

A family of accessibility measures derived from spatial interaction principles

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Abstract

Transportation planning has long prioritized the efficiency of movement, or mobility. However, the concept of accessibility represents a more comprehensive evolution, shifting focus from mere movement to the potential to reach (i.e., spatially interact) with desired destinations. Despite growing recognition of accessibility-based planning approaches, the concept remains fragmented, with inconsistent definitions and unclear interpretations. This work’s aim is to clarify and unify the concept of accessibility by connecting it into spatial interaction modeling. We demonstrate that widely used mobility and accessibility models, such as gravity-based accessibility and spatial interaction models, share common theoretical roots. From this foundation, this paper offers three contributions: (A) we introduce a family of accessibility measures within the principles of spatial interaction, and (B) formally define four members of the family, namely the ‘unconstrained’ measure (i.e., Hansen-type accessibility), the ‘total constrained’ measure (i.e., a constrained version of the Hansen-type accessibility), the ‘singly constrained’ measure (i.e., related to the popular two step floating catchment approach - 2SFCA), and the ‘doubly constrained’ measure representing realized interactions or ‘access’, effectively equal to the doubly constrained spatial interaction model; and (C) we demonstrate the interpretability advantages of the family, as these constrained accessibility measures yield values in units of the number of potential “opportunities for spatial interaction” or “population for spatial interaction” for each zone and zonal flow. The family of accessibility measures proposed here clarifies the concept of ‘potential’ in accessibility, demonstrates theoretical and formulaic linkages across popular accessibility and spatial interaction models, and reintroduces measurement units into accessibility measures. By doing so, we believe this family of measures can unlock a clearer, more interpretable, and cohesive foundation for accessibility analysis.