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Project-level accessibility analysis for land-use planning

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ABSTRACT

The concept of accessibility has made inroads into planning practice, largely at the system level. That is, accessibility is measured or modeled for current or future regional transportation and land-use scenarios for evaluation or broad policy guidance. Yet system-level scenarios cannot readily be applied to the project-by-project decision-making that characterizes the majority of transportation and land-use planning decisions. Accessibility evaluation of individual transportation or land-development projects differs from system-level analysis in essential ways and thus requires specialized tools.

This article proposes an elasticity-based metric of accessibility that can enable project-level evaluation of land-development projects as an accessibility-based alternative to traffic-impact analysis. The metric is demonstrated for three projects in Ann Arbor, Michigan, USA. The metric is shown to be sensitive to the location of development and capable of distinguishing among the analyzed projects in accessibility terms. Where mobility-based evaluation tends to rank peripheral development highly, the proposed accessibility metric appropriately rates central development as contributing the most to regional accessibility even after accounting for the traffic delay it engenders.

1. Moving beyond mobility-based evaluation

Researchers since the 1970s have argued that accessibility is the proper rubric for planning and evaluating transportation investments and the transportation dimensions of land-use developments (Wachs and Kumagai, 1973). This idea stands in contrast to two competing notions. The first is that transportation and land use are best guided by principles of mobility (or frequently, automobility), as embodied in tools such as highway level of service (Transportation Research Board, 2010), value of time lost in congestion (Schrank et al., 2012), traffic-impact analysis (Institute of Transportation Engineers, 2010) or cost-benefit analyses driven principally by travel-time savings (Laird et al., 2014). The second contrasting notion is the implicit idea that accessibility is principally a positive spatial descriptor, and hence a useful independent variable in predictive models of land value, travel behavior, or economic development. Stewart (1948), on whose work Hansen's (1959) seminal paper on accessibility was partly based, argued against the use of accessibility as a normative policy goal to be pursued consciously. While subsequent research did not echo Stewart's explicit cautionary note, it nonetheless tended toward accessibility as a positive descriptor; research into the use of accessibility as a normative goal for has been rare.

Rarer still has been the use of accessibility as a planning and evaluation framework in policy, a shift that has been referred to as a move from a mobility to an accessibility paradigm (Cervero, 1996). The shift from mobility-based to accessibility-based evaluation is logically compelled by the derived nature of transportation demand (Levine et al., 2012, Grengs et al., 2010): since a large majority of travel is for the purpose of reaching destinations rather than movement per se, mobility is an intermediate service whose demand is derived from the directly demanded objective of accessibility. Mobility is thus properly understood as a means and accessibility is its end; other means for promoting accessibility are proximity and remote electronic connectivity. Consistency with the idea that the demand for transportation is largely derived requires that transportation and land-use systems be planned and evaluated with accessibility, rather than mobility, as a goal. Yet the integration of measured accessibility into everyday planning practice has been limited to date. To the extent that accessibility planning has begun to permeate planning practice in North America, it has mostly done so at the scale of the regional transportation and land-use system (see for example: Ammiano et al. (2004), Chicago Metropolitan Agency for Planning (2010), Puget Sound Regional Council (2001) and Anderson et al. (2013)) and typically as a supplement to—rather than substitute for—mobility-based evaluation.

Incorporation of accessibility metrics as performance measures for

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systemwide regional development scenarios is a step forward for accessibility-based planning, yet the impact of this approach is limited. Regional planning agencies typically do not make actual land-use decisions, so integrated transportation/land-use planning at the regional level primarily operates as a persuasive or visioning exercise, rather than as an operational guide to transportation investments or land-use regulation. The use of accessibility metrics in transportation and land-use scenarios can illustrate the consequences of broad development directions and—one hopes—help encourage the alignment of local government planning decisions with a regional vision. But regional-level outcomes, as a practical matter, are the result of the aggregation of thousands of individual decisions on specific transportation investments and land-use regulations—decisions that remain to this day largely guided by mobility-based evaluation procedures, such as highway level of service. With that in mind, this article aims to develop a new practical indicator to facilitate accessibility-based planning practice for land-use decisions at the level of the individual project.

1.1. Attributes of project-level evaluation

The metric is oriented toward transportation and land-use planners in local practice; for this reason simplicity and accessibility of data sources and methodological requirements is central. These practitioners do not generally have ready access to regional travel-demand models yet are regularly called upon to analyze the transportation impacts of contemplated land-use changes. Their primary tool for gauging the transportation impact of land-use change currently is traffic-impact analysis (Institute of Transportation Engineers, 2010), which takes land-development projects as an input and forecasts traffic delay and the resultant level of service for nearby affected intersections. These findings are often incorporated into decisions on project permitting or modification, or traffic mitigation requirements imposed on the developer. Notwithstanding the ubiquity of the traffic-impact analysis tool, it suffers from an inherent flaw: since it is strictly based in (auto)mobility, it is incapable of incorporating the accessibility benefits that may flow from the proposed development's proximity to other origins or destinations. The effect is to penalize proposals in close-in areas currently suffering from congestion, to encourage greenfield development at the metropolitan periphery. While each individual development may be consistent with adequate performance at nearby intersections, the resultant land use pattern likely results in a low-accessibility metropolitan form (Levine et al., 2012).

The proposed metric would be applicable where local planners currently rely on traffic-impact analysis. In fact it begins with current approaches to traffic-impact analysis and demonstrates how these existing analytic tools can be modified for the accessibility analysis of land-development projects.

1.2. Requirements for a shift to project-level accessibility evaluation

The shift from regional-scenario to project-level evaluation is not a shift in geographic scale. In fact, accessibility impacts are gauged at the regional scale for both types of analysis. Instead, it is a shift in the nature of the accessibility question being asked. Regional scenarios pertaining to transportation/land-use systems are states, whether an actual current state or a contemplated future state. Regional-scenario accessibility analysis amounts to a snapshot, automatically capturing relevant transportation and land-use aspects alike. By contrast, project-level evaluation is an analysis of a marginal change in a state, typically asking what would happen if a specific land-development project—which is small relative to the entire regional transportation-and land use system—were developed. Even when analysis focuses on multi-project land-development bundles it remains project-based in that it is characterized by the two attributes described below (basis of comparison, and projection of impacts on the complementary system). By contrast, when a comprehensive set of contemplated transportation investments is analyzed jointly with their anticipated land-use impacts (or vice-versa) the analysis shifts from project- to regional-scenario-based.

Project-level accessibility evaluation of land-development projects differs in two important respects from regional-scenario analysis of accessibility—aspects that render standard regional-scenario-level tools inadequate to the task of project-level evaluation for land use:

1. Basis of Comparison: Project-level analysis of accessibility demands attention to the basis of comparison. Regional-scenario analyses are quite readily compared over time (metro A at time 1 versus time 2) (Levinson and Marion, 2010; Merlin, 2017) or space (metro A compared to metro B) (Grengs et al., 2010). Other bases of comparison flow naturally from regional-scenario analysis, including comparison of accessibility among parts of a region or among sociodemographic groups. By contrast, the basis of comparison for project-level analyses of land development is not immediately apparent. For example, a new residential development in a central location may lower accessibility for its neighbors by increasing congestion without adding destinations. Incoming residents presumably enjoy compensating accessibility increases—but compared to what? Neither their previous residential locations, nor their hypothetical locations in the absence of the proposed development are known to the analyst; for this reason the "compared-to-what?" question demands explicit attention in project-level analysis.
2. Projection of Impacts on Complementary System: Regional-scenario analyses, whether snapshots of a current situation or calculations based on future contemplated regional scenarios, inherently incorporate both transportation and land-use aspects. By contrast, projects generally come packaged in the form of *either* transportation investment or land development. Without attention to the impact of transportation on land use or vice versa (referred to here as complementary systems), the implicit assessment is on of "no impact." There are in fact multiple examples of this is the literature as well as in transportation planning practice, where for example a transportation project is analyzed as if it would have no land use impact (National Cooperative Highway Research Program, 1997, p. 41; Hensher et al., 2014; Gulhan et al., 2014). To be sure, the land-use impacts of a transportation investment take time to materialize and are difficult to model reliably. Nevertheless, anticipating land-use impacts of transportation investment is essential to a meaningful analysis of accessibility because under the implicit assumption of "no land-use impact," all mobility improvements become accessibility improvements. Only when the possibility of induced spread of origins and destinations is introduced do accessibility and mobility become truly separate measures.

This paper is geared at the accessibility-based analysis of land-use projects. Project-level analysis of transportation projects will be considered in a subsequent paper.

1.3. Additional desirable characteristics for project-level accessibility evaluation

In addition to these two inherent differences between regional-scenario and project-level accessibility analyses, seven attributes are either necessary or desirable for project-level analysis; these fall under the categories of geographic interpretability, usability, and consistency with formal definitions of accessibility and derived demand. In sum, the inherent differences and the desirable attributes are referred to below as the nine attributes of project-level evaluation.

1.3.1. Geographic interpretability

a. Regional Impact of Individual Project: Since most land-use and