1. Accessibility analysis and transport planning: an introduction

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Accessibility is a concept that has become central to physical planning during the last 50 years; improving accessibility is an aim which has now made its way into mainstream transport planning and policy-making worldwide. Batty (2009) traces the origins of the concept back to the 1920s. It was used in location theory and regional economic planning, becoming important once transport planning began, mainly in North America where it was associated with transport networks and trip distribution patterns. Its conceptual basis dates back further. Hansen (1959), in his classic and much cited exposé, ‘How accessibility shapes land use’, rolled out our first real definition: the potential for interaction (based on the notion of potential traced back to the social physics school in the nineteenth century). In recent decades, the term ‘accessibility’ has marshalled renewed interest from civil engineering, geography, spatial economics and other academic fields to uncover a variety of new measures.

This book’s purpose is relatively straightforward. It marries advancing approaches in accessibility research and modelling with best practices in accessibility planning and evaluation – to better support integrated transport and land-use policy-making in Europe and the United States.

In the 2000s considerable progress has been made along these fronts. These advances have taken different directions. First, there is a continuing trend of more complex and disaggregated accessibility measures, largely in response to recognizing that aggregate measures fail to account for the wide variation in individual behaviour and population groups at different spatial scales. These trends partly result from improvements in techniques to construct location-based accessibility indicators. These techniques have evolved from simple calculations to complex and detailed methods that use algorithms within a geographic information system (GIS) platform to extract and assemble data from multiple spatial databases at fine levels of spatial resolution (e.g., see Chen et al., 2011; Kwan, 2000). Measuring

accessibility at the individual level – as opposed to a zonal level – is gaining traction as a means to further understand human activities and travel possibilities in space and time (e.g., see Ashiru et al., 2003; Dong et al., 2006; Kwan, 2000; Neutens, 2010; Schwanen and Kwan, 2008).

A second direction addresses economic matters and related transport infrastructure investments, ranging from analysis of utility-based accessibility measures (de Jong et al., 2007; Geurs et al., 2010; Geurs et al., 2006) to spatial spillover effects (e.g., see Condeço-Melhorado et al., 2011; Gutiérrez et al., 2011; Gutiérrez et al., 2010). A related endeavour is to explore the relationships between accessibility and network connectivity structures by also emphasizing the role of different types of impedance/cost functions in Hansen's accessibility potential (de Vries et al., 2009; Hsu and Shi, 2008; Levinson and Krizek, 2008; Reggiani et al., 2011a; Reggiani et al., 2011b).

A third direction of accessibility research focuses on measuring the social dimension of transport using accessibility concepts, linking accessibility concepts to social exclusion, social equity, and/or social justice (Achuthan et al., 2010; Farrington and Farrington, 2005; Páez et al., 2010; Scott and Horner, 2008; Zhang et al., 1998). And a final stream hones in on measuring walking and cycling accessibility and related individuals' perceptions of residential environments (e.g., see Haugen, 2011; Iacono et al., 2010; Krizek, 2010).

ACCESSIBILITY MEASUREMENTS: NEW APPROACHES

These trends in accessibility research provide a rich backdrop to share the next generation of accessibility analysis and modelling; to do so, this book is divided into five parts. The first four parts comprise accessibility research and modelling in Europe and North America linked to the research directions as described above. The final part presents examples of physical planning processes where accessibility has moved from narrow-minded approaches, focusing on the functioning of transport networks in terms of travel speeds, to broader concepts of accessibility linking transport networks, spatial structures and social effects.

In Chapter 2, Aura Reggiani explores the interrelationships between theories and models in spatial economics and network analysis. Network theory uses the topological properties of transport networks to provide useful insights into how the network is structured. Accessibility measures derived from spatial interaction models are found to be simple but powerful approaches which link spatial economics and network analysis. Reggiani

suggests a dual analysis to explore potential connections between novel contributions in network analysis and spatial economic analysis in both directions. Furthermore, Reggiani explores potential linkages between accessibility indicators and resilience or fragility in connectivity network structures. She concludes by suggesting that accessibility will play a fundamental role in reinforcing polycentric networks and strengthening resilience.

Bert van Wee, Caspar Chorus and Karst T. Geurs (Chapter 3) review the literature on the impacts of information and communication technology (ICT) on accessibility. ICT is argued potentially to have an impact on all four components of the concept of accessibility as defined by Geurs and van Wee (2004): (1) the land-use component; (2) the transportation component; (3) the temporal component; and (4) the individual component. Most work to date refers to the direct impacts of ICT; it therefore fails to incorporate impacts owing to interactions between the four accessibility components. To address this, the authors focus on the impact of ICT on the transportation and individual components of accessibility. They discuss the effect of personalized information provisions using mobile phone technologies on generalized transport costs, including comfort of travel, self-selection in the use of ICT in several forms, and the impact of ICT on travel and activity behaviour of non-adults. Van Wee et al. conclude that there are major challenges in developing accessibility measures that integrate physical and ICT accessibility, including those that measure the utility of accessibility.

In Chapter 4, Christof Zöllig and Kay W. Axhausen examine an innovative proof-of-concept simulation of agent-based accessibility to estimate the economic benefits of hypothetical transport investments. Various agent-based models exist in the literature, representing a complex system of individual components which interact with each other; these are seldom applied to estimate the user benefits of transport infrastructure investments, however. The authors show how accessibility and expected maximized utility can play a role; their results suggest that connection choice, departure time choice and location choice be integrated to assess infrastructure investments. People may adapt in all three dimensions within the time horizons usually considered. The common practice in cost-benefit analysis, calculating travel time savings with fixed spatial distributions of activities, may lead to misjudged benefit estimations.

DIMENSIONS OF LOCAL ACCESSIBILITY

Part II presents three chapters on different local dimensions of accessibility. Xinyu Cao and Patricia L. Mokhtarian investigate, in Chapter 5, the

impacts of residential neighbourhood accessibility on walking behaviour by controlling for self-selection and neighbourhood clustering effects, using data collected from residents of eight Northern California neighbourhoods. Several accessibility measures are shown to be positively associated with walking-to-store frequency, including the perception of shopping areas within walking distance, the number of business types, and living closer to grocery stores. These associations hold after accounting for the influences of residential preferences, travel attitudes and demographics (as well as clustering effects). However, residential self-selection also plays an important role in influencing individuals' travel decisions, reducing the apparent impact of several accessibility characteristics. Clustering effects appear to be small in this case, perhaps because unobserved attitudes may be a major source of such effects, and in this study many relevant attitudes are, in fact, observed.

Kevin J. Krizek, Jessica Horning and Ahmed El-Geneidy examine, in Chapter 6, the role of individual perceptions of proximity to urban businesses and facilities and associated measurement issues in Minneapolis, Minnesota (USA). The authors analyse three aspects of distance perception: (1) destination proximity maps; (2) the variation across different socio-demographic and economic groups and physically active or inactive residents; and (3) the type of destination – business or facility. This analysis finds that perceived walking distance varies based on the characteristics of an individual's neighbourhood and the type of destination being judged. The findings will assist urban planners, landscape architects and even business owners in learning the qualities of accessibility that affect perceptual issues such as proximity.

In Chapter 7, Tijs Neutens applies a combination of place-based and person-based measures of accessibility to achieve a rich portrayal of accessibility to public service delivery. A case study of accessibility to government offices in the city of Ghent (Belgium) illustrates complementary insights related to service delivery. Three specific aspects of accessibility are studied: spatial proximity, spatial choice and scheduling flexibility. Neutens finds that spatial proximity is fairly equitable among the population, but spatial choice and scheduling flexibility differ significantly across individuals, depending on the space–time constraints they experience in everyday life.

ECONOMIC VALUATION OF ACCESSIBILITY EFFECTS

Part III of the book comprises three chapters on economic valuations of accessibility changes resulting from land use or transport investments.

The three chapters apply alternatives to the traditional practice of using the travel time savings method as a measure of transport user benefits in economic appraisals of transport investments. In Chapter 8, Karst T. Geurs, Michiel de Bok and Barry Zondag examine the degree to which spatial planning affects the accessibility benefits and economic efficiency of public transport projects. As a case study, plans for a large urban planning project in the Netherlands are examined, combined with major rail investment alternatives (involving the upgrade of an existing bridges and construction of new bridges). The authors apply the logsum measure of user benefits, as an alternative to the travel time savings method (i.e. rule-of-half measure), using a national land-use–transport interaction model for the Netherlands. The authors show the importance of the land-use component in accessibility improvements; the logsum accessibility benefits from the land-use scenarios for the new town of Almere exceed those from the railway investments. Significant synergies are found when land-use policies and public transport investments are better integrated, that is, adding dwellings and jobs to locations near (new) railway stations significantly increases accessibility benefits for public transport users. However, these additional accessibility benefits were small compared to the huge investment costs of the public transport projects examined.

In Chapter 9, Thomas de Graaff, Ghebreegziabihir Debrezion and Piet Rietveld examine the impact of changes in public transport accessibility on house prices. The authors use an hedonic pricing approach which is argued to be a viable alternative to the travel time savings methods in cost–benefit analysis. The authors apply this approach to the same case study as Geurs et al. in the previous chapter, and examine the effects of both urban planning and rail infrastructure investments on house prices. Both are shown to affect housing prices. The former has an indirect effect on passenger flows and thus on aggregate housing values; the latter has a direct effect on individual house values.

In Chapter 10, Arnstein Gjestland, David McArthur, Liv Osland and Inge Thorsen propose a hedonic pricing methodology for measuring and valuing some of the accessibility benefits arising from a large transport infrastructure project, a bridge which recently replaced a ferry with two suspension bridges linking two islands (Stord and Bømlo) in south-west Norway. A key innovation of the chapter is modelling the effect of pecuniary costs on labour market accessibility. The authors show that failure to account for these can lead to an overestimation of the accessibility benefits. This is an important finding given that user charges are frequently applied to finance infrastructure expansions.

ACCESSIBILITY, SOCIAL EQUITY AND EXCLUSION

The social impacts and distributional effects of the transport system and transport decision-making have been far less well researched and are underexposed in *ex ante* policy evaluations (Geurs et al., 2009; Lucas and Jones, 2012). Interest in these issues is increasing (for example see, in the recent special issue in the *Journal of Transport Geography* on this topic, Lucas and Jones, 2012). This fourth part of the book presents three chapters linking accessibility concepts to social equity, social justice and social inclusion. In Chapter 11, Karel Martens and Aaron Golub provide a justice-theoretic exploration of accessibility measures. The authors explain that the outcome of distributive question in transportation (that is, is the distribution of accessibility benefits from investments in the transport system just?), in part depends on the accessibility measure chosen for analysis. The authors argue that the concept of midfare, as the 'middle' position between equality of resources and equality of welfare, is best suited for transportation equity analyses. The authors conclude from their theoretical-based exploration of equity measures of accessibility that a wide set of accessibility measures – for example cumulative opportunities, Hansen's potential accessibility measure, some types of space–time measures – comply with some of the components that are encompassed by the concept of midfare. More research is needed to refine a measure to reflect the meaning of access as midfare.

In Chapter 12, Kevin Manaugh and Ahmed El-Geneidy examine the extent to which proposed public transport infrastructure projects in Montreal, Canada benefit disadvantaged populations. A before-and-after comparison of employment accessibility and change in travel time is conducted to examine whether neighbourhoods with high levels of social and transportation disadvantage benefit from new transit projects. The transit projects seem successful from a social equity perspective; many people who lacked good accessibility and connections to employment centres will see increased benefits, and the transit projects serve many poorer neighbourhoods quite well. Micro-scale analysis, using travel time reductions based on actual home and work locations, shows however that travel time savings are not equitably distributed in the region.

Karen Lucas provides, in Chapter 13, a critical assessment of the effectiveness of accessibility planning as a policy instrument for securing social inclusion goals in the United Kingdom (UK). In the UK, accessibility planning was introduced to complement and underpin other cross-governmental policy commitments to revitalize deprived communities. As part of the accessibility planning approach, GIS-based accessibility mapping tools were developed and applied in several pilot studies. Lucas

concludes however that these tools have tended to underplay the complexity of the lived travel experiences of socially excluded individuals, and have overlooked other important barriers to the take-up of the potentially life-enhancing opportunities that are potentially available to them outside of their immediate local neighbourhoods. A lack of transport, alone, is rarely the most important barrier to access that socially excluded people face. Lucas argues that accessibility assessments are a useful way to begin a process of dialogue about local responses to different transport and accessibility needs and actual or perceived barriers to travel. To better understand and address such difficulties, however, transport planners and policy-makers need to undertake complimentary community consultations; they need to develop participatory survey techniques, emphasizing the need to engage ‘hard-to-reach’ and excluded groups and communities.

TRANSPORT PLANNING AND ACCESSIBILITY MEASUREMENTS

The final part comprises three chapters on the role of accessibility measurements in transport planning in the UK, France and the European Union. The chapters give examples where travel speeds as a transport planners’ perspective of accessibility are replaced by concepts of accessibility linking transport networks, spatial structures and social effects, but also the complexities resulting from this move.

In Chapter 14, Derek Halden explains some of the experiences, pitfalls and lessons learned in 20 years of accessibility planning in the UK, and shows that whilst many problems have been overcome, other obstacles remain. Accessibility planning, in practice, employs a broad definition relying on three factors: the capacity of people to travel or communicate; the location of opportunities and activities; and the availability and quality of transport. GIS accessibility tools have been made available and the national government in the UK has also published a statistical series of accessibility indicators at the neighbourhood level, by combining location data for services and facilities with transport network data and population census data. The indicators show for example travel time to services by public transport and walking, by cycle and by car.

The accessibility planning approach is able to frame the transport planning dialogue within the transport user language of access to jobs, shops and services; integration debates have been able to progress from transport supply-side coordination, to allow practical planning of door-to-door journeys. Accessibility analysis techniques and accessibility policy have however continued to develop in parallel. The challenges of cross-sector

policy consistency continue to present greater barriers than the analytical challenges of measuring accessibility. The rise of accessibility planning has been punctuated with controversy about accountability for access, professional skills, delivery cultures and expectations, economic appraisal, social inclusion and the evolving role of government.

In Chapter 15, Yves Crozet, Aurélie Mercier and Nicolas Ovtracht describe a GIS tool to measure accessibility in Lyon, France. Since the 2000s in France, urban transport policies have faced major shifts. In places where, some years back, road and highway projects were favoured, large cities have opted for the development of public transit, seeking to optimize urban space consumption. The authors state that time gains are no longer the main objective of French local public policies. The Hansen-based accessibility potential estimated for Lyon urban area illustrates that public transit investments are favoured over road transport investments when ‘increased geographical accessibility’ rather than ‘reducing travel times’ is used as a local transport policy objective. This new perspective will also develop new public policies in an era where road traffic is likely to be more constrained as a result of spatial, social, climatic or energy objectives.

In the final chapter of the book (Chapter 16), Panayotis Christidis and Nicolás Ibanez Rivas present an accessibility assessment methodology applied during the preparation of the 2011 White Paper, *Roadmap to a Single European Transport Area* (European Commission, 2011). The authors address an important issue in transport planning related to accessibility. Accessibility can be measured in many different ways, and for policy-makers it is often difficult to select accessibility measures or indicators since they are often asked to serve conflicting policy objectives. For this reason, the authors have tested different formulations, using results from the TRANSTOOLS multimodal transport network model covering all 27 European Union member states. The model is the standard tool used by the European Commission services in policy impact assessments for transport. A set of indicators to measure transport costs, congestion and gravity-based accessibility measures was developed and linked to different policy objectives, including improved connectivity and economic efficiency.

FUTURE DIRECTIONS

This book highlights many dimensions of accessibility from a land-use and transportation perspective. Not surprisingly, it uncovers ways in which in academic research and transport planning practice approach accessibility differently, therefore leading to ambiguity about indicators and

measurement. The choice of an accessibility measure (and the manner it is operationalized) strongly affects related results and, consequently, the forecast effects of accessibility changes on the spatial economy and social inequalities. Lacking a unified 'accessibility' language among the different professions (civil engineers, geographers, transport planners, urban planners, and so on) presents a barrier to developing integrated transport policy strategies necessary for sustainable land-use and transport systems.

In the late 1990s, Handy and Niemeier highlighted the gap between academic and practical applications of accessibility; they asserted: 'It is important that accessibility measures used in practice are theoretically and behaviourally sound and that innovative approaches to measuring accessibility are made practical' (Handy and Niemeier, 1997, p. 1192). It is hard to convince ourselves, however, that the community of researchers and practitioners working on accessibility have strongly heeded this advice; continuing methodological trends favouring complex and disaggregated measures of accessibility live on. Transport planning approaches in the UK, France and the European Union (EU), described in this volume, rely to a great extent on Hansen's aggregate potential accessibility measure. Halden, for example, describes how Hansen-based potential accessibility measures included in Scottish transport appraisal guidance have subsequently been used for appraising several major road and rail transport projects, and appear to have been influential in supporting investment appraisals (see Chapter 14).

Hansen's potential accessibility measure is clearly a 'fundamental accessibility model' from a methodological viewpoint. It is analytically derived from several approaches, such as spatial interaction modelling (see Chapter 2). However, discrete-choice analysis, network analysis and aggregate accessibility analysis fail to allow a full understanding of the opportunities and difficulties of individuals and population groups in accessing key facilities.

To move beyond the current practice of accessibility analysis, modelling and planning, it is important to develop more unified and comprehensive conceptions of accessibility and to test them in practice. It is necessary to bring together different dimensions of accessibility (for example, economic, social, cognitive and psychological) and to incorporate all transport modes, user groups and travel-generating opportunities. Comprehensive accessibility efforts also require strong cooperation between accessibility researchers and public and private planning practitioners; this would enable them to test and implement innovative practices that could be complemented by comprehensive frameworks for economic appraisal and equity impact analysis.

Certainly, there are outstanding questions on accessibility analysis

and modelling – and its practical use in transport planning – which no single volume could adequately address. Major research directions would at least need to be directed towards the following topics: relationships between accessibility and networks (particularly in light of transport security matters); accessibility needs and preferences of different population segments (including elderly people, disabled and minority groups); the potential role of ICT in improving physical accessibility levels for these segments; and the role of accessibility in economic appraisal, equity, social justice and social exclusion analysis. These topics comprise a strong basis from which to proceed with future research paths on accessibility, as well as for other NECTAR volumes to come.

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