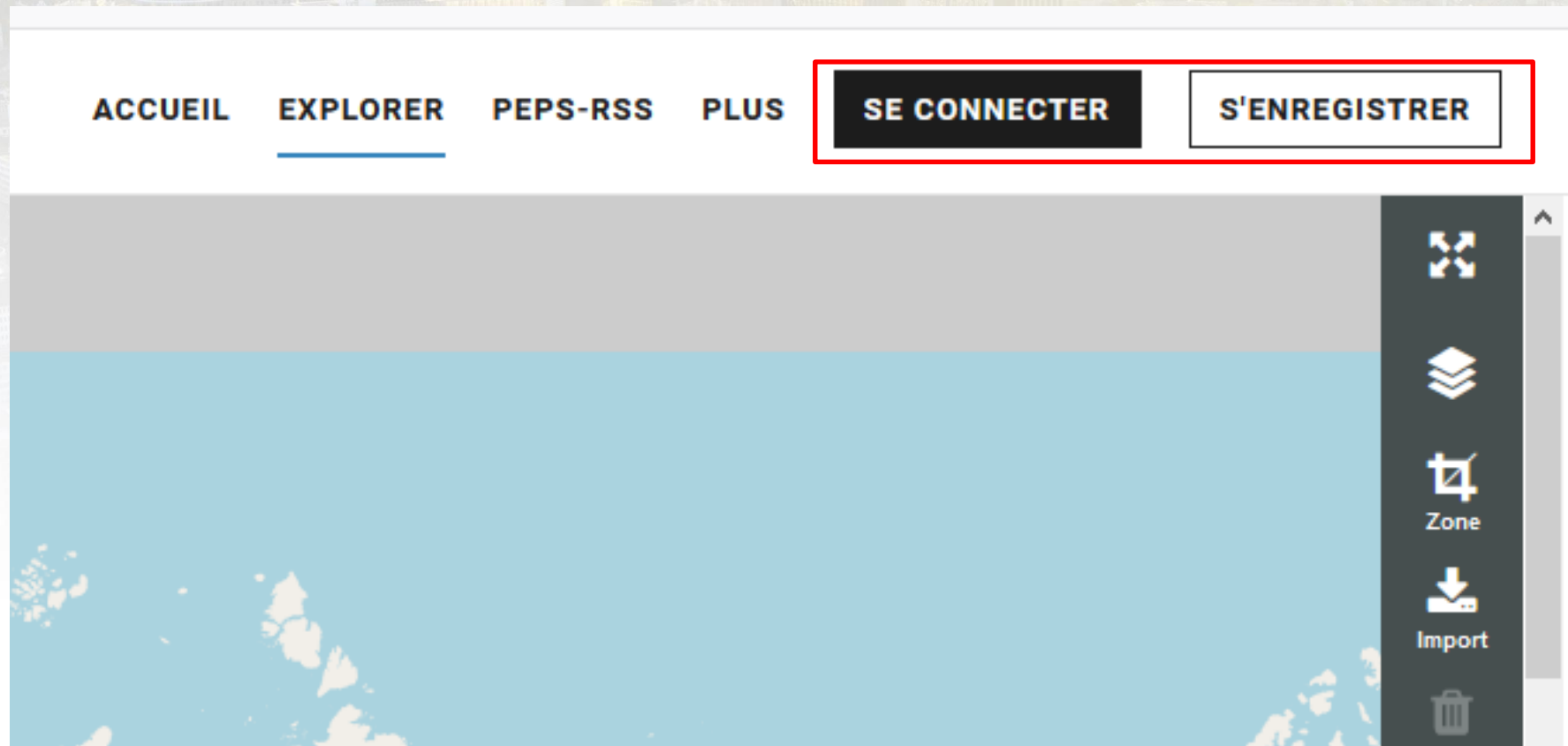


Peps and its functioning:

The screenshot displays the Peps web application interface. At the top, there is a navigation bar with the following items: ACCUEIL, EXPLORER, PEPS-RSS, PLUS, SE CONNECTER, and S'ENREGISTRER. The main content area is divided into a search filter sidebar on the left and a world map on the right. The sidebar includes a search mode selector (Recherche par critères / Recherche sémantique), a 'Période d'acquisition' section with 'Début' and 'Fin' date pickers, and several dropdown menus for 'Collection', 'Plateforme', 'Instrument', 'Niveau de traitement', 'Type de produit', 'Mode du capteur', 'Fraîcheur du produit', and 'Sens de l'orbite'. At the bottom of the sidebar are 'RÉINITIALISER' and 'RECHERCHER' buttons. The world map shows a highlighted region in the North Atlantic, with a 2000 km scale bar at the bottom left. A vertical toolbar on the right side of the map contains icons for 3D, N, Zone, Import, and Effacer. At the bottom of the page, there is a pagination bar showing '50' items per page, 'Environ 17469534 produits trouvés', and a list of page numbers from 1 to 11. A note at the bottom right reads: 'Pour zoomer avec la souris, utiliser la touche Ctrl ou double cliquer (+ majuscule) sur la carte.'

Peps and its functioning:

- User Registration:



Peps and its functioning:

- User Registration :

[ACCUEIL](#)[EXPLORER](#)[PEPS-RSS](#)[PLUS](#)[SE CONNECTER](#)[S'ENREGISTRER](#)

S'enregistrer

Enregistrez-vous pour télécharger des produits Sentinel

En utilisant les données Sentinel, j'accepte les [conditions d'utilisation](#)

[S'ENREGISTRER](#)

Data acquisition, Some platforms: peps



Peps and its functioning:

Période d'acquisition

Début 01/01/2019 19:48 x 🗓

Fin 12/09/2019 19:48 x 🗓

Collection ▾

Plateforme ▾

Instrument ▾

Niveau de traitement ▾

Type de produit ▾

Mode du capteur ▾

Fraîcheur du produit ▾

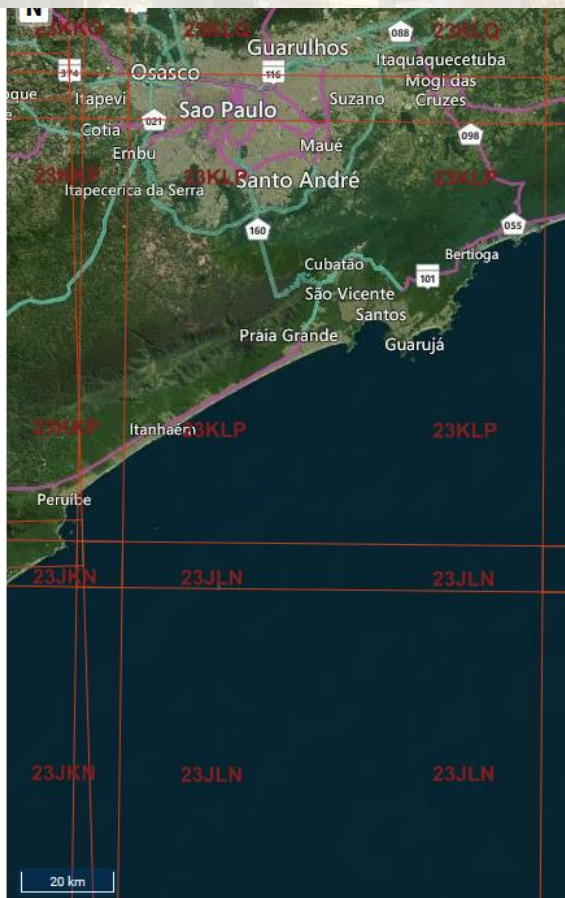
Sens de l'orbite ▾

Numéro d'orbite absolue

Numéro d'orbite relative

RÉINITIALISER RECHERCHER

Contexte de recherche 🗒



Période d'acquisition

Début 01/01/2019 19:48 x 🗓

Fin 12/09/2019 19:48 x 🗓

SENTINEL-2 tuilés ▾

S2A ▾

MSI ▾

LEVEL2A ▾

S2MSI2A ▾

Mode du capteur ▾

Fraîcheur du produit ▾

Sens de l'orbite ▾

Numéro d'orbite absolue

Numéro d'orbite relative

Identifiant de prise de vue de la mission

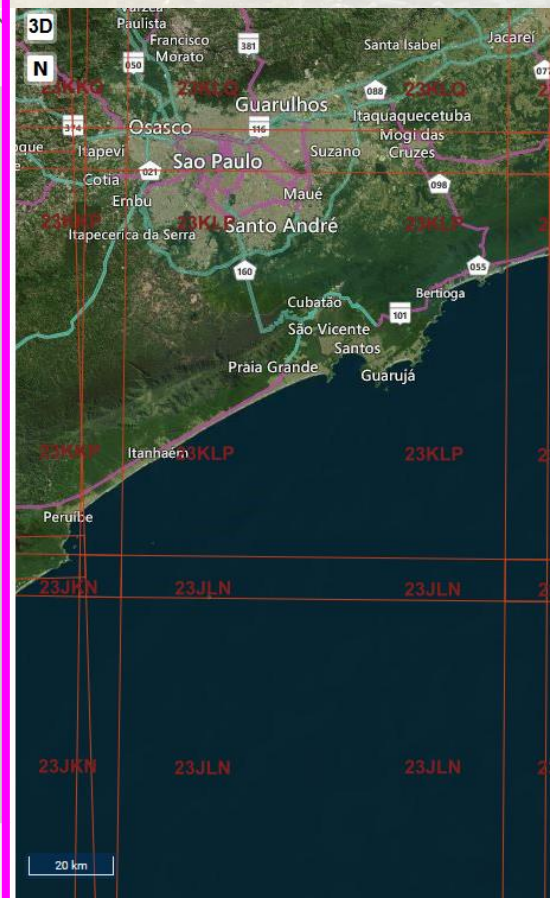
Identifiant de tuile MGRS (ex., 31TCJ)

Zone UTM Bande de le Identificate

Couverture nuageuse

0% 30% 100%

RÉINITIALISER RECHERCHER



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
Localisation : Brazil
Date : 01 juin 2019 - 13:12:51
Fraîcheur du produit : Nominal

Plateforme : S2A
Instrument : MSI
Type de produit : S2MSI2A

Numéro d'orbite : 20584
Niveau de traitement : LEVEL2A
Mode du capteur :

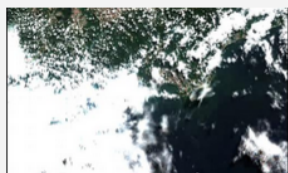


S2A_MSIL2A_20190502T131251_N0211_R138_T23KLP_20190502T153101

Collection : SENTINEL-2 tuilés
Localisation : Brazil
Date : 02 mai 2019 - 13:12:51
Fraîcheur du produit : Nominal

Plateforme : S2A
Instrument : MSI
Type de produit : S2MSI2A

Numéro d'orbite : 20155
Niveau de traitement : LEVEL2A
Mode du capteur :

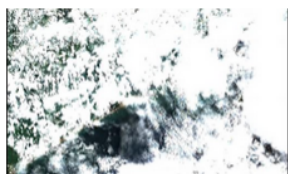


S2A_MSIL2A_20190422T131251_N0211_R138_T23KLP_20190422T170843

Collection : SENTINEL-2 tuilés
Localisation : Brazil
Date : 22 avril 2019 - 13:12:51
Fraîcheur du produit : Nominal

Plateforme : S2A
Instrument : MSI
Type de produit : S2MSI2A

Numéro d'orbite : 20012
Niveau de traitement : LEVEL2A
Mode du capteur :

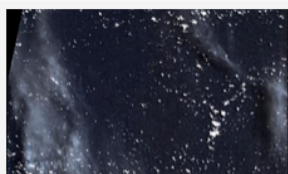


S2A_MSIL2A_20190221T131241_N0211_R138_T23KLP_20190221T152523

Collection : SENTINEL-2 tuilés
Localisation : Brazil
Date : 21 février 2019 - 13:12:41
Fraîcheur du produit : Nominal

Plateforme : S2A
Instrument : MSI
Type de produit : S2MSI2A

Numéro d'orbite : 19154
Niveau de traitement : LEVEL2A
Mode du capteur :



S2A_MSIL2A_20190220T220531_N0211_R129_T01KAP_20190221T001431

Collection : SENTINEL-2 tuilés
Localisation :
Date : 20 février 2019 - 22:05:31
Fraîcheur du produit : Nominal

Plateforme : S2A
Instrument : MSI
Type de produit : S2MSI2A

Numéro d'orbite : 19145
Niveau de traitement : LEVEL2A
Mode du capteur :



Peps and its functioning: Preprocessing toolbox

MA SÉLECTION MES TRAITEMENTS MES RÉSULTATS

Sélectionner un traitement

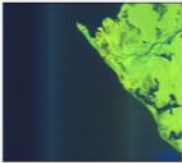





- S1
 - Orthorectification S1 sur la Grille S2 (21)
- S2ST
 - Correction Atmosphérique Maja (64)**
 - Extraction de la Bande TCI (70)
 - Composition Vraies Couleurs (70)
 - Composition Fausses Couleurs IR (70)
 - Composition Fausses Couleurs SWIR (70)
 - Calcul de NDVI (70)

Notification des résultats activé / désactivé

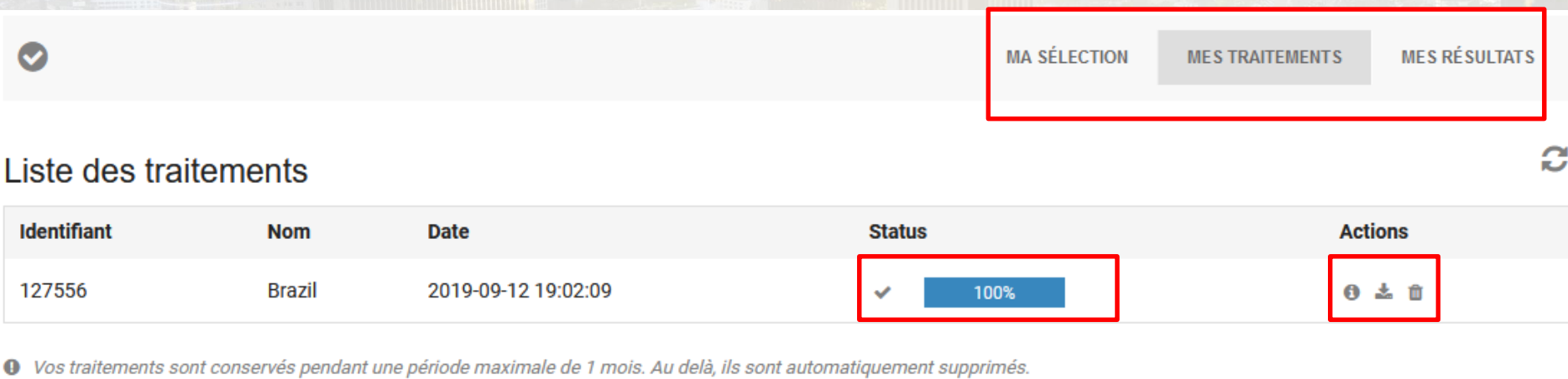
TRAITER LES PRODUITS (0) ⚙️

SUPPRIMER TOUS LES PRODUITS

TRAITER LES PRODUITS (0) ⚙️

<input type="checkbox"/>		S1A_IW_GRDH_1SDV_20180626T050709_20180626T050734_022523_02708D_6586 Collection : SENTINEL-1 Localisation : Gabon Date : 26 juin 2018 - 05:07:09 Fraîcheur du produit : Fast-24h	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD	Numéro d'orbite : 22523 Niveau de traitement : LEVEL1 Mode du capteur : IW	
<input type="checkbox"/>		S1A_IW_GRDH_1SDV_20180626T050644_20180626T050709_022523_02708D_EA31 Collection : SENTINEL-1 Localisation : Gabon Date : 26 juin 2018 - 05:06:44 Fraîcheur du produit : Fast-24h	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD	Numéro d'orbite : 22523 Niveau de traitement : LEVEL1 Mode du capteur : IW	
<input type="checkbox"/>		S1A_IW_GRDH_1SDV_20180609T045901_20180609T045926_022275_02691B_40B6 Collection : SENTINEL-1 Localisation : Gabon Date : 09 juin 2018 - 04:59:01	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD	Numéro d'orbite : 22275 Niveau de traitement : LEVEL1 Mode du capteur : IW	

Peps and its functioning: Preprocessing toolbox



MA SÉLECTION MES TRAITEMENTS MES RÉSULTATS

Liste des traitements

Identifiant	Nom	Date	Status	Actions
127556	Brazil	2019-09-12 19:02:09	✓ 100%	📄 ⬇️ 🗑️

📄 Vos traitements sont conservés pendant une période maximale de 1 mois. Au delà, ils sont automatiquement supprimés.

Last operation: download the image and process it

Some ancilliary data acquisition Platforms:

<https://www.openstreetmap.org/>

And

<http://worldpopulationreview.com/>

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



OpenStreetMap Modifier Historique Exporter

Traces GPS Journaux des utilisateurs Droits d'auteur Aide À propos Se connecter S'inscrire

Abidjan Aller

Résultats de la recherche

Résultats de OpenStreetMap Nominatim

- État / province Abidjan, Côte d'Ivoire
- Ville Abidjan, 01 BP 2325 ABIDJAN 01, Côte d'Ivoire
- Village Abidjan, Région de Brong Ahafo, Ghana
- Quartier Abidjan, Niamey, 8001, Niger
- Rue résidentielle Abidjan, البركتيت, El Mina, Nouakchott, ١٧٠, Mauritanie
- Commercial Abidjan, Place de la Loire, ParcICADE Paris Orly-Rungis, Rungis, Arrondissement de L'Hay-les-Roses, Val-de-Marne, Île-de-France, France métropolitaine, 94150, France
- Bar Abidjan, Manga Williams Avenue, Carrefour Alpha Club, Ambas Bay, Limbé I, CUL, Fako, Southwest, 414, Cameroun

Plus de résultats

Résultats depuis GeoNames

- Abidjan, Côte d'Ivoire
- Abobo, Côte d'Ivoire
- Abidjan, Côte d'Ivoire
- Abidjan, Côte d'Ivoire

Département d'Abidjan Côte d'Ivoire

3 km
2 mi

© Contributeurs de OpenStreetMap ▼ Faire un don. Conditions du site web et de l'API

Some ancilliary data acquisition Platforms:

<http://worldpopulationreview.com/>

Intiation date: 2013

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

Data on several field: population (number of people, birth, pregnancy, 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 adjusted with UN population estimates (WFP).

Data Cost: free acces

Data acquisition Platforms



https://www.worldpop.org/geodata/listing?id=16

Rechercher



ABOUT | NEWS | DATA | CONTACT

Population

Population / Individual countries

Individual countries

Show 10 entries

Search ...

Continent	Country	Year	Geo Type	RES	
Africa	Algeria	-	Population	100m	Data & Resources
Africa	Angola	-	Population	100m	Data & Resources
Africa	Benin	-	Population	100m	Data & Resources
Africa	Botswana	-	Population	100m	Data & Resources
Africa	Burkina Faso	-	Population	100m	Data & Resources
Africa	Burundi	-	Population	100m	Data & Resources
Africa	Cameroon	-	Population	100m	Data & Resources
Africa	Central African Repu	-	Population	100m	Data & Resources
Africa	Chad	-	Population	100m	Data & Resources
Africa	Congo	-	Population	100m	Data & Resources

Showing 1 to 10 of 127 entries

Prev 1 2 3 4 5 ... 13 Next

Preprocessing of Image data

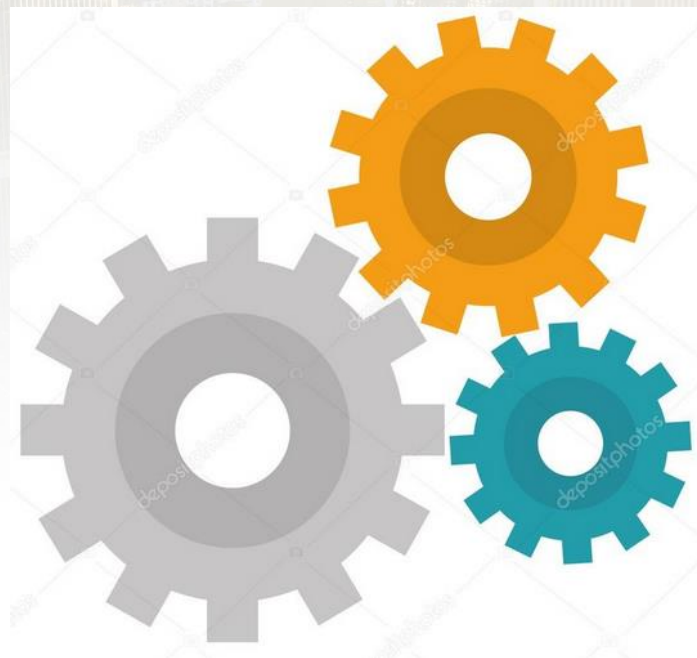


Image credit: <https://fr.depositphotos.com/127985826/stock-illustration-gear-setup-machinery-icon.html>

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

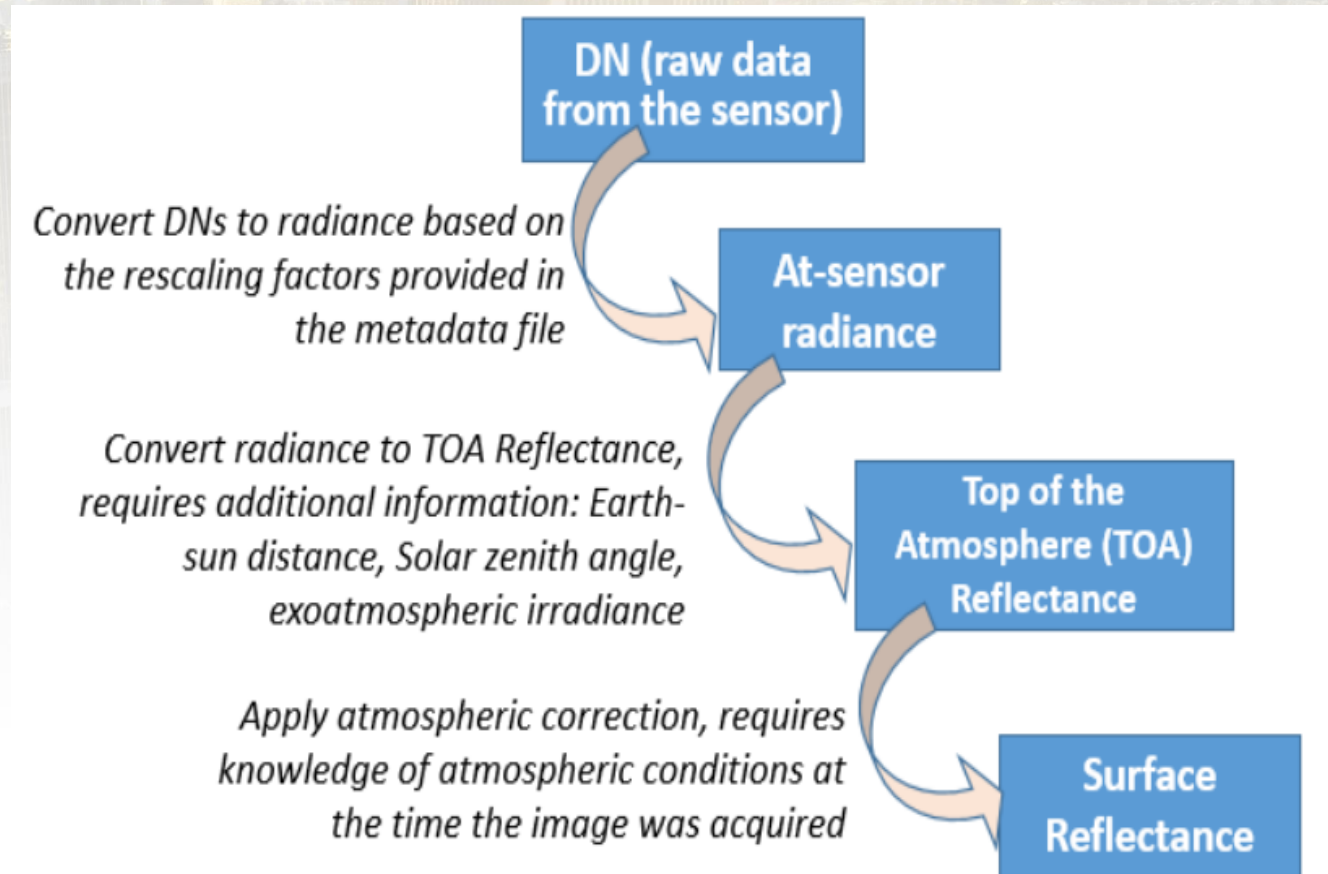
Radiometric Calibration:

- 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

Radiometric Calibration/Atmospheric correction:

- Main steps:



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

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 km ²)
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 km ²)

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

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:

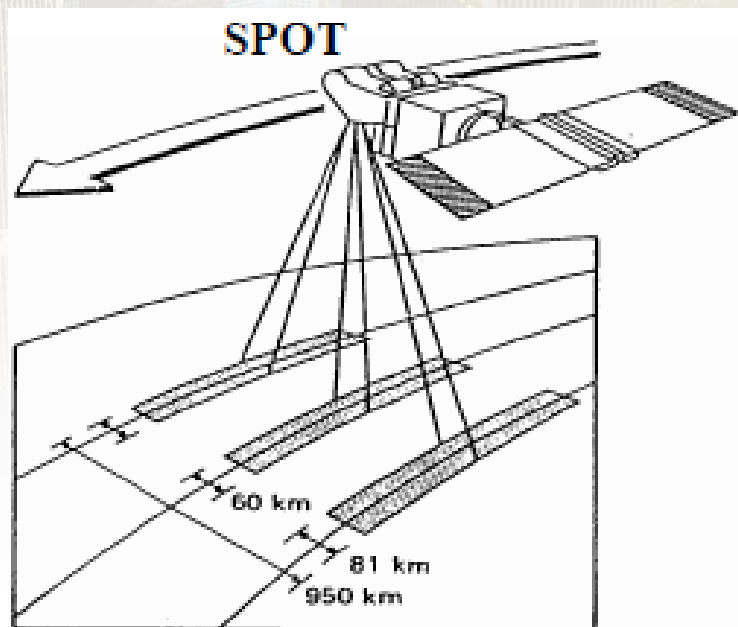
- The random variations of attitude of the satellite on its axis of flight (**pitch and roll movements**)
- The scrolling of the satellite and the inclination of its orbit
- The oblique sights
- The sensor design defects
- The altitude variation on the ground or the discontinuities of the relief
- The 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.

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

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

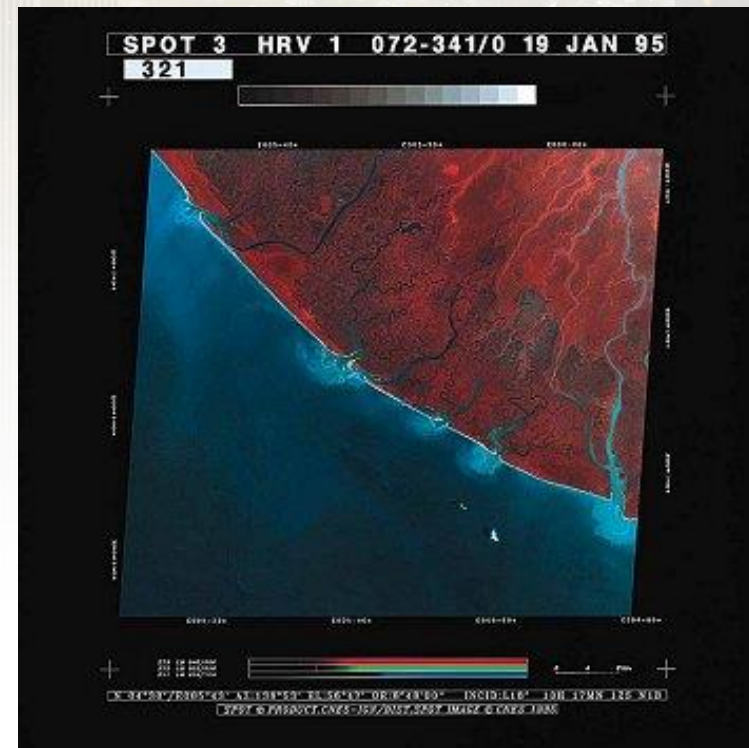
Source: <https://eduscol.education.fr/obter/principe/acquis/acquis418.htm>

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 **parallelogram**
- 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**.



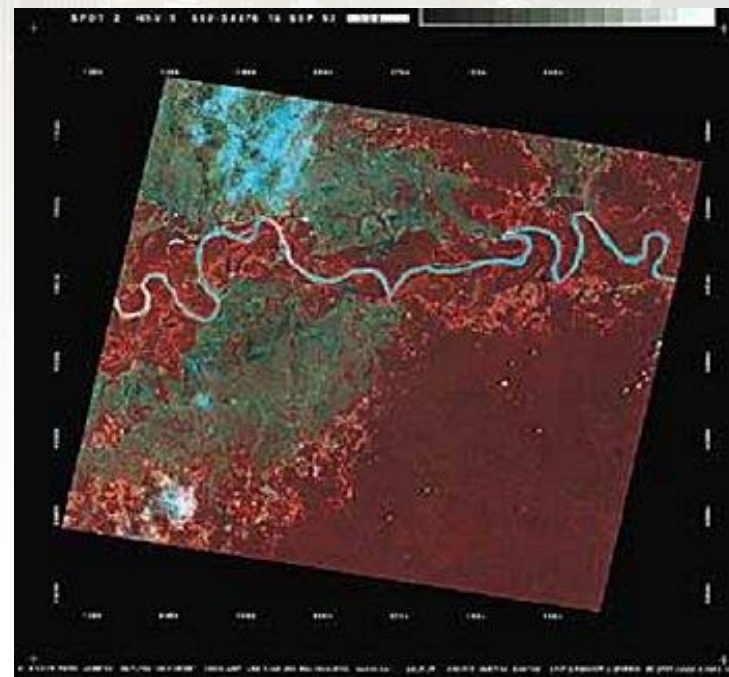
Source: <https://eduscol.education.fr/obter/principe/acquis/acquis418.htm>

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>

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

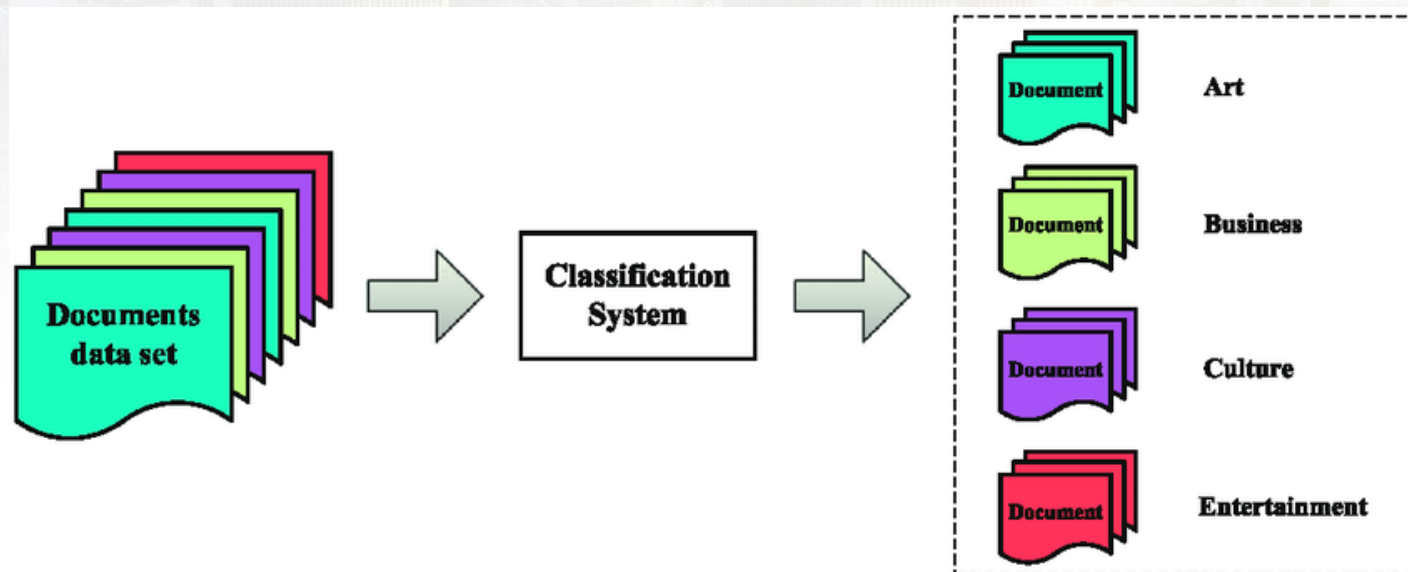
Image classification



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

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

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



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)	Bandwidth (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

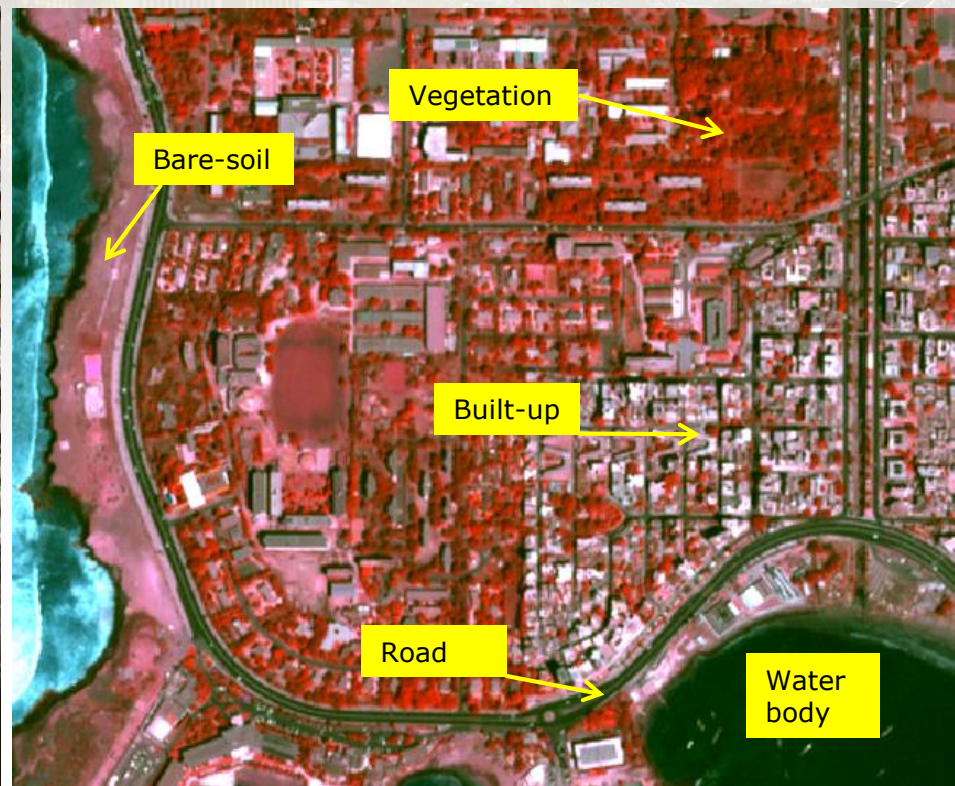
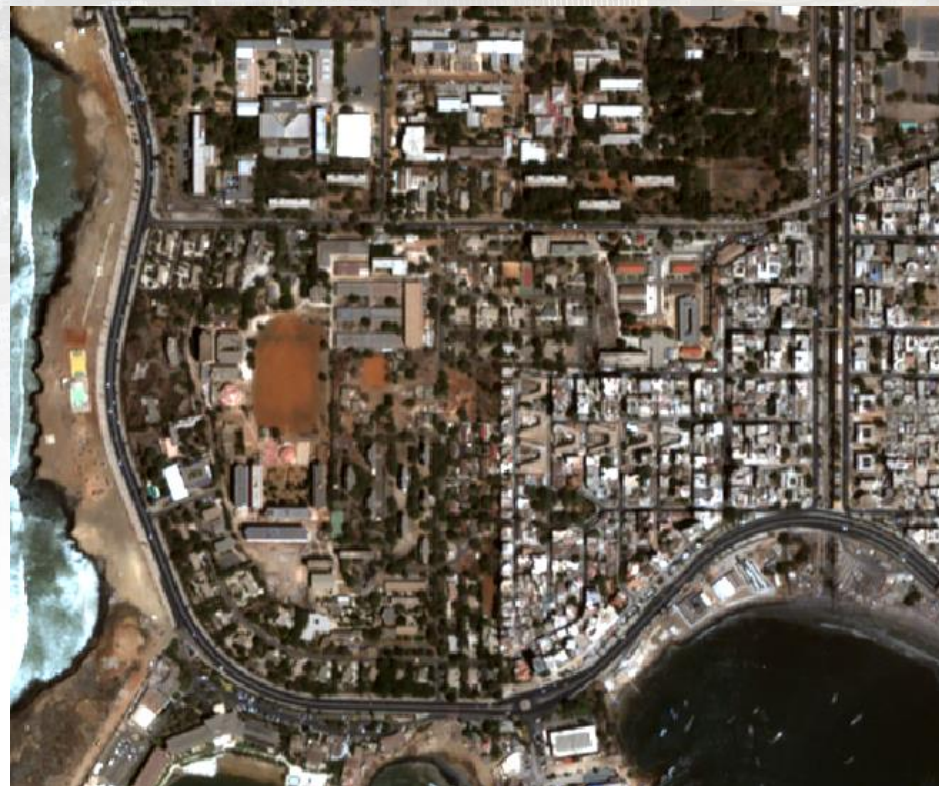
Fig: **Sentinel-2 nomenclature and their applications**

(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 identify the potential information classes and to establish the nomenclature.



Pléiades: Natural composite bands combination: $RGB=(3/2/1)$

$RGB=PIR/Red/Green(4/3/2)$

Some classification prerequisites:

3- Choose the type of classification to be done:

- Unsupervised

or

- Supervised ?

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

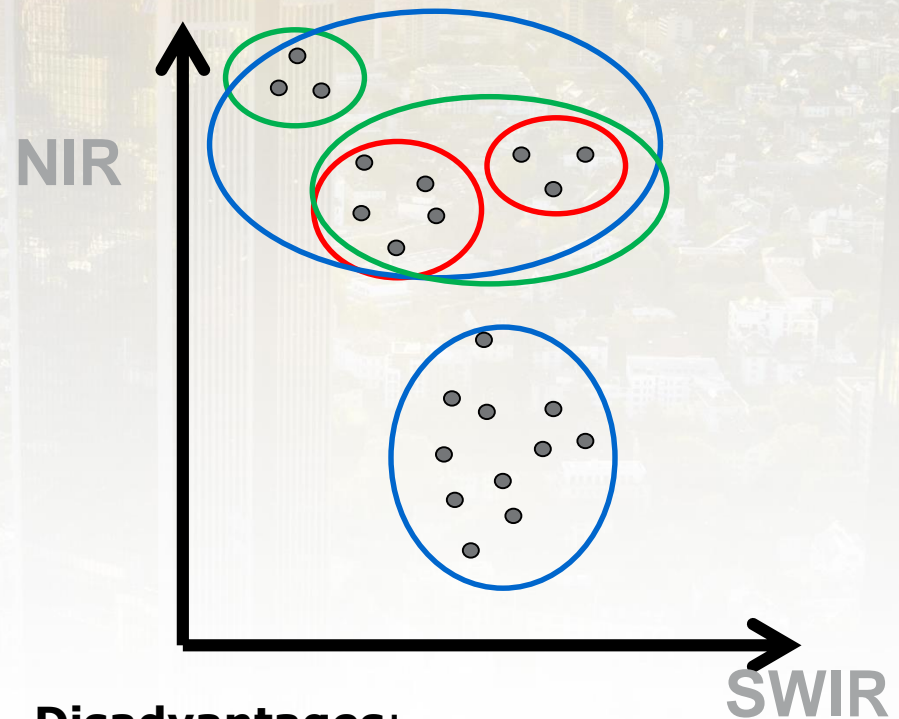
Unsupervised:

- 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:

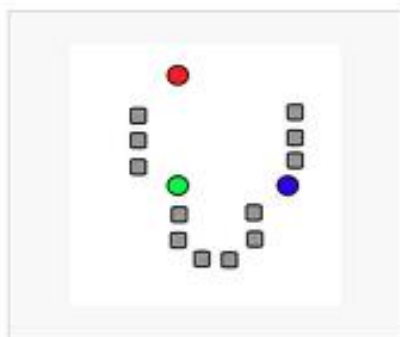
The **interpretation** of the resulting classes **is often difficult** because it requires a full scan of the image to visualize the result of the segmentation.

Unsupervised: some classifiers

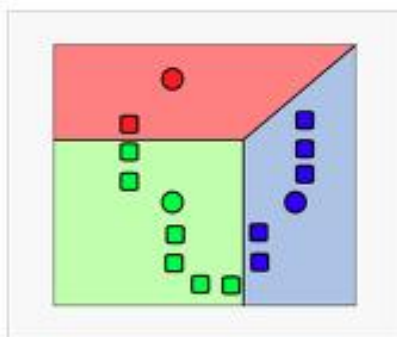
Kmeans

- 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.

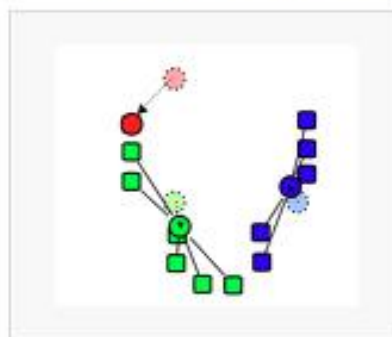
Demonstration of the standard algorithm



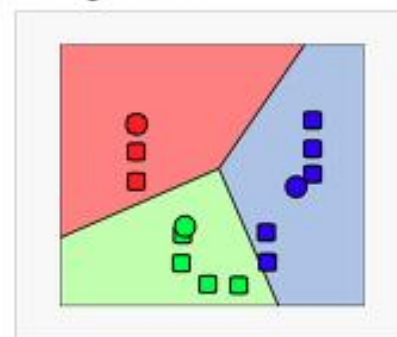
1. k initial "means" (in this case $k=3$) are randomly generated within the data domain (shown in color).



2. k clusters are created by associating every observation with the nearest mean. The partitions here represent the Voronoi diagram generated by the means.



3. The centroid of each of the k clusters becomes the new mean.



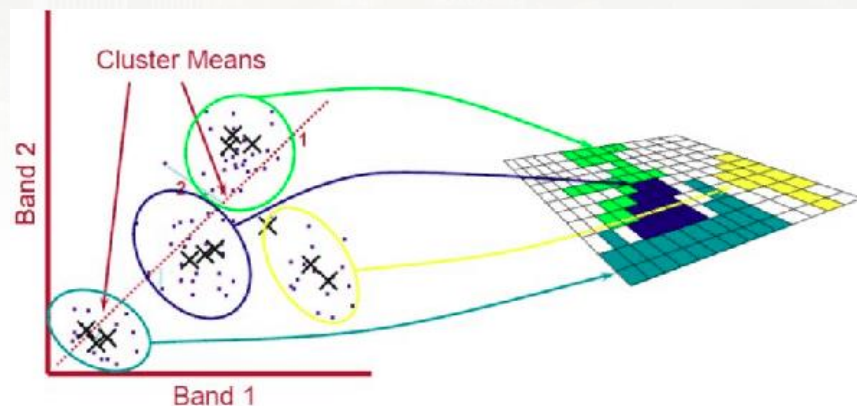
4. Steps 2 and 3 are repeated until convergence has been reached.

<https://iancat.tistory.com/6>

Unsupervised:

ISODATA: Iterative 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

The background of the slide is a faded, aerial view of a city skyline, likely New York City, showing numerous skyscrapers and buildings.

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 through 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)

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

Supervised classification: some classifiers

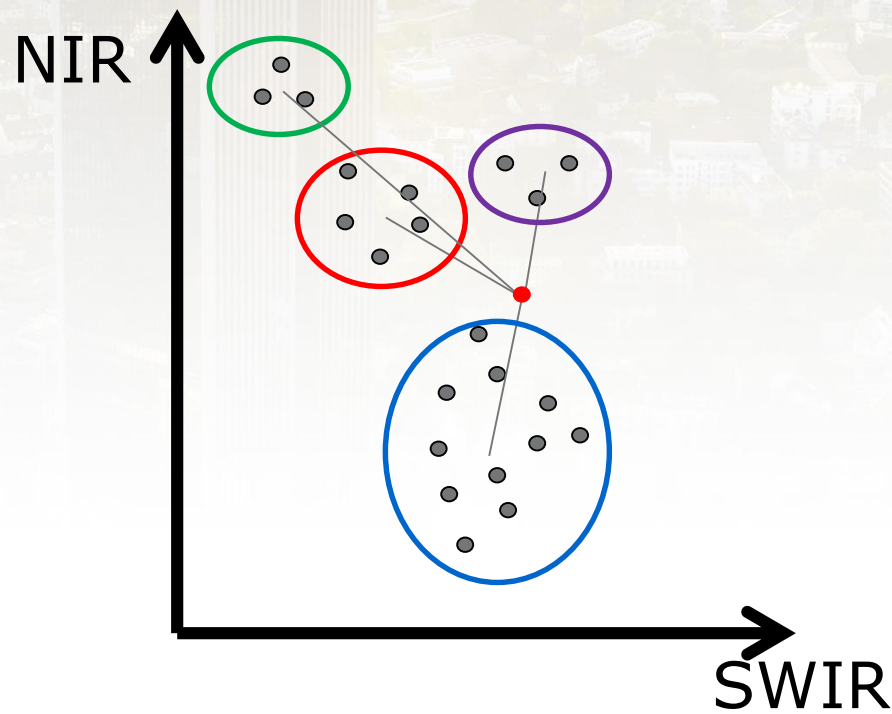
1) Minimum distance to center of potential classes

Class A

Class B

Class C

Class D



Supervised classification

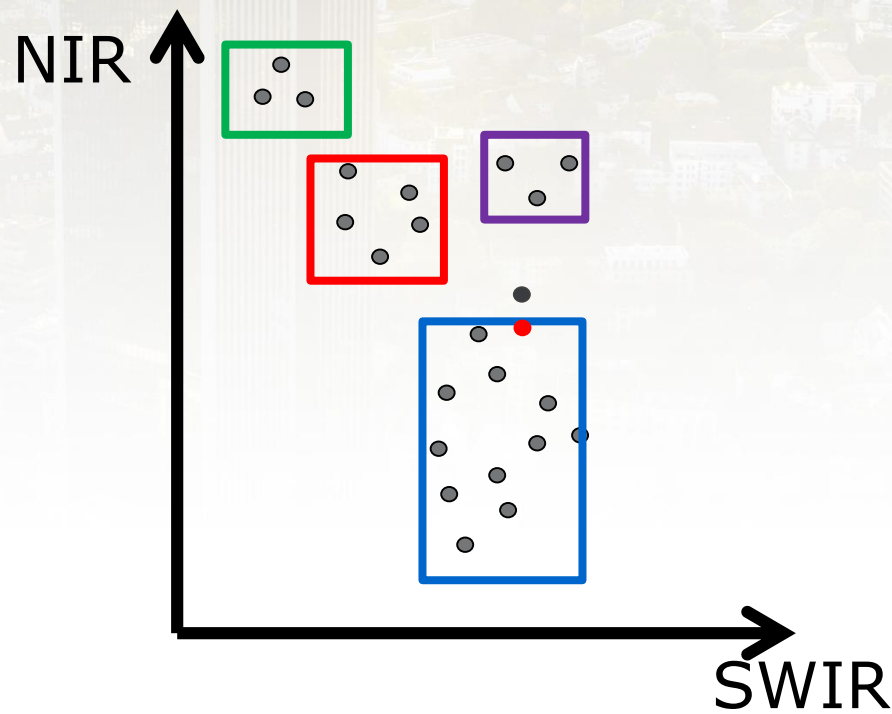
2) Parallelepiped classification:

Class A

Class B

Class C

Class D



Supervised classification

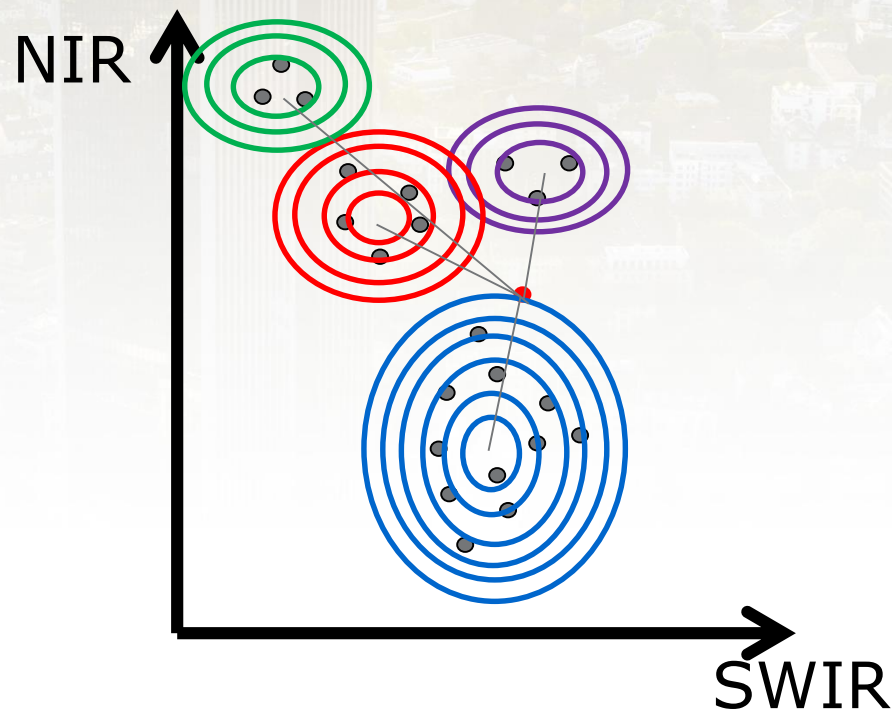
3) Maximum Likelihood – includes the standard deviation of values

Class A

Class B

Class C

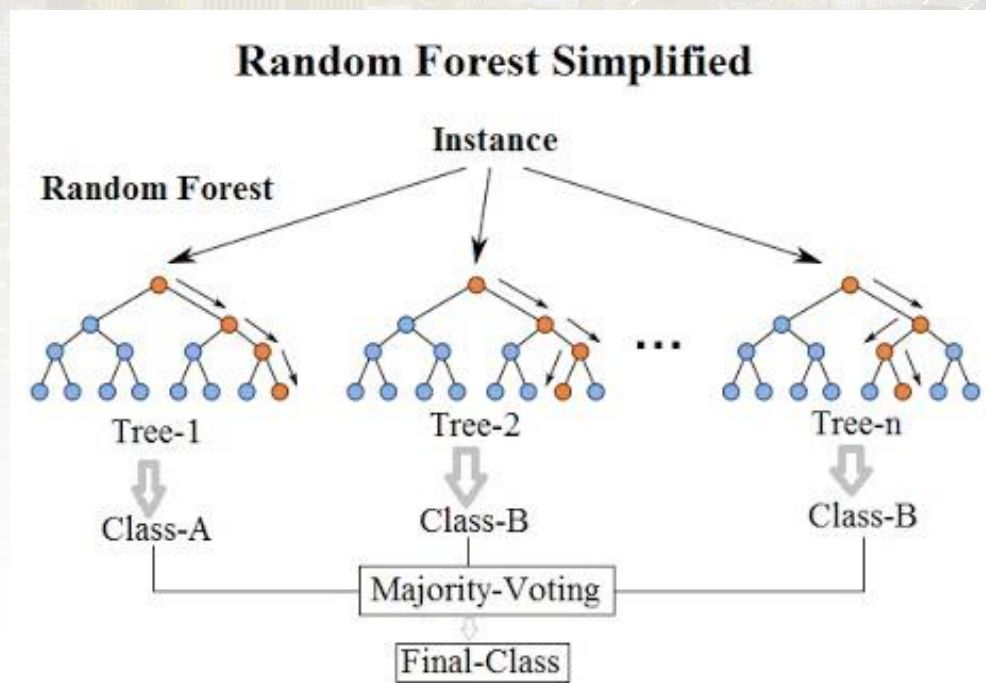
Class D



Supervised classification 4) Random Forest

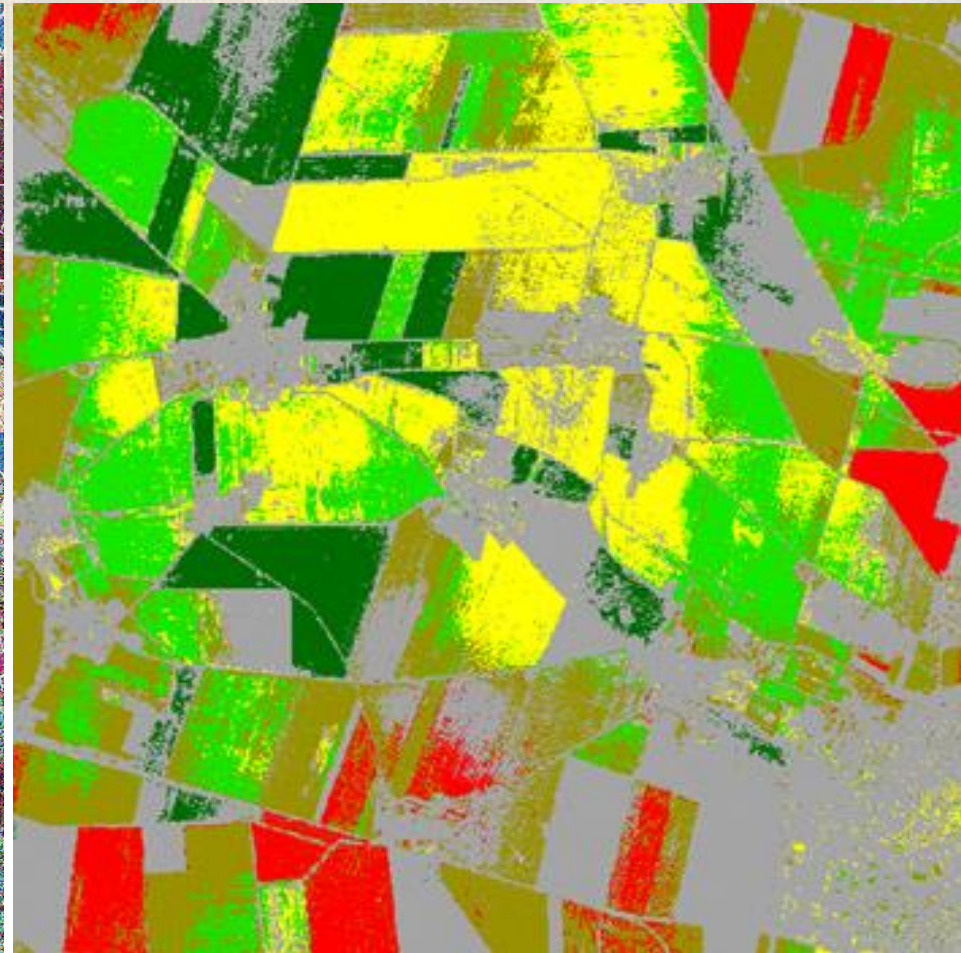
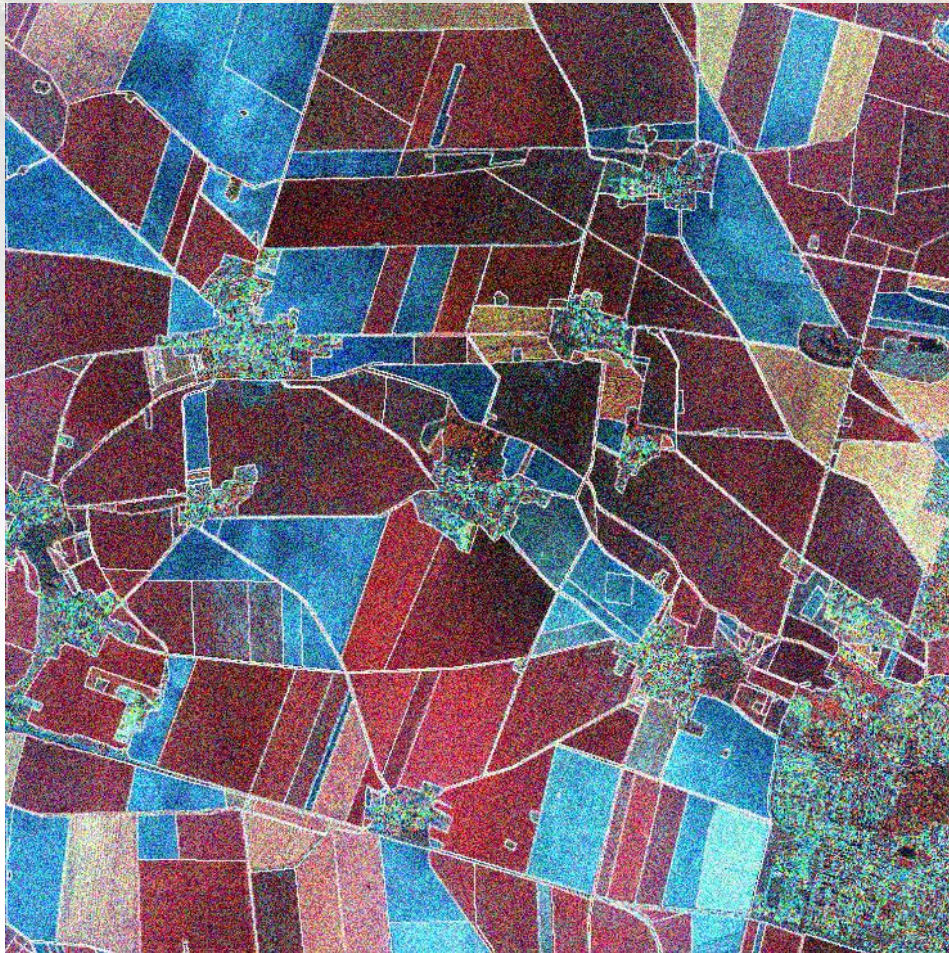
Class A

Class B

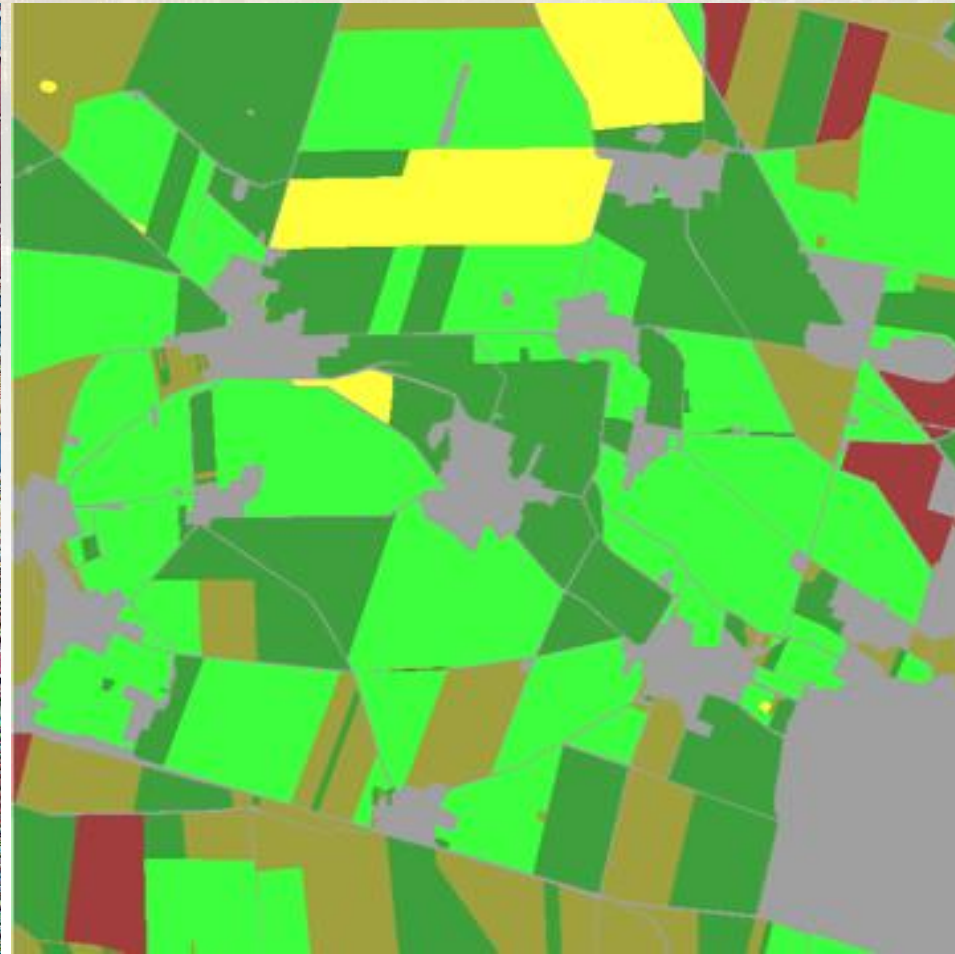


© and more details on <https://www.youtube.com/watch?v=ajTc5y3OqSQ>

Pixels based classification



Pixel vs. segments



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

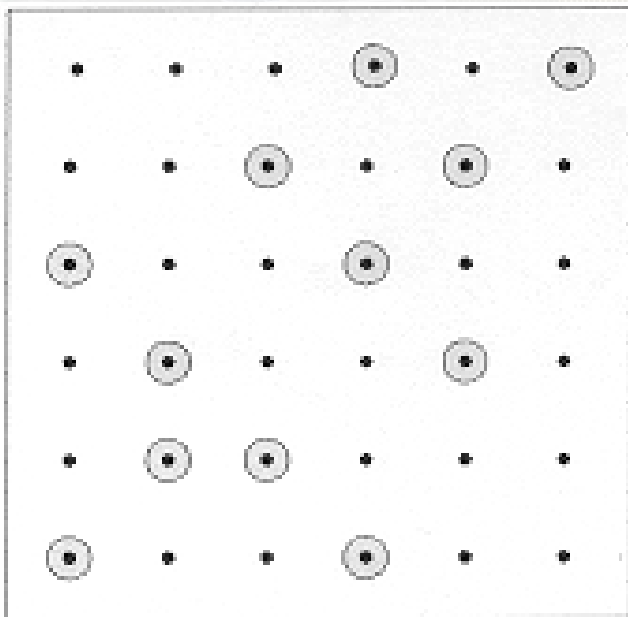
3- The distribution of samples

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

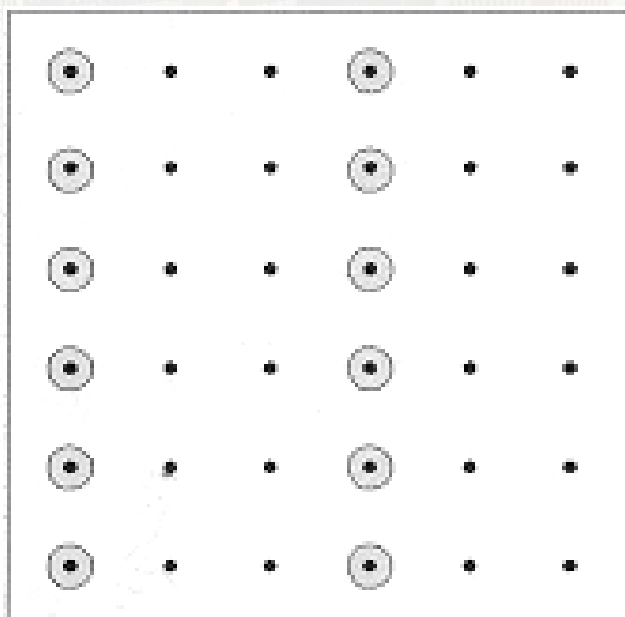
This operation consists in comparing the produced map with the reference data in order to know the level of accuracy of the map.

Sampling designs:

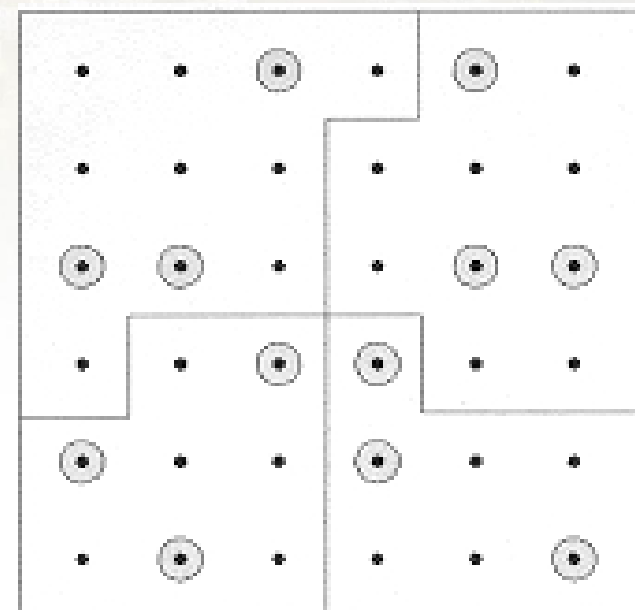
Simple Random sampling



Systematic sampling



Stratified random sampling

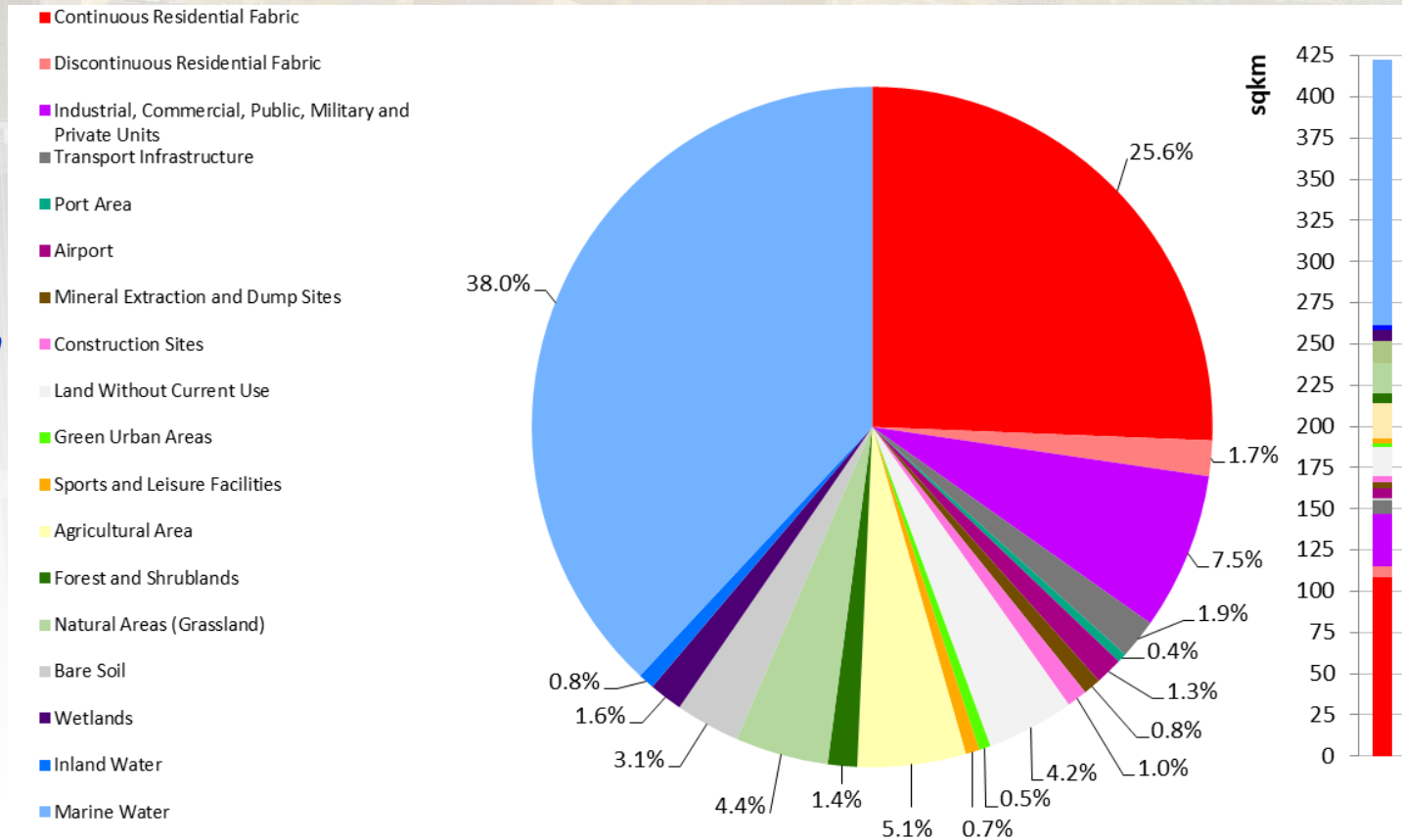


Method use for Eo4SD-Urban LU/LC Products (case of Dakar)=

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).

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

Stratified random
Sampling

Preconditions:

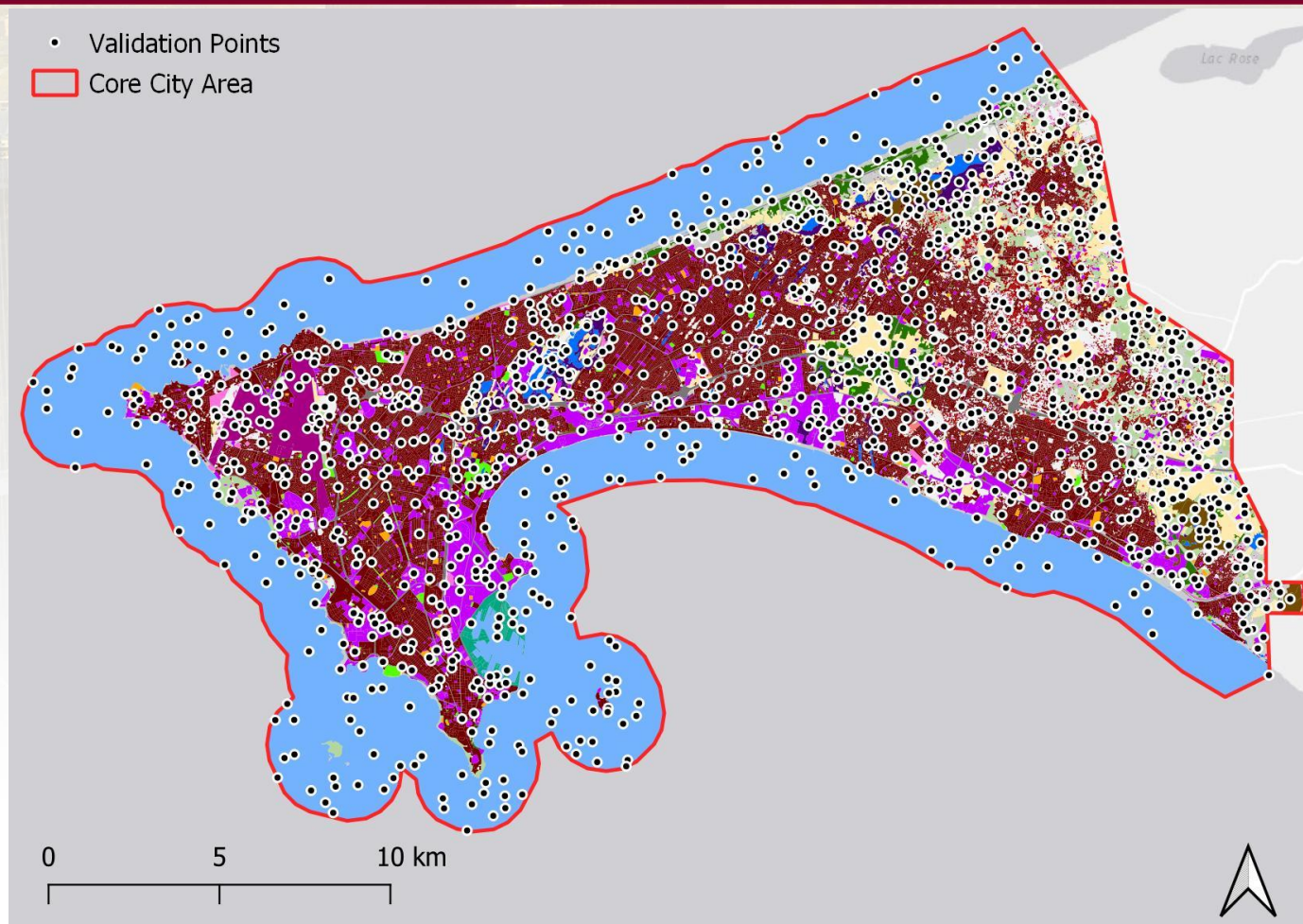
2- Distribute samples according to the area of each stratum.

Class Name	Class ID	No. Of Sampling Points	Km ² 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.

Method use for Eo4SD-Urban LU/LC Products:

Stratified random
Sampling



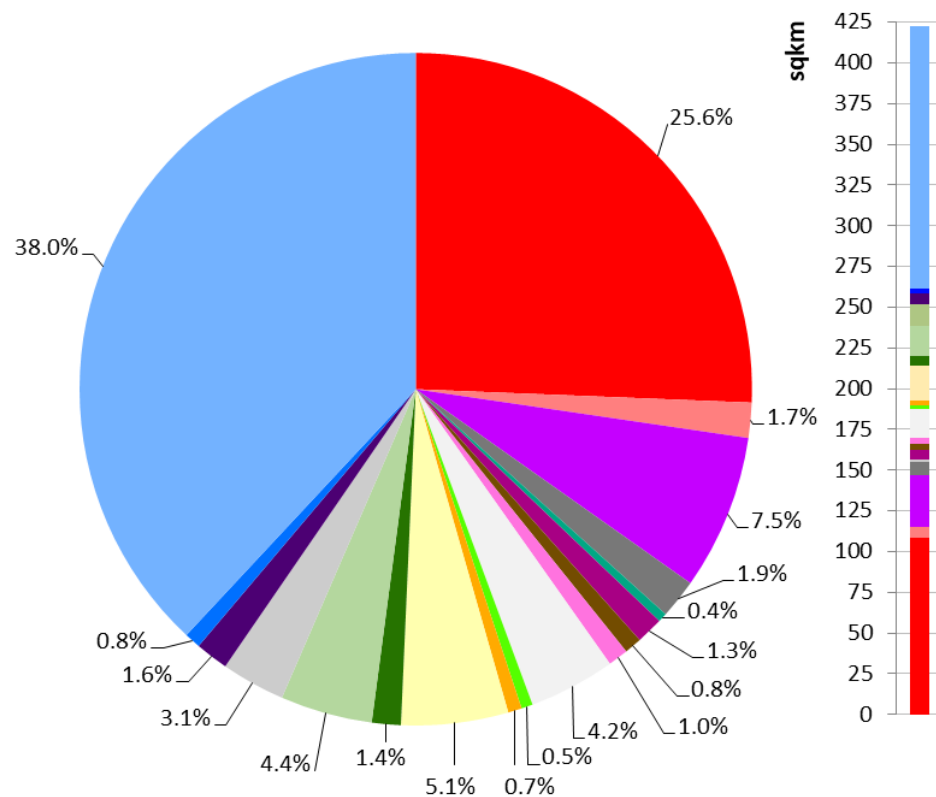
Mapping result of the Core City area of Dakar of the year 2018 overlaid with randomly distributed sample points used for accuracy assessment.

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.

- Continuous Residential Fabric
- Discontinuous Residential Fabric
- Industrial, Commercial, Public, Military and Private Units
- Transport Infrastructure
- Port Area
- Airport
- Mineral Extraction and Dump Sites
- Construction Sites
- Land Without Current Use
- Green Urban Areas
- Sports and Leisure Facilities
- Agricultural Area
- Forest and Shrublands
- Natural Areas (Grassland)
- Bare Soil
- Wetlands
- Inland Water
- Marine Water



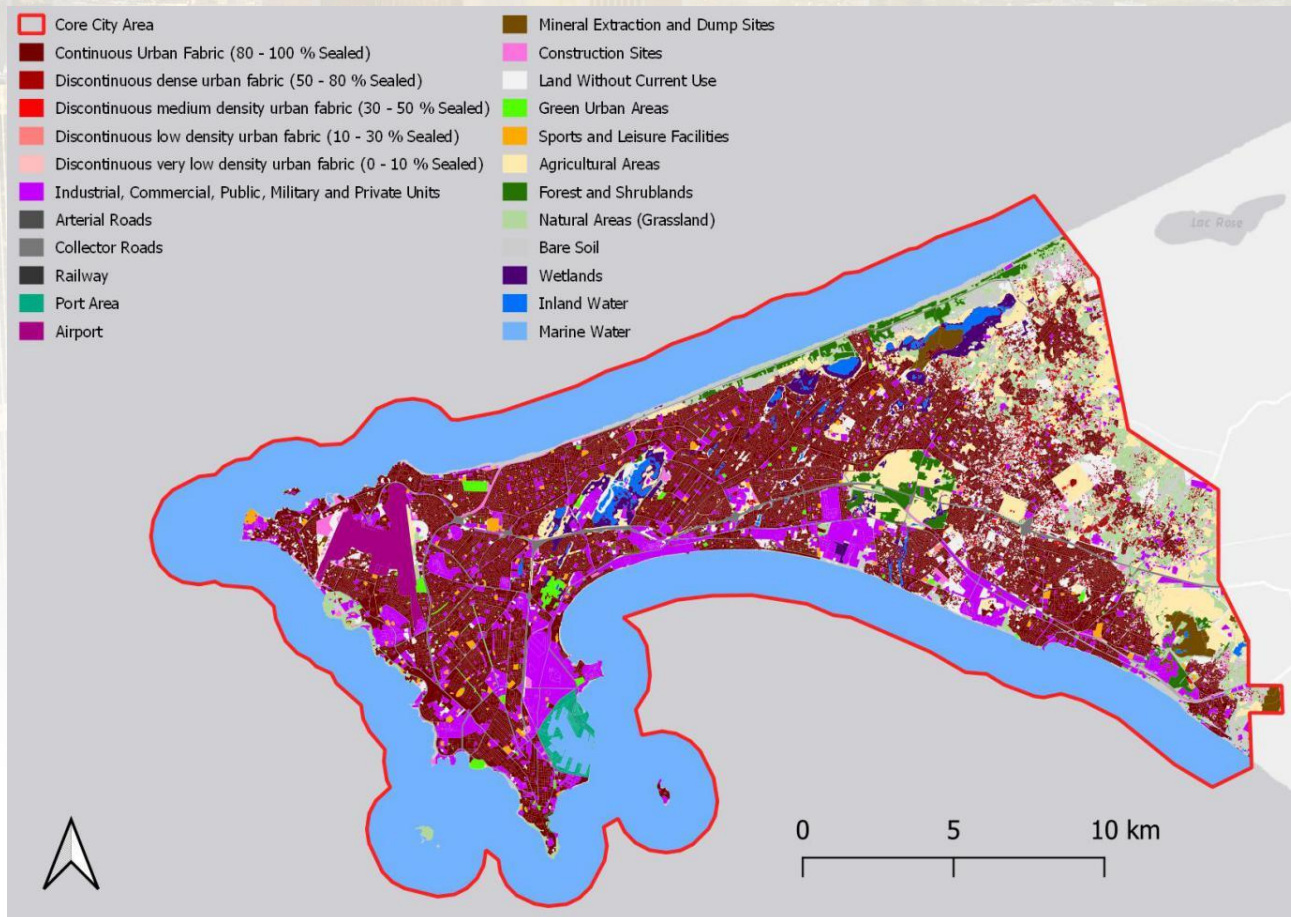
On the LU/LC map, Artificial areas represent in 2018 45% of Dakar's core city area, Water and non artificial areas represent respectively 39% and 16% of the core city area

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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