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PII: S0022-5193(17)30081-4
DOI: http://dx.doi.org/10.1016/j.jtbi.2017.02.026
Reference: YJTBI8982

To appear in: *Journal of Theoretical Biology*

Received date: 31 May 2016
Revised date: 24 January 2017
Accepted date: 19 February 2017

Cite this article as: Arnaud Dragicevic, Vincent Boulanger, Max Bruciamacchie Sandrine Chauchard, Jean-Luc Dupouey and Anne Stenger, Networl Connectivity Value, *Journal of Theoretical Biology* http://dx.doi.org/10.1016/j.jtbi.2017.02.026

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Arnaud Dragicevic[*†‡§], Vincent Boulanger[¶], Max Bruciamacchie[*†], Sandrine Chauchard[‖**], Jean-Luc Dupouey[‖**], Anne Stenger[*†]

Abstract

In order to unveil the value of network connectivity, we formalize the construction of ecological networks in forest environments as an optimal control dynamic graph-theoretic problem. The network is based on a set of bioreserves and patches linked by ecological corridors. The node dynamics, built upon the consensus protocol, form a time evolutive Mahalanobis distance weighted by the opportunity costs of timber production. 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. The results show that the network equilibrium depends on the size of the reception zone, while the network connectivity depends on the environmental compatibility between the ecological areas. Through shadow prices, we find that securing connectivity in partially connected networks is more expensive than in fully connected networks, but should be undertaken when the opportunity costs are significant.

Keywords: Bioeconomics, Graph Theory, Optimal Control, Connectivity Value, Ecological Corridors, Forestry

1 Introduction

Land-use changes and running anthropization of areas lead to the ecological fragmentation of territories and habitats, partly explaining the current biodiversity decline. Accordingly, European public policies have emphasized the need to ensure interconnectivity between selected bioreserve sites (Bonnin *et al.*, 2007). In France, the Environment Round Table Act (CGDD, 2009), which stresses that the protection of biodiversity and ecosystems should be undertaken by means of the green and blue belt networks, has been voted. The supply of bioreserves and ecological corridors has thus been engaged. These networks are meant to facilitate the adaptation of vulnerable species to local or broader environmental disturbances (Williams *et al.*, 2005); suitable channels bring about the species' mobility (Schmitt and Seitz, 2002) and allow them to escape from all kinds of threats (McEuen, 1993; Andreassen *et al.*, 1996). Nonetheless, in forest ecosystems, the implementation

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