Chapter 9
Understanding Accessibility: Accessibility Modeling With Geographical Information Systems (GIS)

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ABSTRACT
Accessibility measures are generally concerned with equity and a better distribution of services in a territory and can be accepted as key variables for supporting supply/demand, location/allocation and service/catchment area related planning policies and strategies at national, regional, and local levels. Since accessibility measures need organization of huge and complex spatial data sets, accessibility modeling often lends itself to Geographical Information Systems (GIS) for analysis and presentation. Since numerous accessibility measures and modeling techniques ranging from simple to sophisticated can be found in the literature, this work aim to provide an overview of the theoretical framework and relevant background about GIS-based accessibility modeling process. The results could provide a significant support for the decision makers who are supposed to deal with transportation planning, accessibility modeling, location/allocation and service/catchment area related issues.

INTRODUCTION
The term accessibility has long been used by geographers, economists, urban and transportation planners and reflects the relative ease of access to/from several urban/rural services by considering several travelling costs (Halden et al., 2000; Makri, 2002; McGrail & Humphreys, 2009). Accessibility measures are generally concerned with equity and a better distribution of services in a territory and help to evaluate the proximity/availability of several services like health, education, recreation, emergency or trade etc. by considering one or more modes of transportation such as such as walking, cycling, driving or public transport etc.

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The accessibility measures basically help decision makers to

- identify regions that have inadequate or excessive service
- select appropriate sites for new or re-located services,
- test and improve the performance of the transportation system.

That is why, accessibility measures can be accepted as key variables for supporting supply/demand, location/allocation and service/catchment area related planning policies and strategies at national, regional, and local levels (Makri, 2002; Juliao, 1999; Kuntay, 1990; Halden et al., 2000; Radke & Mu, 2000).

Numerous accessibility measures, ranging from simple to sophisticated, can be found in the accessibility literature. While simple measures only consider proximity in terms of time and distance, sophisticated ones consider both proximity and availability including the size of supply and demand. Some of the most widely used accessibility measures in the literature are;

- Travel time/distance measures, service/catchment areas (travel time or distance to nearest supply/demand calculated from Euclidian/Network-based costs) (see Ghio et al., 2007; Joseph et al., 2006; Fortney et al., 2000; Sylvie, 2007; Brabyn, 2002; O’Sullivan et al., 2000; Juliao, 1999; Ebener et al., 2005),
- Cumulative opportunity measures (consider the total amount of demand/supply inside the catchment areas) (see Chapelet & Lefebvre, 2005; Boulos et al., 2001; Nadine et al., 2006; Black et al., 2004; Goulias, 2007),
- Supply to demand ratio measures (population to provider ratios, calculated inside the catchment areas) (see Luo, 2004; Scott et al., 2006; Bagheri et al., 2006),
- Kernel density measures (use the Gaussian kernel approach to calculate the density value of each demand/supply) (see Yang et al., 2006; Gibin et al., 2007; McGrail, & Humphreys, 2009),
- Gravity-based measures (a combined indicator of accessibility and gravity by considering the attractiveness of supply/demand) (see Kwan, 1998; Chen, 2000; Guagliardo, 2004),
- Two-step floating catchment area measures (2SFCA) (repeat the process of accessibility modeling considering the overlay areas (see Mitchel et al., 2008; Luo & Wang, 2003; Luo, 2004; Yang et al., 2006; Scott et al., 2006).

Since accessibility measures describe the characteristics of a location and need organization of huge and complex spatial data sets, accessibility modeling often lends itself to Geographical Information Systems (GIS) for analysis and presentation. GIS have unique capabilities to present spatially referenced information in a way, which aids decision-making and provides a powerful interface for handling, organizing, analyzing and presenting huge and complex spatial data sets. For example; data storage, management and manipulation capabilities for both graphical and attribute data, core data analyses capabilities such as buffer, overlay, proximity, shortest path, raster cost-distance etc., programming capabilities to handle current models or create new models and mapping and visualization capabilities to evaluate the results of the analyses (Black et al., 2004; Chen & Weng, 1999; Chen, 2000; Peters & Hall, 1999).

In a more specific way, GIS can handle important steps in accessibility modeling like;

- storing road networks and origin/destination-based geographical databases,
- calculating costs between origins and destinations on transportation networks,