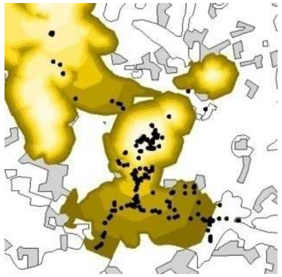
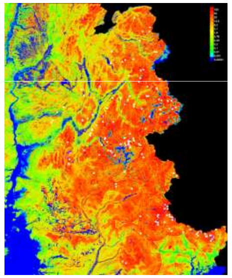
Connectivity and landscape patterns in human dominated landscape

a case study with the common frog Rana temporaria


Samuel Decout, Stéphanie Manel, Claude Miaud, Philippe Delcros, Sandra Luque

Cemagref Science, water & land management

LECA Laboratoire d'Ecologie Alpine

FRAGMENTATION & CONNECTIVITY LOSS

A major threat for biodiversity conservation and landscape ecological functions

MOVEMEMT ACROSS THE LANDSCAPE MATRIX:
A KEY PROCESS FOR PLANT AND ANIMAL SURVIVAL

(Wiens et al. 1993)

Jose Luis Rodriguez

MAINTENANCE AND RESTORATION OF LANDSCAPE CONNECTIVITY

A major concern in conservation biology and land planning

(Pascual-Hortal and Saura 2008)

LANDSCAPE CONNECTIVITY

Defines the degree to which the landscape facilates or impedes movement among ressources patches

(Taylor et al. 1993)

SPECIES SPECIFIC AND FUNCTIONAL

Dispersal distances and behavioural response to physical landscape structure

(Tischendorf & Fahrig 2000, Saura 2009)

GRAPH THEORICAL APPROACHES

(Urban & keitt 2001, Pascual-Hortal & Saura 2006, Minor & Urban 2007)

A growing tool for studies and plannings focused on viable habitat patches consideration in relation with a need for large landscape connectivity

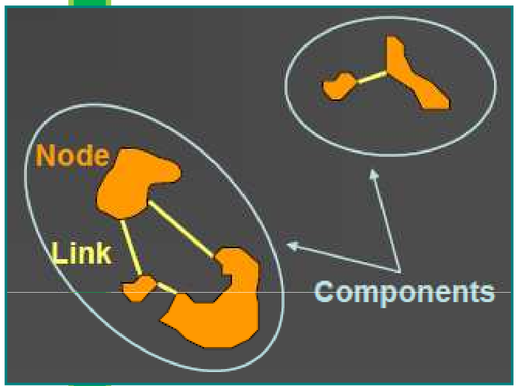
GRAPH THEORICAL APPROACHES

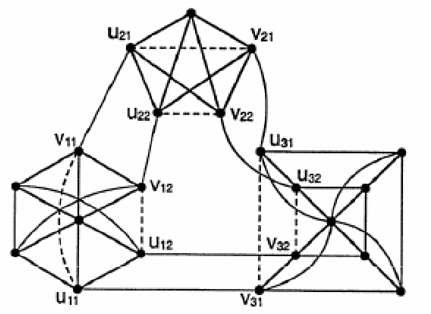
Best effort ratio and pragmatism for conservation problems dealing with connectivity

(Fagan and Calabrese 2004)

Landscape ecology	**Graph ecology**
Landscape mosaic	Graph
Habitat patch	Node
Functionnal connection	Link
Connected region	Component

(Saura, IALE UK 2009)





Quantification of patches importance for connectivity with consideration about habitat availaibility and species ability to cross the landscape matrix

Concepts and pratice well adapted for studiing connectivity with amphibians

Amphibians life cycle:

Seasonal migrations between terrestrial and aquatic habitats

aestivation
& wintering

reproduction

Constrain them to regularly cross an inhospitable landscape matrix

The case of the Common frog *Rana Temporaria*

A widespread amphibian in Europe migrating between
forest habitat and aquatic habitat for breeding

**A connectivity sensitive species depending
on forest patches availability around the pond**

AIM OF THE STUDY

To test and provide a method based on habitat patches distribution and configuration in order to assess how the landscape matrix and ressources patches affect habitat availability and landscape connectivity

METHODOLOGY

1 – Habitat suitability/availability mapping:

Prediction of frog occurrence with Maximum Entropy modelling approach

2 – Quantification of connection between ponds (nodes) in relation with landscape matrix permeability:

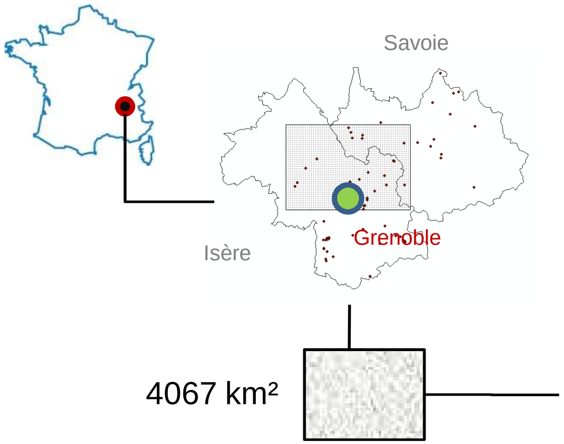
Least cost modelling approach

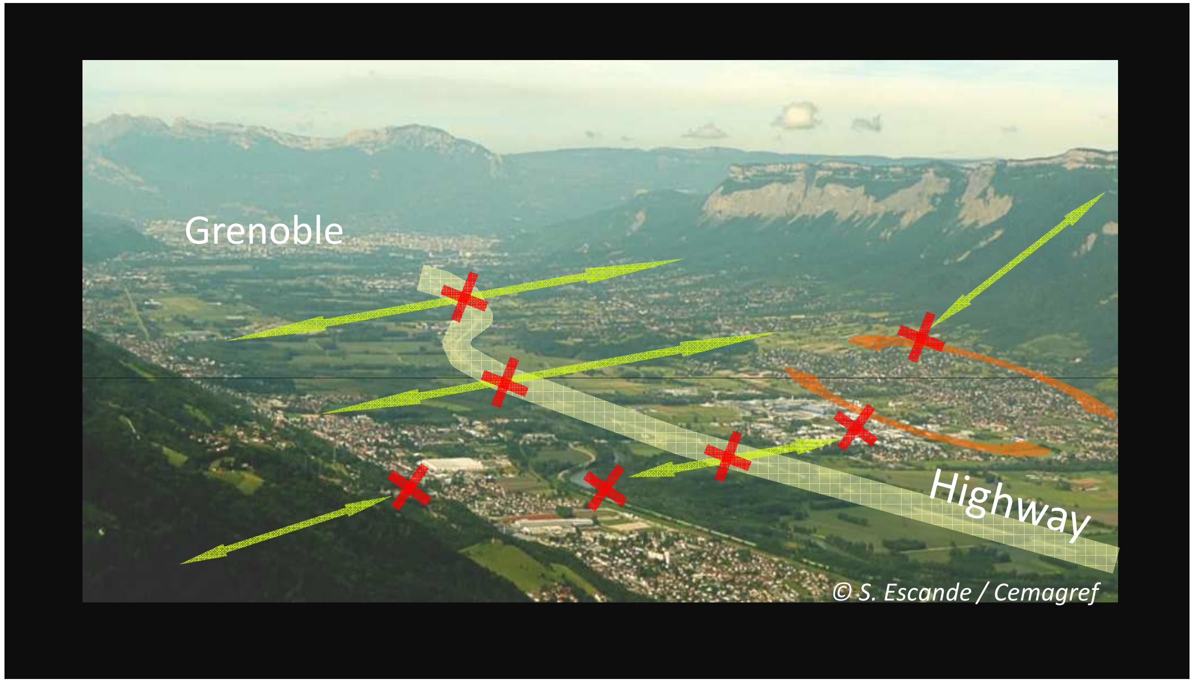
3 – Connectivity and nodes importances assessment:

Graph theorical approach

Restoring the web of life in the Alps

STUDY AREA: Econnect project's pilot region of the French department Isère

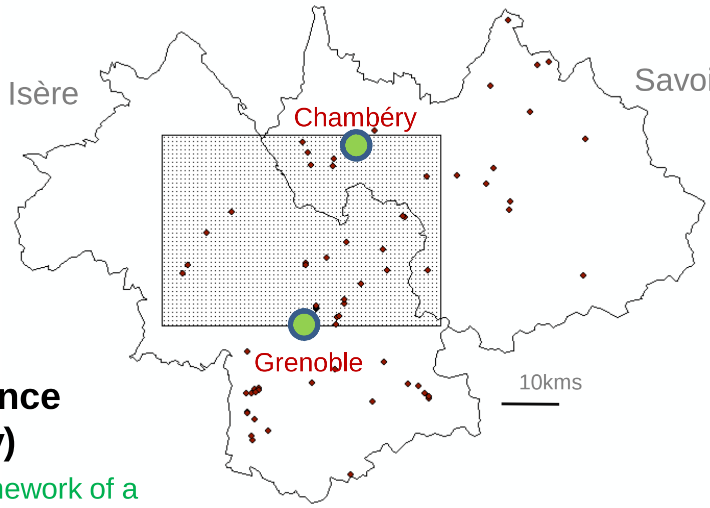




High risks of development of a continuous settlement belt limiting connectivity

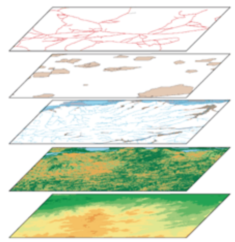
This study is in its first step focused on regional connectivty and barriers identification in the framework of the Econnect project

1 – Habitat suitability/availability modelling



Common frog presence (pond occupancy)

detected and located in the framework of a genetic sampling (Pidancier et al. 2002)



Environnemental variables

(relevant with frog ecological requirements)

-Corine Land Cover 2006
-Slope and elevation
-Distance to rivers
-Forest Patches distribution:
Landscape index computed with the JRC forest/non forest map (res: 25m x 25m)
- Distances to forest patches crossed by a river

MAXIMUM ENTROPY MODELLING

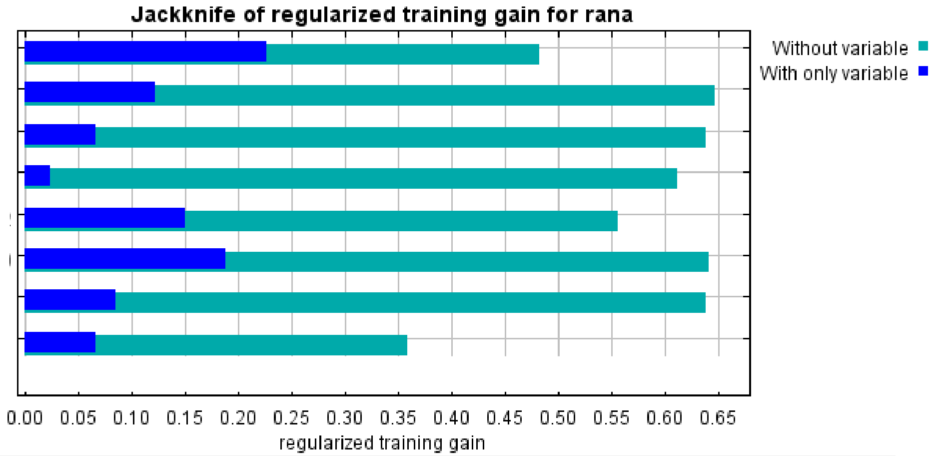
Proabilistic modelling approach based on the ecological niche concept *(Phillips & al. 2004)*
Efficient with low sample size presence dataset *(Baldwin 2009, Kumar et Stohlgren 2009)*

Use of variables describing terrestrial habitat around ponds

47 presence locations used

AUC = 0.874 (training data) – AUC = 0.705 with 15% of the dataset as test data

Elevation
Mean Forest Patch area
Corine Land Cover 2006
Distance to rivers
Distance to forest patches crossed by a river
Largest forest patch Index
Forest patches number
Slope

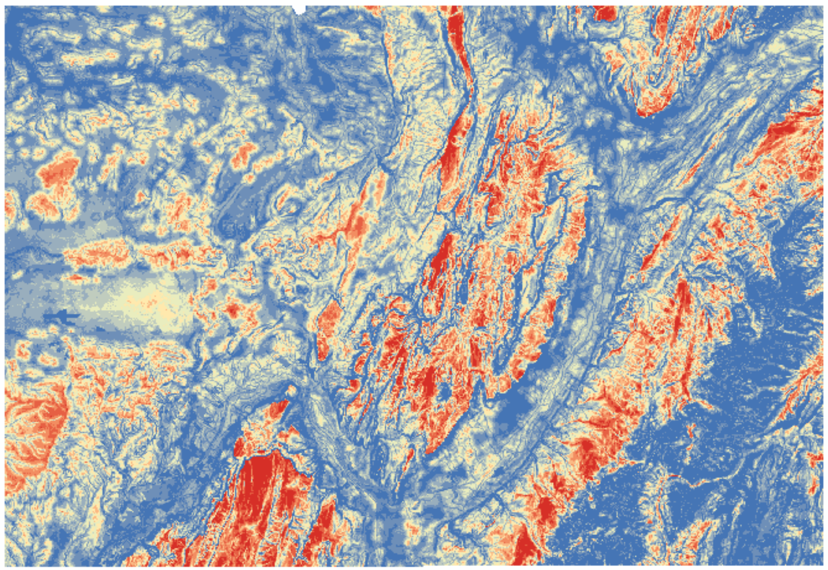


Derived from the JRC forest/non forest map (res: 25x25m²)

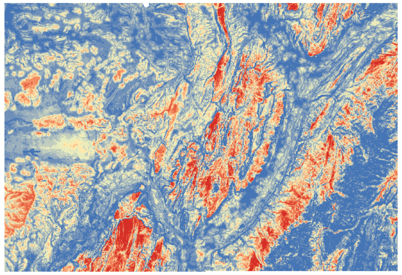
Landscape indices computed with **Fragstat** and the JRC forest/non forest map (moving windows of 1500m)

Common frog probability of occurrence

0.000002332 - 0.077695055
0.077695055 - 0.159087432
0.159087432 - 0.236780156
0.236780156 - 0.314472879
0.314472879 - 0.392165602
0.392165602 - 0.473557979
0.473557979 - 0.562349663
0.562349663 - 0.654841
0.654841 - 0.754731645
0.754731645 - 0.943413973

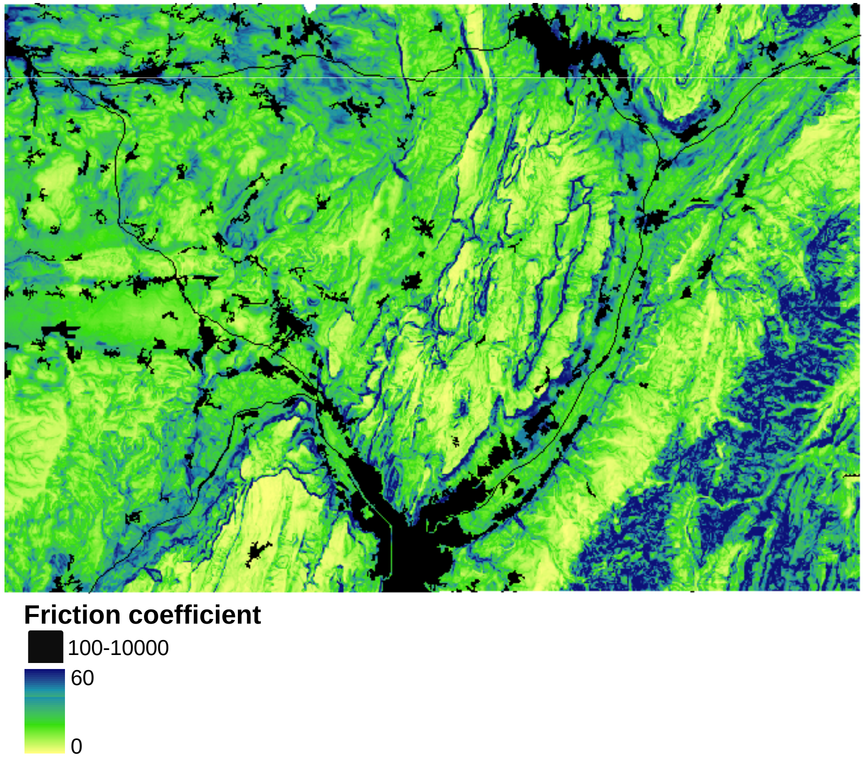


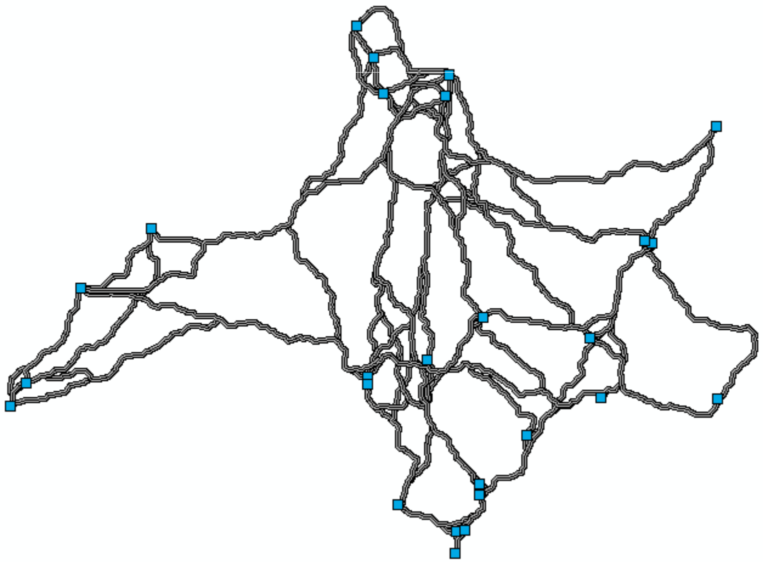
2 – Quantification of connection between ponds (nodes) in relation with landscape permeability



Inverse of the habitat suitability map *(Fulgione et al. 2009)*
+Log transformation
+ Urban zones & highways as barriers (more or less impermeable)

Friction map → **Least cost modelling with pathmatrix (Ray 2005)** → **Least cost paths distances between ponds**





3 – Connectivity and ponds (nodes) importances assessment

Graph theorical approach with the sofware Conefore Sensinode

(Saura & Torné 2009)

Use of the connections between nodes (ponds) quantified by least cost paths

Computation of connectivity index:

-Probability of connectivity

-Integral index of connectivity (IIC):

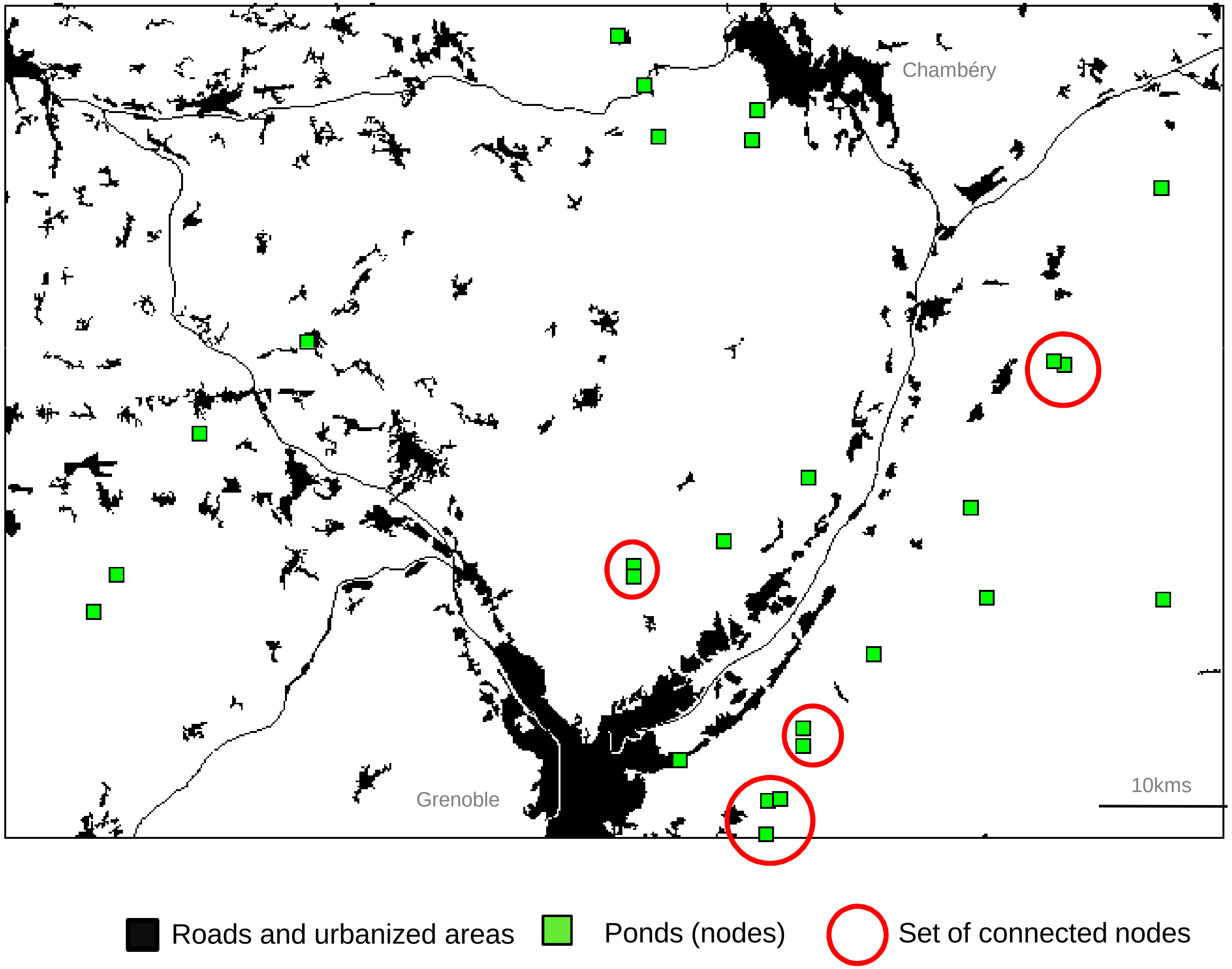
integrating habitat availability and network connectivity in a single measure (Pascual-Hortal et Saura 2008)

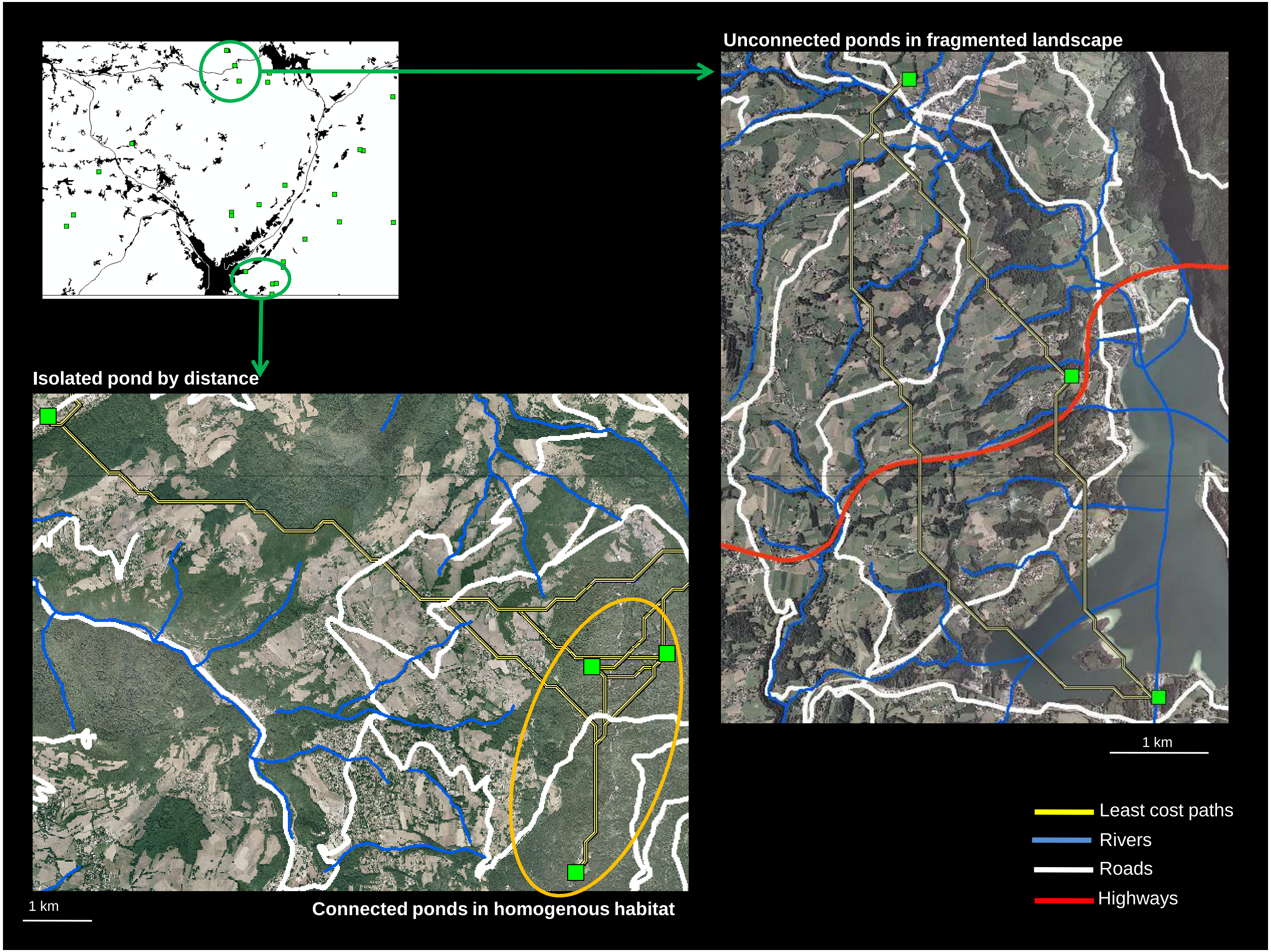
…

3 – Connectivity and nodes importances assessment

Components characterization: connected and isolated nodes

(distance threshold of 3 kms)





Unconnected ponds in fragmented landscape
Isolated pond by distance
1 km
Connected ponds in homogenous habitat
1 km
Least cost paths
Rivers
Roads
Highways

Current assesment of connected nodes limited:

-Missing nodes exist due to the genetic orientation of the sample data

-Need implementation with local pond occupancy location (the work is in progress)

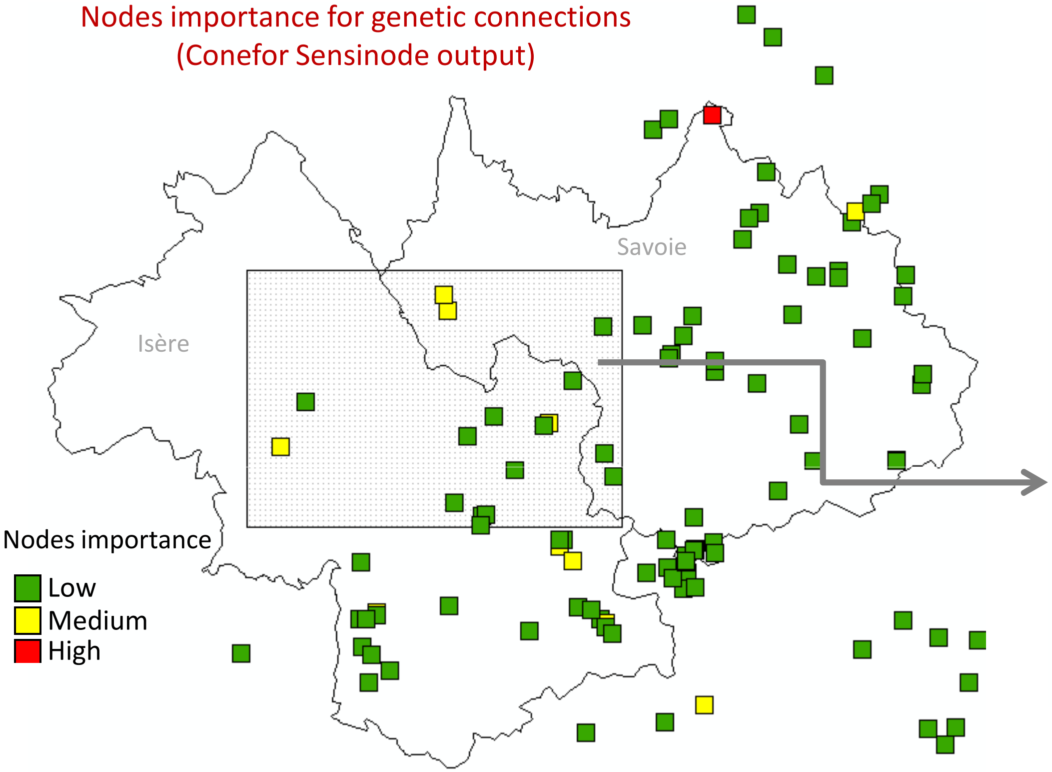
Need for local considerations with knowledge about pond occupancy and local barriers

- Will help to calibrate the friction map

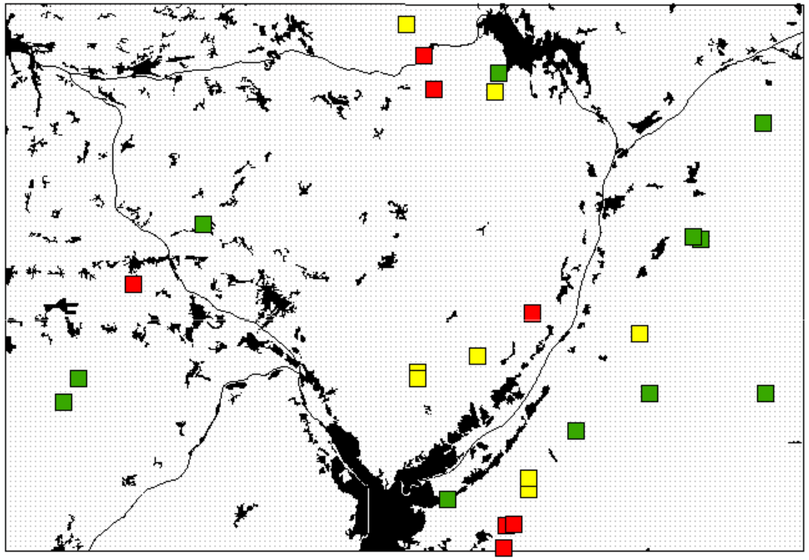
Perspectives:

Consideration of nodes importance from the point of view of genetic and landscape connectivity…

Nodes importance for genetic connections
(Conefor Sensinode output)



Nodes importance for landscape connectivity
(Conefor Sensinode output)



…toward the identification of barriers and corridors between populations

Restoring the web of life

This research is supported and funded by the Interreg Alpine Space Program Econnect