BioSpace25 - Biodiversity insight from Space
10 - 14 February 2025 | ESA-ESRIN | Frascati - Italy

A multisource adaptive strategy for the characterization and monitoring of ecological corridors by remote sensing

Budin R.[1], Beguet B.[1], Rozo C.[1], Debonnaire N.[1], Durou N.[1] Lafon V.[1]

[1]i-Sea, France

Context and motivations

From a long experience with various habitat mapping project, for both natural and urban environments :

- **No unique imagery** allows to get an an exhaustive understanding of ecological corridors
- **No unique method** allows to extract key indicators for analyzing and monitoring ecological corridors

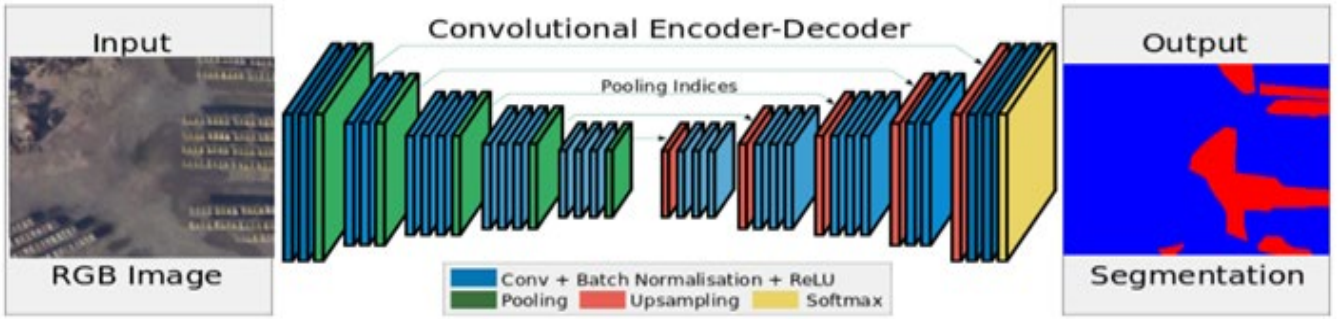
Main idea :

- **Make the most of existing data**, from aerial imagery (10-20cm resolution) to high-density time-domain satellite imagery (Sentinel-2, VHR), not forgetting elevation data (LIDAR stereo) to characterize and monitor tree strata
- **Exploring the operational potential of the most advanced image processing approaches** (DeepLearning) to obtain robust and accurate objective metrics
- **Work with the users of the RS-derived habitat maps** to find ways of combining relevant information for a comprehensive view of the tree heritage and ecological corridors for monitoring purposes

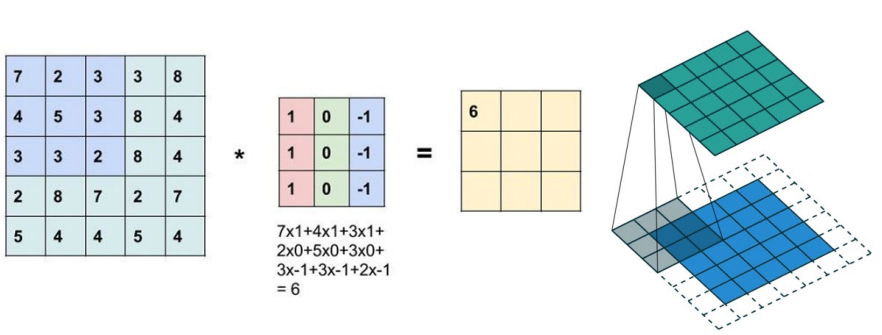
About ConvNets

Semantic segmentation via SegNet architecture :

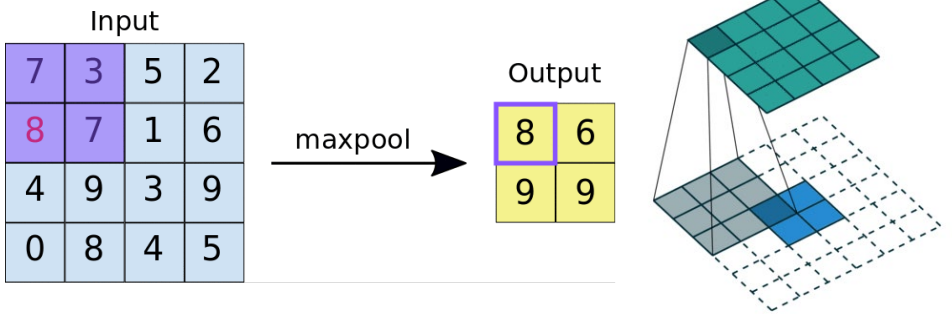
- ➔ a **neural network architecture** adapted to semantic segmentation (or '**pixel classification**') and applied with unrivalled performance to a large number of image processing applications
- ➔ an embedded description of object shape, texture and, of course, image radiometry
- ➔ various streamlined house architecture, allowing for refinements on a case-by-case basis (parent/children)



Exemple : Architecture SegNet, V.Badrinarayanan, A.Kendall and R.Cipolla, PAMI 2017



convolution



max pooling

upsampling

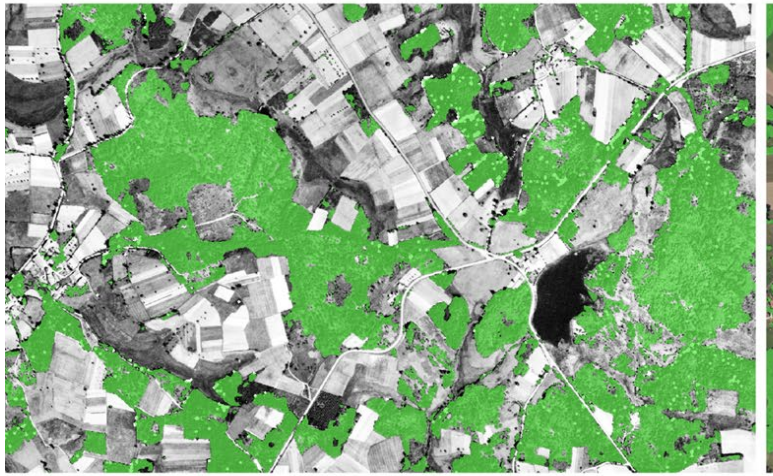
Canopy automatic precise detection

Semantic segmentation via SegNet architecture :

- A specific model trained to map canopies on old aerial imagery in greyscale with variable quality (with resolution ranging from 50cm to 1m)
- A RGB model for recent higher resolution images
- This means that canopies can be tracked with great precision since the era of the first aerial images (and without NDVI ☺).

1959 - Airborne image – greyscale – 50 cm

2020 - Airborne image – RGB – 20 cm



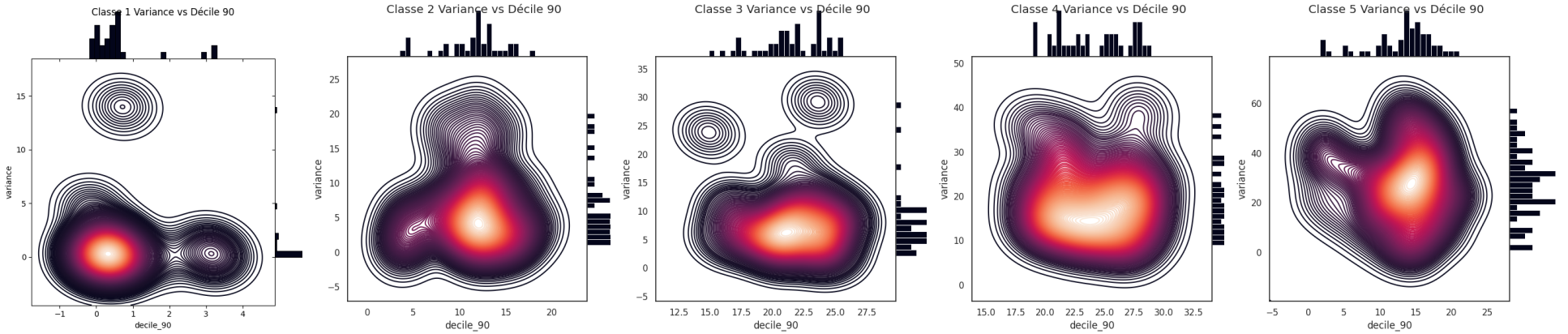
1959 - Tree canopy prediction

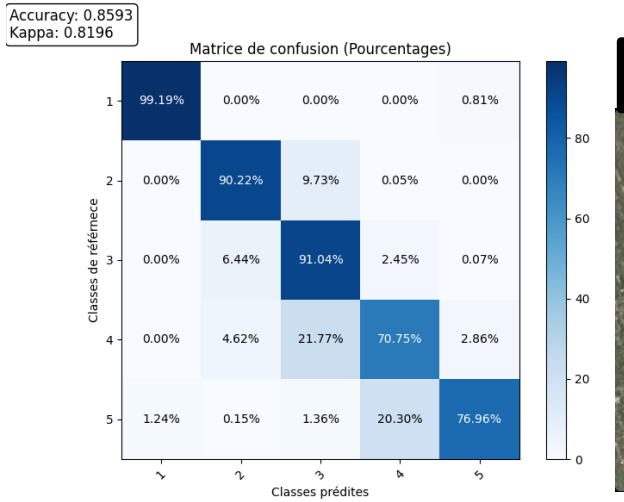
2020 - Tree canopy prediction

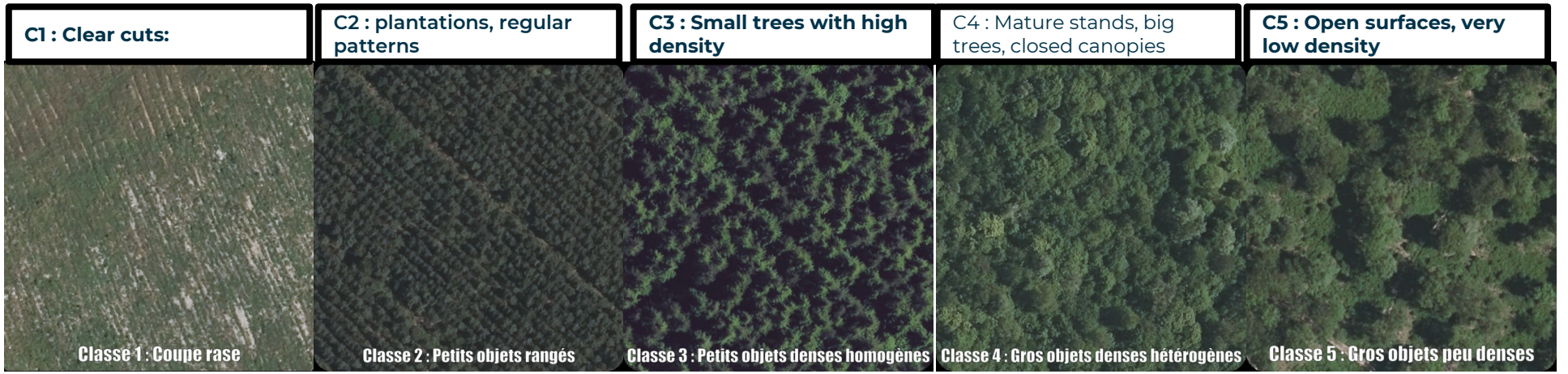
Canopy structure analysis

ConvNets as the best texture analysis approach to map canopy structures from VHR image !

From canopy maps to canopies structure maps !







Individual trees detection

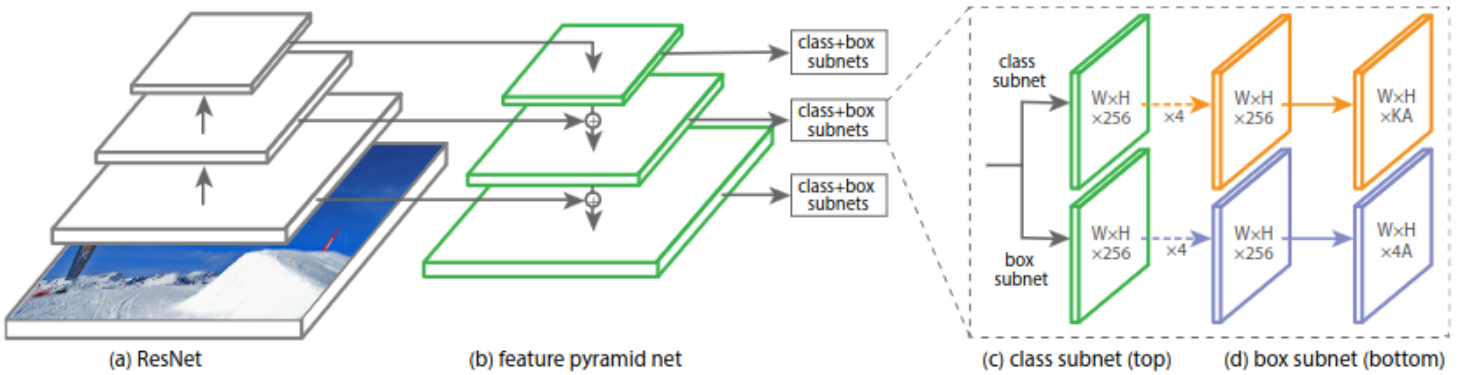
Object detection with RetinaNet :

➔ Individual trees detection on aerial images (or VHR satellite images with resolution <50cm)

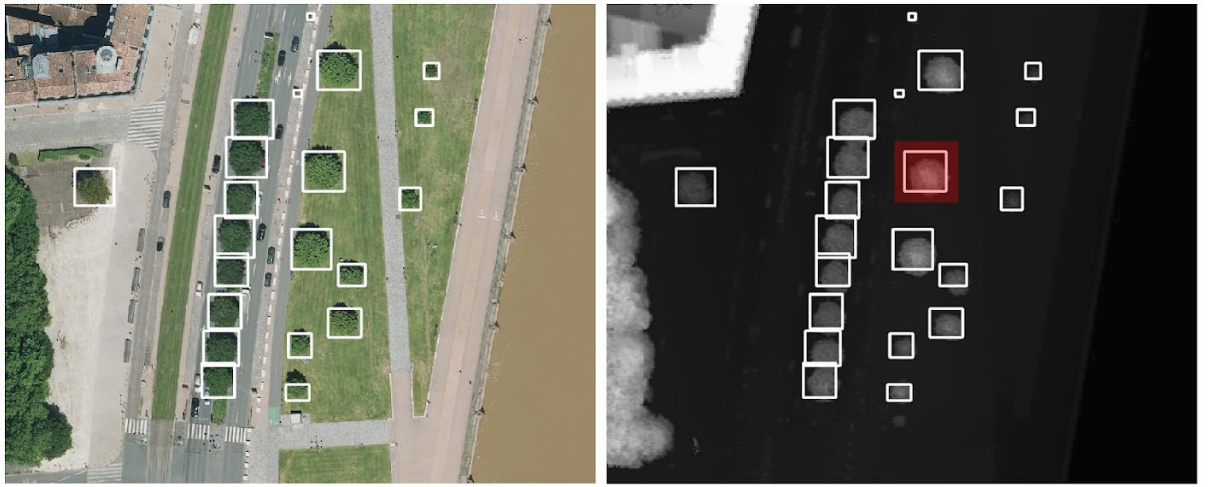
➔ Object detection : drawing a box around the object !

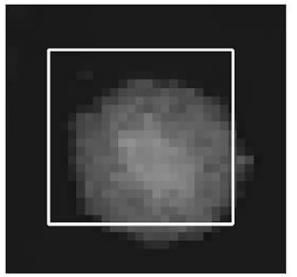
➔ Getting DHM information at tree scale (from Lidar or stereoscopy)

➔ Allows monitoring at tree level



RetinaNet (Focal Loss for Dense Object Detection, Tsung-Yi Lin et al 2018).



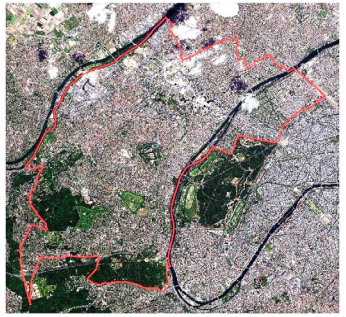


Individual trees detection and digital lidar height model : precise metrics for trees monitoring.

Combining information to derive urban canopy

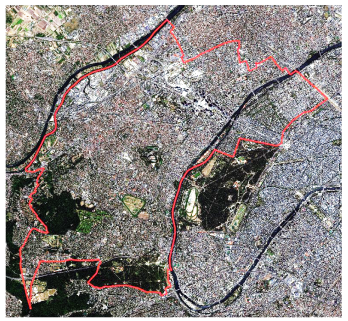
The evidence of combining information, with appropriate post-processing, in order to get an exhaustive representation of **green corridors** !

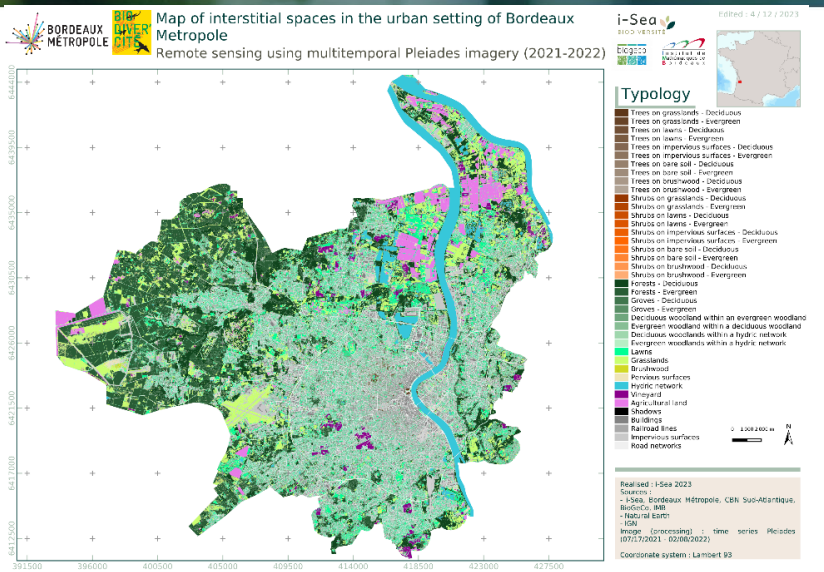
04.23
Pleiades

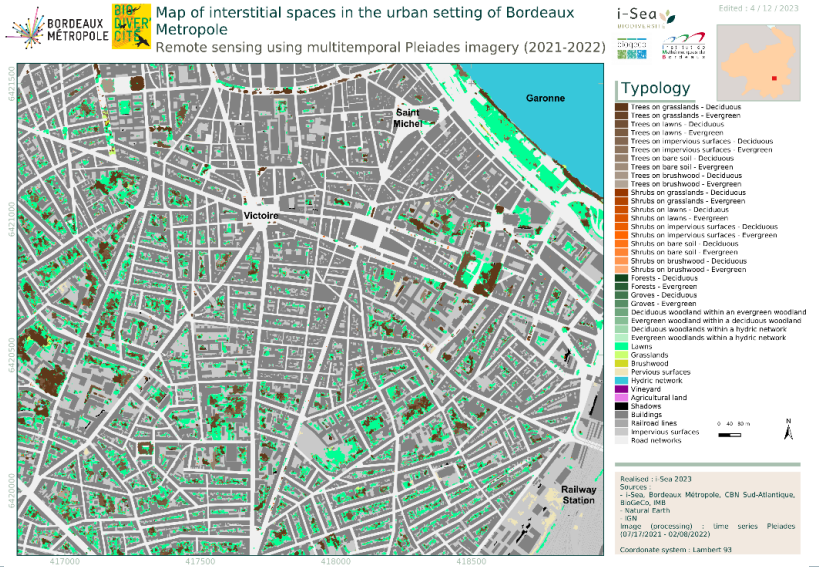


05.23
Pleiades

06.23
Pleiades







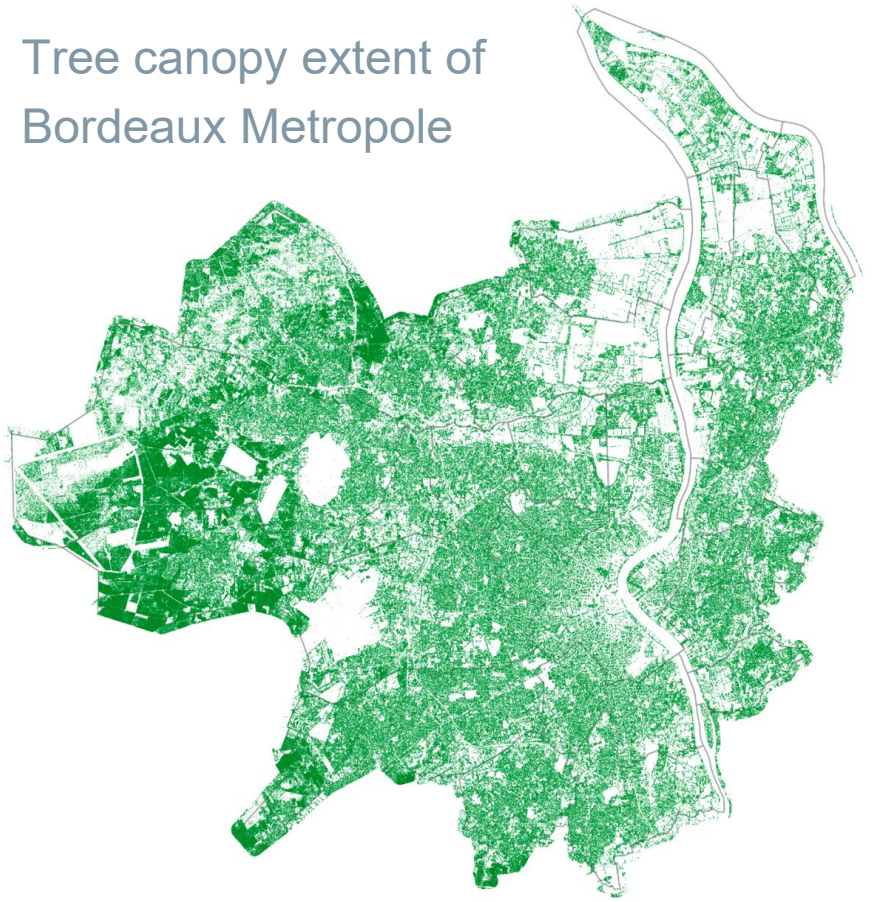
Synthesis

ConvNets as a powerful tool for the characterization of ecological corridors :

- ➔ Precise and large-scale canopy precise delineation on VHR images, even in Greyscale old aerial images.
- ➔ Canopy structures prediction, in an integrated approach **(no more need for tricky textural analysis !)**
- ➔ Individual trees detection and monitoring
- ➔ Obviously, dense optical image times series to access phenological trajectories (species, humidity, mortality…)

And combining all those outputs gives an exhaustive representation or ecological corridors thus improve their monitoring !

Tree canopy extent of Bordeaux Metropole



BioSpace25 - Biodiversity insight from Space
10 - 14 February 2025 | ESA-ESRIN | Frascati - Italy

A multisource adaptive strategy for the characterization and monitoring of ecological corridors by remote sensing.

Budin R.[1], Beguet B.[1], Rozo C.[1], Debonnaire N.[1], Durou N.[1] Lafon V.[1]

THANKS FOR YOUR ATTENTION !

i-Sea