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Effects in the network topology due to node aggregation: empirical evidence from the domestic maritime transportation in Greece

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Abstract
This article studies the topological consistency of spatial networks due to node aggregation, examining the changes captured between different network representations that result from nodes' grouping and they refer to the same socioeconomic system. The main purpose of this study is to evaluate what kind of topological information remains unalterable due to node aggregation and, further, to develop a framework for linking the data of an empirical network with data of its socioeconomic environment, when the latter are available for hierarchically higher levels of aggregation, in an effort to promote the interdisciplinary research in the field of complex network analysis. The research question is empirically tested on topological and socioeconomic data extracted from the *Greek Maritime Network* (GMN) that is modeled as a non-directed multilayer (bilayer) graph consisting of a port-layer, where nodes represent ports, and a prefecture-layer, where nodes represent coastal and insular prefectural groups of ports. The analysis highlights that the connectivity (degree) of the GMN, is the most consistent aspect of this multilayer network, which preserves both the topological and the socioeconomic information through node aggregation. In terms of spatial analysis and regional science, such effects illustrate the effectiveness of the prefectural administrative division for the functionality of the Greek maritime transportation system. Overall, this approach proposes a methodological framework that can enjoy further applications about the grouping effects induced on the network topology, providing physical, technical, socioeconomic, strategic or political insights.

Keywords complex network analysis, spatial networks, multilayer networks, layer transformations, node scale.

1. Introduction

Spatial and specifically transportation networks have been diachronically developed to serve economic, social, political, and cultural needs among the social configurations (such as the urban units) they connect (Ducruet and Beauguitte, 2014). According to this aspect, they suggest communication systems that on their structure reflect information about their socioeconomic environment and thus they may operate as economic indicators of their interconnected spatial units (Tsiotas and Polyzos, 2015a). This implies that the information being immanent in the structure of networks representing the same socioeconomic system should have a common basis on the way they describe their environment, regardless their level of resolution or the scale of the spatial units that their nodes may refer to.

A relevant on this topic study was conducted by Ducruet at al. (2011), which examined the participation of cities in worldwide air and sea flows through three different