

Impacts on Marine Ecosystems Using a Multilayer Network Approach

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Abstract : Bays, estuaries and coastal ecosystems are some of the most used and threatened natural systems globally. Its deterioration is due to intense and increasing human activities. This paper aims to monitor the socio-ecological in Brazil, model and simulate it through a multilayer network representing a DPSIR structure (Drivers, Pressures, States-Impacts-Responses) considering the concept of Management based on Ecosystems to support decision-making under the National/State/Municipal Coastal Management policy. This approach considers several interferences and can represent a significant advance in several scientific aspects. The main objective of this paper is the coupling of three different types of complex networks, the first being an ecological network, the second a social network, and the third a network of economic activities, in order to model the marine ecosystem. Multilayer networks comprise two or more "layers", which may represent different types of interactions, different communities, different points in time, and so on. The dependency between layers results from processes that affect the various layers. For example, the dispersion of individuals between two patches affects the network structure of both samples. A multilayer network consists of (i) a set of physical nodes representing entities (e.g., species, people, companies); (ii) a set of layers, which may include multiple layering aspects (e.g., time dependency and multiple types of relationships); (iii) a set of state nodes, each of which corresponds to the manifestation of a given physical node in a layer-specific; and (iv) a set of edges (weighted or not) to connect the state nodes among themselves. The edge set includes the intralayer edges familiar and interlayer ones, which connect state nodes between layers. The applied methodology in an existent case uses the Flow cytometry process and the modeling of ecological relationships (trophic and non-trophic) following fuzzy theory concepts and graph visualization. The identification of subnetworks in the fuzzy graphs is carried out using a specific computational method. This methodology allows considering the influence of different factors and helps their contributions to the decision-making process.

Keywords : marine ecosystems, complex systems, multilayer network, ecosystems management

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