COSINE: A TOOL FOR CONSTRAINING SPATIAL NEIGHBOURHOODS IN MARINE ENVIRONMENTS

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Spatial analysis methods used for detecting, interpolating, or predicting local patterns in geographic data require delineating a neighbourhood to define the extent of the spatial interaction. Certain spatial analysis methods, such as interpolation, have implemented the concept of directionality and barriers. However, not all approaches take into consideration geographic or environmental constraints such as impassable mountain ranges, road networks, or coastlines. Specifically, complex marine landscapes and coastlines pose problematic neighbourhood definitions for standard neighbourhood matrices used in the spatial analysis of marine environments. Here, we offer a new approach to constraining spatial neighbourhoods when conducting geographical analysis in marine environments. We developed methods and open source software (COnstraining SpatIal NEighbourhoods—COSINE) for modifying spatial neighbourhoods, and demonstrate their utility with a marine study of oil spills. The COSINE graphical user interface allows users to modify the most common standard spatial neighbourhood definitions such as fixed distance, inverse distance and k-nearest neighbour.

Les méthodes d'analyse spatiale utilisées pour la détection, l'interpolation ou la prévision des modèles locaux dans les données géographiques exigent la délimitation d'un voisinage pour définir l'étendue de l'interaction spatiale. Certaines méthodes d'analyse spatiale, comme l'interpolation, font appel au concept de la directionalité et des obstacles. Toutefois, les approches ne prennent pas toutes en compte les contraintes géographiques ou environnementales comme les chaînes montagneuses impraticables, les réseaux routiers ou les littoraux. Plus précisément, les paysages et littoraux complexes posent des problèmes de définition de voisinage pour les matrices standard de voisinage utilisées pour l'analyse spatiale des environnements marins. Dans le présent article, nous présentons une nouvelle approche pour limiter les voisinages spatiaux lors de la réalisation de l'analyse géographique en environnement marin. Nous avons développé des méthodes et des logiciels ouverts (COnstraining SpatIal NEighbourhoods — COSINE) pour modifier les voisinages spatiaux et démontrer leur utilité pour une étude marine des déversements de pétrole. L'interface utilisateur graphique de COSINE permet aux usagers de modifier les définitions de voisinage spatial standard les plus courantes comme la distance constante, la pondération inverse à la distance et les k *plus proches voisins.*

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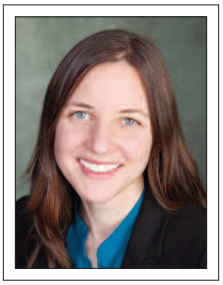

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Introduction

Geographical information systems have revolutionized the way we manage, visualize and interpret geospatial data, leading to unparalleled advancements in spatial analysis. Spatial analysis considers aspects such as location, distance, area and interaction in geospatial data to quantify patterns in phenomena, with the objective to understand and predict complex human or environmental processes [*Anselin* 1989; *Wong and Lee* 2005; *Anselin and Getis* 2010]. Rooted in spatial analysis is the concept of geographic dependency where phenomena in close proximity are more likely to be related than phenomena farther apart [*Tobler* 1970]. Quantifying the spatial extent of this geographic dependency is important for understanding a wide variety of processes, with applications in fisheries [*Booth* 2000; *Lorenzen et al.* 2010], air pollution *[Jerrett et al.* 2005], land use [*Chomitz and Thomas* 2003] or human behaviour [*Rushton* 1993] research. The level of influence or interaction of geographic features is defined by the user as a spatial neighbourhood and often operates behind the scene as a roving window.

Delineating the spatial neighbourhood is a key component and often misunderstood step in spatial