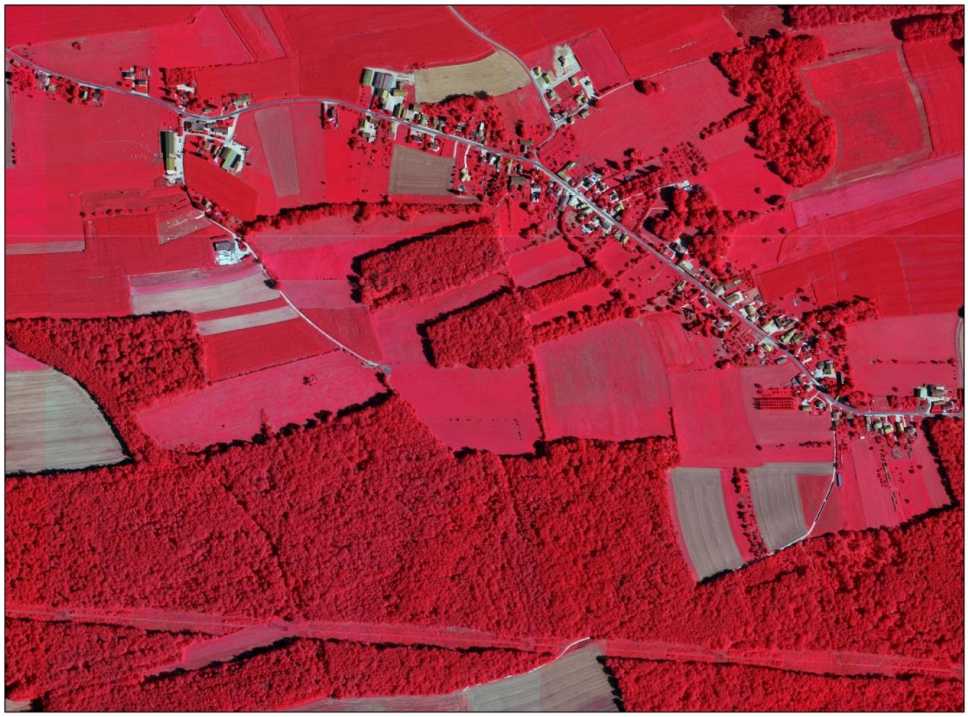
GRECOR



Dynamique Spatiale des Corridors Verts

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Partners: Ecologie et Ecophysiologie Forestières (EEF)

Collaboration: Office National des Forêts, Département RDI

Context — Land development and expansion of anthropic areas have caused the ecological fragmentation of territory, leading to the decline of species. In order to minimize the ensuing damages and to ensure the species viability, the supply of green corridors has been developed. Indeed, biologists have emphasized the need of connecting areas of biological and ecological significance. Thereby, correctly implemented green corridors provide benefits by returning the landscape to its natural connected state; they likewise facilitate the adaptation of vulnerable species to the environmental disturbances.

Objectives — The objective is to analyze the ecological networks under the spectrum of graph theory seen by the optimal control. The ecological network is defined as a connected network of bioreserves and patches linked by the green corridors. The ecological network is composed of bioreserves and patches connected through green corridors. The network is defined as a graph, in which bioreserves, which host the species, are represented by the target nodes provided with an attraction function. The role of patches, which are represented by the unmarked nodes, is to receive the species before redirecting them to bioreserves. We consider a case of complete graph, where the ecological network is fully connected, and a case of incomplete graph, where the ecological network is partially connected.

Approach — When dealing with the species migration through the green corridors, we shall use an ecologically and economically weighted Mahalanobis distance rather than the standard Euclidean distance. We submit the coordinates of the graph nodes to the Laplacian dynamics or the consensus

differential equation. The output of the model is a matrix equation subjected to optimality constraints on the shadow values.

Key results —

- Our results show that the connectivity between ecological zones depends on their ecological similarity.
- At the equilibrium, the ecological network maintains its connectedness while minimizing the impact on timber production on which depend the forest owner revenues.
- Optimization and control of partially connected ecological networks are more expensive than the optimization and control of ecological networks fully connected.
- When the sacrifice in timber production is significant, only partially connected ecological networks should be established.

Main conclusions including key points of discussion — We applied the optimal control properties to a network topology in order to obtain the graph-theoretic characterization of controllability. By doing so, we allowed for the ecological network control. To nuance the last statement, this work has to be considered as initiatory, provided that graph theory is a schematized representation of network patterns. Thereby, case studies related to forest environments should be done. For example, one could value the levels of shadow values, through market-based mechanisms such as auctions, and assess the opportunity costs, through the inventory of forest stands, with a view to reveal the landowners' optimality thresholds.

Future perspectives — The future avenues of research can be classified in two categories. The first category concerns the migratory species, that is, the introduction of population dynamics and migratory flows, in order to estimate the needed sizes of bioreserves and the number of patches that would prevent from the occurrence of congestion. The second category involves the graph topology, through the implementation of probabilistic corridors on random graphs, by reason of the stochastic processes in nature. As the risk of occurrence of exogeneous events, such as storms, fires, pathologies, and floods steps up, the probability of existence of the ecological network in its inital configuration is threatened. The second category also pertains to the introduction of an evolutive variance-covariance matrix, so as to seize the impacts of climate change on the biophysical properties of ecological sites.

Valorisation —

Presentations

RMA Conference, (2015), University of Bordeaux, Bordeaux, France;

FAERE Conference, (2014), University of Montpellier, Montpellier, France;

ISDG Symposium, (2014), University of Amsterdam, Amsterdam, Netherlands;

WCERE Congress, (2014), Istanbul Technical University, Istanbul, Turkey.
M3d Workshop, (2013), French National Network of Complex Systems, Oléron Island, France;

AFSE Congress, (2013), Aix-Marseille School of Economics, Aix-en-Provence, France.

Publications

Dragicevic, A., Boulanger, V., Bruciamacchie, M., Chauchard, S., Dupouey, J.-L. and Stenger, A. (2013), Value of Ecological Network Connectivity, Cahier du LEF – Chaire Forêts pour Demain: 2013–05. Version révisée : Août 2015.

Perez, M. (2015), Economic Impact of the Implementation of Green Corridors, Mémoire de fin d'études, réalisé au Laboratoire d'Economie Forestière, sous la direction d'Arnaud Dragicevic.

Dragicevic, A. and Barkaoui, A. (2015), "Network Price Identity", Cahier du LEF – Chaire Forêts pour Demain: 2015–11.