Center
Provence-Alpes-Côte d'azur

MitiConnect v1.0 - User Manual

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1 About MitiConnect

1.1 Preamble

MitiConnect[1] is a modeling tool to quantifiy the impact of development projects on ecological networks connectivity.

1.2 Processing chain

MitiConnect is a QGIS plugin designed as a step-by-step process, from raw data integration to scenario comparison. Landscape graph construction is based on Graphab[2] . Other processing and the graphical interface are inspired by BioDispersal[3] . Each tab in the graphical interface corresponds to a step:

1. Definition of general parameters
2. Import data into the tool
3. Definition of target species
4. Definition of friction coefficients
5. Building scenarios
6. Treatment launches for each scenario/target species pair
   - **6.1.** Land use constitution
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   - **6.7.** Scenario comparison

[1] https://github.com/MathieuChailloux/MitiConnect/blob/main/README.md
[2] https://sourcesup.renater.fr/www/graphab/fr/home.html
[3] https://umr-tetis.fr/index.php/fr/productions-fr/outils/biodispersal

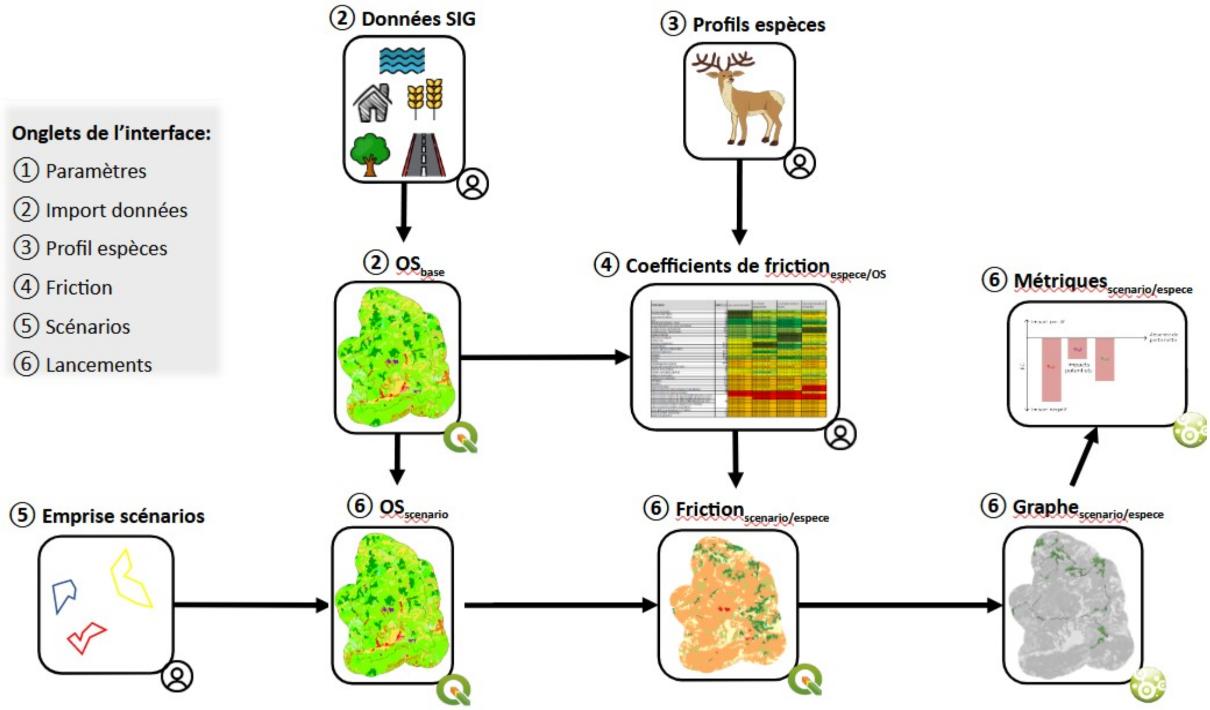

Figure 1: MitiConnect processing chain

1.3 Prerequisites

1.3.1 Configuration

MitiConnect runs on any operating system (Linux, Windows, Mac, etc.) with a QGIS version greater than or equal to 3.16 (https://www.qgis.org/fr/site/forusers/download.html) and a Java version greater than or equal to 8 (https://adoptopenjdk.net, preferably the 64-bit version).

Tests were carried out under QGIS 3.28, Windows 11 and Ubuntu 18.04.1 (bionic). Under Linux, installation of the *python-gdal* package is required. Some features may work without Java.

MitiConnect is freely available under GPL license.

File and folder names must not contain accents or spaces.

The amount of RAM required for computing depends on the size of the study area, the chosen spatial resolution and the number of patches per species.

1.3.2 Installation

To install MitiConnect from QGIS, go to '*Plugins*' menu, then '*Install/Manage plugins*'. In '*All*' tab, search for the '*MitiConnect*' plugin, select it and press '*Install plugin*'.

To install the extension in QGIS from the .zip archive, go to '*Extensions*' menu, then '*Install/Manage plugins*', '*Install from zip*' and select the downloaded '*MitiConnect.zip*' file.

Once succesfully installed, icon appears in QGIS toolbar and a new *MitiConnect* entry is available in '*Plugins*' menu. If the icon doesn't appear, go to the '*Plugins'* menu, uncheck and then recheck the line corresponding to *MitiConnect*.

1.4 Citation

Chailloux M., Tarabon S., Papet G., Amsallem J. & Vanpeene S (2024). MitiConnect: a QGIS plugin to quantify ecological network state in mitigation policies

1.5 Graphical interface

Graphical interface is launched from the icon or from MitiConnect entry in the *Plugins* menu. The interface is tab-based, with each tab corresponding to a step in the method.

GUI also contains project management buttons, English/French translation buttons, description of the current tab and the processing progress bar.

1.6 Project file

We strongly recommend that you regularly save your MitiConnect project settings. These settings are saved in an XML file.

Figure 2: MitiConnect project management buttons

The project file is managed using following buttons at the top left of the interface:

Open a MitiConnect project: select an existing project (.xml) and open it.

Create a new project: enter the workspace folder and the project name to initialize a MitiConnect project (create output folders and project file).

Save project as: save the project in a new file (.xml) or in an existing file which will be overwritten.

Save project: saves the project in the .xml file already created (*projectFile* table field).

1.7 Video tutorials

Video tutorials illustrating step-by-step use of the tool are available at: https://www.youtube.com/playlist?list=PLh9oFe6PuPCUC2RQcDhRgl9oGP0tj91sv

1.8 Available data

An inventory and identification of available data ensures that the layers are assembled and that a synthetic, complete and relevant land use map is produced.

Various data sources can be used and combined in the background, for instance :

- Cesbio's LUO[4] covers all French departments,
- Regional data such as the MLU[5] in Ile-de-France, the OCSGE2[6] in Grand Est...,
- Urban Atlas[7] covering all major European metropolitan areas.

These data, complete and homogeneous over large study areas, can (and must) be supplemented by more precise data available on the whole the French territory:

- BD Topo® from IGN[8] ,
- Registre Parcellaire Graphique (RPG)[9] , farming parcels register,
- Local inventories of vegetation, wetlands, ponds or other remarkable habitats, etc.

The use of CORINE Land Cover data is strongly discouraged regarding data quality (1/100,000th).

[4] https://www.data-terra.org/actualite/produit-theia-oso-2020-nouvelle-carte-doccupation-des-sols/
[5] https://www.institutparisregion.fr/referentiels-geographiques/mode-doccupation-du-sol-mos/
[6] https://ocs.geograndest.fr
[7] https://land.copernicus.eu/local/urban-atlas/urban-atlas-2018?tab=download
[8] https://geoservices.ign.fr/telechargement
[9] https://www.data.gouv.fr/fr/datasets/registre-parcellaire-graphique-rpg-contours-des-parcelles-et-ilots-culturaux-et-leur-groupe-de-cultures-majoritaire/

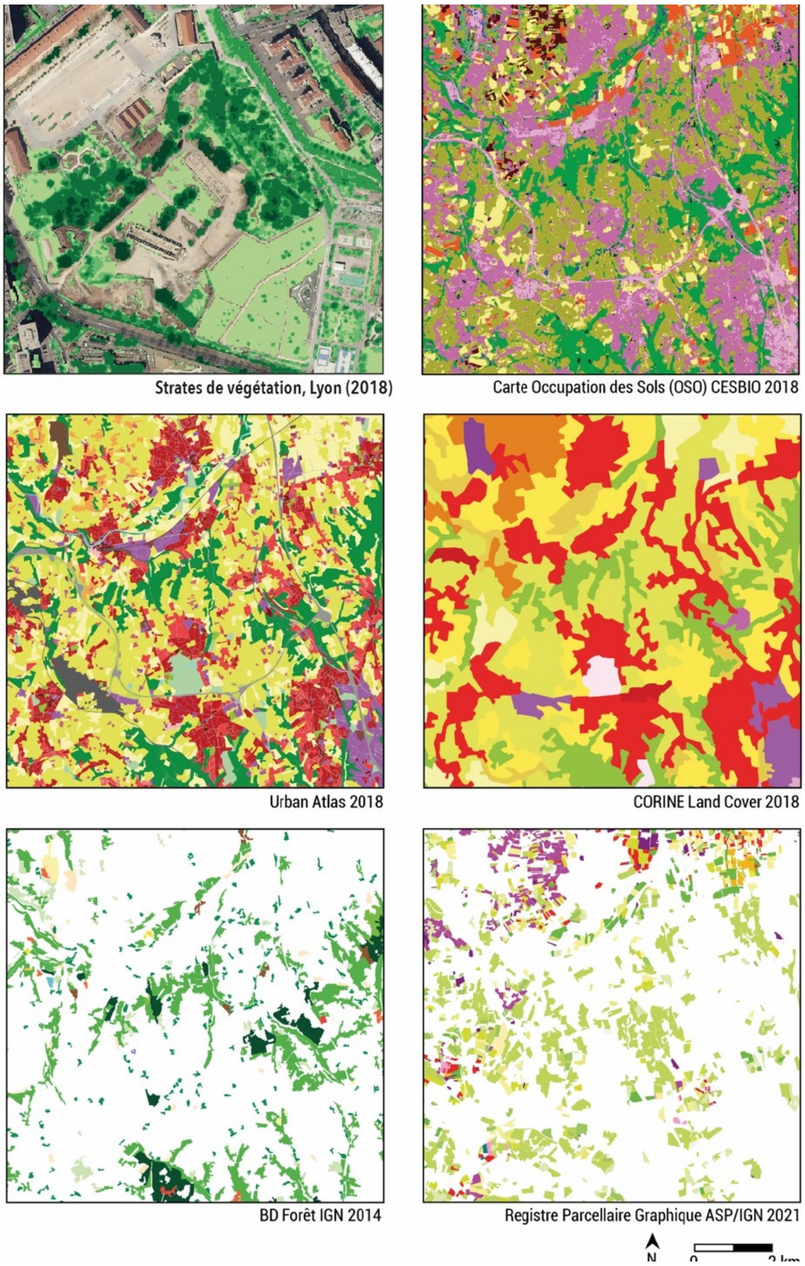

Figure 3: Illustrations of various complete and partial land-use databases. Taken and modified from Bourgeois (2023)

2 MitiConnect step by step

2.1 General parameters (tab *1-Parameters*)

First step is to define the analysis framework. All parameters must be specified to enable processing. Workspace folder must be specified before further steps.

Specified parameters are displayed in the bottom table of this tab.

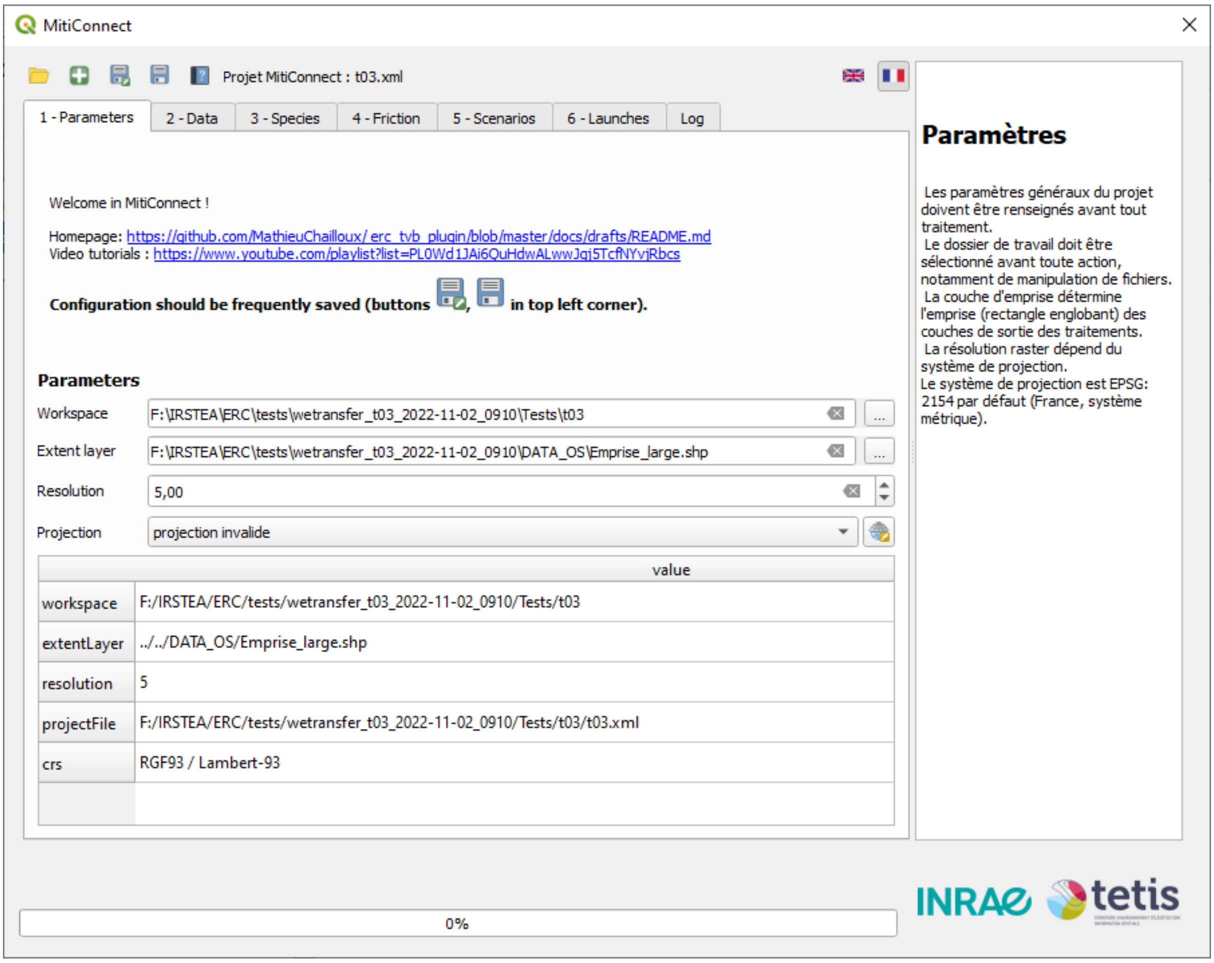

Figure 4: Tab 1 - General settings

The elements to be filled in are as follows:

- **Workspace**: folder path in which the project and data outputs will be stored. It is best not to change workspace during the project.
- **Extent layer**: represent the study area boundaries. The spatial extent of the study must take into account the spatial configuration of ecological networks and the maximum dispersal capacity of species, to avoid any bound effect[10] . It is therefore advisable to apply a buffer area of at least 1.5 × the dispersal capacity of the most mobile species around the project or its geographical variants, or even more if the aim of the study is also to find *ex-situ* compensation sites. Note that if the study area is underestimated at this stage, the project and associated modelling should be re-launched.

[10] Bound effect occur when spatial analyses include the vicinity of the studied perimeter in their calculations. The absence of information in the vicinity can be a source of bias (underestimation of the stakes).

- **Resolution**: size of the pixels, expressed in meters, for all raster layers of the[11] project. Spatial resolution depends on scale and computing capacity. High resolution (low pixel size) refines the results, but increases computing time and requires greater computing capacity, especially if the study area is large. Depending on the scale, a resolution of between 5 and 10 m is recommended.

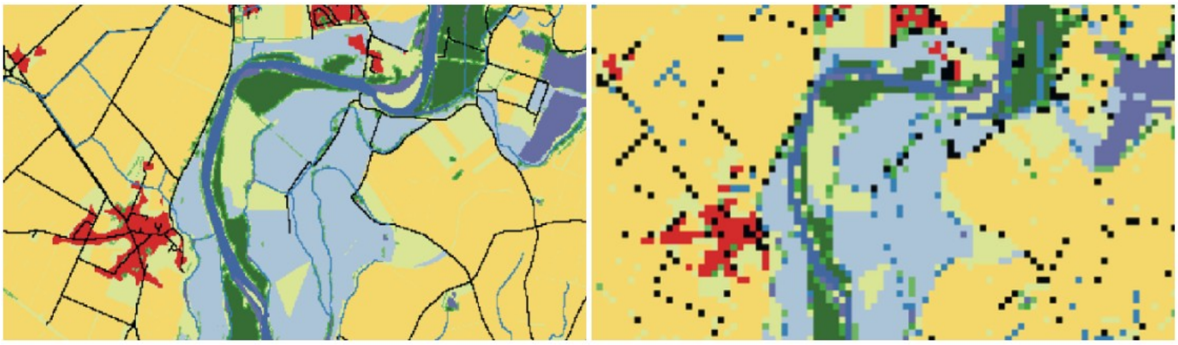

Figure 5: Land use map at 10m (left) and 50m (right) resolution. The representation of linear and/or small objects is strongly degraded at 50m resolution. Taken from Clauzel et al., 2020.

- **Projection**: reference coordinate system (default is EPSG:2154 / Lambert 93). The system must be a metric projection .

2.2 Import land use data (tab *2-Data*)

This step is used to import input data and standardize it in raster format with the same resolution and extent, so that it can be properly aligned.

If you already have a complete land use map, you should still import it at this stage and then proceed to next step. Alternatively, you can create land use maps directly in MitiConnect by merging several imports, for instance to take account of linear features (cf. 2.2.3) and species-specific environments.

This tab is divided in several steps:

1. Import land use data

   1.1. Set import parameters by pressing or depending on layer format (vector or raster).

   1.2. Press Import button to start importing. Results are loaded into the Imports group,

2. (Optional) If needed (see above) create one or more land use layers.
It may be a good idea to create several land use maps depending on the target species, for example distinguishing forest environments only for some of them.

   2.1. Press button and set the layer creation parameters

   2.2. Press button to create layer(s)

3. Check imports and reclassification parameters in *Classes* table. You can change the new value and add a description.

[11] The land use map is produced in raster format. This implies a simplification of reality to a given pixel for which a single type of environment is associated.

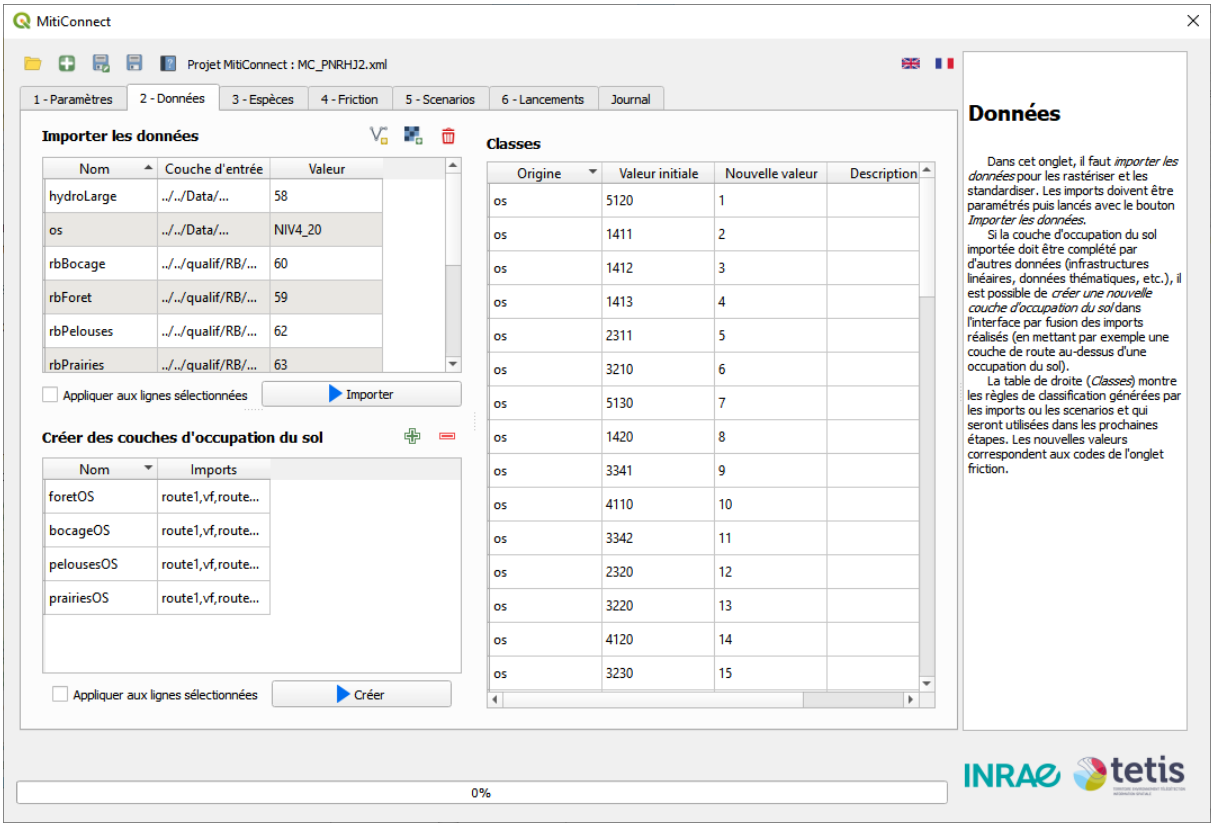

Figure 6: Tab 2 - Data

2.2.1 Vector data

- Enter import **name**. Output layer is named after it.
- Select source vector **layer.**
- (optional) If needed, define a **selection** expression. Only matching features in the source layer will be selected for import. The expression editor on the right helps user to build such expression.
  For example: "WIDTH" = 'From 0 to 15 meters' for a watercourse
- Define **rasterization mode** :
  - By **Field value**: each unique value of this field will be considered as a specific class. **Keep original values** option ensures that reclassification keeps the same values if the field is numeric.
  - By **Fixed value**: all features will be associated with this value
- The **all pixels touch** option ensures that rasterization does not create artificial discontinuities for linear data such as roads (see Figure 7).
- The **buffer** option allows you to apply a buffer area to the input layer before rasterization.

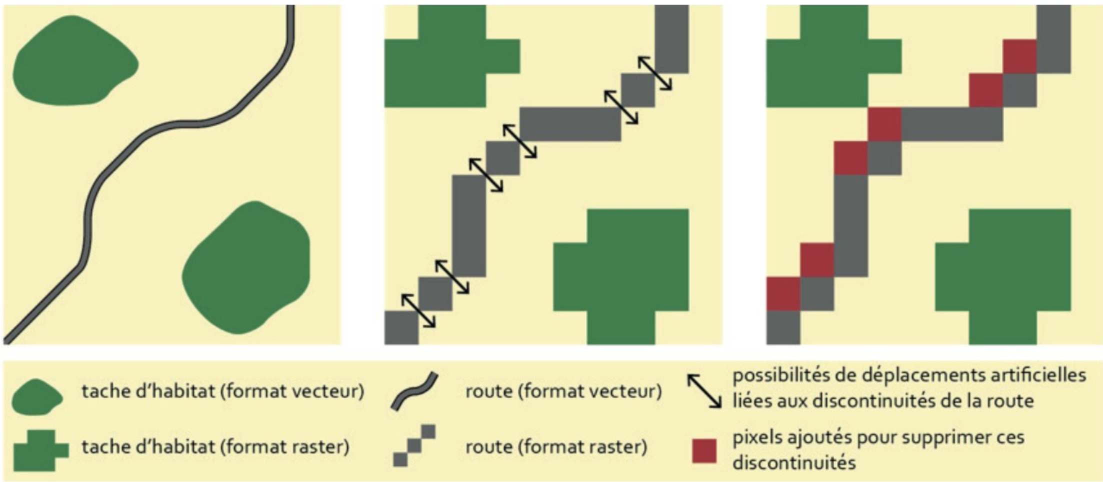

Figure 7: all pixels touch option

2.2.2 Raster data

- Enter import **name**. Output layer is named after it.
- Select source raster **layer.**
- **Keep original values** option ensures that the reclassification keeps the same values.
- Input raster layer is resampled with nearest mode.

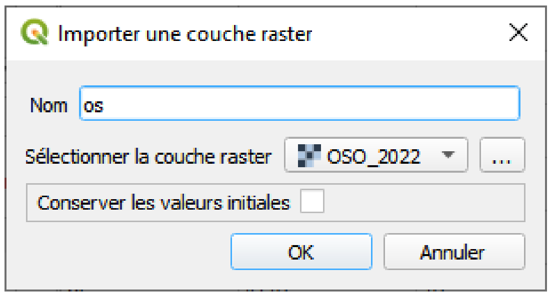

Figure 8: Import raster data

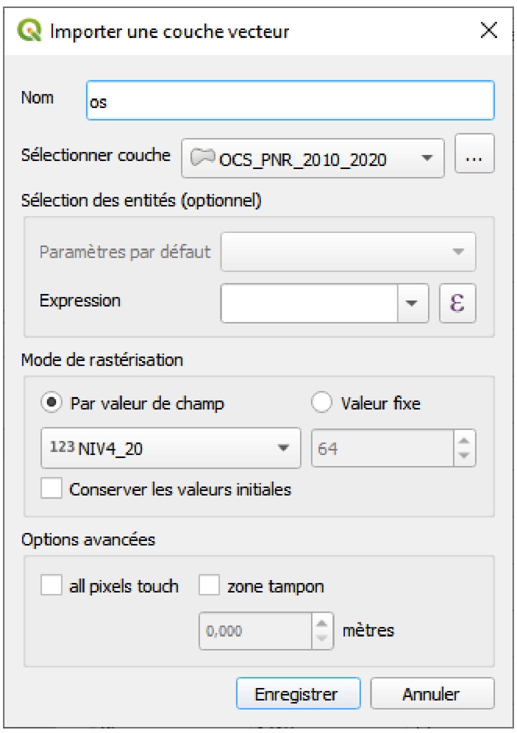

Figure 9: Import vector data

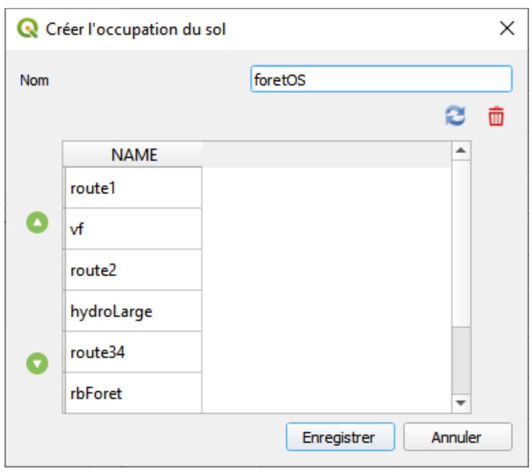

Figure 10: Create new land use layer

2.2.3 Create new land use layer

- Enter layer base **name**.
- Below table contains import names list. If some imports are missing, press the button to **reload** the list.
- **Delete** imports not required for current layer creation. Select unwanted imports and press the delete button.
- **Rank** imports. Select target import and press arrow buttons to upgrade or downgrade it. Output layer is produced by imports merge, according to specified ranking (above import will erase below ones).
  For example, linear features should be placed on top of the land use base layer. To deal with roads and watercourses crossings:
  - *For an amphibian, the road (on a bridge or culvert) is not always an obstacle, as the species can follow the watercourse. In this case, the road network can be placed below the watercourse;*
  - *On the other hand, for other species (land mammals, birds, etc.), individuals will be more directly affected by the road, which may represent an obstacle. In this case, the road can be placed above the watercourse.*

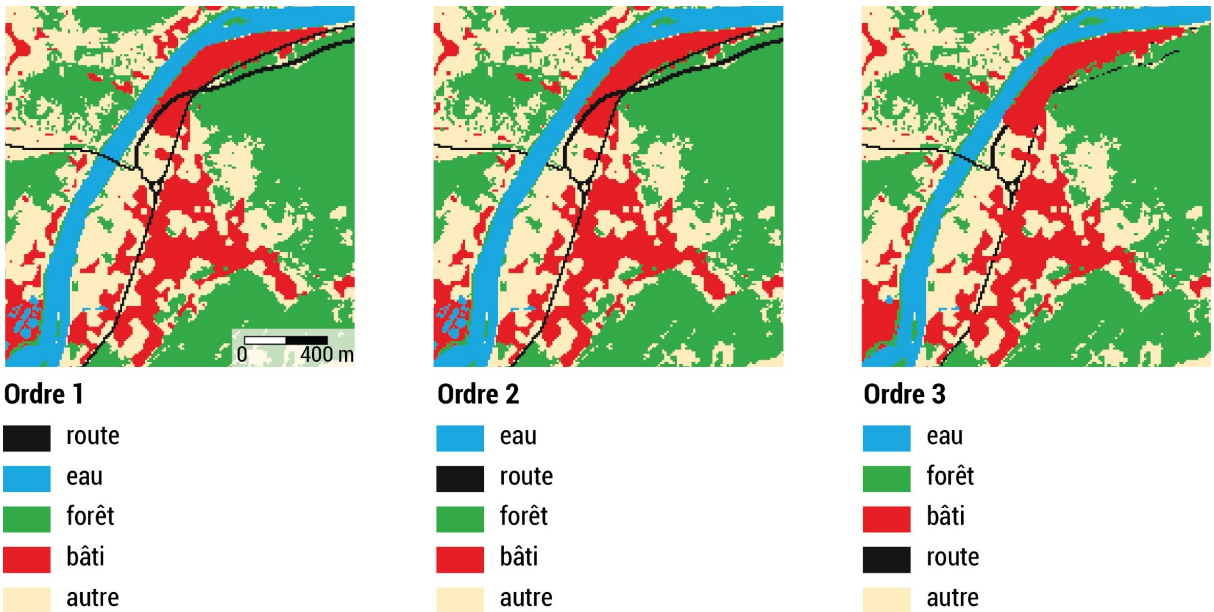

Figure 11: Examples of simplified assembly of land use data from different sources. Taken from Bourgeois (2023)

2.3 Definition of target species (tab *3-Species*)

As the analyses based on landscape graphs are species-centric, this third step is to define target species with their ecological parameters.

To add a species, press the "+" button and enter the following parameters:

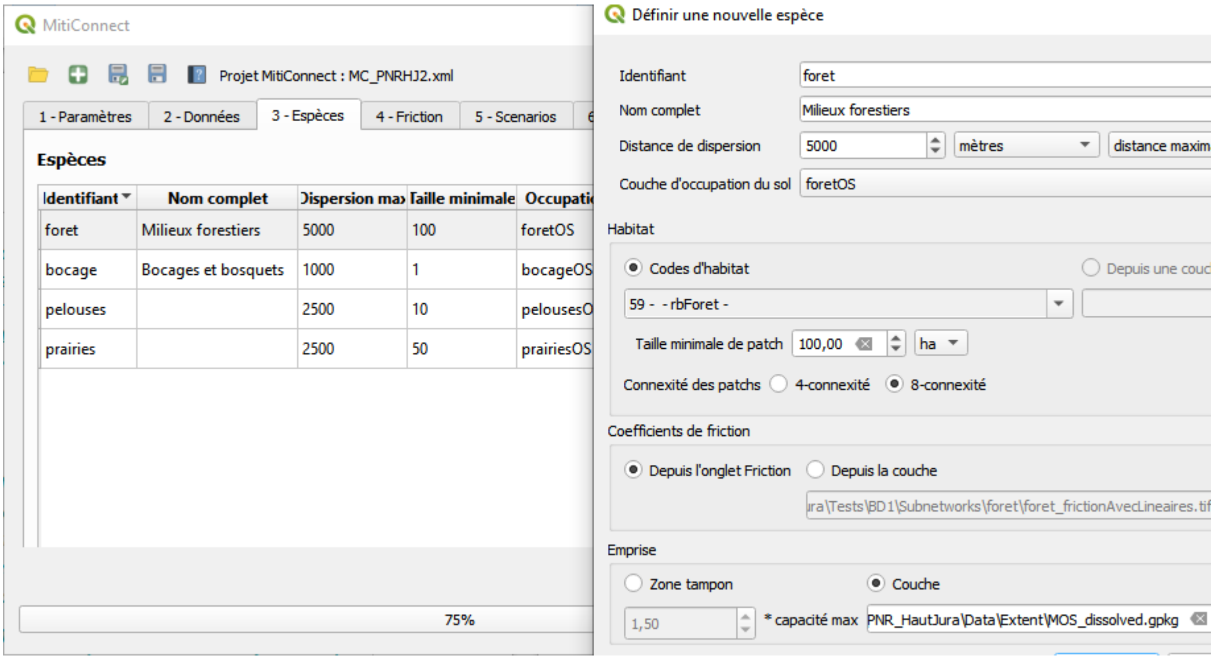

Figure 12Tab 3 - Species

- The species **identifier** and optionally its **full name.**
- **Dispersal distance.** Maximum distance is the distance the species can cover during interpopulation exchanges[12] . The average distance is more a daily movement. It is easier here to find bibliography on the maximum dispersal distance of the species[13]. If the distance is expressed in meters, Graphab will translate it into cost units by linear regression. It is also possible to express this distance directly in cost units to compare 2 scenarios under the same conditions.
- **Land use** or import name used for this species (cf 2.2.3)
- **Habitat codes**, i.e. land-use categories as reclassified in step 2, matching a habitat environment. Matching features will be dissolved to build patch layer.
- **Minimum patch size**[14] for the species to complete all or part of its life cycle. Patches smaller to this size will be excluded. It is a good practice to set a minimum value even if this information is not know to avoid isolated pixels being identified as nodes in ecological networks.
- **Connexity** defines the way patches are formed, considering 4 or 8 adjacent pixels to be part of the same patch.
- By default, **coefficients** are defined in the *4-Friction* tab, but they can also be imported from an existing layer.
- By default, **the extent** is a buffer area of 1.5 times the maximum dispersion around the project extent (see later in Tab *5 - Scenario*), but it can also be defined from a layer.

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[12] Ecological network modeling at the dispersal scale is the most common approach to population viability.

[13] Several metrics include a weighting in their calculation, where distances between spots are converted into probability of movement. Here, the software takes into account a low p-value (0.05).

[14] The capacity of a spot reflects its "intrinsic quality", considered as an indicator of its demographic potential. A spot's capacity is expressed by its surface area.

***SPECIES SELECTION**: Given the large number of species that may be affected by a given project, it is necessary to specify the species for which a quantitative approach to ecological continuities is relevant and/or useful. The number of target species depends on the objectives of the study, and will not be the same if we are interested in ecological continuities specific to a species with high stakes (regulatory, conservation, etc.) or in a broader biodiversity strategy. Several strategies exist, and the most common are umbrella, focal and mosaic species (Albert and Chaurand, 2018). Target species must be sufficiently numerous and complementary considering the environments (wooded, open, cultivated, aquatic, etc.), dispersal capacities (low to high) and life-history traits (type of reproduction, dispersal strategy, etc.). Species for which we have a good knowledge of their ecological requirements (based on bibliography or expert opinion) are preferable, in order to be able to fill in friction costs more easily in the next step (tab 4-Friction). Species list should also take into account locally available data (collaborative databases: naturalist associations, Atlas, INPN, etc.).*

2.4 Definition of friction values (Tab *4-Friction*)

Ecological network modeling using landscape graphs is based on the notion of environmental permeability, i.e. the ease with which a species can move through an environment.

This permeability is expressed by a numerical value called cost or friction value, which represent the energy required to pass through the environment. The lower this value, the more permeable the environment, making it easier to move.

Absolute value of these costs is not important; it's the ratio of proportionality between each friction class that determines that an environment A is, for example, 5 times more permeable than an environment B. However, the difference between classes must be clearly marked to avoid all environments to be equivalent for the species.

The numerical values of these costs must be strictly positive integers. If no value is specified, this land use category will be ignored for the matching species.

Coefficients can be filled in directly in the table, or via a CSV file (spreadsheet) using the buttons at the top left of the table.

If some values appear to be missing, press the refresh button to reload the entire table.

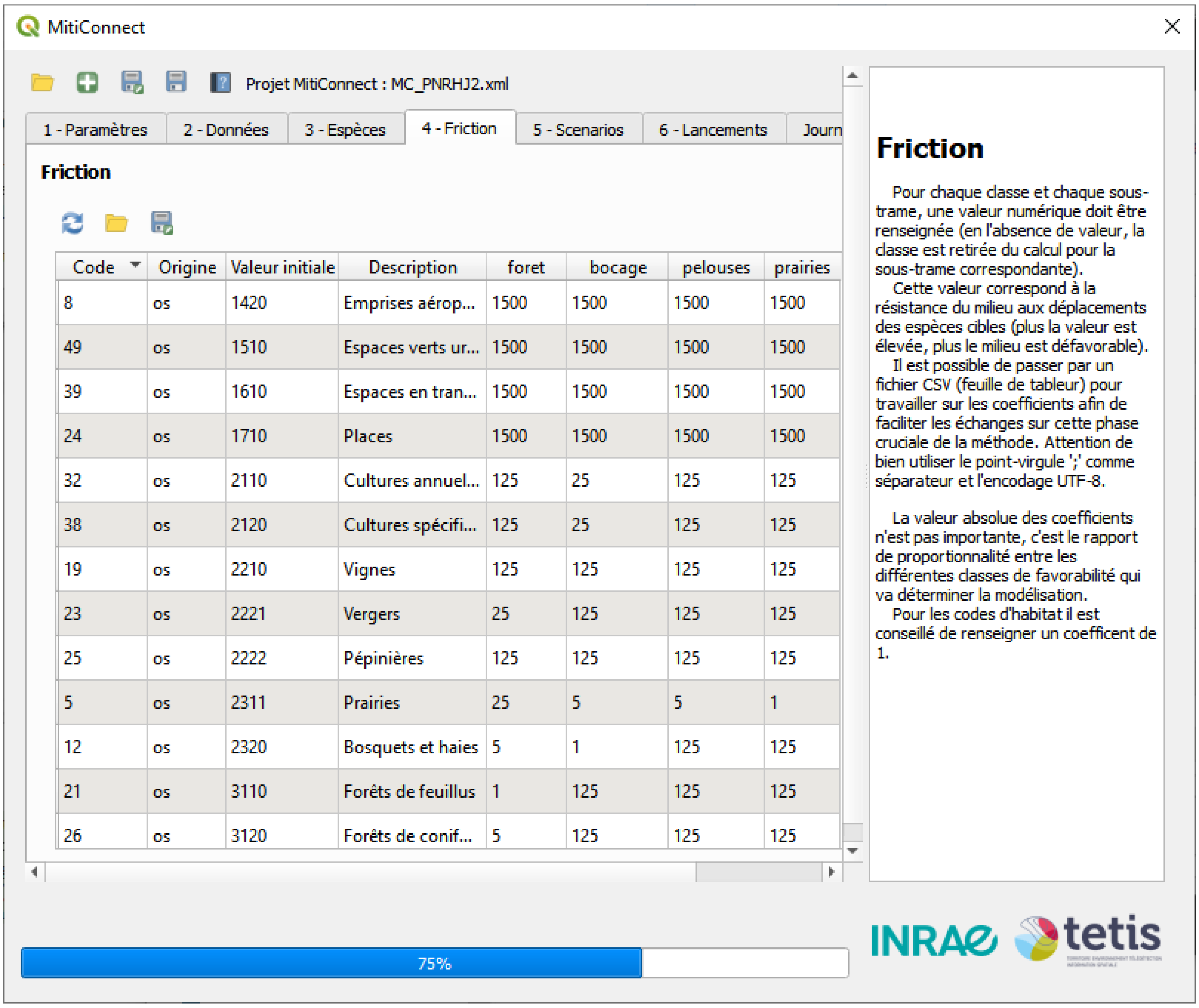

Figure 13Tab 4 - Friction

FRICTION VALUES *There are currently no "standardized" friction values database. INRAE is currently working on some guidelines for species selection, with information on dispersal distance parameters. However, the results should be treated with caution, as the approach is generic and significant variations have been noted between project types and countries studied. This work will not be a final result but should serve as an aid, to be thought through according to context.*

Théma laboratory in Besançon is currently looking into this matter to build a participatory library where anyone can present his or her methodological protocol in relation to a given context, initial problem, etc.

In the meantime, a number of bibliographical studies have been carried out to help define costs by interpreting biological knowledge in terms of movement capacity in different types of environment. These include, for example, the sheets drawn up by the MNHN and the OPIE on 39 species proposed for the French ecoloigcal network resource center, or those produced by the PACA DREAL and Regional Council on the national coherence species present in the region.

2.5 Scenario definition (tab *5-Scenarios*)

Scenarios are defined as land use changes representing a stage of Avoid-Mitigate-Compensate sequence (French policy for impact studies):

- Initial state
- Avoidance scenario, e.g. to test different possible extents for a linear transport infrastructure (LTI) project
- Mitigation scenario, e.g. to test different wildlife crossing locations across an LTI
- Compensation scenario, e.g. to test the installation of new hedges

The initial scenario is already present in the interface. Other scenarios are defined by "stacking", i.e. based on an existing scenario.

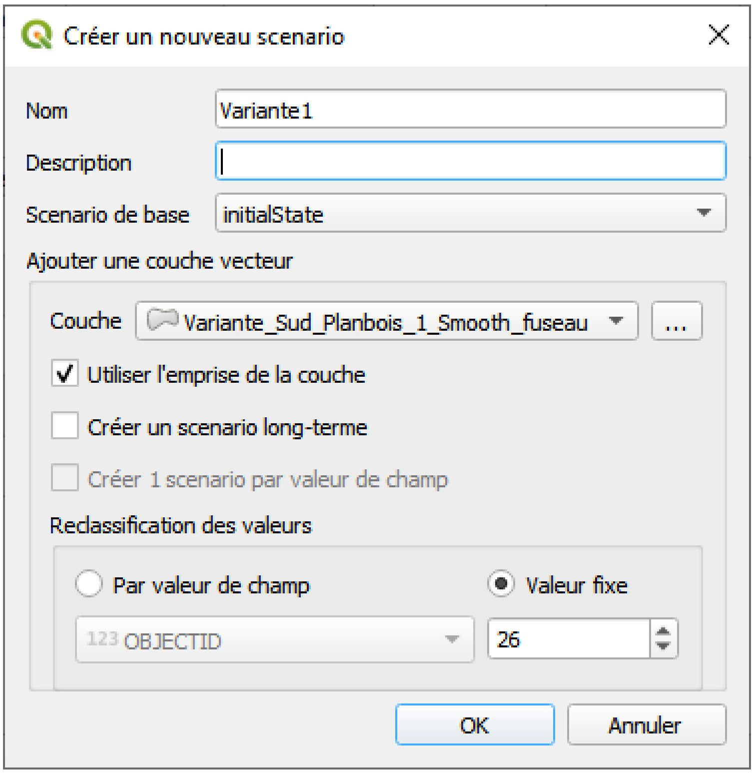

Figure 14: Create new scenario

To define a new scenario, specify:

- Scenario **name of** (a short identifier), and if needed a more complete **description.**
- **Base scenario** on which the land use changes will be applied
- Scenario **layer** containing the extent of the land use changes
- **Use layer extent** option specifies that the study area will be centered around the previous (land use changes) layer, according to the parameters specified in step 3 for the species concerned.
  If several stacked scenarios use this option, their extents are dissolved.
- **Create a long-term scenario** option can be used to duplicate scenario in cases where land-use changes are not the same in the short and long term, typically for compensation actions where the implanted environments are not functional for several years.

- **Value reclassification** defines to which land use classes (*Code* column in the *Friction* tab / *New value* column in the *Data* tab) are associated scenario layer features.
    - **By field value**: unique values of specified numeric field matches land use classes. If these values do not match land use classes, they can be modified later in the *Data* tab.
    - **Fixed value**: all features will be reclassified to this value.

2.6 Processing launches (tab *6-Launches*)

This last tab lets you manage launches for each scenario and species.

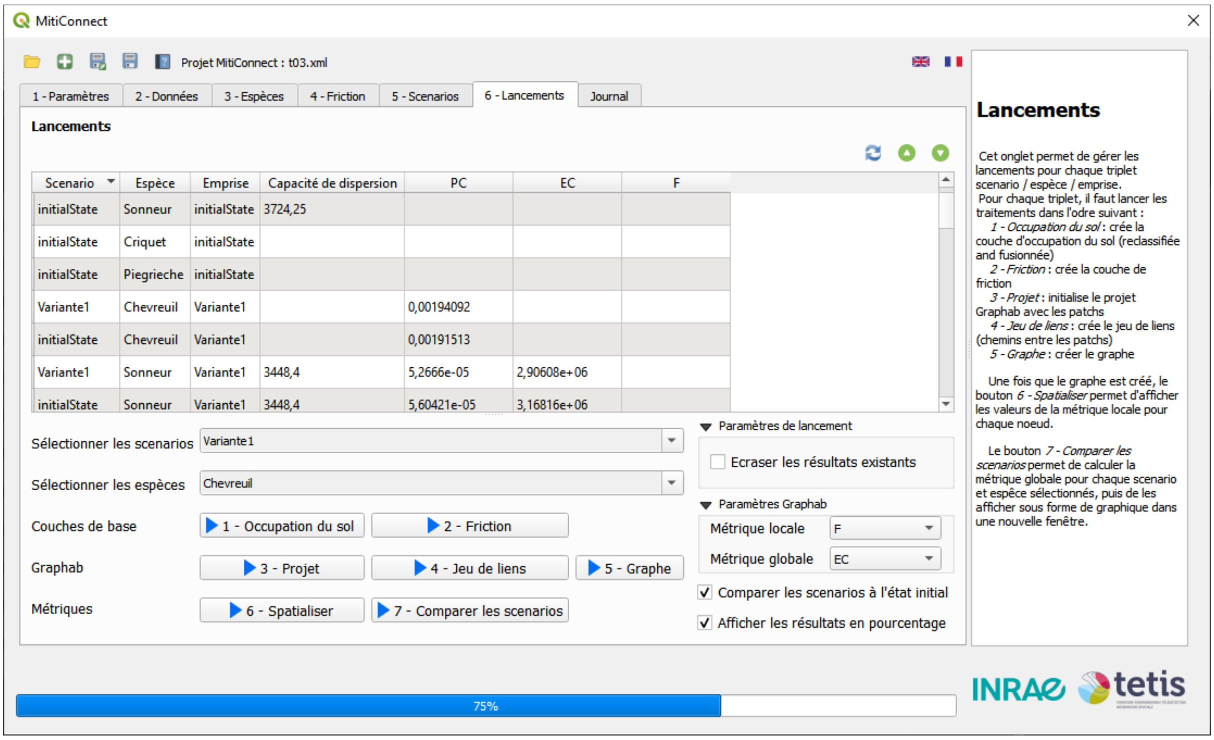

Figure 15Tab 6 - Launches

The table is filled in automatically from the other tabs. Each line conntains to a scenario / species / extent tuple and displays additional information:

- Dispersal capacity computed by Graphab when computing links set, expressed in cost unit. This capacity must be the same to compare 2 scenarios for a given species.
- Global metrics calculated at the scenario comparison stage

Initial state scenario for a specific species is duplicated for each extent to enable comparison under the same conditions (extent and maximum dispersal capacity). When a step is launched for a variant/species pair, it is also launched for the species' initial state with variant extent.

Erase existing results overwrites existing results if existing to ensure a clean re-launch.

To start launches, select scenarios and species, then press a step button:

1 - **Land use**: Clips reclassified land use layer to matching extent boundaries

2 - **Friction**: reclassifies land use to a friction layer according to the *Friction* tab

3 - **Project**: initialization of Graphab project and identification of patches (biodiversity reservoirs)

4 - **Linkset**: calculates all link sets, i.e. the shortest paths between patches. Each link contains its metric length and its cumulative cost (friction values sum of the pixels crossed).

5 - **Graph**: builds landscape graph by keeping only those links whose cost distance is less than maximum dispersal capacity. The graph represents patches in the form of circles whose size depends on capacity (in this case, area), and selected links in the form of segments. The *Components layer* displays connected components, i.e. interconnected sub-networks.

6 - **Spatialize**: computes specified local metric for patches and displays the result as a colored legend.

7 - **Compare scenarios**: computes specified global metric for each landscape graph and opens a window with a graph displaying difference of metric value between selected variant and initial state, expressed in percentage.

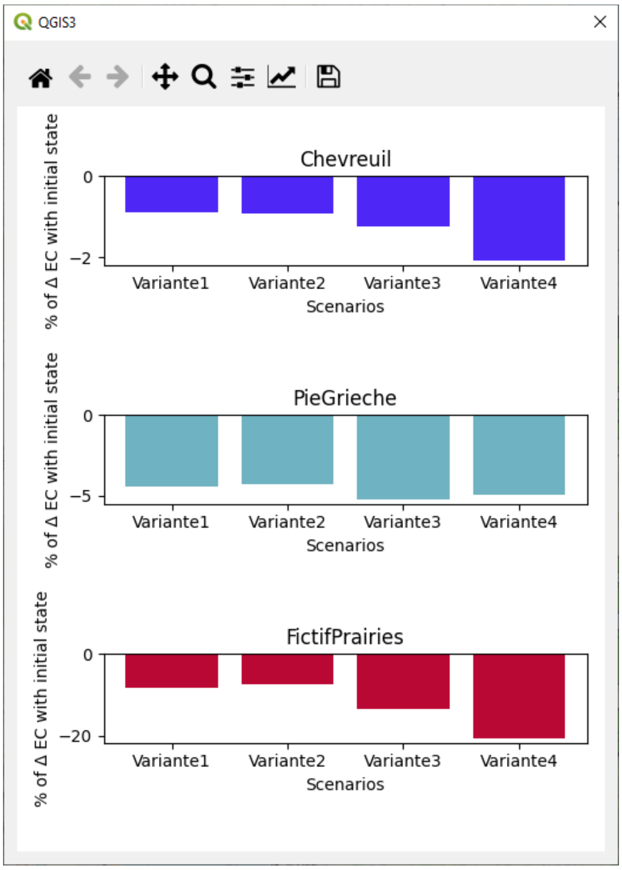

Figure 16: Scenarios comparison

METRIC INTERPRETATION: *Caution for use: Weighted metrics, whether global or local, take into account the distance between habitat patches and their capacity. As their results are rather complex to interpret, the values must be interpreted by comparing them to each other (spot X has a greater connectivity value than spot Y), and not as a single result (knowing that spot X has an Interaction Flow value of 0.8653 doesn't tell us whether this value is strong or weak).*

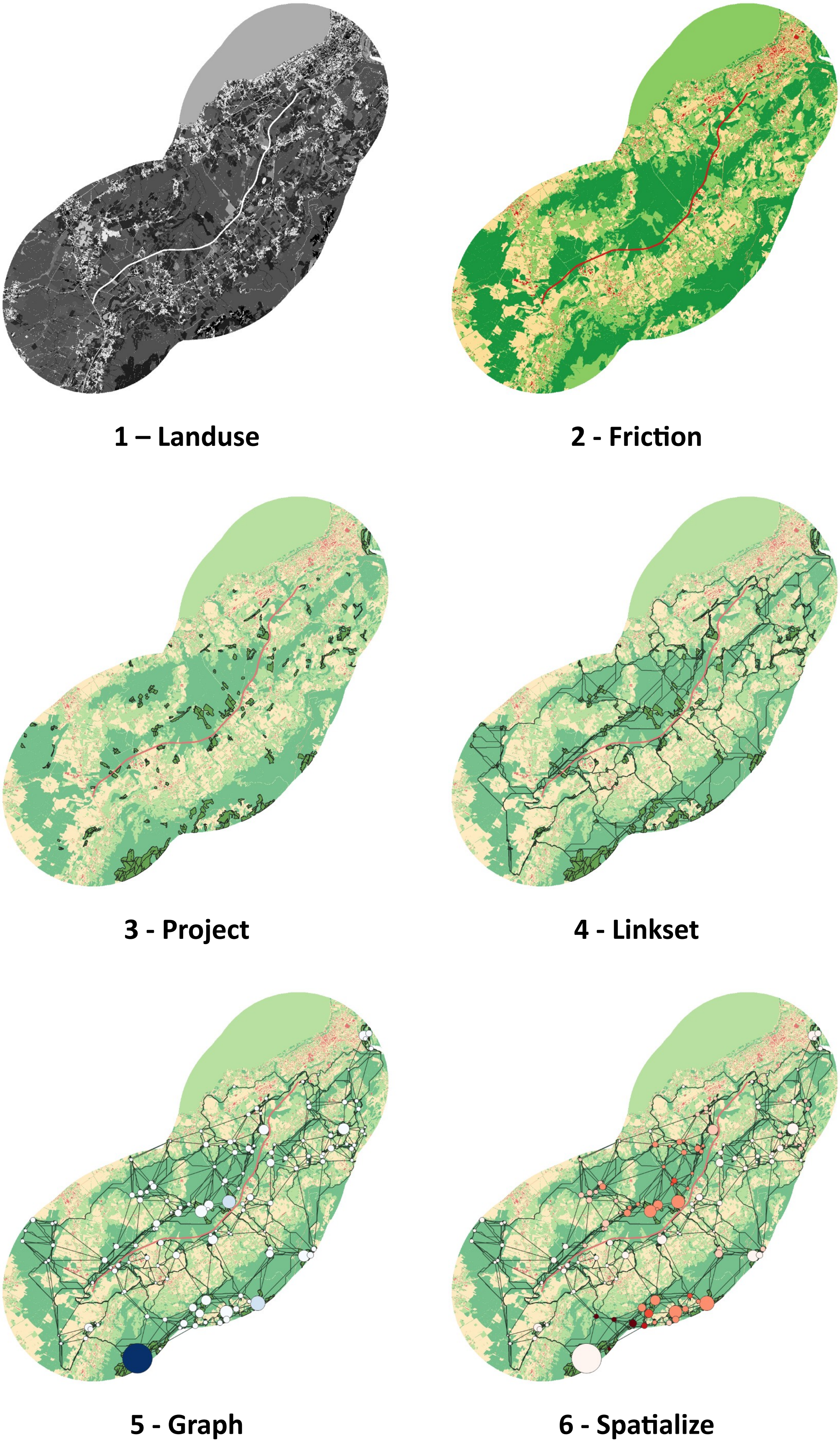

Figure 17: Launches results

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