Applying the *What if?* Planning Support System for Better Planning at the Urban Fringe

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21 Applying the *What If?* Planning Support System for Better Understanding Urban Fringe Growth

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Abstract: This chapter reports on the application of the collaborative GIS-based *What If?* planning support system for managing data and creating exploratory future land use change scenarios. The case study area is Mitchell Shire, a local government municipality located on the urban fringe of the City of Melbourne, Australia. In this research we describe the various modules comprising the *What If?* planning support systems (PSS) and how they have been applied to assist local planners within the shire to better understand land suitability and the probable impacts of projected population growth. The research also aims to increase awareness of the potential benefits of PSS for planning.

21.1 Introduction

Computers were introduced to urban planning in the 1950s and 1960s (Klosterman 2001). Since then the philosophy of planning has changed considerably from planning *for* communities to planning *with* communities (Forester 1999). The role of computers to support planning practice has in-turn evolved from the application of top-down large-scale urban models to
the adoption of participatory spatial planning tools. The development of GIS and its proliferation as a research tool in the 1980s was significant in this evolution (Budic 1994). GIS are recognised as an essential tool for planning, but alone are not sufficient to meet the needs of planners (Klosterman 1999). Planning support systems (PSS) provide a more tailored tool, designed specifically for planning purposes. Through resources like the ESRI Virtual campus course ‘Introduction to urban and regional planning using ArcGIS’ (Pettit and Pullar 2001) planners are provided with a fundamental knowledge of GIS and the necessary skills to apply GIS and PSS in practice.

PSS are a specialised type of spatial decision support system which focuses on assisting planners and decision makers in making better decisions about current and future land uses. PSS offer an evidence-based approach for incorporating socioeconomic and biophysical data to formulate land use change scenarios. There are many tasks PSS can assist with, including: land use/land cover change, comprehensive projections, three-dimensional visualisation, and impact assessment (Klosterman and Pettit 2005). There are also numerous PSS available (Brail and Klosterman 2001; Geertman and Stillwell 2004), which fall into the following modelling categories: large-scale urban, rule-based, state-change, and cellular automata (Klosterman and Pettit 2005).

However, even though there has been a number of PSS developed in the 1990s and 2000s there remain issues in bridging the gap between GIS and PSS (Geertman and Stillwell 2004) and an acknowledged ‘bottleneck’ in the adoption of PSS tools by planning practitioners. A lack of awareness is a major hurdle in the widespread adoption of PSS in planning practice (Vonk et al. 2005). To disseminate knowledge of the existence of planning support systems, ‘real-world example projects … of PSS application in planning practice will be crucial’ Vonk et al. (2005, p. 909). This is precisely what this chapter aims to address in providing a case study of an application of the What If? PSS, using real data and planning metrics for the Mitchell Shire, Australia.

21.2 The What If? Planning Support System

What If? is a collaborative GIS-based planning support system developed by Klosterman (1999), which is supported by What If? Inc. <http://www.whatifinc.biz/>. The PSS is not an academically supported planning tool rather it is a commercial off-the-shelf (COTS) software package. Based on initial feedback from end users of the software, some of
the advantages and disadvantages of *What If?* in the context of urban and regional planning in Victoria will be discussed in the ensuing sections of this chapter.

The application of *What If?* version 2.0 — which can be categorised as a rule-based, comprehensive projection, task-oriented PSS — is discussed in this chapter. *What If?* is a stand-alone software package, developed using ESRI’s MapObjects embeddable mapping and GIS components [http://www.esri.com/software/mapobjects/index.html](http://www.esri.com/software/mapobjects/index.html). To date there have been a number of applications of *What If?* (version 1.0) in the United States and elsewhere (Kim 2004; Klosterman et al. 2002, 2006; Li 2003; McClintock and Cutforth 2003; Pettit 2005; Webb 2003). In Australia, *What If?* (version 1.0) has been applied to assist the Shire of Hervey in Queensland to come to terms with the impact of projected population growth contributed to the ‘sea-change’ phenomena fuelled by tourism and an aging retiring population (Pettit 2005).

The PSS comprises two programs — *Setup* and *What If?*. *What If?* version 2.0 has several significant enhancements from version 1.0. These include:

- the ability to not only project land use, but also population and employment figures
- greater flexibility in the number of land use classes and suitability factors that the PSS can handle, and customisable slider bars to capture planning metrics (ratings and weightings)
- disaggregated reporting on the projections for sub-areas as well as the total study area
- improved cartographic and mapping capability.

*What If?* requires pre-processing (buffering, union, clip, clean...) of input data layers to create a Unified Analysis Zone (UAZ) file, which is stored in ESRI’s shapefile (*.shp) format.

*What If?* is a PSS that recognises developments that have occurred in urban planning, yet has been developed based on the principle of keeping the models as simple as possible. It is a GIS-based PSS that supports collaborative planning and public participation. *What If?* is a scenario-based, policy oriented PSS that uses GIS data to conduct land suitability analysis, project future land use demand, and allocate these projected demands to the most suitable locations (as described below). It allows users to create future urban growth scenarios and determine the impacts of alternative policy choices on future land use patterns and social trends. *What If?* involves a simple user interface that allows the user to enter data and weightings, generate scenarios and examine results, then go back and alter pa-
rameters easily to generate further scenarios. Maps can then be compared within *What If?* which provide a powerful tool for assisting in the collaborative planning process. Figure 21.1 illustrates the *What If?* PSS framework as a planning policy tool.

*What If?* is made up of three main modules: suitability, demand and allocation. The role each of these modules play in projecting future development patterns is described briefly below.

### 21.2.1 Suitability Module

The land suitability analysis (LSA) module enables the user to input a number of constraints and opportunities that can be represented geographically. These spatial constraints and opportunity layers are referred to as ‘suitability factors’. The LSA approach is based on the simple but effective sieve mapping overlay approach (McHarg 1969). A spatial overlay of all the suitability factors is created and enables users to assign ratings and weightings of importance to specific factors (e.g. distance to railway station) in order to define the overall land suitability for a particular land use (e.g. industrial). *What If?* can produce either maps or reports on the land suitability for a particular land use.

### 21.2.2 Demand Module

The land use demand module projects the demands for residential, employment-related, preservation, and local land uses. The demand assumptions are driven by the available or calculated projection figures and include projected population and employment trends, future population and employment densities, and desired quantities of open space and recreational land. The demand assumptions are converted into the equivalent land use demands and can be viewed in table format.

*What If?* can input available demographic projections of population, housing and employment data to derive land use demand. However, if such projections are not available then *What If?* applies a linear extrapolation of existing and/or past trends to project future population, housing and employment figures.

### 21.2.3 Allocation Module

The *What If?* allocation module projects future land use patterns using both the inputs from the LSA and land use demand modules. The allocat-
tion module also takes into consideration public policies (e.g. farm preservation), zoning ordinances, growth controls, infrastructure services (roads, sewers and water) to guide the future allocation of land for particular purposes. The allocation engine incrementally allocates land required for a particular land use on a user-defined time interval. Once the required land for a particular land use is satisfied then the allocation engine proceeds in assigning land for the next prioritised land use until its demand has been met and so on. The allocation engine proceeds in matching land use supply and demand for up to four time step intervals. In the Mitchell Shire case study this has occurred in five-yearly intervals which align with population project years (2006, 2011, 2016 and 2021). However, as What If? only supports four time intervals, the final interval has been extended from 2021 to 2031 to allow 30-year land use change scenarios to be developed.

What If? has benefits over other methods of planning as is an integrated tool that allows planning tasks to be performed quickly and easily, and it can be customised to specific database and policy issues (Klosterman 1999). It is designed to identify what would happen if the underlying assumptions used in a scenario were correct, rather than produce a single ‘exact’ prediction of the future. Therefore it is intended as a tool to explore likely policy options and facilitate open and ongoing processes of community learning. Feedback from the Mitchell Shire planners suggested that one of the biggest strengths of What If? was its ability to analyse, test, see and think about spatial planning policy. However, the complexity or comprehensiveness of such PSS software offer challenges to planning practitioners. Further feedback from Mitchell Shire planners indicated the potential practical applications of What If? took quite a bit of time and assistance from tool experts to achieve a sound conceptual understanding of the program.

21.3 Mitchell Shire Application of What If?

Mitchell Shire local government authority (LGA) is located 35 to 100 km north of the City of Melbourne, Australia. The shire comprises 2,864 km² and is situated along the Hume Highway, connecting Melbourne and Sydney (Fig. 21.2). This area is broadly known as an ‘High Amenity Landscape’ which is driven by rural lifestyle living (Barr 2005). The natural resource base and rural areas are significant assets to the shire, with wool and beef being the most important types of agriculture (Mitchell Shire Council 2006). Socioeconomic characteristics of the region include: strong population growth; average to low levels of unemployment; and major
employment sectors in manufacturing, retail, government administration and defence. The main planning aim for Mitchell Shire is to maintain the urban–rural mix of the area and the integrity and character of the towns (DSE 2006a, 2006b).

Fig. 21.1. *What If?* planning support system framework for informing planning policy
The residential population has grown by 48% over the period 1981–2001 (DSE 2006b) and is currently estimated as 32,600. The location of Mitchell Shire relative to Melbourne strongly influences its growth and development. A large proportion of the shire’s workforce commutes to Melbourne for employment, while Puckapunyal Military Base is the largest employer within the shire (DSE 2006b). Continuing population growth will place demands on land, services and infrastructure. Extensive areas around the shire’s major towns have been zoned for residential development and the shire wishes to retain tight control of residential expansion into rural areas (DSE 2006a). The Mitchell Shire planners acknowledge the role and relationship of farming land with people, the economy, strategic policy and practice is very important. The planners believe *What If?* is a useful tool to facilitate a greater understanding of what is really happening and how government policy, legislation and controls are impacting the shire.

The *What If?* PSS has been applied to Mitchell Shire to create future land use change scenarios up until 2031, and thus align to the Melbourne 2030 strategic vision (DOI 2002). *What If?* land use change scenarios have been created for 2031 rather than 2030, to fit with Australian Bureau of Statistics (ABS) estimates. The objectives outlined in Mitchell Shire’s Local Planning Policies and Municipal Strategic Statement (DSE 2006a, 2006b), as well as those objectives ascertained from discussions with plan-
ners from Mitchell Shire, have been the drivers for creating four likely allocation scenarios for 2031:

- Conservation/Low Growth/Strategic Plan
- Conservation/High Growth/Strategic Plan
- Conservation/Low Growth/No Strategic Plan
- Conservation/High Growth/No Strategic Plan

The Conservation component of these scenarios has been derived from LSA. Conservation represents the main planning aim for the Mitchell Shire which is to maintain the urban–rural mix of the area while protecting existing agriculture and productive land from the encroachment of urban growth. This scenario imposes strict restrictions on the supply of suitable land for development in an attempt to preserve the area’s rural character. In particular, it incorporates the following assumptions:

- all eleven of the suitability factors are considered when they are appropriate for a particular land use
- development is discouraged from areas of significant land, or where there is vegetation protection
- development (other than agricultural) is severely limited in areas with the highest quality agricultural soils.

The Low Growth component of the scenarios relates to land use demand. The Low Growth scenario employs low population growth projections, in this case as prepared by the Department of Sustainability and Environment Victoria and assumes that the study area’s population will be 48,835 persons in 2031. The High Growth option incorporates the comparatively high population growth projections prepared by ID Consulting (2002) and assumes that the study area’s population will be 61,502 persons in 2031.

The Strategic Plan component of the scenario is part of the allocation module. This component uses the planning zones spatial layer for the shire and aims to determine whether the planning zones existing for Mitchell Shire can handle the projected population growth. The No Strategic Plan scenario aims to discern how appropriate or restrictive the planning zones are on the future development of the area and does not restrict ‘greenfield’ development.

21.3.1 Input Data Layers

A number of spatial and aspatial input data layers have been collated from various government and private sector sources in order to create the four
likely allocation scenarios for Mitchell Shire. A number of socioeconomic
datasets used to define the demographic projections and land demand sce-
narios have been used, including:

- current housing unit figures for rural and urban residential areas within
  Mitchell Shire
- current employment figures by industry sector for Mitchell Shire
- past total population, group quarters and household figures for Mitchell
- past employment figures by industry sector for Mitchell Shire in 1996
  and 2001
- low projected population figures for Mitchell Shire including total popu-
  lation and average household size for the five projection years; 2011,
  2016, 2021, 2026 and 2031
- high projected population figures for Mitchell Shire including total
  population and average household size for the five projection years;
- percentage breakdown density of residential housing types
- future employment density by industry sector
- total hectares of preservation land uses for the five projection years (as
  above)
- area demand projections for local land uses for the five projection years.

In defining land suitability and allocation requirements, a number of
spatial datasets have been integrated into a common geodatabase for
Mitchell Shire. Table 21.1 describes the spatial datasets and their source
information used to define land use, suitability factors and allocation pa-
tameters. Of particular significance to the strategic planning scenarios was
the planning zones layer. This layer was switched “on” when creating the
Strategic plan based allocation scenarios and switched “off” when creating
the No strategic plan allocation scenarios. The Conservation scenarios are
related to constraint layers determined by the slope, soil, and proximity to
infrastructure such as roads and drainage. Roads, rivers and local govern-
ment area (LGA) boundaries have been used as display layers for visual
reference to end users.

Through integration of socioeconomic, environmental and physical fac-
tors into the What If? spatial planning framework (Fig. 21.2), planners can
begin to understand regional dynamics by taking onboard a number of in-
terrelated factors. With regards to the use of PSS such as What If?, the per-
ceptions of the Mitchell Shire planners were that the tool has the ability to
assist in thinking regionally. This potentially empowers planners to engage
in a discourse with other regional practitioners and understand the global
context associated with regional issues, contemplate the consequences of local decisions, and have a greater level of regional responsibility associated with such decisions.

**Table 21.1. Land suitability and allocation data inputs**

<table>
<thead>
<tr>
<th>Original data layer</th>
<th>Data layer produced for use in UNION file</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitchell LGA</td>
<td>ABS boundary file</td>
</tr>
<tr>
<td>Locality areas</td>
<td>Townships – Corporate Spatial Data Library (DSE)</td>
</tr>
<tr>
<td>Statistical local area (SLA)</td>
<td>ABS boundary file</td>
</tr>
<tr>
<td>Vacant land</td>
<td>Existing land use – Mitchell Shire Council data</td>
</tr>
<tr>
<td>Land use mapping for Victoria Cadastre</td>
<td>Australian Land Use Mapping classification Corporate Spatial Data Library (DSE)</td>
</tr>
<tr>
<td>10 m contours</td>
<td>Slope derived from Corporate Spatial Data Library (DSE)</td>
</tr>
<tr>
<td>Planning zones</td>
<td>Corporate Spatial Data Library (DSE)</td>
</tr>
<tr>
<td>Soil</td>
<td>Corporate Spatial Data Library (DPI)</td>
</tr>
<tr>
<td>Roads plan 2030(^a)</td>
<td>Parcels served by roads in 2030</td>
</tr>
<tr>
<td>Drainage</td>
<td>Parcels served by drainage – Mitchell Shire Council data</td>
</tr>
<tr>
<td>Floodway overlay and Land Subject to Inundation overlay</td>
<td>State government planning overlay</td>
</tr>
<tr>
<td>Erosion Management overlay</td>
<td>State government planning overlay</td>
</tr>
<tr>
<td>Salinity Management overlay</td>
<td>State government planning overlay</td>
</tr>
<tr>
<td>Rail stations</td>
<td>1 km rail station buffer</td>
</tr>
<tr>
<td>Wildfire Management overlay</td>
<td>State government planning overlay</td>
</tr>
<tr>
<td>Existing roads</td>
<td>100 m Goulburn Valley Highway/Hume Freeway buffer</td>
</tr>
<tr>
<td>Vegetation Protection overlay</td>
<td>State government planning overlay</td>
</tr>
<tr>
<td>Significant Landscape overlay</td>
<td>State government planning overlay</td>
</tr>
<tr>
<td>Heritage overlay</td>
<td>State government planning overlay</td>
</tr>
</tbody>
</table>

\(^a\) The original data layer was directly used to create the UNION file. ABS: Australian Bureau of Statistics.

Figures 21.3 and 21.4 provide examples of two fundamental data inputs used to create land use categories and suitability factors (e.g. suitable soil) respectively. The land use mapping layer has been generated from the standardised Australian Land Use Mapping (ALUM) classification, which has been appended with the more disaggregated urban land use data to generate a comprehensive existing land use map. The soils data comprises mapped parent material lithology combined with landform description. Further interpretation by soil scientists has resulted in a soil suitability layer which rates suitability from very poor to very good. All soil within
the Mitchell Shire is considered moderate, poor or very poor. Both of the land use mapping and soils datasets are managed by the Department of Primary Industries (DPI) Victoria. Before this project commenced, Mitchell Shire did not know that this data existed. One of the tangible benefits of this project is an increased awareness of existing natural resource management datasets available. Feedback from the Mitchell Shire planners affirms this by stating one of the strengths in applying a scientific tool such as *What If?* is that it instigates a data- and information-sharing environment which is empowering to local government.

Fig. 21.3. Land use mapping data input layer for the Mitchell Shire study

### 21.3.2 Land Suitability Analysis

Eleven suitability factors were defined for representing the land suitability for future land use within the Mitchell Shire. Figures 21.5 and 21.6 illustrate the graphic user interfaces (GUIs) for determining user-defined ratings and weightings of importance. These interfaces are a powerful tool for capturing planning metrics. For the first iteration of land suitability scenario generation, the ratings and weightings have been determined by the model experts (the authors). Future work will engage the planners to undertake an iterative process of refining these land suitability variables and their weightings of importance.
Fig. 21.4. Soil classification data input layer for the Mitchell Shire study

Fig. 21.5. Screen shot showing the Conservation scenario–factor importance ratings for residential land use
The first iteration of land suitability scenarios generated for Mitchell Shire resulted in four land use change scenarios. Figure 21.7 illustrates an example of the suitability (ranging from not developable to highly suitable) for future residential land for the low conservation scenarios. The land suitability scenarios are in themselves a valuable planning tool as they enable planners to understand the extent of land suitability for specific land uses such as residential, commercial, industrial, agricultural and conservation.

21.3.3 Demographic Projections and Land Use Demand

There are three sources of population information available to formulate land use demand scenarios for Mitchell Shire, these include:

Fig. 21.7. Screen shot of land suitability map for residential land in the Mitchell Shire

Fig. 21.8. Screen shot showing land use demand assumptions
Employment projection information is currently unavailable for Mitchell Shire and subsequently no employment projection information has been included in the current suite of land use change scenarios for the shire. Ongoing research will develop these employment projections. Figure 21.8 illustrates the land use demand assumptions. The user can select which projection figures are to be used to determined household and employment growth. For the four Mitchell Shire scenarios both the DSE and ID consulting population projections were used. The Mitchell Shire planners were interested in comparing the results of the two population projection forecasts in order to better understand the potential land use conflicts and opportunities which arise from population growth.

### 21.3.4 Future Land Use Allocation Scenarios 2031

The four scenarios run for Mitchell Shire are a combination of high and low population growth, with and without the existing strategic plan land use control. Figure 21.9 illustrates the future land use allocation scenario for the Conservation/Low Growth/No Strategic Plan scenario. Without taking into account existing planning zones the shire can see where future land use change would likely occur, based on land suitability, with no planning instruments. In this scenario there is some new residential development which would occur outside the existing urban centres, as indicated in Fig. 21.9. *What If?* produced accompanying reports for the changes in land use allocation for each derived scenario. Table 21.2 shows the projected land use change associated with the Conservation/Low Growth/No Strategic Plan scenario.

<table>
<thead>
<tr>
<th>Land use</th>
<th>2006</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural residential</td>
<td>4,392.12</td>
<td>4,911.14</td>
<td>5,253.49</td>
<td>5,621.61</td>
<td>5,947.50</td>
<td>6,271.95</td>
</tr>
<tr>
<td>Undeveloped</td>
<td>19,983.22</td>
<td>19,208.45</td>
<td>18,698.86</td>
<td>18,119.09</td>
<td>17,670.77</td>
<td>17,165.72</td>
</tr>
<tr>
<td>Urban residential</td>
<td>1,628.46</td>
<td>1,884.21</td>
<td>2,051.45</td>
<td>2,263.09</td>
<td>2,385.52</td>
<td>2,566.12</td>
</tr>
</tbody>
</table>
Based on the existing data limitation imposed by not having access to any derived employment projections, employment is considered to stay constant it is only urban residential and rural residential land uses which currently absorb any undeveloped land within the shire for urban growth. Employment projection data would be valuable to derive so that all future land uses (including industrial and commercial land uses) could be allocated in the scenarios, as opposed to being limited to only the range of residential land use types.
21.4 Future Work

A quantitative measure of applying *What If?* in the Mitchell Shire has not yet been determined, nor is it likely to be. Work with the shire is ongoing as the research team continues to refine suitability factors, weightings, ratings, projection figures and further develop and evaluate land use change scenarios. Within the context of the Mitchell Shire case study the research team is also investigating the benefit of producing land use change scenarios in an interactive three-dimensional computer-game environment. Once this is achieved further testing will be undertaken to evaluate if there is added value in communicating land use futures to planners using a virtual world paradigm.

In the general area of PSS research much work is needed to bridge the gap between model expert and planning practitioner. Vonk et al. (2005) have identified there are bottlenecks to adoption of PSS, and that much effort has been placed in developing software tools whilst little has been done in supporting and evaluating their application. As indicated by the Mitchell Shire planners there have been identified barriers in understanding PSS tools such as *What If?* It is therefore identified that further work is required to ensure educational institutions that take responsibility for training planners introduce PSS into their curriculum to ensure that planners are conversant with such tools before entering the work force. Such planners can then be advocates for PSS adoption amongst government and private sector planning agencies.

21.5 Conclusion

This chapter discusses the application of the *What If?* PSS for developing land use change scenarios for a local municipality in the context of Australia. Initial feedback from questionnaires and interviews of planners from Mitchell Shire and managers the State Government of Victoria, indicated the following perceived benefits in applying the *What If?* PSS:

- It provides a useful knowledge-management environment to assist local government in undertaking strategic planning.
- The system enables local government planners to think regionally.
- It empowers local government to critically examine planning policy through an evidence-based science approach.
- The lifespan of existing planning strategies can be evaluated against population and ultimately employment projections.
The system enables a clearer understanding of the impact on farming land from urban growth.

For strategic planning purposes the What If? PSS offers an improvement to standard GIS. The PSS reduces the complexity of using map overlays in a GIS as well as reducing the time required to explore a range of land use change scenarios. A strength of PSS tools, such as What If?, is that they guide users through a straightforward land use allocation process. The procedure for allocating land is incremental and enables a degree of trade-off to occur between competing land uses, based on user defined weightings and controls. It is a complex process that consumes a lot of time if done manually within a GIS, that is automatically achieved using What If?.

PSS such as What If? hold a lot of potential for planners, but they will need to consider whether the benefits outweigh the data requirements for running such a data intensive system. What If? version 2.0 has been configured to input ESRI Community Tapestry socioeconomic data <http://www.esri.com/data/community_data/community-tapestry/index.html>. However, the automated loading of such data outside the United States is not currently supported. In Australia disaggregated employment projection data are not available at the LGA level. Therefore, the Land Use/Population/Employment option in What If? can only be used to project small area land use and population values.

There are many challenges which remain in having PSS such as What If? as a common tool on the planning practitioner’s desktop computer. Some of these challenges include access to data, training existing staff and educating up-and-coming planners. There are also many perceived benefits in applying PSS in practice which have been discussed in this chapter. However, the real value of applying such PSS tools as What If? is in the development of cross-jurisdictional collaborations. This will lead to shared understanding, new learning and robust knowledge management systems to assist Government planners in making better decisions to realise sustainable urban and regional futures.

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