International Transport Forum

The Accessibility Shift
Conceptual Obstacles and How to Overcome (One of) Them

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Roundtable

Discussion Paper

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The International Transport Forum

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ITF Discussion Papers

Cite this work as: Levine, J. (2020), "The Accessibility Shift: Conceptual Obstacles and How to Overcome (One of) Them", *International Transport Forum Discussion Papers*, No. 2020/23 OECD Publishing, Paris.

Acknowledgements

The contributions of Professors Grengs and Merlin are gratefully acknowledged.

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Introduction

The accessibility concept was brought into the urban planning field in the early 20th century, was formalised by mid-century, and has been the subject of a virtual cottage industry of academic researchers ever since (Haig, 1974). But accessibility metrics are used sparingly in applied planning practice and have not supplanted their mobility counterparts in transport evaluation (Papa et al., 2015). In places where planners have tentatively begun to use the language of accessibility, its application remains largely at the conceptual and visioning levels (Levine, Merlin and Grengs, 2017).

Box 1. Accessibility versus mobility

For the purposes of this paper, a mobility improvement is an increase in the territory that can be reached for a given investment of time and money. An accessibility improvement is an increase in the value of destinations that can be reached for a given investment of time and money. Mobility and accessibility metrics, respectively, are tools based in the differing concepts; mobility and accessibility planning, respectively, are approaches to policy making regarding transport and land use that are organised to pursue goals framed in terms of the differing concepts.

The transition to accessibility-based planning will not be complete—in fact, it cannot even really begin—until accessibility-based performance indicators supplant metrics such as highway level of service in evaluating transport success and guiding transport and land-use decision making, a move referred to here as the *accessibility shift.* Yet the transfer of accessibility-based evaluation to planning practice and decision making has been impeded by a family of interrelated obstacles (Silva et al., 2017; Boisjoly and El-Geneidy, 2017). Many of these are rooted in external political factors, including the scale mismatch between municipal land-use planning and regional transport planning, entrenched interests of people and institutions that benefit from mobility-based transport planning, and traditions of localist control (Wolf and Fenwick, 2003; Goddard, 1996; Briffaut, 1990).

Other obstacles are more within the purview of transport and land-use planners and researchers themselves; these are rooted in conceptual and analytical challenges associated with accessibility. The most obvious is the relative complexity of accessibility metrics, especially when compared with their mobility counterparts. Measures like traffic speeds, highway level of service, and time lost in congestion are directly observable and unidimensional constructs that have the added advantage of being interpretable in easy-to-grasp terms like speed or hours. By contrast, accessibility is concerned with the people and places that transport systems serve and simultaneously incorporate, at a minimum, attributes of the transport and land-use systems (Geurs and van Wee, 2004). This tends to render them more difficult to gauge and to interpret than many of those based in mobility.

But the obstacle of analytic complexity is diminishing. With increasing sophistication and distribution of tools for spatial analysis, together with spatial datasets, planners' technical capacity to evaluate accessibility can lower this barrier and potentially eliminate it altogether. Moreover, the needed inputs for accessibility metrics are regularly developed as part of travel-demand modelling at the regional level, a mainstay of transport planning in many regions around the world. Thus the technology, data, and methods for a significant shift to accessibility-based transport planning are readily available.

At a broader level, the accessibility shift is impeded by institutional factors. For example, mobility models and metrics persist in their central role in transport and land-use policy in part because they represent professional norms in the transport fields. For example, highway level of service is a central metric of transport engineering practice and is defined and updated regularly in the United States through the Transportation Research Board's Highway Capacity Manual (National Research Council, 2010; TRB, 2010). Land-use decisions are constrained by adequate public facilities ordinances or state-wide concurrency requirements mandating traffic-impact analysis, a technique whose methods are codified by the Institute of Transportation Engineers (ITE, 2010). Practitioners bound to uphold their professional norms by legal or ethical constraints, or by simple convention, would find themselves hard pressed to deviate from established standards such as these.

Deeper conceptual impediments stem from beliefs about what accessibility is, ought to be, or what would count as evidence to support the accessibility shift. Since these are largely internal to urban- and transport-planning discourse, these barriers are perhaps more readily overcome than the external obstacles referred to above. This paper, which is based on previous works by the author and peers (Levine, Grengs and Merlin, 2017, 2019) explores these conceptual barriers, and demonstrates an approach to overcoming one of them.

Conceptual barriers to the accessibility shift

Accessibility is the very service provided by a transport system. This view is rooted in the derived nature of transport demand, i.e. the consensus view that, for the large majority of trips, the demand for transport stems from people's desire to access destinations (Marshall, 1895; Bonavia, 1936; Meyer and Miller, 2001). The implication of this view is that mobility is merely an intermediate service that is consumed as a means to the end of reaching destinations, the directly demanded service. In the case of physical access, this demand is met through some combination of mobility and proximity. It follows that a transport improvement must be gauged in terms of the directly demanded service, that is, the ability to reach a greater value of destinations for a given investment of time and money. Under the derived-demand view, accessibility is its own benefit.

Greater accessibility may facilitate planning for additional benefits, such as reduced vehicle-kilometres travelled (VKT), improved social equity, or accelerated economic development (Handy, 1996; El-Geneidy et al., 2016; Banister and Berechman, 2003). A shift to accessibility as the core logic of transport planning may ease the way for more walkable, cyclable, and transit-friendly forms of urban development (Rode et al., 2017). One prevalent view holds implicitly that a shift to accessibility-based planning is desirable *to the extent* that it furthers goals such as these (Handy, 2002). In this view, accessibility is not the inherently desirable service provided by transport systems; instead, its desirability is conditional on its instrumental capacity to advance other goals (Stevens, 2017).

The instrumental, rather than inherent, view impedes the accessibility shift. If an accessibility improvement needs an accompanying gain in another realm—such as VKT savings—to ensure that it has a positive social value, the implication is that, absent that ancillary gain, the value of accessibility is either zero or negative. This would be inconsistent with the derived-demand-based view that accessibility, as the purpose of transport, is valuable in its own right. Apart from the logical inconsistency of this view with the derived nature of transport demand, it represents a poor strategic choice because it fails to communicate accessibility's inherent value to political constituencies, sending the opposite message instead.

The instrumental position impedes the accessibility shift further because it conditions accessibility's benefit on scientific evidence of causation. Large societal questions, for which controlled experimentation and standardisation of treatment and subjects are generally impossible, tend to be surrounded by significant scientific uncertainty (Hammond, 2000). For example, the connection of accessibility, and urban form more generally, to travel behaviour has been the subject of massive research efforts from 1970 onward (Ewing and Cervero, 2010). Researchers test the travel-behaviour impacts (e.g. how much VKT can be reduced) when people live or work in compact, mixed-use, transit- and pedestrian-friendly environments. Unsurprisingly for a complex causal question such as this, a range of magnitudes and statistical significance has been found across multiple individual research investigations. This uncertainty in the magnitude and significance of effects is of little consequence to the accessibility shift when its benefits are viewed as inherent, since such benefits would be independent of scientific proof of ancillary payoffs. By contrast, if accessibility is a means to other goals, uncertainty in the causal link between accessibility and those goals is construed to undermine the rationale for the accessibility shift to begin with (Boarnet and Crane, 2001).

Advancing the accessibility shift based on its asserted ancillary benefits may appear to be a savvy strategic move, especially where those benefits have engaged constituencies and institutionalised interests behind them. But ultimately, the move backfires when scientific uncertainty in the relevant causal linkages is construed as evidence against the shift. The better approach, both in terms of strategy and consistency with the purpose of transport, is to avoid conflating transport benefits with progress in these other realms. When goals in other planning realms are articulated separately, transport progress may be gauged by accessibility per se, and its priority considered against these goals, which may be either congruent or conflicting with accessibility promotion.

While the inherent view means that accessibility should be viewed as benefit per se, the shift to reliance on accessibility measurement is merely a needed starting point, but not a sufficient condition for desirable reform. Shifting what is measured in transport and land-use planning can help shift problem definitions; in combinations, these can facilitate changes in policy and ultimately the built environment. Similarly, while the accessibility shift is a necessary step for the analysis of transport equity, it alone is insufficient to ensure more equitable transport policies (Martens, 2019).

Travel-cost minimisation fallacy

The validity of the accessibility paradigm and the derived-demand concept on which it rests is sometimes presumed to require that people choose residential locations, routes, modes, or destinations so as to minimise transport costs. Under this fallacy, failure to minimise transport costs in this way is interpreted as a challenge both to the derived nature of transport demand and the accessibility paradigm (Mokhtarian and Salomon, 2001; Redmond and Mokhtarian, 2001; Salomon and Mokhtarian, 1998). Yet nothing in derived demand or the accessibility concept requires that transport costs trump all other considerations related to travel or residential-location choice, simply that travellers view the time spent in transport as a cost for most trips. The fact that travellers may choose more travel than the bare minimum because of concerns about the quality of opportunities at their destinations, or the desired characteristics of their homes and neighbourhoods, is evidence that they weigh the impulse to reduce travel costs against other attributes of the trip. It is neither evidence that travel is undertaken for its own sake nor evidence against the notion that access to destinations is the service that most travellers seek from their transport systems. The burden of travel time may at times "translate into becoming a gift for the individual traveller," (Jain and Lyons, 2008) but travellers who take the long way home in order to spend more time in the car are rare indeed. Notwithstanding claims regarding a positive value of time spent in travel, the understanding that transport demand is derived—and that as a consequence, accessibility, and not mobility is transport's purpose— remain apt descriptions for the large majority of trips.

Accessibility as urbanism fallacy

"Accessibility" sometimes stands for a set of investments and policies that promote pedestrianism, cycling, transit use, and compact development (Duranton and Guerra, 2016). Its counterpart, "mobility," stands in this formulation for priority given to vehicular movement, highway investments, and auto-oriented development patterns (Cervero, 1997; Handy 2002). But an investment in automotive infrastructure can be accessibility increasing if it speeds up travel more than it increases distances, and dense development can potentially degrade accessibility if it slows down movement too much. Moreover, even if one assumes that most urbanist policies are accessibility increasing, it does not follow that most accessibility-increasing policies are urbanist. For example, a job centre twenty kilometres away contributes more to one's accessibility than a similar one forty kilometres away, even if each is only accessible by car, yet this distinction is lost when accessibility is defined as urbanist development patterns. Ironically, an equation by definition between accessibility and urbanist policies has been promoted by some accessibility advocates themselves, who, in doing so, have unwittingly enabled a stereotype of accessibility as relevant to a niche market rather than the theoretically sound alternative to mobility-based transport planning (Tumlin, 2012). As a practical matter, denser regions tend in fact to offer more accessibility than their lower-density counterparts, but this is a matter of empirical observation rather than definition (Levine et al., 2010).

This equation by definition of accessibility and urbanism is closely related to the instrumental view described above. Under one version of the instrumental view, the purpose (and hence test) of the accessibility shift is its capacity to foster more urbanist development; the related instrumental view described in this section simply equates the two by definition. Neither view is consistent with either the derived nature of transport demand or classical definitions of accessibility.

Positive versus normative accessibility

Accessibility can be both a positive descriptor of the world and a normative goal for transport and land-use planning. The view that accessibility is inherently valuable as a normative goal has been at times controversial (Stewart, 1948). Social science in general is more comfortable with analysis and prediction than it is with prescription, and scholars have been more inclined to use measured accessibility as a predictive variable in complex models of land use, real-estate prices, or travel behaviour than to transform planning practice (Flyvbjerg, 2001). Conceived of in explicitly normative terms at the beginning of the 20th century, accessibility became strictly positive until the 1970s (Hurd, 1903; Haig, 1927; Hansen, 1959; Stewart, 1948). Throughout the 1960s, a growing number of studies built on the accessibility concept for analytical and predictive purposes. These included choice models of residential location (sometimes combined with transport-mode choice), predictions of traffic flows, and refinements of the accessibility concept itself and its measurement (Hansen, 1961; Hill, 1965; Leathers, 1961; Overgaard, 1966;

MacKinnon and Hodgson, 1970; Wilson, 1971; Hayes and Wilson, 1971; Ingram, 1971). With data improvements and the advent of advanced tools for spatial analysis, the analytical and predictive uses of the accessibility concept accelerated rapidly in the 1990s (Kwan, 1998; Miller, 1999; Thorsen and Gitlesen, 2002).

Within this positive tradition, researchers developed increasingly sophisticated accessibility metrics based on ever more fine-grained spatial data, but their focus on modelling exercises implicitly assumed either that measured accessibility has little to do with the professional practice of planning or others will make the link from the laboratory to practice. By the 1970s some researchers were calling for the use of accessibility indicators as normative goals for transport planning, but practice was slow to respond (Wachs and Kumagai, 1973; Morris, Dumble and Ramsay Wigan, 1979). By the second decade of the 21st century, accessibility indicators were starting to be adopted as normative guides to practice, generally without replacing indicators of mobility and often at an advisory or visioning level as opposed to guiding on-the-ground decision making (Duranton and Guerra, 2016; Boisjoly and El-Geneidy, 2017, Papa et al. 2015).

Comprehensive versus partial accessibility

Metrics of accessibility are sometimes judged by their comprehensiveness, with richer description being treated as inherently superior or more accurate than sparser representations. For example, access to health care is not simply a matter of people's ability to reach the doorstep of the clinic but is shaped by their awareness that they need to see a doctor, the kind of health insurance they have, and their ability to overcome any societal forces impeding their ability to get the care they need (Moore, Lucas and Bates, 2013). Thinking about accessibility in this comprehensive way may make aggregate place-based measures appear to be woefully inadequate descriptors of people's actual lived accessibility; to capture accessibility properly, perhaps only the comprehensive person-based measures, which take into account people's attributes and destination types, will do (van Wee and Geurs, 2016).

This view misconstrues the nature of accessibility, which is not an objectively existing quantity like length or weight to be measured with either greater or lesser accuracy. Accessibility metrics are more akin to eyeglass prescriptions: they enable users to see things that would otherwise be missed, but only where there is an appropriate fit between the tool and both the user and the user's purpose. Transport and land-use planners, for example, need guidance regarding transport investment and land-use regulation to improve physical access to health-care facilities. While person-level attributes are in many cases important inputs to planning actions, health-care obstacles rooted in knowledge, finance, or culture, while vital, are generally beyond their professional purview. For this reason, metrics relying on these dimensions would be of little service in guiding their work, though they would be vital for other professions with whom the planners collaborate, such as public health.

Modal dimension

The accessibility paradigm in transport and land-use planning has become closely associated with multimodalism and alternatives to the automobile. For example, a 2019 call for papers for a special "planning for accessibility" issue in a transport journal reads, in part: "During the past several decades, government policies in many countries have gradually evolved from automobile-centred mobility planning toward accessibility-oriented planning." (Elsevier, 2019). The implication is that a shift from an automobility focus to its alternatives is the hallmark of accessibility planning. This is not consistent with the classic definition of accessibility used here, under which accessibility planning would be planning based on the ability to reach destinations rather than simply to travel fast—by any given mode. While the accessibility shift can be a tool for improving public transport, cycling, pedestrianism, and interconnections between modes, it is not equivalent to any of these goals. Instead, the accessibility shift implies planning-practice reform for all transport modes, including the automobile. An analysis of auto versus transit accessibility, for example, might lead one to conclude that there is an unacceptable deficit in public-transport service; however, the accessibility shift constitutes reform in the kinds of outcomes that matter for the various modes, not a fixed position on the priority to be accorded to each. Relatedly, access to the public transport system is sometimes used as a metric of accessibility, an inadequate formulation on two grounds (TRB, 2003). First, it removes the automobile (and, for that matter, walking and cycling) from the realm of accessibility-relevant transport modes. Second, it conflates access to the transit system with access to destinations. The bus may run through one's neighbourhood, but if job centres are two hours away, work accessibility remains poor.

Definitions of accessibility as either urbanism or multimodalism have supported a common formulation of the goals of transport plans as "accessibility and mobility." This pairing, which is even enshrined in Federal law in the United States (United States Code, 2012), appears on its surface to be a reasonable statement calling for balance between disparate goals. In this formulation, "accessibility" appears to stand for alternatives to the automobile and automobile-oriented development patterns, while "mobility" stands for car-oriented planning. The combination is a kind of double counting, because accessibility already incorporates mobility. More importantly, the formulation is inconsistent with the derived-demand view that in transport planning, accessibility is the end and mobility is a means. The pairing thus combines the end with one means while giving short shrift to the other two means to providing accessibility: proximity and connectivity.

Accessibility and equity

Accessibility may be viewed as a resource that can be distributed more or less equitably. But when accessibility is viewed as an equitable distribution of accessibility, the distinction between the resource and its distribution is lost. One expression of the equity fallacy is seen in planning practice in a tendency to limit accessibility analysis to the transport disadvantaged, as if accessibility is the service needed by these populations, in contrast to the more affluent car drivers, who need mobility. While car ownership enables higher accessibility than public-transport use in most locations, accessibility remains the service sought by transport users across modes and incomes. All populations benefit when their accessibility increases, though some populations start from a position of greater accessibility deficit. The accessibility shift allows transport analysis to focus on its performance with respect to populations rather than its performance with respect to infrastructure links. It thereby enables analyses of transport equity, which can help direct resources to greater transport justice (Martens, 2016).

Scenario versus project-based accessibility

Embedding accessibility as a guide to applied planning practice demands accessibility tools appropriate to a full range of planning actions. Formal accessibility analyses began to appear broadly in professional planning practice in the first two decades of the 21st century, commonly at the level of the region or metropolitan area as part of an informational, advisory, or visioning effort. While these efforts represent a step toward the accessibility shift, they leave a particular gap at the level of applied decision making about transport investment and land-use regulation. In many locales, at the operative level, as when a municipality evaluates a development proposal, or a transport agency evaluates transport-investment plans, decisions tend to be guided by a mobility-based level-of-service or traffic-impact analyses. The accessibility shift depends on accessibility-based evaluation displacing its mobility counterparts at these operational levels as well as in the regional visioning processes. Yet project-level analysis differs in fundamental ways from regional-scenario analysis of accessibility, and it demands adaptation of the regionally scaled tools. With accessibility tools scaled to the level of the individual transport-investment or land-use-regulatory decision, accessibility analysis can be brought to the applied decision-making level. The remainder of this paper considers this final conceptual obstacle more fully and demonstrates a method to handle the challenge of project-level transport analysis of land-development projects.

Distinguishing scenario-based from project-level accessibility

Planners in municipal practice frequently assess the transport impact of land-development proposals as an input to their recommendation on regulatory decisions (such as “accept,” “reject,” or “modify or add other requirements”). In many countries, this assessment comes in the form a traffic-impact analysis, a strictly mobility-based tool that seeks to gauge the impact of the proposed development on roadway congestion. Consistency with the purpose of transport demands that these assessments be carried out based on accessibility, which would account for both mobility and proximity impacts of the development. Yet there exists a distinct gap between accessibility tools developed for the regional scenario and the needs of the individual project discussed here. In particular, 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.

- Basis of comparison: Regional-scenario analyses are quite readily compared over time, for example, metro A at time 1 versus time 2, or space, metro A compared to metro B (Levinson and Marion, 2010; Merlin, 2017; 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 neighbours 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.
- 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 transport and land-use aspects. By contrast, projects generally come packaged in the form of either transport investment or land development. Without attention to the impact

of transport on land use or vice versa (referred to here as complementary systems), the implicit assessment is one of “no impact.” There are in fact multiple examples of this is the literature as well as in transport planning practice, where for example a transport project is analysed as if it would have no land-use impact (Lomax et al., 1997; Hensher, Ellison and Mulley, 2014; Gulhan et al., 2014).

- Anticipating land-use impacts of transport 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. By the same token, anticipating the mobility impacts of land development is vital to any accessibility analysis, since an assessment that omits mobility impacts would reduce to a proximity measure alone.

In addition to these two inherent differences between regional-scenario and project-level accessibility analyses, four attributes pertaining to geographic interpretability and usability are either necessary or desirable for project-level analysis. In combination, the inherent differences and the desirable attributes are referred to below as the six attributes of project-level evaluation.

- Geographic interpretability: regional impact of individual project. Since most land-development proposals are considered on a project-by-project basis, accessibility indicators must be able to evaluate project-level decisions, yet they must not be restricted in their geographic scope to the project's immediate area. That is, they should be able to assess the marginal impact of a proposed project on regional accessibility; restricting the geographic scope of accessibility analyses to the local area can produce misleading results (Levine, Merlin and Grengs, 2017).G
- Geographic interpretability: comparison based in regional context. Every evaluated project needs a basis for comparison to facilitate the interpretation of its accessibility performance. Since the goal is to evaluate projects within their metropolitan context, the basis of comparison should be relative to the potential of the region, rather than absolute. For example, a land-development project in a small region would be reachable by many fewer people than a similar project in a large region and would thus offer a smaller marginal accessibility contribution. It would not be reasonable to expect similar accessibility contributions from the two; instead, the relevant question for the planner is “how does this project perform in accessibility terms relative to other alternatives in our region?”
- Usability: easy interpretability. Individual projects are not likely to shift regional accessibility metrics by much; they suffer from the “drop in the ocean” phenomenon when it comes to regional accessibility measurement. Analytical results must be interpretable notwithstanding the frequently infinitesimal impact of an individual project on overall regional accessibility.
- Usability: technical ease of use. The audience for the indicators presented here are transport or land-use planners in local practice. These people are presumed to have access neither to regional travel demand models nor sophisticated multivariate statistical tools. There are a few examples of research that evaluates alternative proposals and puts forth tools to evaluate both transport and land-use changes on accessibility in an integrated fashion, but their approach requires high technical capacity (Geurs et al., 2010; Geurs, de Bok and Zondag, 2010). The section below presents an accessibility-based decision support indicator that can be put into practice in most local planning offices with reasonable amounts of technical capacity.

Methods

The six attributes listed above are addressed through an accessibility elasticity metric that is calculated after incorporating the results of a traffic-impact analysis into the regional travel time matrix. Accessibility elasticity is defined as the percentage change in accessibility divided by the percentage change in regional size (measured in either population or employment); see Equation 1 below for a formal definition. It is calculated with respect to population for residential development, and with respect to jobs for non-residential developments such as retail or commercial.

Equation 1: Accessibility elasticity for residential development proposals =

$$\frac{[\text{accessibility}^{\text{after}} - \text{accessibility}^{\text{before}}]/\text{accessibility}^{\text{before}}}{[\text{population}^{\text{after}} - \text{population}^{\text{before}}]/\text{population}^{\text{before}}}$$

"Accessibility" is total regional accessibility for a given mode and trip purpose. The current study used employment accessibility by automobile, with accessibility estimated via the gravity method. "Before" refers to the baseline condition, and "after" refers to projected conditions after the construction of the proposed development.

Using accessibility elasticity in conjunction with traffic-impact analysis addresses the challenges of project-level accessibility analysis. The first challenge is dealing with the problem of establishing a meaningful baseline for comparison. Using accessibility elasticity implicitly establishes the existing built environment as the basis of comparison. An accessibility elasticity of 1.0 indicates that the marginal person or job at the contemplated location contributes to the region's accessibility equally to the person or job that is at the average level of accessibility in the region (while 1.0 may be a useful baseline for comparison, it is not offered as threshold of desirability, which would need to determined according to local circumstances and policy priorities). Elasticities of over 1.0 indicate that incoming people or jobs are contributing more than the average; elasticities of under 1.0 reduce average regional accessibility by introducing residents or jobs at locations at lower accessibility than the average.

In addition to establishing a baseline for comparison, this attribute automatically scales the results to the region in which they are calculated (attribute four). The baseline of comparison is the accessibility contribution of the average person or job in accessibility terms. Because it is scaled to the region in which it is calculated, this metric can be relevant across a range of metropolitan conditions; it avoids creating accessibility comparisons between small and large metropolitan regions, preferring instead a comparison against a baseline determined by local potential.

The second attribute—projection of the impacts of land-use change on the transport system—is met through incorporation of the results of previously estimated traffic-impact analyses. These analyses forecast additional seconds of delay at intersections surrounding a proposed development; the procedure described below adds these delays to the travel time of the zonal pairs for which they are relevant.

This procedure also addresses the third attribute (the regional impact of an individual project). With percent change in population or employment in the denominator, the metric is automatically scaled to the size of the project, and even projects that are small relative to their region may be meaningfully analysed and their metrics readily interpreted (attribute five).

An updated regional zone-to-zone travel-time matrix is used to estimate regional accessibility with the proposed project in place. In this way, the impacts of the proposed land development are projected on the transport system in the form of traffic-impact analysis before accessibility impacts are projected.

Traffic impact-analyses forecast additional delays, denominated in seconds, to intersections near the proposed developments. These delays, together with the land-development proposals, are used to calculate accessibility impacts. The analysis is implementable with readily accessible tools, including commonly available GIS software (ArcGIS Network Analyst) which addresses attribute six. It does not require access to the regional travel-demand model, though it uses output exportable from the model, including travel-analysis zone boundaries and the zone-to-zone travel-time matrix.

Results

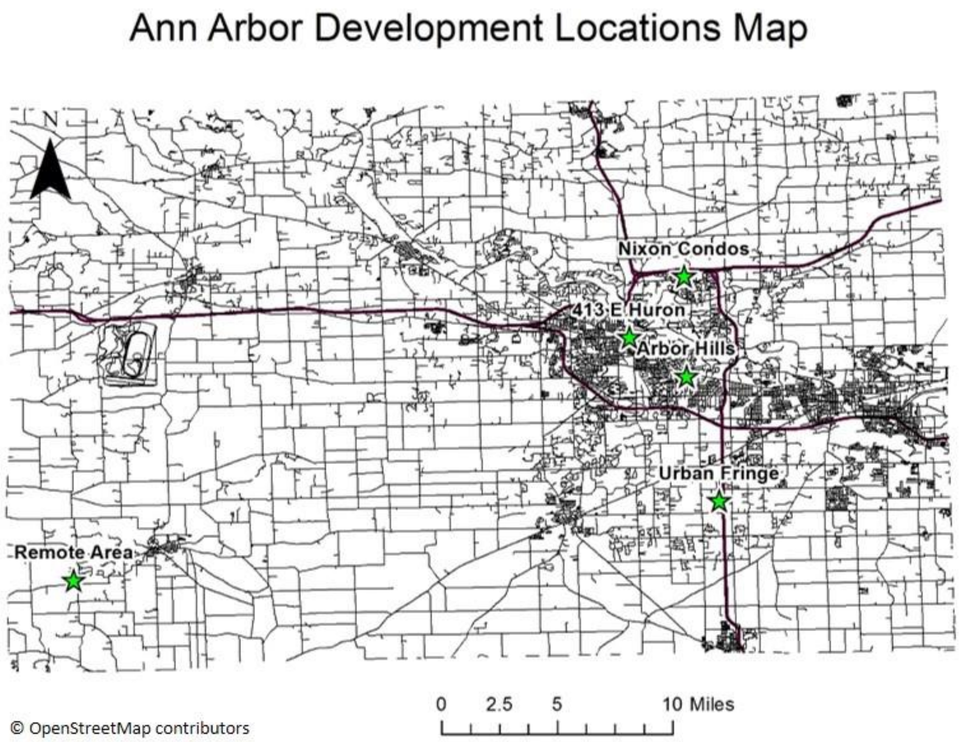
The procedure is illustrated here with data from three proposed developments in Ann Arbor, Michigan, shown in Figure 1: a centrally located residential tower, a peripherally located residential development, and a suburban shopping centre.

413 East Huron is a residential tower located in downtown Ann Arbor including 216 residential units and 450 commercial square meters on the ground floor (the impact of the commercial is not included in this accessibility analysis). Peak trips for this development were estimated at 112 for the hour between 4:45-5:45 pm.

Nixon Condominiums are a moderate-density residential development of 473 units located about six kilometres away from the centre of Ann Arbor, contiguous to existing single-family and multi-family residential developments. Trips were projected at 265 for the 8:00-9:00 am morning peak period.

Arbor Hills is a high-end retail development located about six kilometres away from the centre of Ann Arbor along the major east-west corridor of Washtenaw Avenue. It includes 8 400 square meters of retail space with 692 estimated trips occurring during the afternoon peak hour.

Figure 1: Proposed developments analysed for accessibility impact



Source: Open Street Map, https://www.openstreetmap.org/copyright.

Accessibility results for proposed Ann Arbor developments

The results of the accessibility evaluation of the three land-use development projects indicate that two projects exceed the average-accessibility threshold for Washtenaw County: 413 East Huron (1.86) and Arbor Hills (1.49), with 413 East Huron providing somewhat higher accessibility overall (Table 1). The Nixon Condominiums project has an elasticity of less than unity, which indicates that an incoming new resident would contribute less accessibility than the regional average resident. Each resident of 413 East Huron would contribute auto accessibility to work at a rate 86% higher than the average resident of the county. By contrast, each resident of Nixon Condominiums would contribute accessibility at a rate 41% lower than the county average. As a retail facility, Arbor Hills is evaluated on the basis of the jobs it is expected to provide; each job at that site contributes accessibility at a rate 49% greater than the average retail job in Washtenaw County.

Depending on circumstances, planners may have good reason to advocate for projects that result in elasticities of less than 1.0. Indeed, based on this small sample, it is clear that the 1.0 threshold is relatively difficult to reach for a new development, except in locations quite close to the urban centre. The necessary level of accessibility elasticity for development approval will require analysts to make judgments tailored to local circumstances.

The metric as developed is highly sensitive to residential location. To illustrate this sensitivity, the impact of the Nixon condominium development was tested in two hypothetical locations, an “urban fringe” location 16 kilometres from the centre of Ann Arbor, and a “remote area” 41 kilometres away (Figure 1).

The accessibility indicator for the identical development dropped by 26% and 91%, respectively, in this move. These marked drops further demonstrate the indicator's locational sensitivity.

Table 1: Accessibility analysis of land-use developments in Ann Arbor to jobs by car

Project Name	Nixon Condominiums	413 East Huron	Arbor Hills
A. Development Type	Population (Residential)	Population (Residential)	Retail Employment (Commercial)
B. Analysis Area	Washtenaw County	Washtenaw County	Washtenaw County
C. Impedance Coefficient	0.13	0.13	0.28
D. Time of Day	AM	AM	PM
E. Accessibility Before	7.439E+09	7.439E+09	1.020E+08
F. Accessibility After	7.448E+09	7.452E+09	1.035E+08
G. Percent Change in Accessibility [(F/E)-1]*100	0.125%	0.182%	1.455%
H. Total Baseline Before	344,791 (population)	344,791 (population)	19,466 (retail jobs)
I. Total Baseline After	345,529 (population)	345,128 (population)	19,644 (retail jobs)
J. Percent Change in Baseline [(I/H)-1]*100	0.214%	0.098%	0.914%
K. Accessibility Elasticity (G/J)	0.59	1.86	1.49

Beyond traffic-impact analysis

Projects like the ones shown here all result in added forecast roadway congestion; local jurisdictions typically need to decide, after a traffic-impact analysis, whether the cost of worsened congestion is at an acceptably low level. The proposed accessibility elasticity method goes beyond the mobility-only focus of traffic-impact analysis to show not just the cost of congestion but also the countervailing benefits of enhanced proximity. The tool takes a standard (mobility-based) traffic-impact analysis as an input but combines it with the proximity dimension in order to support a proper accessibility analysis of an individual land-development project.

Development approval must consider multiple factors beyond accessibility alone, such as the adequacy of infrastructure, the quality of the urban design, and consistency with current zoning. However, to the extent that transport is the issue at hand, the derived-demand view implies that accessibility impacts should be the primary benchmark by which transport-related impacts are assessed. Although the case study demonstrated here is focused on automobile-based accessibility, the method can be extended to other modes as well. A thorough accessibility evaluation for a proposed development project would take into account the accessibility impacts for all modes and consider the importance of each mode according to local planning priorities.

The metric is presented as a methodological approach to overcoming one of the conceptual impediments to the accessibility shift: the absence of tools for the analysis of project-based, as opposed to scenario-based, accessibility. Other obstacles described here, notably those based in ideas about what accessibility is, what it should be, or what would justify the shift, are not remedied with methodological advances. It is hoped that the naming of conceptual obstacles presented here can assist accessibility advocates in combating them.

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The Accessibility Shift

This paper explores conceptual barriers to shifting the foundation of transport planning from mobility to accessibility. These barriers include an implicit belief that accessibility must bring other benefits to be of value, the idea that individuals' failure to minimise costs in their transport choices somehow challenges the derived nature of transport demand; and a lack of techniques for project-level accessibility analysis. The paper also presents a technique for overcoming the latter barrier.

All resources from the Roundtable on Accessibility and Transport Appraisal are available at:
www.itf-oecd.org/accessibility-and-transport-appraisal-roundtable

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Published: 11/2020 | Photo credit: Robert_Chlopas /Shutterstock