Learnings from developing and implementing geospatial urban planning decision-support tools in Aotearoa New Zealand

M. Schindler*[1] and R. Dionisio[2], Ines Falcao[2] and S. Kingham[2]

[1]School of Geography, Environment and Earth Sciences, Victoria University of Wellington
[2]Department of Geography, University of Canterbury
*Email: mirjam.schindler@vuw.ac.nz

Abstract

We present findings from developing and implementing spatial decision-support tools (SDST) to assist New Zealand urban planning stakeholders in visualising, assessing and comparing alternative urban regeneration scenarios. The SDST support the identification of urban areas suitable for specific regeneration strategies at the city-region scale and enable the assessment of alternative regeneration scenarios as to their environmental, social and economic impacts at the neighbourhood scale. We report learnings from our journey of developing the tools in close collaboration with stakeholders and implementing them in with diverse New Zealand planning authorities and discuss along key themes: i) local context matters in a system of data, tools and place, ii) potential path dependence through SDST with respect to urban outcomes, and iii) how geospatial tools can foster sustainable transformation in urban regeneration.

Keywords: geospatial decision-support tool, urban planning, complex systems, geovisualisation, geosimulation.

1. Urban complexities and the need for local SDST

Urban planning stakeholders face challenges coping with the emerging complexity of modern urban systems (Batty 2008). Urban planning is posed with a range of complexities regarding the functioning of cities, addressing population increase without degrading the local environment, while improving urban liveability, health and wellbeing; and related to how decisions are informed through current evidence for better social, environmental and economic outcomes at the city and neighbourhood scales. Planners often face multiple challenges to comply with several planning processes which recurrently do not have an integrated approach to environmental, social and economic assessment of planning scenarios.

Treating cities as complex systems (Batty, 2008) has seen the emergence of algorithmic approaches and modelling methodologies to analyse the complexity of systems (White et al. 2011). Urban planners and decision-makers increasingly make use of models to better understand how urban sustainability could be achieved and to attain evidence tools (e.g. Stevens et al., 2007; Schetke et al., 2012; Chevalier et al., 2012; Glackin et al., 2016). However, adding to this complexity in Aotearoa New Zealand, there is a lack of local geospatial tools to support planners in evidence-based decisions, or to support the visualisation of planning scenarios to involve other actors in the process.

2. Aims of this research

This research developed a geospatial toolkit to support evidence-based decision-making in urban planning and regeneration in Aotearoa. ENVISION aims to support the identification of urban areas suitable for specific regeneration strategies at the city-region scale, through the analysis of demographic and property-level data. ENVISION Scenario Planner (ESP) enables the assessment of alternative regeneration scenarios as to their environmental, social and economic impacts at the neighbourhood scale. These spatial decision-support tools (SDST) equip stakeholders with novel ways of modelling and examining potential trade-offs of their decisions on the environment and socio-economics. While New Zealand's urban planning decision-support tools so far offer a predominantly market-driven perspective which strongly advocates for developers' interests in 'business as usual' approaches to redevelopment, our tools shed light on alternative regeneration scenarios. These tools offer novel ways to define, create and assess alternative regeneration scenarios, which are being made available through continuous better integration of spatial data sources, geospatial technologies and information about the built environment. This has the potential to provide urban planning practitioners with evidence and visualisation material. Planning decisions are complex, and urban models such as ENVISION and ESP can provide a more comprehensive perspective on impacts of such decisions on the underlying interdependencies.

The interest of the project is not only of technical nature; it is also interested in better understanding socio-technical interactions, which arise through the use of technology (e.g. Clarke et al 2006) in decision-making, such as ENVISION and ESP and receive increasing attention among the geocomputation community. Based on these geospatial tools and engagement work with local stakeholders (e.g. urban planning authorities, local communities), the project aims at teasing out lessons for the development and implementation of geospatial tools such as ENVISION and ESP in Aotearoa New Zealand and the wider spatial community, highlighting challenges and potentials.

3. The geospatial tools ENVISION and ESP

The two geospatial tools can be used separately or in a workflow as illustrated in Figure 1.

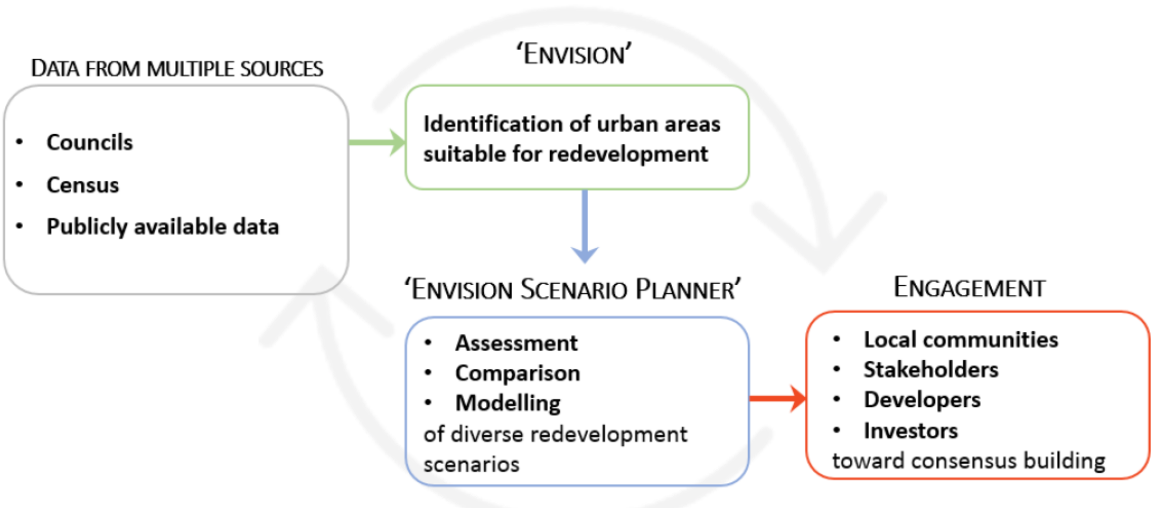

Figure 1: Workflow of the geospatial tools ENVISION and ESP.

ENVISION – Where to regenerate?

ENVISION is a web- and map-based tool for the identification of areas for urban regeneration. It consists of a suite of tools to examine the potential of land parcels for regeneration. It allows to identify urban areas across the city suitable for specific regeneration strategies, through a multi-criteria evaluation tool, land parcels across the city that are prone to be redeveloped, considering a redevelopment potential index, and to assess the financial viability for diverse regeneration scenarios (at neighbourhood scale) (Figure 2). Users can easily adapt input criteria with instantaneous spatial mapping of outcomes.

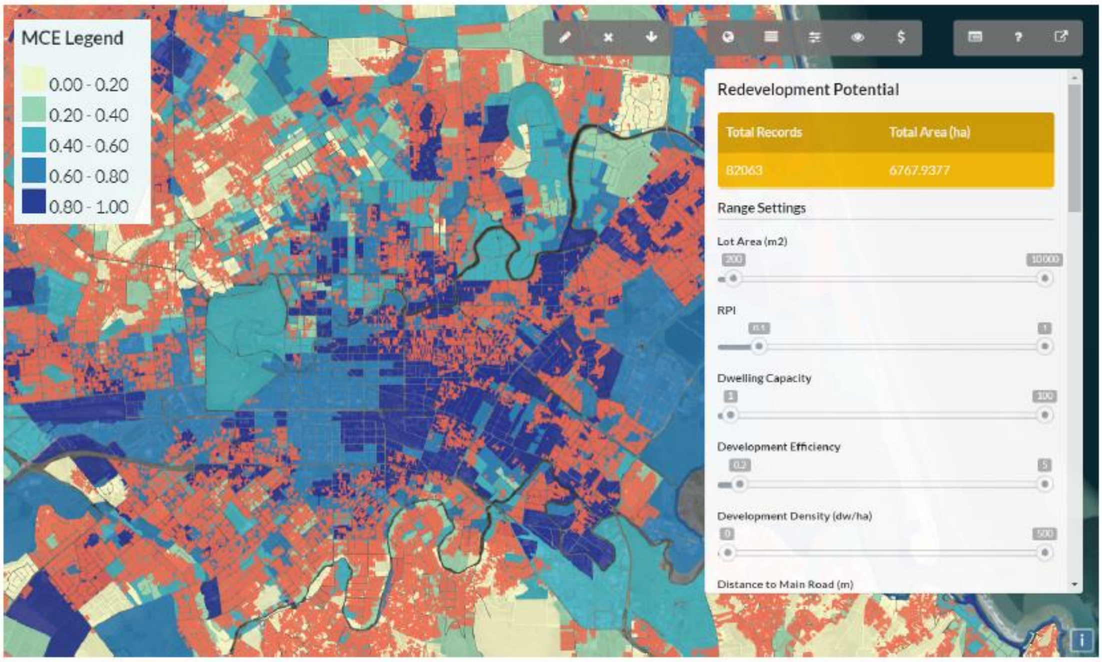

Figure 2: ENVISION – A web- and map-based tool to identify areas for urban regeneration.

Envision Scenario Planner (ESP) – How to regenerate?

ESP is a geospatial, web-based tool with 2.5D visualisation for the design of regeneration scenarios at neighbourhood scale and the visualisation and assessment of their environmental and socio-economic impacts (Figure 3). The assessment reports can provide a good basis to facilitate conversations with both experts and non-experts.

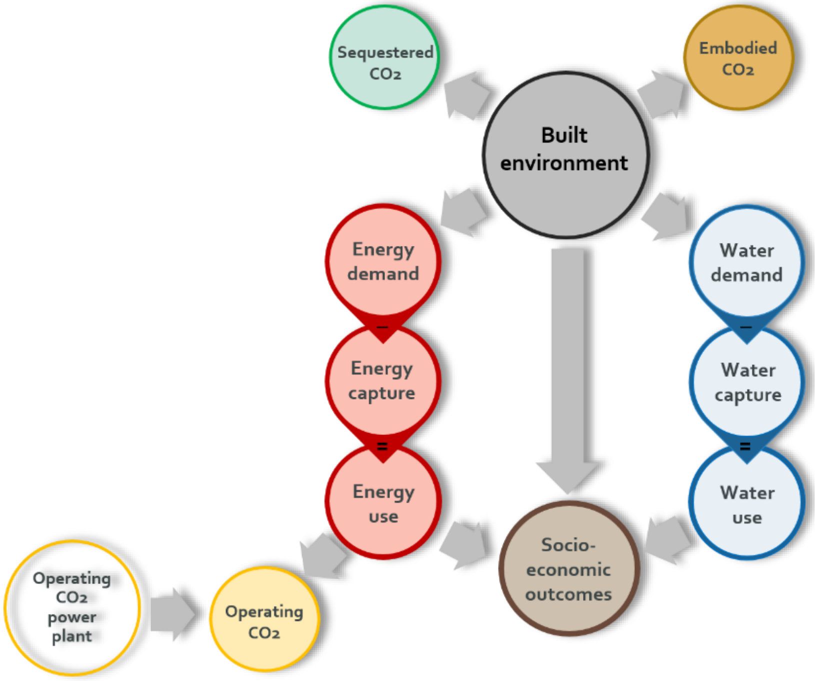

Figure 3: ESP algorithm scheme.

Users can allocate buildings, open spaces and pathways in a development area, and explore individual and aggregated impacts. ESP generates a set of outputs: i) a spatial visualisation of land use and allocated building typologies in 2.5D, ii) a summary of the site characteristics of scenarios (e.g. dwelling density, area, footprint, number of residents), and iii) an assessment report on environmental and socio-economic impacts (e.g. property and operating costs, energy and water use). Users can integrate various (spatial) information about building typologies and urban neighbourhoods, and translate regeneration strategies into visible and measurable scenarios providing indicative evidence for decision-making on social and environmental amenities. ESP was developed to provide a more holistic approach, extending the list of indicators beyond the 'business as usual' market perspective, and looking beyond the scale of a single building.

Figure 4: ESP – Example assessment of two alternative regeneration scenarios.

An example contribution of the geospatial tools is to assess which alternative scenarios to the 'business as usual' are feasible. Both geospatial tools offer new perspectives on urban planning potentials in New Zealand's cities. For instance, ENVISION offers a visibility tool to assess not only a 'business as usual' residential housing scenario, but, for instance, also a social housing scenario. Likewise, ESP offers the possibility of comparing, for instance, economically driven scenarios to environmentally or socially conscious scenarios. ESP allowsnot only the assessment of various energy efficiency scenarios but also of various densities and land use mixes.

4. Learnings from the research project

Stakeholder engagement is a key component of this research, and the team has been working with diverse planning authorities (e.g. central and local government planning authorities, a grass roots organisation) to assess the suitability and usability of the geospatial toolkit and identify areas for improvement considering local specific needs and priorities across the country. Drawing from a review of international literature and this work with stakeholders, three key themes emerged in a spatial socio-technical system: i) local context matters, ii) there is potential path dependence through the use of SDST, and iii) the key characteristics SDST would need to fulfil for transformative urban regeneration.

4.1. Local context matters – socio-technical interactions in a complex system of data, tools, and place

The use of the geospatial tools provides an example to highlight the need to view spatial planning decision-support tools in a spatial socio-technical system, integrating tools, data and local context to better align tools with regulatory frameworks and planning processes (Figure 5).

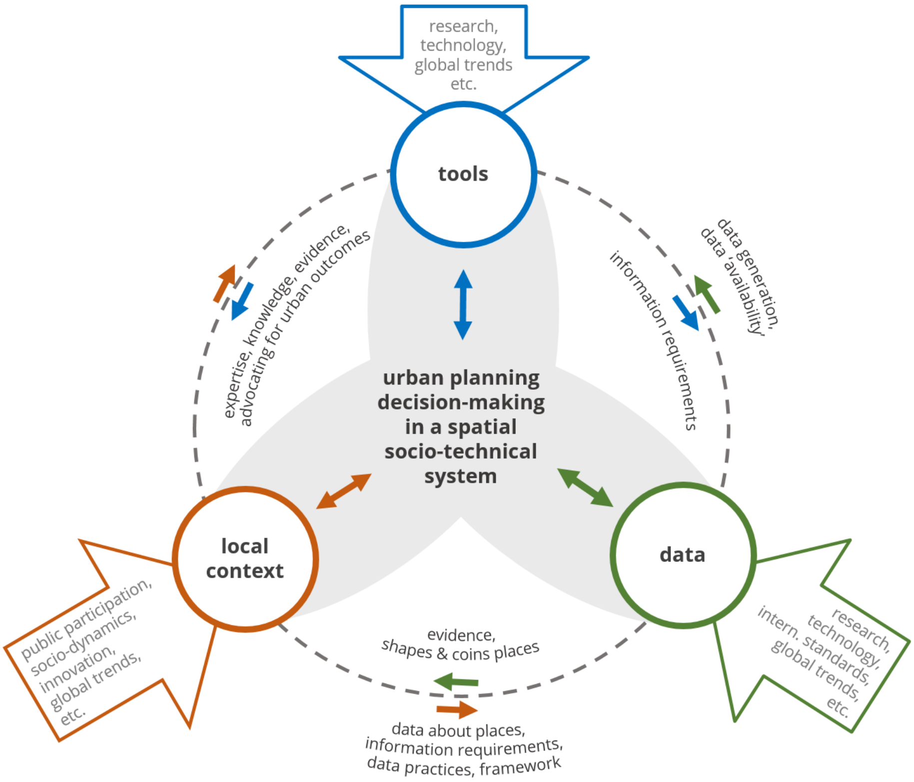

Figure 5: Urban planning decision-making in a system where data, tools and place interact.

Local context matters in this systems approach to promote the uptake of decision-support tools. SDST change the way decisions are being made and play an important role in shaping future cities. Yet, decision-makers must be aware of challenges around SDST such as technological and user subjectivity and view SDST in a wider, spatial socio-technical system to fully leverage their potential and ensure improved urban outcomes adequately considering the local context. A key factor in this is a focus on SDST which initiate conversations and collaborations between developer and user teams from early in the process.

4.2. Path dependence in urban outcomes induced through the use of (S)DST

SDST aim at facilitating decision-making processes but they often do not provide straightforward answers and expertise is required for their use. Decisions depend on the actors involved in the processes (Andersson-Sköld et al., 2016). SDST can steer urban planning decision-making and the use of particular SDST can, consciously or unconsciously, influence urban planning outcomes. Different SDST yield different outputs (i.e. assessments, visual information), and the practices of specific socio-technical systems can alter the use of a particular SDST (Figure 6).

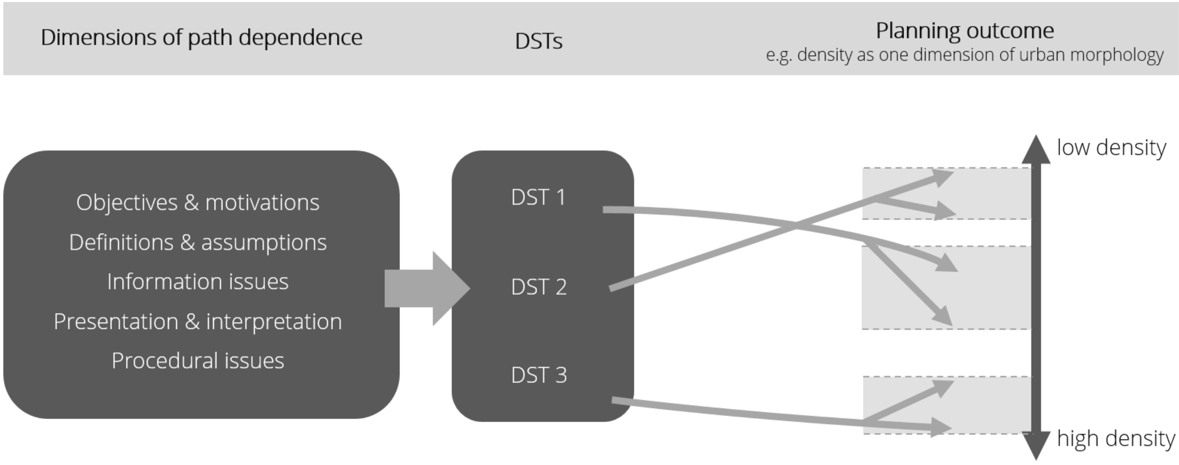

Figure 6: Path dependence through the use of different (spatial) decision-support tools (DST), along five dimensions in a spatial socio-technical system.

We use the geospatial tools as an example to illustrate potential path dependence in the use of SDST on urban outcomes and highlight the need to transform the entire system if aiming to change urban outcomes. We argue that fundamental change will not occur using the same tools with different data, altered objectives or a different storyline. Tools are deeply grounded in belief systems and other aspects along the dimensions of path dependence. Our analysis calls for a critical reflection on the choice and adoption of tools endorsed by decision-makers. Such inertia and lock-in (Hensley et al., 2014) might induce path dependence. Aligning expectations and strategies with the use of SDST is required to foster urban transformation. To break out of path dependence, considerations of SDST in spatial socio-technical systems can be beneficial. Understanding the wider system in which a SDST is embedded (Hämäläinen and Lahtinen, 2016; Clarke et al., 2006), the context of urban planning SDST in the spatial socio-technical system, helps identifying potential sources of path dependence. Raising awareness of such sources is a first step towards change, supporting the understanding of barriers to change (Hämäläinen & Lahtinen, 2016).

4.3. SDST for transformative urban regeneration

Finally, we use the described geospatial tools as examples to explore which characteristics SDST might need to exhibit for transformative urban regeneration. Figure 7 illustrates that the role of successful SDST is to articulate between the global and the local planning context, and thereby initiating a transformation of the system. We discuss for instance that cross-sectorial and tools which cut across various spatial scales demonstrate a higher potential for transformative urban regeneration.

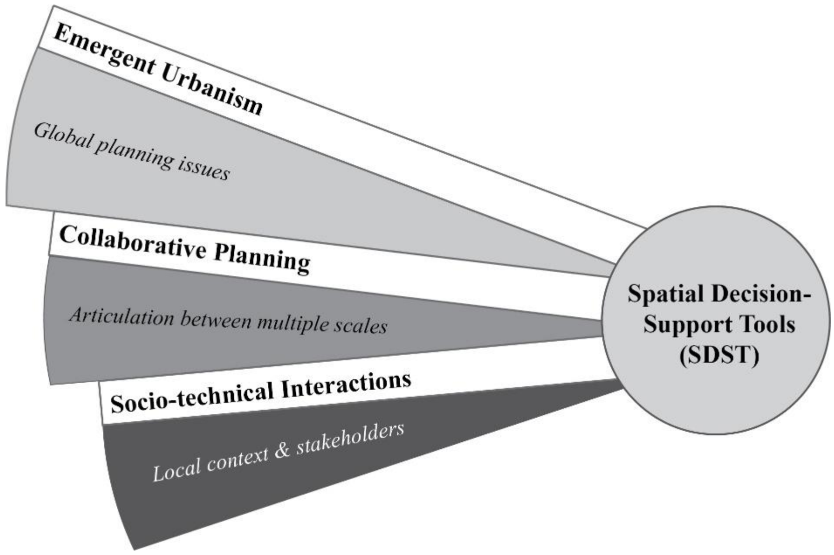

Figure 7: SDST articulating between the global and the local planing context.

Technology is a key component of SDST; however, feedback between the technological design and social components of the spatial socio-technical system, such as stakeholder needs, priorities, and challenges, demand to be equally considered in SDST to support urban decision-making. We integrated these findings into the development of ENVISION and ESP.

5. Acknowledgements

The authors would like to acknowledge the National Science Challenge "Building Better Homes, Towns and Cities: Ko ngā wā kaingā hei whakamahorahora" as funding source for this research.

6. References

Andersson-Sköld, Y., P. Suer, R. Bergman and H. Helgesson (2016). *Sustainable decisions on the agenda – a decision support tool and its application on climate-change adaptation*, Local Environment, 21(1): 85–104.

Batty, M. 2008. *Cities as complex systems: scaling, interactions, networks, dynamics and urban morphologies*, 131.

Chevalier, P., I. Thomas, D. Geraets, E. Goetghebeur, O. Janssens, D. Peeters and F. Plastria. 2012. *Locating fire stations: An integrated approach for Belgium*. Socio-Economic Planning Sciences, 46(2).

Clarke, K., G. Hardstone, M. Rouncefield and I. Sommerville. 2006. *Trust in technology: A socio-technical perspective*, Dordrecht, The Netherlands: Springer.

Glackin, S., R. Trubka and M.R. Dionisio. 2016. *A software-aided workflow for precinct-scale residential redevelopment.* Environmental Impact Assessment Review, 60.

Hämäläinen, R.P. and T.J. Lahtinen. 2016. *Path dependence in Operational Research-How the modeling process can influence the results.* Operations Research Perspectives. 3: 14–20.

Hensley, M., D. Mateo-Babiano and J. Minnery. 2014. *Healthy places, active transport and path dependence: A review of the literature*. Health Promotion Journal of Australia. 25(3): 196–201.

Schetke, S., D. Haase and T. Kötter. 2012. *Towards sustainable settlement growth: A new multi-criteria assessment for implementing environmental targets into strategic urban planning*. Environmental Impact Assessment Review. 32(1): 195–210.

Stevens, D., S. Dragicevic and K. Rothley. 2007. *iCity: A GIS-CA modelling tool for urban planning and decision making*. Environmental Modelling and Software. 22(6): 761–773.

White, R., I. Uljee and G. Engelen. 2012. *Integrated modelling of population, employment and land-use change with a multiple activity-based variable grid cellular automaton.* International Journal of Geographical Information Science. 26(7).