Land-Use Modelling in Planning Practice

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Foreword

A generation or more ago when land use transport models were first being developed, the focus was on how different models compared with one another in technical and theoretical terms. There was a concern for dynamics, for interaction and for calibration and validation, but less so for how such models might be interfaced with wider planning processes and the stakeholders that operate such systems and are indeed influenced by the plans that emerged from them. The state of the art then consisted of comparative studies of cross-sectional comprehensive spatial interaction model applications catalogued, for example, in the ISGLUTI Project – the International Study Group on Land Use Transport Interaction – and reported in the book by Webster, Bly and Paulley (1988). The dominant focus was very much in terms of the technical performance of models rather than their use in planning or policy-making.

As our experience of these models grew and evolved, this focus began to shift to the context in which models were best used. Onto the agenda came ideas about the various tools that had been developed to inform how we might best make good plans, and how these could be stitched together into coherent planning methods. Planning support systems in analogy to decision support in management were first formally suggested over 20 years ago by Britton Harris (1989) in his seminal article *Beyond geographic information systems: computers and the planning professional* as a way of bridging the development of computer models and tools with the activities of plan-making. Since then, a series of contributions to ways of building this bridge have been forged, the most recent being reported by Brail's (2008) in the collection of papers in his book *Planning Support Systems for Cities and Regions*. Many of these sketch the wider context and illustrate how a diversity of models and methods are coming together to define appropriate forums for dialogues between model builders, planners and the wider set of stakeholders involved in policy and its implementation.

So far we do not have a detailed blow by blow account of building and applying models as part of planning support systems. Until now that is, because this book represents the first such chronology of how a suite of land-use modelling tools called LUMOS – Land Use MOdelling System – which is centred on the Land Use Scanner model with another model Environment Explorer being sometimes

used in parallel, is being fashioned to examine a wide array of different planning issues ranging from climate change to ways of reducing energy use in transport. This book should convince sceptics of the need to use formal tools in a sensitive and appropriate manner to explore different urban and regional futures that can best address the various grand challenges involving the environment that will dominate the next 20 years and beyond. All of the authors writing here provide a splendid picture of planning support systems in action, in fact of several variants of a generic planning support system fashioned around the various tools and models that have been developed by many groups in the Netherlands which are now maintained by PBL Netherlands Environmental Assessment Agency.

This book reflects experience of using these tools over a 15 year period from the time when the Land Use Scanner was first developed, through its development to finer scale levels of spatial resolution and through its development from an analytical tool to one with a direct optimisation capability. The first three chapters in the book set the context by describing these models and setting them in the wider context of spatial modelling more generally. Koomen, Hilferink and Borsboom-van Beurden provide a comprehensive and technically useful description in the first chapter where they define the basic structure and purpose of the model as a 'specification of regional demand for land, a definition of local suitability, an allocation module', and resulting depictions of future land use.

This introduction is followed by setting the LUMOS-models in an international perspective based on a report by Timmermans, Batty, Couclelis and Wegener who were involved in developing a critique of the experience in 2007. It might seem a little odd that one of these reviewers is writing this foreword but as a group, we had a privileged role in learning about the project, and thus I can communicate our feelings that this entire effort should be brought to the attention of the wider world of land-use and urban modellers as well as planners engaged in the search for good practice in the kinds of planning that LUMOS has been used to support. In fact, the LUMOS toolbox is unusual in that the models generally operate across several scales from the countrywide Netherlands itself down to quite small urban and rural regions. What indeed is impressive is the range of applications that are reported here. These pick up on significant questions about sprawl, environment, city compaction, climate change, and energy reduction in the context of sustainability. The toolbox does not quite extend to dealing with demographic factors per se but there are plenty of hooks to suggest how these other sectoral models can be plugged into any planning support system fashioned on LUMOS principles.

Before the various contributions move onto applications and extensions of the models, van Schrojenstein Lantman, Verburg, Bregt, and Geertman provide an interesting and informative review of land-use models ranging from land cover to cellular automata and thence to agent based models. They review six generic types in more detail including *GEOMOD2* which is land cover based, *SLEUTH* which is a cellular automata land development model, *UrbanSim* which is probably the best example of a contemporary land use transport model based on discrete choice theory but also embodying fine scale spatial grain with an agent-based focus, *IMAGE* an ecological–environmental framework to explore the long-term dynamics of global

change, *CORMAS* a multi-agent framework simulating natural resources allocation, and *ILUMASS* a micro-simulation model of urban land use. A brief review of the modelling process involving calibration and validation is present and this sets the scene for many applications in practice.

Sustainability issues follow focusing on climate change – flooding risks and water damage, shortages and salt-water intrusion – biodiversity, accessibility and environmental impacts, quality of life, global business issues, and landscape quality. Transport modelling and its relation to land-use change are then explored using the example of a well-established model in which many features of the land market appear. This model which is called Tigris XL is linked to Land Use Scanner through the housing market which lies at the heart of linking different kinds of urban model. Applications then focus on the potential for resource allocation across the Netherlands and its region where the various simulation models are used to look at bio energy production and more general regional spatial strategy planning. Many important lessons for the use of models in planning support are gleaned from these analyses. These lessons have been noted many times but here, they are based on a wealth of experience which is only possible when you have had the sort of sustained modelling effort that has been characteristic of planning in the Netherlands for the last 20–30 years at least.

Future developments are then charted and it is here that we see how the critical mass built up from this experience provides an important guide to how these models might be extended and improved. Dekkers and Rietveld begin this process by developing a land market basis for Land Use Scanner while Kuijpers-Linde provides the wider context of planning support. Last but not least a new market-based land-use model is proposed by Borsboom-van Beurden and Zondag. This builds on the Tigris XL schema and from this and other contributions below, it clear that the general consensus is that all these tools need a stronger economic underpinning for the processes of land allocation that they simulate and forecast as well as optimise.

This book is a timely and important contribution to ways in which we might use models in planning, models in practice, and how we might best use them to inform the dialogue between professionals and decision-makers. Case studies are essential in this but all too often, we do not have enough detail to know how effective the models and tools applied have actually been. This book redresses this balance for it contains a wealth of experience that is not available anywhere else. What is unusual and impressive is the way this experience is being used to improve planning support, to reconcile a changing balance between experts, professionals, informed lay interests and the public-at-large. Joshua Epstein (2008) in a fascinating essay entitled *Why Model?* makes the point ‘The choice, then, is not whether to build models; it’s whether to build explicit ones. In explicit models, assumptions are laid out in detail, so we can study exactly what they entail’. The contributions in this book provide this explicitness that Epstein calls for in a way that provides us with clear rules of engagement for the use of models in planning.

London, UK Michael Batty

References

Brail, R. K. (Ed.). (2008). *Planning support systems for cities and regions*. Cambridge, MA: Lincoln Institute of Land Policy.

Epstein, J. M. (2008). Why model? *Journal of Artificial Societies and Social Simulation, 11*(4), 12. Available at http://jasss.soc.surrey.ac.uk/11/4/12.html. Retrieved March 2011.

Harris, B. (1989). Beyond geographic information systems: Computers and the planning professional. *Journal of the American Planning Association, 55*, 85–90

Webster, F. V., Bly, P. H., & Paulley, N. J. (1988). *Urban land use and transport interaction: Policies and models*. Farnborough, Hants: Gower.

Preface

Land-use modelling has been firmly established in Dutch planning practice in the past 10 years. The Land Use MOdelling System (LUMOS) toolbox, managed by PBL Netherlands Environmental Assessment Agency, has made this development possible. The development of this toolbox started in 1996 and builds on the cooperation of public research organisations such as PBL and the Agricultural Economics Research Institute (LEI), academic institutes (VU University Amsterdam) and commercial IT companies (Geodan and Object Vision). The ongoing model development process is unique in the sense that it reflects almost 15 years of continuous interaction between planners, researchers and IT specialists.

This book gives an overview of the wealth of recent applications and developments of the LUMOS toolbox. It contains contributions of the many partners that are active in applying and developing the toolbox and focuses specifically on the Land Use Scanner model that was applied in a wide range of policy-related studies in the past years. In addition to being employed for trend extrapolation, scenario studies and optimisation at the national level, the model has also been frequently used at the lower, regional scale level as is demonstrated in the various regional cases that are included in the book. Besides these applications, the book also considers some of the more theoretical aspects of land-use models and discusses various studies preparing the further development of the model. As such, this book is a continuation of the previous Dutch *Ruimtescanner* book published in 2001 that described the development and initial applications of Land Use Scanner.

The current book is aimed at planners and researchers worldwide that are interested in the current state of the art of land-use modelling in planning practice. It shows which types of applications are possible with current operational instruments and discusses possible pathways for further development. The book allows scholars and practitioners around the globe to learn from the extensive experience of Dutch planners and modellers. This may be particularly interesting since the Netherlands have a longstanding experience in this field, which is exemplified by the fact that the well-known and often-used CLUE and MOLAND-based models also originate here.

Obviously, the book is only a snapshot of work in progress. It does, for example, not document recent work related to climate adaptation that is carried out within the

Climate changes Spatial Planning and Knowledge for Climate research programs. Neither does it pay attention to the many recent land-use models – based on Land Use Scanner – that were built in international projects related to, amongst others, the catchment areas of the Rivers Elbe, Rhine and Meuse, the region of Flanders, Surinam and Honduras. It does also not highlight the pan-European EU-ClueScanner model commissioned by the European Commission that is built upon the Geo-DMS model framework underlying Land Use Scanner. This new model follows the specification of the Dyna-CLUE model and uses a dynamic version of the algorithm that is also underlying the new discrete version of Land Use Scanner. Publications on these and other new model developments can be found on the websites: www.lumos.info and www.feweb.vu.nl/gis/research/lucas.

The first part of the book discusses the scientific and theoretical aspects of applying land-use models. After a concise introduction of the Land Use Scanner model in Chapter 1, the evaluation of the two land-use models that comprise the LUMOS toolbox (Land Use Scanner and Environment Explorer) by an international audit committee in 2007 and their recommendations for improvement of the current models are summarised in Chapter 2. Following, Chapter 3 explores the theoretical foundation of current land-use models and examines the pros and cons of various concepts and methods in land-use modelling.

Then, Part II discusses a number of applications of Land Use Scanner for a wide range of research and policy questions in environment, agriculture and spatial planning, and at various scale levels. The Chapters 4 and 5 highlight the comprehensive application of Land Use Scanner at the national level for the Second Sustainability Outlook on the future of the Netherlands. Chapter 4 introduces this study, while Chapter 5 discusses the link to the Tigris XL transport model that was realised in order to be able to analyse the joint impact of spatial planning and transportation measures. Chapter 6 explores the potential for bio-mass production in a regional case-study in the Province of Friesland and its agro-economic benefits. Subsequently, the role of different optimisations of land-use patterns and their environmental impact in a regional spatial planning process in the Province of Overijssel is evaluated in Chapter 7. Then, Chapter 8 zooms in at the methodological aspects of a number of recent applications at the regional scale level and their similarities and dissimilarities.

The final part of the book reports recent research initiatives working towards the development of a new land-use model. Chapter 9 describes how information on actual land prices can be used to develop a new method for modelling land-use transitions in Land Use Scanner. Subsequently, in Chapter 10 the information needs of spatial planning, in particular on land-use changes, and the requirements to a new model from the perspective of actual policy questions, are considered. Lastly, the way forward to a model meeting those requirements, and the various options to realise such a model in a cost-efficient way, are outlined in Chapter 11.

This book would not have been here without the joint efforts of many individuals and organisations. We are particularly grateful to the authors who contributed to this book and the many people at PBL (notably Bas van Bemmel, Filip de Blois, Bart Rijken and Annemieke Righart) who helped with the logistics of production

including the revision of text and graphics. In addition, we want to thank the Dutch National research programme ‘Climate Changes Spatial Planning’ for sponsoring part of the extensive work involved in editing the book.

We hope that this book provides inspiration to planners worldwide to use a modelling approach to better understand the spatial context of their planning problems and to suggest potential solutions. A demonstration version of the model has therefore been made available on a separate website (www.feweb.vu.nl/gis/landusescanner.htm) to familiarise users with the potential of this kind of tools.

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