Chapter 16

MICROSIMULATION OF METROPOLITAN EMPLOYMENT DECONCENTRATION

Application of the UrbanSim model in the Tel Aviv region

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Abstract: Employment deconcentration has become a major issue on the policy and planning agenda in many metropolitan areas throughout the western world. In recent years, growing evidence indicates that in many developed countries, the deconcentration of employment - particularly of retail centres and offices - has become a key planning issue. This chapter uses the *UrbanSim* forecasting and simulation model in order to investigate some of the projected changes in land use, land value and sociodemographic characteristics of metropolitan areas undergoing employment deconcentration. The process of model application in the Tel Aviv metropolitan context is described. Two land-use scenarios of very different scale are simulated: a macro-level scenario relating to the imposition of an 'urban growth boundary' and a micro-level scenario simulating the effects of shopping mall construction in different parts of the metropolitan area. The results are discussed in terms of the potential and constraints of microsimulation for analyzing metropolitan growth processes.

Key words: Employment deconcentration; land use; microsimulation; *UrbanSim*

1. INTRODUCTION

The spatial deconcentration of retail, manufacturing and office activities is a very visible phenomenon in the large metropolitan areas. 'Edge city' development is an entrenched metropolitan phenomenon in the US (Lang, 2003). In Europe, incipient edge city development is becoming an increasingly familiar sight on the edges of many large metropolitan areas. Whether on the outskirts of Amsterdam, Paris, Madrid, Bristol or Prague, the picture of out-of-town office developments, shopping centres or industrial parks seems to repeat itself. With nearly 80% of Europe's population living in cities, recent years have witnessed a steady shift in population between city centres and suburban areas. Consequently, urban densities in the centres of major European metropolitan areas have been constantly declining in many cities. While this change is not uniform across countries or even within countries themselves, there is no doubt that a more polycentric European metropolitan area is emerging (Bontje, 2001; Kratke, 2001).

Very little, however, is known about the prospective effects of employment deconcentration (or non-residential sprawl) in a non-US context[1]. We can hypothesize that in developed countries outside the US (and especially in European-type countries), the effects of employment deconcentration will be very different to those arising from residential deconcentration. While employment sprawl has received little systematic attention, a wealth of anecdotal evidence points to it raising questions of efficiency and equity as contentious as those raised by residential sprawl.

On the one hand, it can be viewed as a response to needs and free choice in the market. Allowing firms and offices to move to suburban locations will encourage the creation of jobs that would not be produced in the dense and expensive inner parts of metropolitan areas. This leads to a rational and efficient allocation of resources (land, jobs, et cetera) and a higher quality of life. Producers are expected to make higher profits in suburban locations and will also create employment that would not have been produced in the dense and expensive inner parts of metropolitan areas. Consumers and workers gain as deconcentration of offices, 'big box' retailers and factories to the urban fringe provides more employment choice and greater services at reduced prices.

On the other hand, many contest this benign view of employment deconcentration and present a string of equity and welfare issues that are affected by this process (Persky and Wiewel, 2000). These can be classified as socioeconomic issues pertaining to the spatial mismatch of employment, job opportunities, community cohesion, costs of infrastructure provision and accessibility, environmental effects such as noise, congestion, pollution, groundwater quality and resource effects relating to the loss of open space, the consumption of agricultural land et cetera. When negative deconcentration effects predominate, these patterns of development can

[1] Employment deconcentration is taken to mean here the movement of economic activities (industry, retail, services) from the centre to the urban fringe or the relative decline of employment in the city centre versus the urban periphery. The latter can result not just from movement from the centre to the fringe but from in-situ growth in the urban perimeter or in-movement to the fringe area from outside the region. Deconcentration can be measured by relative employment densities, land consumption, floorspace and similar metrics.

undermine the viability of inner/central cities, and the decline of central cities is likely to harm the quality of life of residents in suburban locations as well. If the positive aspects of deconcentration predominate, the reverse will be the case. These issues have been debated extensively in the North America context (Ding and Bingham, 2000; Felsenstein, 2002; McMillen and McDonald, 1998) and increasingly appear on the European urban agenda (Urban Audit, 2000).

This chapter explores the effects of employment deconcentration going beyond the measurement and morphology of metropolitan change that has attracted much attention in the literature (Ewing *et al.*, 2002; Galster *et al.*, 2001; Torrens and Alberti, 2000). We attempt to address the broader issues of deconcentration by simulating the wider socioeconomic impacts associated with this process. To capture these effects, we use the *UrbanSim* land-use simulation model (Waddell, 2002; Waddell *et al.*, 2003) to forecast land-use change in two metropolitan areas and to explore the resultant socioeconomic and demographic changes that they imply.

UrbanSim continues a microsimulation tradition in land-use modelling and extends the earlier work of Wegener (1982), Mackett (1990) and Simmonds (2001). Contemporary efforts in this area are centered on both improving the economic modelling mechanisms at the base of the allocation procedures that drive the models and on extending the level of disaggregation at which the model operates. The PECAS modelling system (Hunt and Abrahams, 2005), for example, uses a spatial input-output approach to capture the exchanges between producers and consumers in an equilibrium framework. The *UrbanSim* system is grounded in a random utility approach in which the main agents in the land market (workers, households, firms, institutions and developers) attempt to maximize their utility and make choices accordingly. In this way, a price structure emerges (capitalized via land prices) and markets clear. All agents are modelled at a very fine level of analysis (the grid cell) which allows for dynamic microsimulation at a level of disaggregation that captures the full behaviour of the individual agent.

The spatial context for this study is the Tel Aviv metropolitan area which has experienced accelerated patterns of employment deconcentration since the mid 1980s. This chapter proceeds as follows. Section 2 describes the *UrbanSim* applications and the process of data preparation undertaken for the two case study areas. In Section 3, we present results arising from two types of simulations relating to employment deconcentration. The first relates to simulating an attempt to deal with employment deconcentration through regulatory instruments such as imposing an urban growth boundary (UGB) or restrictive zoning. The second relates to the micro-based implications of deconcentration arising from particular development events such as the building of new industrial parks, shopping malls and the like. In all cases we compare results of the 'with event' scenario case with results for the baseline 'without event' (business as usual) case. Finally, some tentative ideas about the microsimulation of urban growth processes and their planning implications are presented in Section 4.

2. MODEL AND APPLICATION DESCRIPTION

2.1 Modelling system

UrbanSim is a land-use modelling system for scenario simulation and policy analysis developed by the Center for Urban Simulation and Policy Analysis at Washington University, Seattle, USA. It comprises a series of interlinked models that together form a dynamic activity-based system that simulates the activities of three major urban 'actors' that interact with each other in the land market; a) grid cells that represent the land parcels of the study area and their physical traits; b) households and their characteristics and c) jobs represented by workers. The unique attributes of the model include its high resolution of prediction (150m by 150m grid cells), full integration with GIS systems and a modelling approach based on microeconomic and behavioural foundations. The full workings of this system have been outlined elsewhere (Waddell, 2002; Waddell *et al.*, 2003). Here, we limit ourselves to a short description of the integrated models, depicted in Figure 16-1, that make up the system.

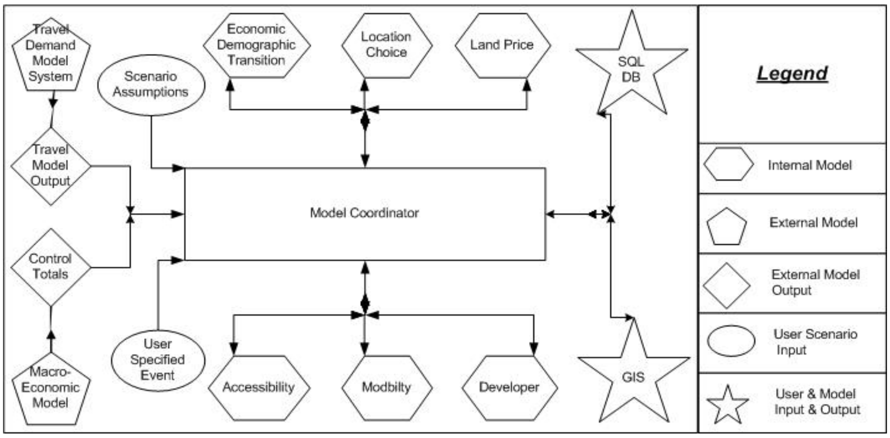

Figure 16-1. The *UrbanSim* land-use modelling system

Two *external models* serve the system. The first is the '*macro-economic model'* which is used to predict the changes in annual household and employment totals within the study area. The data created by this model is imported into the different model parts and used as a guideline (control total) for the different model components. The macro-economic model creates predictions for the changes in the number of households, by size and race, as well as the change in employment by sectors. The second external model is the '*travel model'*. The travel model is used to create the composite utility of getting from one travel analysis zone (TAZ) to another, given the available travel modes. This data is created externally and then imported into the model to create accessibility measures between different grid cells.

Six separate *internal models* simulate the different actions of the three urban "actors". The '*economic and demographic transition model'* uses the control totals created by the exogenous macro-economic model to create new households and jobs which will be added into the study area. In cases where the number of households (in a specific group) or jobs (in a specific sector) has declined, the transition model removes those households and or jobs from the study area. The '*employment and household mobility model'* simulates the decision of households and jobs to change location within the study area during each year of simulation. The model creates a list of households and jobs which have decided to move from their current location within a specific year and extracts them for relocation. The *'household and employment location choice model'* simulates the location decisions taken by the households and jobs in the study area. This includes all households and jobs created by the transition model as well as the households and jobs which have decided to change location in the mobility model. The *'real estate development model'* simulates the actions of real estate developers within the study area. The model predicts the grid cells that will encounter a development event and the type of development that will result. The *'land price model'* simulates the changes occurring within the real estate market using a hedonic regression of the land value on the attributes of the land parcel and its surroundings. Finally, the 'a*ccessibility model'* combines the data created by the external travel model and the land-use data in order to create an accessibility matrix between different grid cells.

The input data for the system are imported into the model from a number of different source (GIS, tables, et cetera). These data create the base year from which the model runs as well as the coefficients for the different internal models and the scenarios. None of the different models listed above connect directly. The interaction between the models is done within a 'Model Coordinator' module and is then exported back in to the different models parts. The exported data are the result of the model prediction. The data can be exported for each simulated year as well as for specific years only. These data can be fully integrated with GIS layers allowing for further examination as well as improved visualization.

2.2 Study area

The Tel Aviv metropolitan area lies on the western shoreline of Israel (Figure 16-2). This region has 2.98 million inhabitants and a million employees in an area of approximately 1,683 km^2 and is the largest metropolitan area in Israel. The Tel Aviv metropolitan area is the economic heart of Israel and produces approximately 49% of the country's GNP. The residential and employment deconcentration processes in the Tel Aviv metropolitan area began during the 1980s. The rising levels of car ownership, the improvement in living standards and the mass immigration from the former communist countries of Eastern Europe created growing pressure for suburban residential, commercial and industrial development. These pressures created a metropolitan region which, today, is increasingly suffering from congestion, lack of open space, air and noise pollution et cetera. Although the new Israel National Outline Plan #35 (TAMA 35) tries to confront these sprawl-related problems, no real spatial modelling has been done to try and predict the effects of these processes on the quality of life in the future.

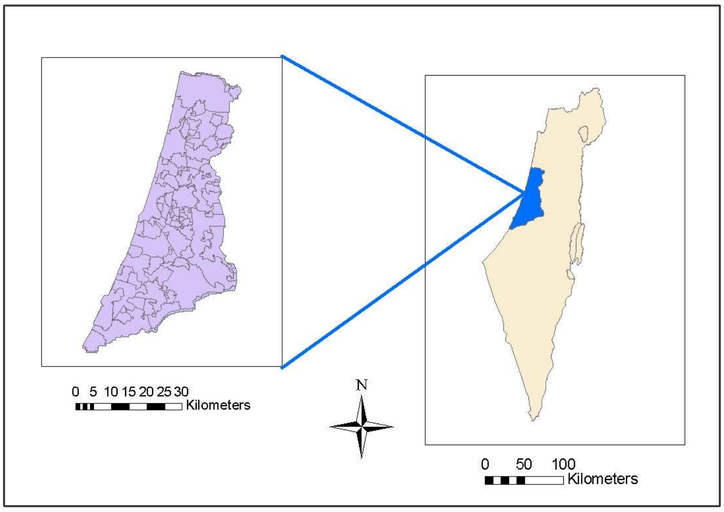

Figure 16-2. The Tel Aviv metropolitan area

2.3 Data description and preparation

The process of constructing the Tel Aviv *UrbanSim* databases, required the use of a number of data sources and software products such as ArcInfo 9.0, Excel, and Access. The data collected was used to create the grid cells, households, and jobs databases as well as the data needed for the control totals, relocation rates and the different model coefficients (Table 16-1).

Table 16-1. Sources and formats of input data

Theme	Data source	Format
Households	National Census, 1995	Grid cells
Jobs	Travel Survey, 1996	Tables
Relocation rates	Labor Force Surveys, 1995-2003	Tables
Control totals	Israel National Plan for the year, 2020	Tables
Land use	Hebrew University (HUJI) GIS Database	Grid cells
Historical events, land prices	The Israel Lands Administration.	Grid cells
Accessibility	Tel Aviv Metropolitan Area Travel Model (NTA Corp.)	Grid cells

The most extensive data available on the metropolitan area are available in the national census of 1995 and the travel census of 1996. These two sources determined the way in which the data were collected and implemented. In order to keep the information as exact as possible, the grid cell size selected for the Tel Aviv application of the *UrbanSim* model was 250 m by 250 m. This size allowed us to also include the data available in the smallest census tracts, covering 500 by 500 m, without losing any information. Using GIS, a fishnet of grid cells of 250m by 250m was created covering the whole metropolitan area creating the base-year grid cell data base.

The division and insertion of the census data into the base year database was done using standard GIS and database software. Each grid cell was allocated a census tract to which it corresponded. The data from each census tract were transferred into the grid cell using a GIS join command. In cases where there was more than one grid cell per census tract, the data were divided in an equal fashion between the different grid cells. This was based on the definition of the census tracts as homogenous units. The households in each census tract were divided into separate entities with their spatial location based on the census tract from which they came, creating the households database.

In order to complete the grid cells database, with information that were not available through census tracts, such as percentage road or percentage water, additional data were imported into the database using GIS layers from the Hebrew University (HUJI) GIS database. All data were converted to a raster format, following the import process shown in Figure 16-3.

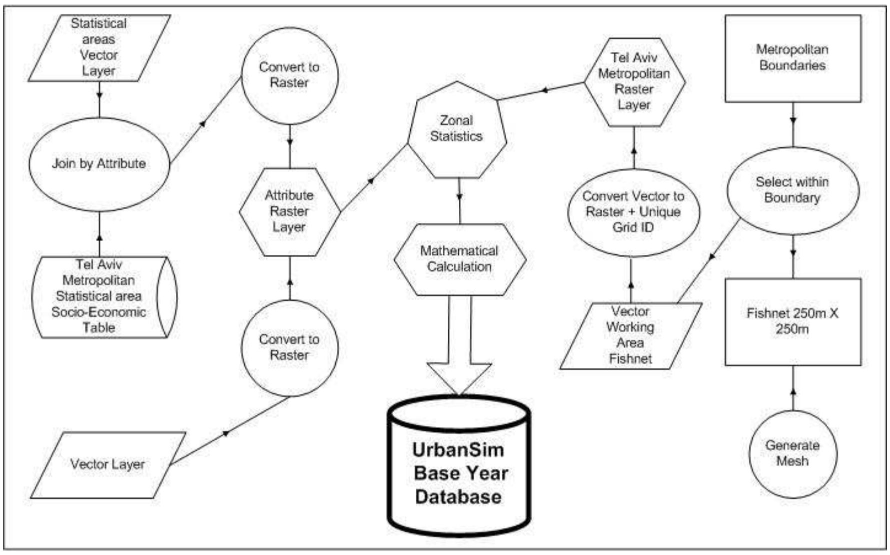

Figure 16-3. Base year database construction: the raster and vector import process

The jobs database was created using the national travel survey (1996). This includes data about the movement of workers, from different employment sectors, from and to work. These data were used to allocate each job within the Tel Aviv metropolitan area to a grid cell according to the census tract the job belonged to. Having created the base-year database (grid cells, households and jobs), the other tables had to be updated according to the Tel Aviv guidelines. The control totals for the employment and households were taken from the Israel National Plan for 2020. The accessibility and travel analysis zones data were collected from the Tel Aviv metropolitan area travel model developed by the Tel Aviv transit authority (NTA) and the relocation rates for jobs and households were taken from the Israel Labour Force survey between the years 1995 and 2003. Land price data both current and historical were made available by the Israel Land Administration (ILA).

The Tel Aviv application of *UrbanSim* was accomplished mainly under textbook conditions. Relatively large amounts of the data were readily available and were imported directly into the model databases. The modifications done in the Tel Aviv case were mainly concerned with the data for the estimation process of the different location choice models and estimation of land values and improvement values. The land and improvement values created in the Tel Aviv metropolitan area were initially based on a sample of approximately 1,000 residential, commercial and industrial property transactions collected from the ILA. The data from these transactions were then used for an inverse distance weighted interpolation for the whole of the metropolitan area. When further data became available, we were able to use real rather interpolated values. The process of location choice model variable estimation for both households and jobs should, preferably, be based on a sample of households and jobs that recently moved. While this form of data is not available for Tel Aviv, we created a Monte Carlo random sample of 5,000 households and jobs (per sector) on which the models were estimated. All statistical discrete choice models were estimated in STATA using either standard or multinomial logit estimation.

3. SIMULATIONS

In this section we report the *UrbanSim* results for two very different scenarios. The first relates to a 'policy scenario' where a major regulatory restriction is imposed on metropolitan development. We simulate the effects of an Urban Growth Boundary (UGB) for metropolitan Tel Aviv. The second case presents results relating to the simulated outcomes of 'event scenarios' in the Tel Aviv metropolitan area. These are micro-level interventions that have a more limited direct land-use impact. However, they can have significant indirect impacts in terms of the socioeconomic composition and land values of the areas in which they are located.

3.1 Macro-level simulation: urban growth boundary imposition

This policy scenario imposes an UGB within the Tel Aviv metropolitan area as outlined in the Israeli National Outline Plan #35 (NOP35). This UGB is a non-continuous series of boundaries around the main urban clusters within the metropolitan area (Figure 16-4). The testing of this scenario included running a 'business as usual' (BAU) baseline case beginning in the year 1995 (the base year for the Tel Aviv model) and ending in the year 2020. This scenario simulated a non-intervention policy allowing unregulated development of all forms of land use.

A second ('with UGB') case was run stipulating the UGB and prohibiting development beyond its limit. Each of the grid cells within the model was allocated a marker which located them within or outside the UGB. Within the UGB no restrictions were imposed on development. Outside the UGB, the model was directed to prohibit any development from the year 2005 (the year the plan became legally binding) to the target year 2020.

The scenario results are described in two parts. The first part describes the simulated land-use patterns, densities and land values given the UGB scenario. The second part presents the sociodemographic implications of this forecasted land-use change. This data describes the characteristics of the households within the metropolitan region in the year 2020 under the UGB scenario.

3.1.1 Land-use patterns

The results shown in Tables 16-2 and 16-3 clearly show that the UGB has an effect on the development of residential and commercial land use as well as on the land value. The UGB results in a very clear decline in the amount of development in the metropolitan area. Both total and average residential units and commercial floorspace decline in the metropolitan area due to the UGB. However, when we look at the results *within* the UGB area, we observe that average density and the sums of both residential units and commercial floorspace increase. The UGB scenario results in the development of approximately 200,000 less residential units in comparison to the BAU scenario but the number of residential units within the UGB is higher by approximately 13,000 units. When we analyze commercial land use, the results show a similar pattern. The UGB results in an average commercial square metre per grid cell which is approximately 30% less than the BAU scenario. However, when we look at this average within the confines of the UGB, the results show a higher density of commercial land use compared to the BAU scenario.

Table 16-2. BAU and UGB scenario results for the whole metropolitan area: total and mean per grid cell values compared for 2020

Theme	Type	BAU	UGB	Change
Residential units	sum	1,448,567	1,230,299	218,268
	mean	54	46	8
Commercial area [m^2]	sum	81,035,036	54,175,886	26,859,150
	mean	3008	2011	997
Residential unit value [NIS]	mean	1,046,450	70,933	975,516
Commercial area value [NIS/m^2]	mean	19,332	12,055	7,277

Table 16-3. BAU and UGB scenario results within the UGB: total and mean per grid cell values compared for 2020

Theme	Type	BAU	UGB	Change
Residential units	sum	906,207	919,333	-13,126
	mean	101	102.5	-1.5
Commercial area [m^2]	sum	25,801,111	26,917,741	-1,116,630
	mean	2877	3002	-125
Residential unit value [NIS]	mean	1,187,432	1,243,371	-55,939
Commercial area value [NIS/m^2]	mean	20,893	22,364	-1,471

These simulations also indicate that imposing a UGB results in a change in both residential and commercial land values in the metropolitan area. The average residential unit value in the Tel Aviv metropolitan area is approximately 30% lower in the UGB scenario than in the BAU scenario. The average improvement value, i.e. the difference in value between built and un-built commercial land use, is approximately 7,000 NIS (New Israeli Shekel i.e. $1,500) per square metre higher in the BAU scenario than in the UGB scenario. Although the average commercial and residential land value is lower in the metropolitan area overall, opposite results are forecast *within* the UGB area. The value of an average residential unit within the UGB is roughly 55,000 NIS higher and the average improvement value for commercial land use (per square metre) is roughly 1,400 NIS higher.

These initial results suggest that imposing an UGB results in an overall decline in residential and commercial land-use development as well as commercial and residential land value in the metropolitan as a whole. However, within the confines of the UGB, an opposite effect can be noted. The UGB serves to increase the divide between the areas within the UGB and those outside this boundary.

Maps created using the grid cells exported for the year 2020 reiterate the results shown in the tables above. Figure 16-4 shows that imposing the UGB produces a clearly different outcome from permitting uncontrolled development in the BAU scenario. The UGB case results in a controlled form of commercial development with high commercial densities in the UGB and low densities elsewhere. The BAU scenario reflects the possible effects of unregulated development with high density commercial development across most of the metropolitan area. Note that by 2020, the eastern and southern parts of the metropolitan area display a level of commercial density not far from the density levels attained in the core of the metropolitan area.

In terms of land value, Figure 16-5 show that the average commercial improvement value per grid cell the metropolitan area overall is lower in the UGB than in the BAU scenario. In the latter scenario, continued development outside the UGB has resulted in a higher commercial improvement values. Imposing a UGB does not seem to have driven up land prices within the confines of its boundaries. Rather, releasing development restrictions serves to keep commercial land markets buoyant everywhere. The commercial improvement value in the metropolitan core and around the city centres (which are located inside the UGB) remains high under both scenarios. Finally, the increased commercial development under the BAU scenario results in regional differences within the metropolitan area with a particularly pronounced rise in commercial improvement value in the southern sections.

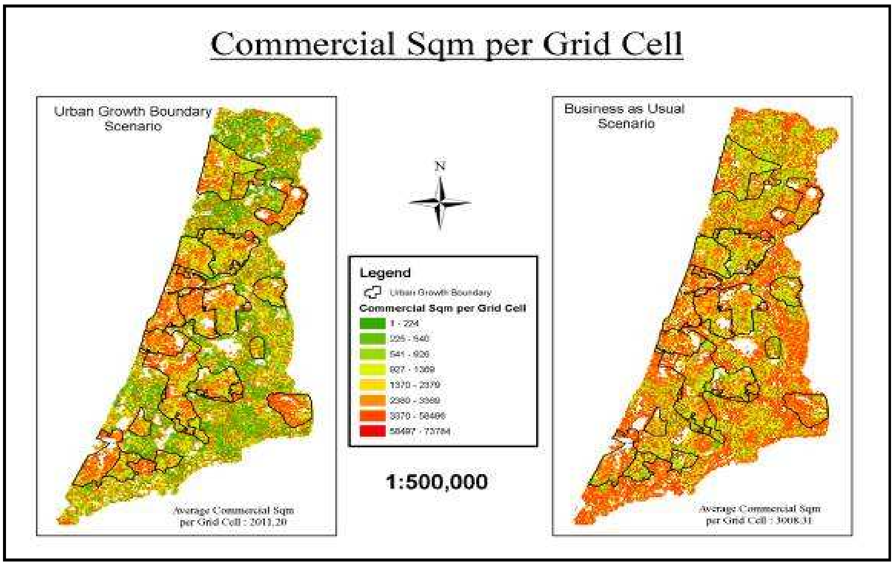

Figure 16-4. Commercial land-use density, 2020; UGB and BAU scenarios compared

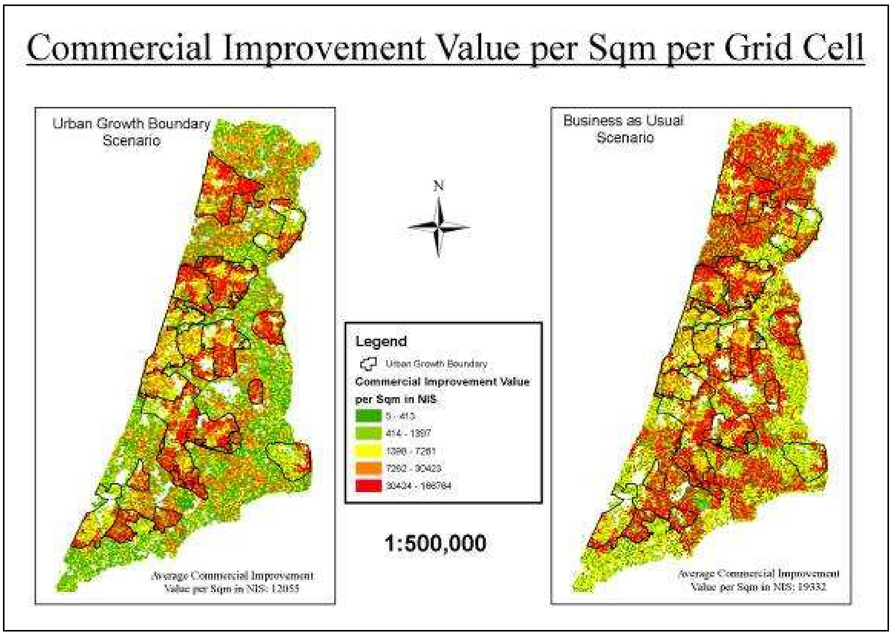

Figure 16-5. Commercial improvement value per grid cell, 2020: UGB and BAU scenarios compared

3.1.2 Household socio-demographics

As each grid cell in the *UrbanSim* model is linked to a string of socio-demographic attributes of the households occupying the cell, simulated land-use change can also be examined in these terms. Tables 16-4 and 16-5 outline the effects of the UGB on the whole metropolitan area, the area within the UGB and the area outside it, respectively. In all cases key social, economic and demographic attributes and their differences under the two scenarios are highlighted. As can be seen, the UGB scenario results in a metropolitan population which is approximately 500,000 persons smaller than the BAU scenario. In terms of household density, as expected, the UGB scenario results in higher density of households within the UGB (74.7%) than the BAU scenario (62.4%) (Table 16-5).The latter scenario results in particularly high levels of density in the metropolitan core and near the city centers. In terms of household size, the simulated results show that under the BAU scenario the distribution of all household sizes is evenly distributed across the metropolitan region (61.2% of all the households within UGB). But in contrast, the UGB scenario results in a concentration of the smaller households inside the UGB (72.4% of all the households within the UGB) whereas the large households concentrate outside. The UGB seems to force the larger households to seek residential opportunities outside its borders.

Table 16-4. BAU and UGB socio-economic scenario results for the whole metropolitan area: total and mean per grid cell or household values compared for 2020

Theme	Type	BAU	UGB	Change
Households	Sum	1,397,364	1,230,299	167,065
	Mean	51.9	45.7	6.2
Cars	Sum	1,020,053	833,612	186,441
	Mean	37.9	31.0	6.9
	per household	0.73	0.68	0.05
Children	Sum	501,753	448,921	52,832
	Mean	18.6	16.7	1.9
	per household	0.36	0.36	0.00
Persons	Sum	4,118,121	3,641,941	476,180
	Mean	152.9	135.2	17.7
	per household	2.95	2.96	-0.01
Workers	Sum	1,397,220	1,231,713	165,507
	Mean	51.9	45.7	6.2
	per household	1.00	1.00	0.00
Income	Mean	10,268	12,147	-1,879

Table 16-5. BAU and UGB socio-economic scenario results within the UGB: total and mean per grid cell or household values compared for 2020

Theme	Type	BAU	UGB	Change
Households	Sum	872,075	919,333	-47,258
	Mean	97.2500	102.5200	-5.2700
Cars	Sum	614,209	594,155	20,054
	Mean	68.5000	66.2600	2.2400
	per household	0.70	0.65	0.05
Children	Sum	305,000	322,392	-17,392
	Mean	34.0100	35.9500	-1.9400
	per household	0.35	0.35	0.00
Persons	Sum	2,521,689	2,636,592	-114,903
	Mean	281.2200	294.0300	-12.8100
	per household	2.89	2.87	0.02
Workers	Sum	872,835	920,595	-47,760
	Mean	97.3400	102.6600	-5.3200
	per household	1.00	1.00	0.00
Income	Mean	8,720	8,559	161

The spatial distribution of workers per grid cell under both scenarios seems almost identical (Table 16-4) in the whole of the metropolitan area. The highest concentration of employed persons, in both scenarios, is in the core of the metropolitan area and around the major city centres. However, this obscures some geographic detail that shows that under the UGB scenario 74.7% of the workforce is located within the UGB where under the BAU scenario this figure is only 64.5%.

The simulation results also report similar average household car ownership rates within the overall metropolitan area under both scenarios. However, per household and per geographic unit rates differ considerably with higher rates under the BAU than under the UGB scenarios. This seems to suggest that regulated development created by an UGB results in employment, shopping and recreation possibilities contained within an UGB and compels the households outside the UGB to travel more frequently.

3.2 Micro-level simulation: shopping mall development

The micro event scenario simulates land use, land price and sociodemographic effects associated with the development of shopping malls in different rings (inner, middle and outer) of the metropolitan area. We were particularly interested in observing the differential effects of location in the different rings given that the core area contains a highly developed and competitive retail market while the intermediate and outer rings offer greater opportunity for non-residential land-use development.

We simulate the effects of three similar sized malls, each approximately 90,000 gross square metres each (Figure 16-6). In each case, we simulate a 'with shopping mall' scenario (SM) that is compared with a baseline 'without mall' (BAU) scenario. We observe differences within 1 km and 5 km distances. The inner ring mall (Givatayim) is an existing development that started operation in 2005. The middle ring mall (West Raanana) is a simulated (fictitious) development on a land parcel zoned for commercial development but with no approved plan. Finally, the outer ring mall (Modiin) is presently under construction and due to open in 2008. The malls were inserted into the *UrbanSim* model using the development events table. The baseline year for the inner ring mall was taken as 2005 and for the middle and outer rings 2008 was the starting year. In all three cases, the model was run to the year 2020.

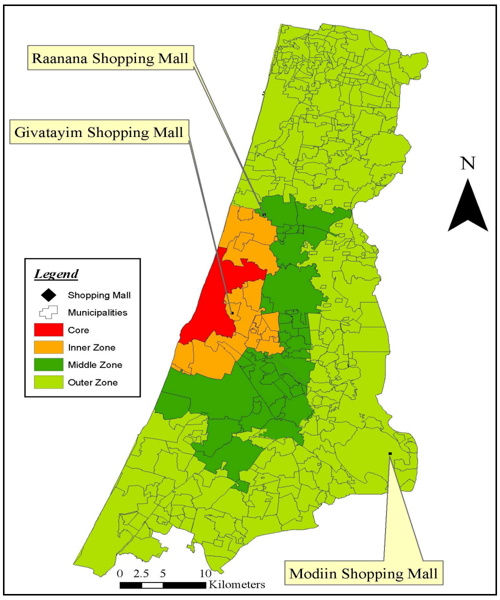

Figure 16-6. Tel Aviv metropolitan ring structure and shopping mall locations

The results show that locating the shopping malls in the various rings produces differential impacts. Using spline interpolation, we simulated the effect of mall location on other retail and commercial land uses. In all three cases, the effect of the shopping malls decreases with distance and is negligible at a distance of 5km (Figure 16-7). This effect remains invariant over time.

However, within the immediate vicinity of the shopping malls, we observe very different effects. Table 16-5 summarizes the simulated results for all three malls within a 1 km radius. Each column in the table shows the 'with' and 'without' mall simulations. The effect of the mall on average residential prices is particularly dramatic. In the inner ring scenario, the mall has a negative effect on average house prices but this is overturned in the intermediate and outer rings. This probably suggests that the externalities associated with adding further commercial activity in an already developed area, are in the main negative. In terms of effect on commercial land use, a new mall in both the inner and middle rings has only negligible effects on stimulating other commercial activity (adding a further approximately 5,000 square metres within as 1 km radius up till 2020). However, in the outer ring where the commercial land market is less developed, a mall of 90,000 square metres simulates a further 12,000 square metres of commercial activity, on top of the 90,000 square meters by the mall, by the target year. Perhaps not surprisingly this extra supply of commercial floor space serves to pull land values down. The result is that the 'with mall' land prices in 2020 are forecasted to be lower than those in the 'without mall' situation, but they still remain considerably higher than in the baseline year of 2008.

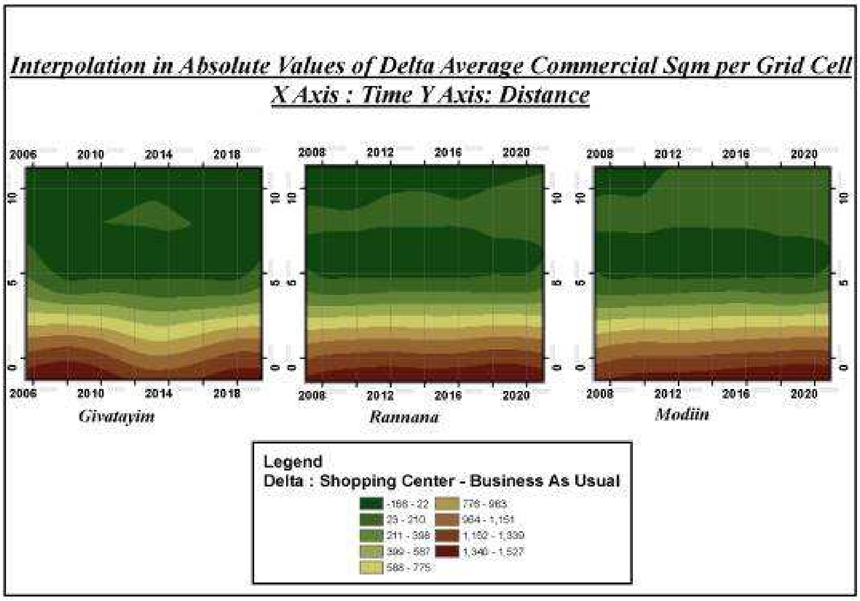

Figure 16-7. Shopping mall effects on commercial land use 2020.

Table 16-5. Simulated micro impacts within a 1km radius for three shopping malls (SM) in metropolitan Tel Aviv, 2020: total and mean per gridcell values compared

		Givatayim Mall (inner ring)		Raanana Mall (middle ring)		Modiin Mall (outer ring)	
		SM	BAU	SM	BAU	SM	BAU
Residential units	sum	30,590	30,571	6,338	6,314	2,124	2,101
	mean	369	368	76	76	26	25
Res.unit value [NIS]	mean	974,686	994,557	1,804,680	1,801,181	699,892	696,087
Commercial area [m^2]	sum	375,031	279,307	241,676	146,529	387,122	284,971
	mean	4,518	3,365	2,912	1,765	4,664	3,433
Comm.area improvement value [NIS/m^2]	mean	7,314	6,589	43,231	42,346	4,590	5,243
Residential land use	[%]	94.5	93.4	74.0	74.0	52.4	52.3

4. CONCLUSIONS

On the empirical level, the results of the simulations highlight two implications for the planning of metropolitan areas. The first relates to the need to disaggregate the metropolitan area into its constituent parts (inner, intermediate and outer rings) for any analysis of deconcentration. As evidenced from the simulations, employment deconcentration in the inner ring elicits very different land-use impacts to those emanating in the outer ring. Very different and distinct processes may be going on in different parts of the metropolitan area. The second issue relates to the policy response to employment deconcentration. If this is perceived as a negative process, the usual policy response (and the one illustrated in this chapter) is to impose regulatory restrictions through growth management (UGBs) or taxation (impact fees). An alternative response exists, however, that relates to redistributing (rather than regulating) the benefits of employment deconcentration. This can be achieved for example, through encouraging public sector housing in the outer metropolitan area or via reverse commuting. These policy responses can also be accommodated within the simulation capabilities of the *UrbanSim* system and remain a challenge for future work.

Our experience in applying *UrbanSim*, suggests both opportunities and constraints associated with microsimulation as a tool for analyzing metropolitan growth patterns. The simulations presented above show the potential for dynamic analysis at a variety of scales and with agents operating according to different time schedules. We are able to provide answers to a whole score of ‘what-if’ scenarios in different temporal, spatial and market settings. This, coupled with the assumption of disequilibrium conditions that underpins the *UrbanSim* modelling strategy, means that a constant process of re-adjustment between economic agents takes place based on short-term time schedules. This serves to ground the microsimulation in a much more plausible picture of reality where markets are not perfectly competitive, resources not perfectly mobile and agents do not have full information.

On the constraints side, the data requirements and their limitations cannot be over-stated. Microsimulation requires considerable investment in assembling the initial database. Ideally, this should contain information on the individual agents being modelled: households and their dwellings, workers and their places of employment, developers and the like. In practice however, selection of a finer grid cell level will lead to a simple proportional division of available larger units in order to provide minimum data for the grid cell. Additionally, our experience has been that estimated data sometimes needs to be used in the absence of a comprehensive survey or census source. Similarly, small sample sizes may also require the use of Monte Carlo sampling in order to generate probability distributions of a sufficient size in order to be able to generate decision rules for individual behaviour. A problem therefore arises in that the need to amass data of the right quality and quantity for microsimulation, leads to an ever-increasing 'synthetization' of the data.

Finally, the lure of coupling a microsimulation capacity with a GIS capability means that the analyst is enticed into ever-disaggregated levels of analysis. It takes a veritable leap of faith in order to honestly claim the ability to forecast land-use or land-value changes twenty years into the future at the level of the individual grid cell. In this respect, microsimulation may unwittingly serve as a vehicle for entrapping analysts in their own forecasts.

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