QUALITY OF LIFE EFFECTS ASSOCIATED WITH EMPLOYMENT SPRAWL; APPLICATION OF THE URBANSIM MICROSIMULATION MODEL

Eyal ASHBEL
Research Assistant
Department of Geography
Hebrew University of Jerusalem
Mount Scopus 91905, Jerusalem ISRAEL
Email: eashbel@netvision.net.il

Hester BIEMANS
Researcher
Netherlands Environmental Assessment Agency (MNP)
Antonie van Leeuwenhoeklaan 9
3721 MA Bilthoven, the Netherlands
E-mail: Hester.Biemans@mnp.nl

Daniel FELSENSTEIN
Associate Professor
Department of Geography
Hebrew University of Jerusalem
Mount Scopus 91905, Jerusalem ISRAEL
Email: msdfels@mscc.huji.ac.il

Marianne KUIJPERS
Researcher
Netherlands Environmental Assessment Agency (MNP)
Antonie van Leeuwenhoeklaan 9
3721 MA Bilthoven, the Netherlands
E-mail: Marianne.Kuijpers@mnp.nl

Abstract: Urban sprawl has become a major issue on the policy and planning agenda in many metropolitan areas throughout the western world. While residential sprawl has received most of the attention, growing evidence in recent years has shown that in European countries, the deconcentration of employment – particularly of retail centres and offices - is a particular policy problem of itself. Moreover, recent research on sprawl has quantified outputs in terms of changing land use patterns alone while the quality of life effects associated with sprawl have become a relevant issue in the EU because of increasingly restrictive environmental policies. This paper is based on the work currently being undertaken within the EU-funded SELMA project (Spatial Deconcentration of Economic Land use in European Metropolitan Areas). It addresses the issue of the quality of life effects associated with employment sprawl in two metropolitan contexts: Amsterdam (Randstad-Northwing) and Tel Aviv. Using the UrbanSim land use simulation model it endeavors to forecast the land use changes associated with the application of both policy and event scenarios and to translate these outcomes into quality of life effects.

Keywords: employment sprawl, land use, simulation, UrbanSim, quality of life

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1 INTRODUCTION

The deconcentration of employment centres (retail, office, industrial) is becoming an increasingly familiar sight on the edges of the large metropolitan areas in Europe. Whether on the outskirts of Amsterdam, Madrid, Bristol or Prague, the picture of out-of-town office developments, shopping centres or industrial parks seems to repeat itself. With nearly 80 percent of Europe's population living in cities, recent years have witnessed a steady shift in population between city centres and suburban areas and urban densities in the centres of major European metropolitan areas have been constantly declining. 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 impacts of employment deconcentration (or non-residential sprawl) in the European context. This paper examines the way the dispersal of industrial, commercial and office activities affects urban quality of life. 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 centre versus the 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. Metropolitan quality of life is captured in three dimensions. The 'economic' realm refers to employment opportunities, earnings levels and ease of accessibility to urban services; the 'social' dimension is captured by housing quality, levels of local service provision, earnings and employment opportunities and the 'sustainability' sphere refers to environmental and resource based factors such as congestion levels, air quality and noise levels, loss of open space and agricultural land and so on.

While the measurement and morphology of sprawl has attracted much attention in the literature (Ewing .et al. (2002), Galster et al (2001), ,Torrens and Alberti (2000), the object of this paper is to analyze sprawl in terms of its' resultant quality of life consequences. To capture these quality of life effects, the paper uses the UrbanSim land use simulation model (Waddell 2002, Waddell et al 2003) to forecast land use change in two metropolitan areas and to convert these forecasts into possible quality of life impacts. The two contexts are rather different (non US) metropolitan areas both experiencing accelerated patters of employment deconcentration - Amsterdam (Randstad- Northwing) and Tel Aviv.

The paper proceeds as follows. In the next section the links between employment sprawl and possible quality of life outcomes are explored. Section 3 describes the UrbanSim applications in a non-US context and the process of data preparation undertaken for the two case study cities. The results arising from two different simulations (one policy-based, the other event based) are then presented in Section 4. Output is presented for both the 'with' and 'without' event cases and the results compared. As this is still very much work in progress, some tentative ideas about converting model outputs into quality of life effects are presented in Section 5. The paper concludes with a discussion of the planning implications arising from the simulations.

2 EMPLOYMENT SPRAWL AND URBAN QUALITY OF LIFE; EXPLORING THE LINKS

In Europe, employment sprawl can be considered more acute than residential sprawl. This is partly due to strict land use planning controls and slow demographic growth in many European countries. In addition there is only a low level of consensus relating to the negative influences of residential sprawl on issues such as energy consumption and traffic congestion. In contrast, the spatial deconcentration of retail, manufacturing and office activities is a very visible phenomena in the large metropolitan areas of Europe. For example, incipient 'edge city' development is now visible south of Amsterdam, at Saclay around Paris and on the urban peripheries of cities as diverse as Prague, Tel Aviv and Copenhagen. This has begun to raise issues as to the desirability, efficiency and equity of this form of sprawl and its overall impact on quality of life in these areas (Razin 1996, Dieleman et al 1999).

We can hypothesize that quality of life impacts arising from employment sprawl will be very different to those arising from residential sprawl. While the former has received much less systematic attention in Europe than in the US, a wealth of anecdotal evidence points to it raising questions of efficiency and equity as contentious as those raised by residential sprawl. These quality of life consequences however, are far from clear-cut. In terms of quality of life effects, employment deconcentration has both efficiency and equity implications. 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 etc) and a higher quality of life. All are expected to benefit from the deconcentration of offices, retail centres and industrial plants. Producers will 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 the 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 sprawl and present a string of quality of life issues that are affected by this process (Persky and Wiewel 2000). These can be classified as *socio-economic* issues pertaining to spatial mis-match of employment, job opportunities, community cohesion, costs of infrastructure provision and accessibility, *environmental* effects such as noise, congestion, pollution, ground-water quality and *resource* effects relating to the loss of open space, the consumption of agricultural land etc. When negative quality of life effects predominate, these patterns of development can undermine the viability of inner/central cities, and the decline of central cities is likely to harm quality of life of residents in suburban locations as well. If the positive aspects of deconcentration predominate, the reverse will be the case.

The above 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). However we should note that not all US experience is directly relevant to the European urban context due to:

- greater government regulatory controls over urban development at all levels in Europe.
- the very different relationship between national and local governments in Europe
- the different composition of European housing stocks
- differing attitudes to car ownership and public transportation in European cities
- the lack of a Tiebout-style adjustment mechanism in Europe whereby people move to gain better access to public goods

The reason for the relative neglect of the issue of non-residential sprawl may lie in the fact that its quality of life affects are less obvious than those connected with residential sprawl. Assuming an urban area comprised of a central city and an urban fringe we can posit the following relationships between deconcentration and quality of life (Table 1):

Table 1: Quality of Life Impacts by Type of Sprawl

		Type of Sprawl:	
		Residential Sprawl	Employment Sprawl
Quality of Life Impacts on:	Residents: City Centre	-	- / +
	Residents: Urban Fringe	+	- / +

+ = positive quality of life effects
- = negative effects

As can be seen, the impacts of residential deconcentration seem relatively straight-forward. If residences deconcentrate this will generate negative quality of life effects (economic, social, cultural and environmental) for inner city residents and positive effects for suburbanites (greater private land consumption, accessibility to amenities). In contrast, if employment deconcentrates, the impacts are much more indeterminate. They result in both costs and benefits for residents of the city centre and for residents of the suburban fringe. Residents of the city centre may gain new local employment opportunities as workers move out to live close to their workplace. By the same token however they may also loose if they are less mobile than their jobs, resulting in socially polarized and excluded communities. By the same token, when economic functions move to the metropolitan fringe, suburban residents may gain from proximity to places of work and consumption but loose in terms of open space and environmental quality.

3 DESCRIPTION OF THE MODEL AND APPLICATIONS

3.1 The Modelling System

UrbanSim is a land use model for scenario simulation and policy analysis developed by the Center for Urban Simulation and Policy Analysis at Washington University, Seattle, USA. It is a dynamic activity based model which has 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 (150mx150m 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)

UrbanSim is a system of integrated models as follows:
Exogenous Models: Two exogenous 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.
Core models: this part of the system is made up of six separate models which simulate the different actions of the three urban "actors".
The *Economic and Demographic Transition Model* uses the control totals created by the exogenous macroeconomic model to create new house holds and jobs which will be added into the study area. In cases where the amount of households (in a specific group) or jobs (in a specific sector) has declined, the transition model removes those house holds 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 with in 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.

The *Accessibility 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 is imported in to the model from a number of different source (GIS, tables, etc.). This data creates 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 is the result of the model prediction. The data can be exported for each simulated year as well as for specific years only. This data can be fully integrated with GIS layers allowing for further examination as well as improved visualization.

3.2 Description of the Study Areas

Amsterdam (Randstad Northwing): The Randstad Northwing Region, situated mainly in the western low-lying part of the Netherlands, contains Amsterdam, Utrecht and a few smaller cities. It is a polynuclear region functioning as one of the main economic centres of the country. The region is densely populated, with 3.3 million inhabitants and a working population of 1.7 million (2002) in an area of approximately 3300 km^2 (CBS, 2005)

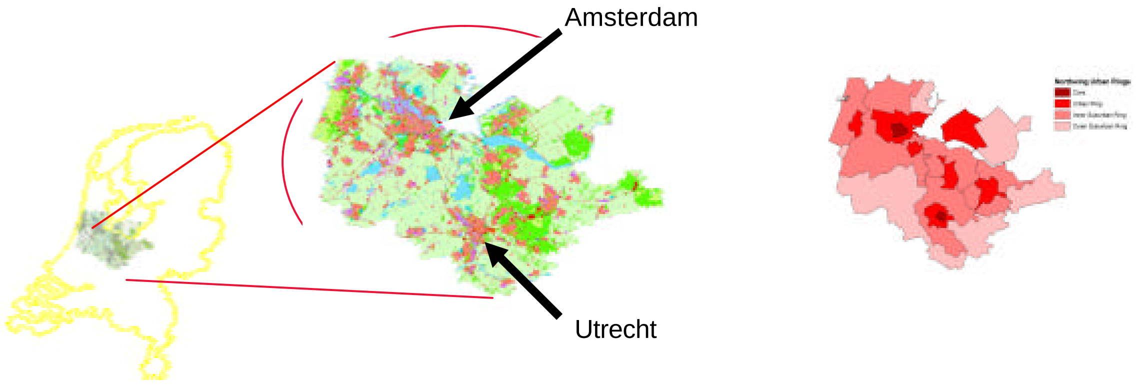
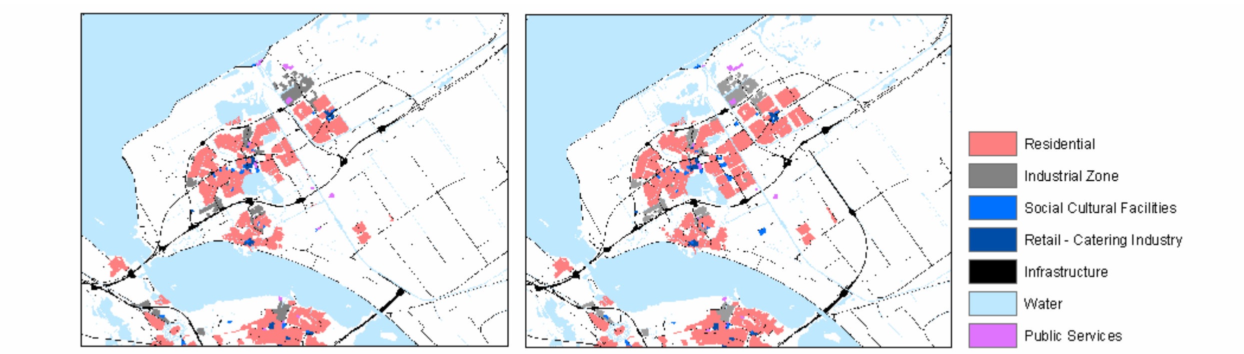


Figure 1 The Northwing of the Randstad Metropolitan Area & Ringstructure

Due to high population density, the whole Randstad region has been affected by problems such as lack of space for building, traffic congestion associated with urban expansion, scarcity of space for leisure and recreation activities, and noise, water, air and soil pollution (Bogaerts et al., 2003). For many years now, the Netherlands has been subjected to a very strict spatial policy, which gives cities their very typical concentrated, contiguous and balanced pattern of new development (see Figure 1a). The forthcoming implementation of a new less stringent spatial planning system (VROM, 2004) has increased the concerns about a growing rapid sprawl process and quality of life issues like the loss of open space and air quality.



1995 2000

Figure 1a Dutch pattern of city development seen in the expansion of the city of Almere (Source: CBS Landuse Statistics 1995; 2000).

Tel Aviv: The Tel Aviv Metropolitan area lies on the western shoreline of Israel (Figure 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 (Freeman 2002). The residential and employment sprawl processes in the Tel Aviv metropolitan area began during the 1980's. 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 pollution, noise pollution etc. Although the new national outline plan (TAMA 35) tries to confront this growing problem of sprawl, no real spatial modeling has been done to try and predict the effects of these processes on the quality of life in the future.

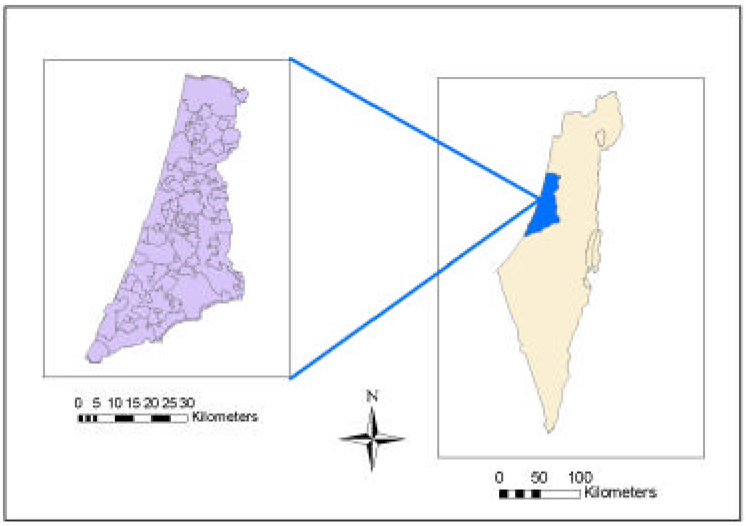


Figure 2 The Tel Aviv Metropolitan Area

3.3 Data Description and Preparation

Amsterdam (Randstad Northwing): In implementing the UrbanSim model in the Netherlands context, we followed two tracks. In the first instance we stayed close to the original model, without making any changes to the model structure. The results of scenario studies using this application are presented in this paper. At the same time however, we tried to adapt the model to local data availability and policy contexts. Land use regulation in the Netherlands is very different to the United States and its restrictive nature needs to be taken into account. The process of real estate development and land use change is not only driven by market forces, but is strongly influenced by local, regional and national governments. Spatial impacts of choice behaviour of households and workers are relatively limited in comparison with other countries.

This specific Dutch policy context required an intensive pre-processing procedure. Instead of using the original model structure, the model needed to be adapted to the local situation calling for a conceptual change in the model. Consequently, in the Northwing Randstad model, all possible land use transitions were reconsidered and a small subset of observed transitions were chosen. These transitions all consider urbanisation processes, new development and intensification of existing development. Furthermore, all variables used in the logit estimations for development and location choices were redefined based on literature in order to reflect the Dutch situation (Borsboom-van Beurden et al., 2005; Conijn et al, 1998).
A second reason for modifying the model was data-related. Not all data required for running the original model was available. Instead of estimating data, we attempted to make use of the best available data sources and adapt the model accordingly. There are three significant data issues in this respect. First, data on land prices are not available. Second, there is no available spatially-detailed data for price or quantity of non-residential real estate in this region. Third, there is quite good data on land use that could be incorporated into the application.

Since land prices have less influence on development in the Netherlands than in a 'pure' market-led situation, we decided to use housing values instead of land values for modeling location choices. In this way the land price model is really a housing price model.

We did not attempt to synthesize prices of non-residential floor space. Instead, the improvement values in the gridcells table were set to zero and all variables about improvement values were eliminated from the model. This means that we were not using all the models potential capabilities but we felt this preferable to using synthetic variables. Quantities of non residential floor space were estimated by the amount of employees in the grid cells. This assumption seemed plausible, because the non-residential floor space is used by the model to calculate available job locations in the grid cells. Since there are no data on vacancy rates of non residential real estate we added a vacancy rate of 1% in each grid cell in addition to the locations occupied by actual jobs.

UrbanSim uses 'development types' to simulate changes in land use. A grid cells' development type is based on its densities of residential and non residential real estate. Data for residential real estate densities exist, but not for non residential real estate. Because of this data deficiency, we preferred to substitute development types with very detailed land use data that is available for long time periods in the Netherlands. The original development types were replaced by our own land use data, classified into 23 land use types. Based on observed transitions of land use types into other land use types and corresponding changes in real estate, the possible land use transitions of the model were defined. For each possible transition, relevant variables were chosen, based on literature (Borsboom-van Beurden, 2005).

In terms of data collection, the annual household control totals and the annual employment control totals were derived from the outputs of external models PRIMOS (Heida 2003) and RAM (Verkade & Vermeulen, 2004) and applied to the model. In the absence of census data, the households database was created synthetically by running a part of the RAMBLAS model. This model is an activity based travel model developed by Timmermans et al (2000). It simulates travel choices of individual households and persons.

The household database was created by micro simulation. Individual household records were taken from the Housing Demand Survey (VROM 2003) and resampled until boundary conditions were met. These boundary conditions were defined by the total population per municipality classified into age, sex, and civil status (CBS 2005), the number of residential units per zipcode area classified into housing types, the number of residential units per municipality and social economic characteristics on neighbourhood level. This resulted in a database with records for each individual household with its characteristics influencing location choices.

The jobs database was derived from a database containing information on all businesses in the Netherlands (LISA 2000). This was used to assign locations and sectors to each individual job.
The gridcells database stores information on grid cell level. All geographically explicit variables used by the model to simulate housing prices and location preferences for households and jobs are listed in this table. For the Northwing Randstad application, all UrbanSim 'development types' were replaced by land use types (25 classes)

Estimation of the individual choice models related to four main models. The housing price model used regressed the log of the average housing value in the gridcell as the dependent value on a series of grid cell and neighbourhood characteristics (site characteristics, accessibility and neighbourhood characteristics). The developer model used a sample of 30.000 observed land use transitions between 1996 and 2000 (land use statistics aggregated to 100 meter gridcells) in order to explain the variation in land use transitions as a function of current land use, characteristics of the nearby build environment, housing density and accessibility to work and shopping locations. The household location choice model used data from the Housing Needs Survey 2000. All households that moved within the previous five years were included in the estimation. Finally, the employment location model used data from the 1996 and 2001 employment LISA databases in a logit estimation.

Tel Aviv: 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, house holds, and jobs data bases as well as the data needed for the control totals, relocation rates and the different model coefficients (Table 2).

Table 2: Data Source & Data Bases

Data Source	Database
National Census 1995	Grid Cells, House Holds
Travel Survey 1996	Jobs
Labor Force Survey 1995-2003	Relocation Rates
Israel National Plan for the year 2020	Control Totals
HUJI GIS Database	Grid Cells
The Israel Lands Administration.	Grid Cells, Historical Events

The most extensive data available on the metropolitan area is available in the national census of 1995 and the travel census of 1996. These two sources determined the way in which the data was collected and implemented and the grid cell size was decided according to the smallest census tract in the metropolitan area which was 500 m X 500 m. In order to keep the information as exact as possible, the grid cell size for the Tel Aviv application of the UrbanSim model was 250 m X 250 m. This size allowed us to include all the data available in all census tracts without losing any data which is available. Using GIS a fishnet of grid cells 250m X 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 GIS and Access software. Each grid cell was allocated a census tract to which it corresponded. The data from each census tract was 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 was 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 house holds data base.

In order to complete the grid cells database, data which was not available through the census tracts, such as percentage road, percentage water etc. was imported into the data base using GIS Layers from the HUJI GIS Database. This data was available in two forms Raster and Vector layers. The import process is shown in Figures 3 and 4.

The jobs data base was created using the national travel survey (1996). This includes data about the movement of workers, from different employment sectors, from and to work. This data was used to allocate each job with in 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 guide lines. The control totals for the employment and house holds were taken from the Israel National Plan for the year 2020. The accessibility and travel analysis zones data was collected from the Tel Aviv metropolitan area travel model developed by the government company planning the Tel Aviv mass transit system (NTA) and the relocation rates for jobs and house holds were taken from the Israel Work Force survey between the years 1995 and 2003.

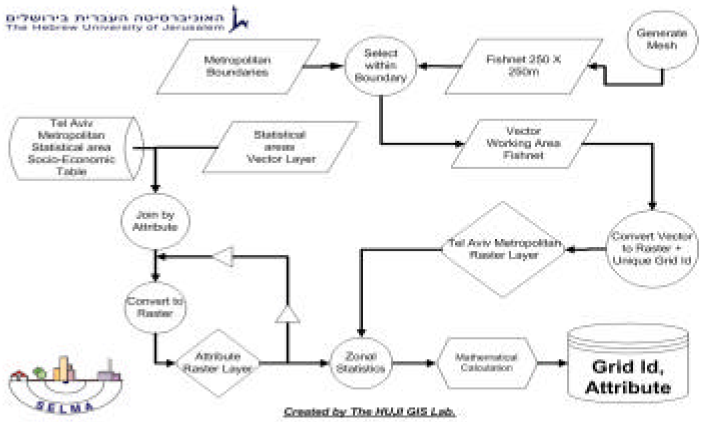


Figure 3 Base Year Database Raster Import Process

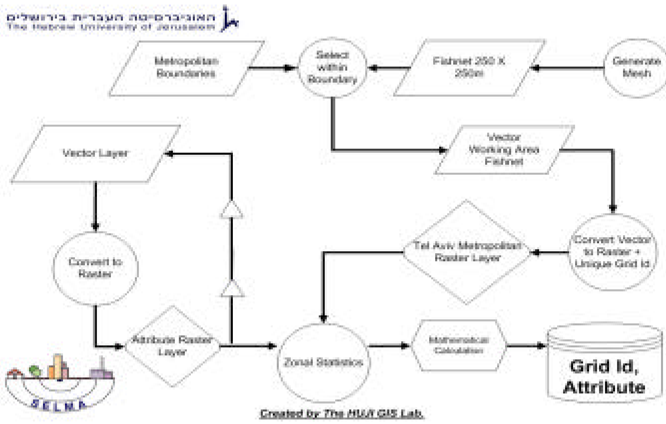


Figure 4 Base Year Database Vector Import Process.

The application of the UrbanSim model to the Tel Aviv test case was in the most part “by the book”. In contrast to the Northwing Randstad case a large amount of the data was readily available and was imported, as is, 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 value and improvement values. The land and improvement value created in the Tel Aviv metropolitan area is based on a sample of approximately 1000 residential, commercial and industrial properties transactions collected from the Israeli Land Authority. The data from these transactions was then used for an inverse distance weighted interpolation for the whole of the metropolitan area. The process of location choice model variable estimation for both households and jobs is 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.

4 SIMULATIONS

UrbanSim is able to test three major groups of scenarios "Policy Scenario", "Projection Scenarios" and "Event Scenarios". Here we report some simulations based on policy and event-driven scenarios.

4.1 An Urban Growth Boundary in Randstad Northwing: A 'Policy-based' Scenario

This scenario reports a strongly regulated land use plan. The scenario was created with the model implementation in its original structure (no changes made to the configuration of the model and variables and coefficients copied from a test case). We postulate the existence of an Urban Growth Boundary with no development allowed beyond this limit. Within the UGB there are no restrictions on development. Figure 5 shows the simulated densities in non residential floorspace in 1995 and 2020. In 1995, there are still open areas in the north and south of Amsterdam. In 2020, those open areas have disappeared in both scenarios. For the Urban Growth Boundary scenario this is the result of employment deconcentration and increasing densities mainly in the open areas around Amsterdam. In the scenario without restrictions the deconcentration process is much stronger: new development can be found evenly spread throughout the whole region. While, these scenarios are not really realistic, they are presented here to illustrate the kind of sprawl-related applications the model can deal with.

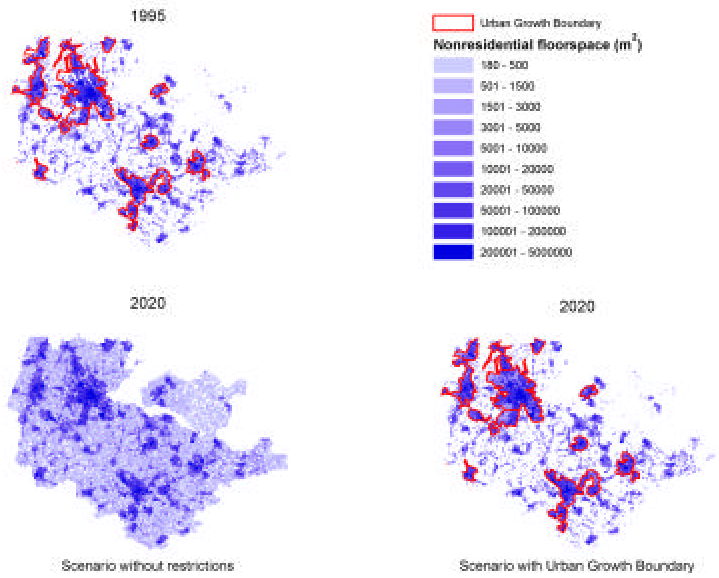


Figure 5 Densities of non-residential floorspace in 1995 and 2020 for the Randstad Northwing. Scenario without restrictions and scenario with Urban Growth Boundary.

4.2 Employment Deconcentration in Tel Aviv: An Event-Driven Scenario

This scenario tests the effect of two major employment deconcentration projects (Figure 6). The first scenario simulates the impact of 'Airport City ' and industrial /high tech adjacent to Ben Gurion International Airport. This project, located in the intermediate ring of the metropolitan region was inaugurated in 2000 and covers an area of 375,000 sqm with a total floor area of 450,000 sqm. The second event, simulates the building of another industrial/service park this time in the outer metropolitan ring, due north of the city of Raanana. This hypothetical event is similarly simulated for the year 2000 on open reserves of land slated for economic development and covering a larger area of 562,500 sqm with a total floor area of 675,000. In both simulations a "Business as Usual" scenario is also reported. Each of the three scenarios is run separately from the year 1995-2020 and results relate to the impacts generated within a 15 km radius of the projects.

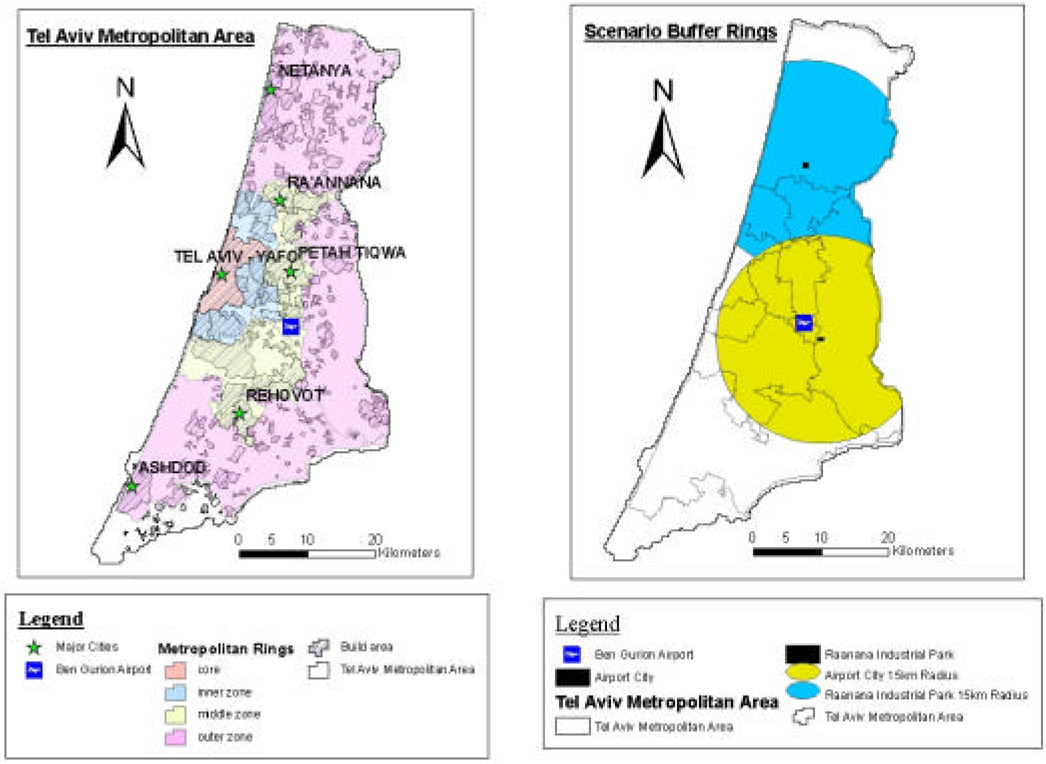


Figure 6 Tel Aviv Metropolitan Area & Scenario Buffers

Airport City Scenario: The results of the Airport City scenario shows certain differences for the 'without event' (Business as Usual) and the 'with event' (Airport City) cases for 2020 (Fig 7). Comparing residential land use effects, we observe that while the total residential area increases, in both cases it is evident that the residential density has also grown. Certain low density residential areas, especially to the west of the airport, change into non-residential land use and the area to the east of the airport experiences a large increase in residential land use. The effects of Airport City are most evident to the south of the project. Although the 'without' scenario creates 916 more residential units within the 15km radius it seems as though the residential density within the 15 km radius, is lower than in the case with Airport City. In the business as usual scenario the area to the south of Airport City project shows a greater mass of low residential land use. The same area in the Airport City scenario shows a higher density of residential land use and higher concentration adjacent to the Airport City project (Table 3).

Table 3. Airport City Scenario: Land Use Totals & Means Compared

	Airport City Scenario		
	Business as Usual Results 2020	Airport City Results 2020	Difference (ARP-BAU)
Total Area (sq km)	665.7	665.7	0
Total Commercial sq km	46.06	46.60	0.53
Mean Commercial sq m (per gridcell)	4325	4375	50
Total Industrial sq km	16.94	17.39	0.45
Mean Industrial sq m (per gridcell)	1591	1633	42
Total Residential Units	715381	714465	-916
Mean Residential Units (per gridcell)	67	67	0

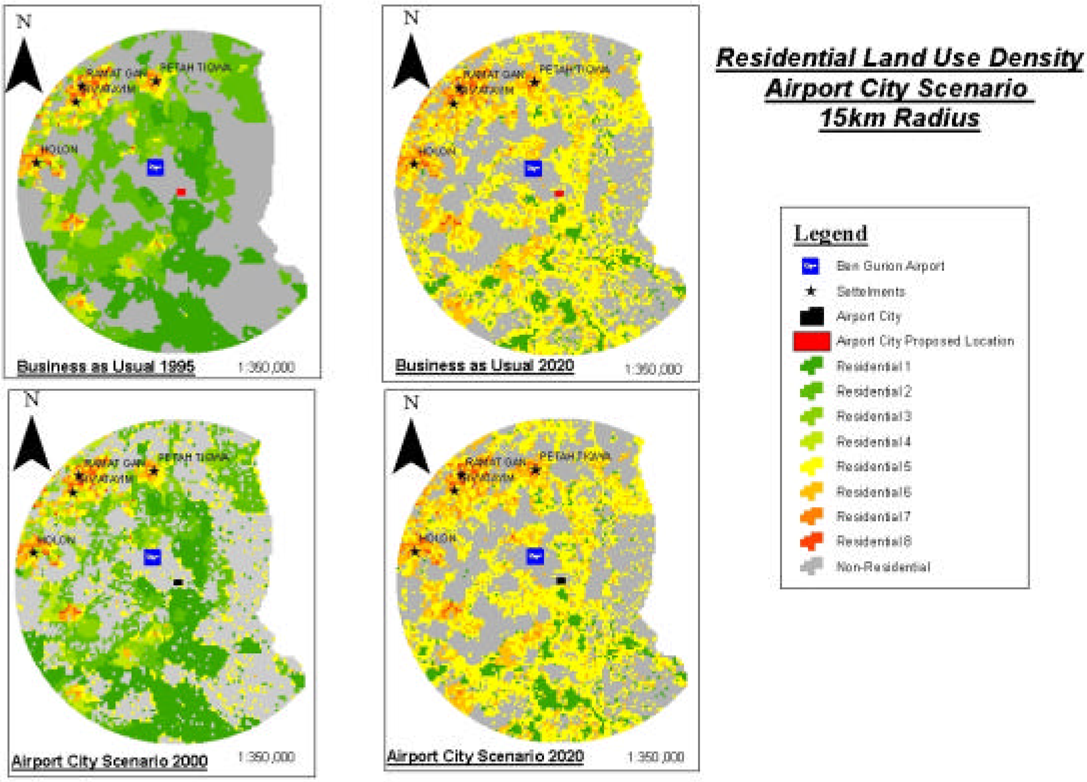


Figure 7 Airport City Scenario Comparison

Raanana Industrial Park Scenario: this scenario tests for differences in land use. As in the previous scenario, 'with event' (Raanana Industrial Park) and the 'without event' (Business as Usual) cases are compared for the year 2020. The establishment of an industrial park in the year 2000 changes the direction of the residential land use development. In the business as usual scenario, the area adjacent to the proposed industrial park is residential, where as in the industrial park scenario the area develops as mixed use (Fig 8). In the latter case, clusters of mixed use development converge around the new industrial park. The industrial park scenario causes a decrease in the amount of commercial floorspace (-0.45 sq km) available to the population within the 15km radius. The commercial area that develops in the business as usual scenario is replaced, in the industrial park scenario, by growth in industrial floorspace and residential units (Table 4).

Table 4: Land Use Totals & Means Compared (Raanana)

	Raanana Industrial Park Scenario		
	Business as Usual Results 2020	Raanana Industrial Park 2020	Difference (RIP-BAU)
Total Area	532.43	532.43	0
Total Commercial sq km	39.83	39.37	-456459
Mean Commercial sq m (per gridcell)	4675	4622	-53
Total Industrial sq km	8.84	9.51	0.67
Mean Industrial sq m (per gridcell)	1038	1117	79
Total Residential Units	439508	441152	1644
Mean Residential Units (per gridcell)	51	51	0

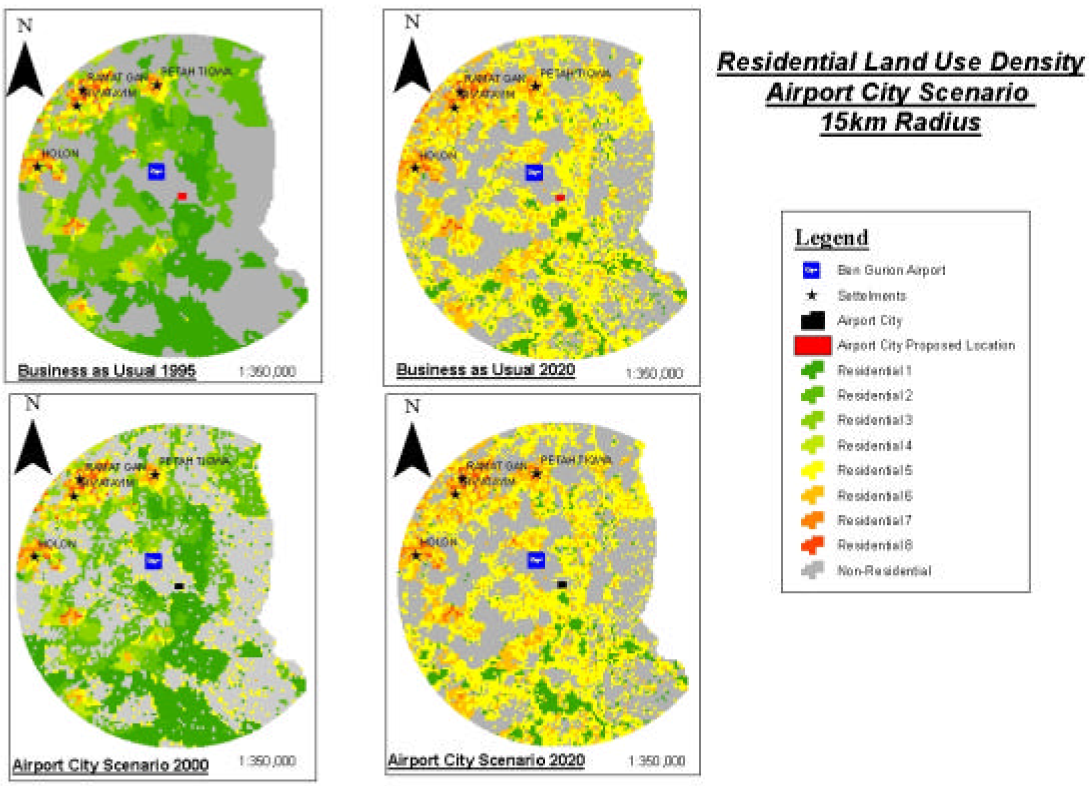


Figure 8 Raanana Industrial Park Scenario Comparison

5 QUALITY OF LIFE EFFECTS

These applications of UrbanSim are ultimately aimed at assessing the Quality of Life effects associated with different patterns of employment sprawl. Here we present some very rudimentary applications of this approach.

For the Randstad Northwing case we use exposure of residential units to noise as an example of quality of life effects arising from employment deconcentration. Because of the tendency for deconcentration close to major highways, for both economic and residential activities, an increase in sound pollution can be expected. To calculate this indicator, we can combine a simulated distribution of residential units with a noise contour map calculated from the coupled land use transportation model. However, since this coupling is not yet completed, the noise contour of 2000 is used to show the calculation. Figure 9 visually illustrates the extent of residential units exposed to noise (>65dba) as a result of simulated employment sprawl (no growth boundary as well as scenario without restrictions). The amount of houses exposed to noise is much higher in the scenario without restrictions on development then in the scenario in which an Urban Growth Boundary was imposed. Because housing densities outside the Urban Growth Boundary increase in this deconcentration scenario, the amount of houses built close to highways will also increase. This will cause more noise pollution, as was expected.

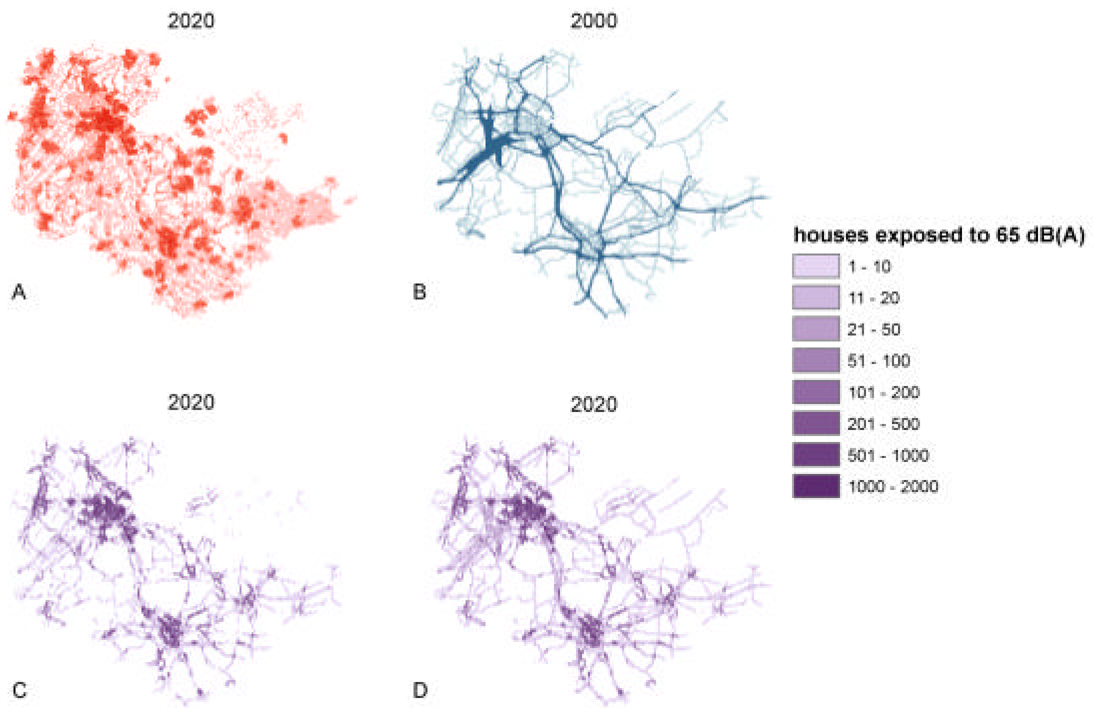


Figure 9 A) Residential Units in scenario without restrictions B) Percentage of each gridcell exposed to noise > 65 dB(A) C) Scenario with Urban Growth Boundary: Residential units with an exposure at façade >65dB(A) D) Scenario without restrictions: Residential units with an exposure at façade >65dB(A)

For the Tel Aviv case we chose to test the quality of life impacts by estimating population accessibility affected by the two employment sprawl scenarios. These measures relate to population accessibility to both commercial areas and employment sources within a 15km radius of the event simulated. The amount of commercial, industrial and employment area (commercial sq m + industrial sq m) per residential unit was compared between the Business as Usual scenario on the one hand and both the Industrial Park and Airport City scenarios, on the other.

The results in Table 5 show that the Airport City project has increased the accessibilty of employment with a growth of 1.5 sq m of employment area per residential unit. This results in 1,071,698 additional sq m for employment within the commercial and industrial employment sectors. The amount of commercial sq m available to the population in the Airport City scenario also increases by 0.84 sq m per residential unit. This results in 600,150 additional commercial sq m.

Table 5:Quality of Life: Airport City Scenario

	Airport City Scenario		
	QOL Business as Usual	QOL Airport City	Difference (ARP-BAU)
Commercial Sq m per Residential Unit	64.40	65.23	0.84
Industrial Sq m per Residential Unit	23.69	24.35	0.66
Employment Sq m per Residential Unit	88.09	89.59	1.50

The Industrial Park scenario shows different results (Table 6). The growth in employment area within the 15km radius is only 0.08 sq m per residential unit. Even though the growth in industrial area is 1.46 sq m per residential unit within the industrial sector, the commercial sector sufferes a decline of 1.37 sq m per residential unit.

Table 6. Quality of Life: Raanana Industrial Park Scenario

	Raanana Industrial Park		
	QOL Business as Usual	QOL Raanana Industrial Park	Difference (RIP-BAU)
Commercial Sq m per Residential Unit	90.63	89.26	-1.37
Industrial Sq m per Residential Unit	20.12	21.58	1.46
Employment Sq m per Residential Unit	110.76	110.84	0.08

6 CONCLUSIONS

The paper has reported some preliminary results of forecasting land use change arising from employment deconcentration in two diverse metropolitan areas and the quality of life implications arising from these changes. These results are the outcome of applying the UrbanSim simulation model in a non-US context. While the findings are very tentative and the models still need to be fully calibrated, taking stock of progress so far seems to indicate two main substantive issues relating to the relationship between employment sprawl and quality of life in metropolitan areas.

The first relates to the need to disaggregate the metropolitan area into its constitutent parts (city centre, inner ring, outer ring) for any analysis of deconcentration. As evidenced from the simulations above, employment deconcentration in an inner ring elicits very different land use impacts to that emanating in an outer ring. The quality of life responses are also very different. For example, a key quality of life issue associated with employment sprawl relates to accessibility in general and spatial mismatch in particular. If employment deconcentrates from the city centre to the outer metropolitan ring, quality of life for workers resident in the centre will have worsened (longer journey to work) while it will have improved for the outer city residents. Quality of life effects are therefore a cost in one part of the metropolitan area and a benefit in another. To further complicate matters, we can note that quality of life issues with an environmental dimension (air quality for example) cannot be spatially contained and thus generate serious externality effects. Noise, air or water pollution emanating from deconcentration in one part of the metropolitan area can easily have repercussions in other parts, as our simulations show. Therefore, fully accounting for quality of life costs and benefits generated by employment sprawl in a metropolitan area becomes very complicated.

The second issue relates to the policy response to employment deconcentration. If the quality of life effects of job sprawl are perceived as negative, the usual policy response (and the one illustrated in this paper) is to impose some form of regulatory restriction on employment deconcentration. This can be effected either through growth management (UGB's) or taxation (impact fees etc). However, another response exists 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 ring or reverse commuting. These are policy responses that can be accommodated within the simulation capabilities of the UrbanSim system and remain challenges for our future work.

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