



Urban sprawl will save ecosystems - what happens at the urban fringe?

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Background:

Czamanski, D., Benenson, I., Malkinson, D., Marinov, M., Roth, R., Wittenberg, L., "Urban Dynamics and Ecosystems" invited paper in *International Review of Environmental and Resource Economics*, 2, 2008, pp. 1-45

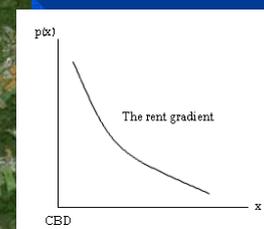
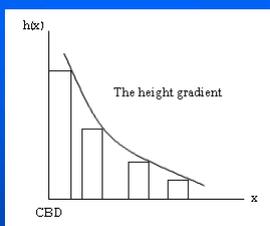


Traditional
ecology is
concerned
with
“natural”
ecosystems

Urban
economists
are concerned
with the CBD
and its
surroundings

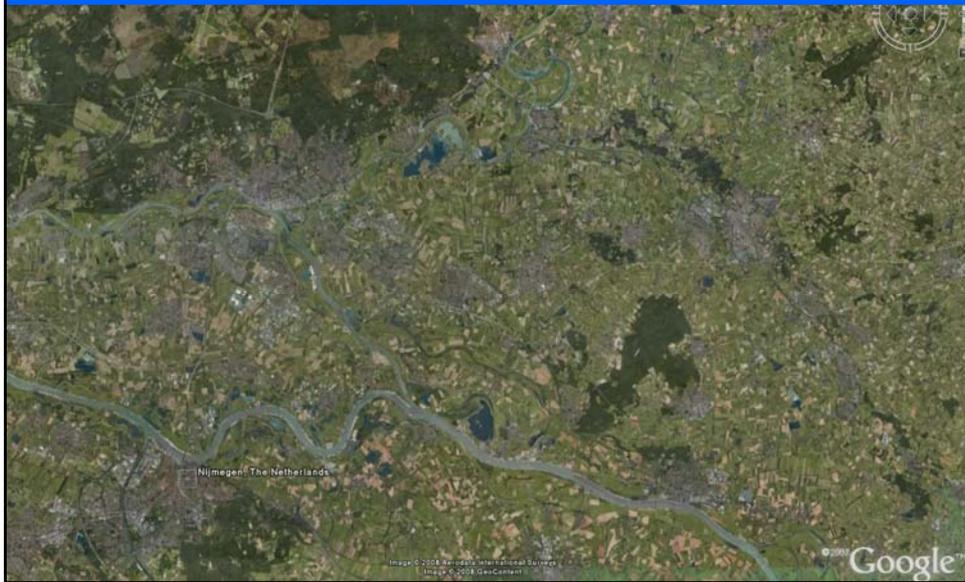


The classical urban story – wave of expansion





Despite the legend, even some Dutch cities are not at all compact. They sprawl all over, into the surrounding “nature” which is essentially “anthropogenic”



The urban sprawl is characteristic of the Western world, and Israel does not differ in this respect. Tel Aviv, Haifa, Jerusalem, Beer-Sheba - are all sprawling at various rates



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Nesher

The modern urban story is sprawl and we have a plenty of data on its footprints

Haifa

Daliya and Issafiya

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Our past work

The works on the evolution of Tel Aviv from 1935 – 1990's

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WHEN AND WHERE IS A CITY FRACTAL

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LEAP FROGGING

[HTTP://CCR.TECHNION.AC.IL](http://ccr.technion.ac.il) *Lacim Benguezi, Daniel Comandó, Maria Marinos*

[HTTP://CCR.TECHNION.AC.IL](http://ccr.technion.ac.il) *Lacim Benguezi, Daniel Comandó, Maria Marinos*



Background:

Benguigui, L., Czamanski D., Marinov, M. and Portugali, Y., "When and Where Is a City Fractal?" in *Environment & Planning B*, 27, 2000, pp. 507-519

Benguigui, L. Czamanski D., Marinov, M., "The Dynamics of Urban Morphology: the Case of Petah Tikvah" in *Environment & Planning B*, 28, 2001, pp. 447 – 460

Benguigui, L., Czamanski D. and Marinov, M., "City Growth as a Leap-Frogging Process: an Application to the Tel Aviv Metropolis" in *Urban Studies*, 38(10), 2001, pp. 1819 – 1839

Benguigui, L. and Czamanski D., "Simulation Analysis of the Fractality of Cities" *Geographical Analysis*, 36(1), 2004

Benguigui, L., Czamanski D. and Marinov, M., "Scaling and urban growth" *Journal of Modern Physics C* 15(7), 2004, pp. 989-996

Benguigui, L., Blumenfeld, E., Czamanski, D., "The Dynamics of Urban Morphology" in *Environment and Planning B*, 33, 2006, pp. 269 – 284

Benguigui, L., Czamanski, D., Roth, R., "Modeling cities in 3D: a cellular automaton approach" in *Environment and Planning B*, 35(3) 2008, pp. 413-430

Aravot, I., Benguigui, L., Blumenfeld, E., Czamanski, D., "Studying urban development in Tel Aviv based on its morphology alone" in *Emergence: Complexity and Organization*, 11:1, 2009

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Insights from our past work

- It is possible to depict cities by simulation models – e. g. the “p model”.
- We have demonstrated leap-frogging as a characterization of the evolution of spatial morphologies in cities like Tel Aviv.
- Cities display clustering of built up areas. Clusters are defined as contiguous built-up urban areas.



The Model in StarLogo

A 3D dynamic spatial model of Tel Aviv (Benguigui Lucien, Czamanski Daniel and Roth Rafaeel)

Speed: full speed Patch Size: 1

Initial share: 41 Inertia percent: 31

Vari-count-thresh: 2 Variation: 1 Vari-avg-thresh: 4

Noise percent: 71 Average height: 12.77 Time wait: 1

7. Average height with: 31

8. Histogram of heights: 2511

Build city Stop Continue

Report statistics Clear Save picture

Save output Clock plot histogram

Legend

- 1 floors
- 5 floors
- 11 floors
- 15 floors
- 21 floors
- 25 floors
- 31 floors
- 35 floors
- 41 floors
- 48 floors



Temporal Changes

The city after 15 periods

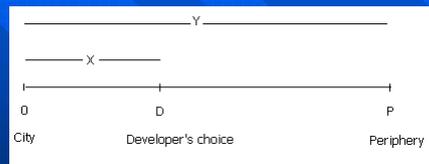
The city after 25 periods

The city after 60 periods

The city after 100 periods and more

Basic spatial approach

The developer tries to find an **optimal location** on a **line** and to choose **optimal height**.



Objective Function

$$\begin{aligned} \text{Max}_{x,h} \quad & FV(t=\tau) = -I(x)(1+r)^\tau - c(h) + p(x)h \\ \text{s.t.} \quad & \tau = \tau(x,h) \end{aligned}$$

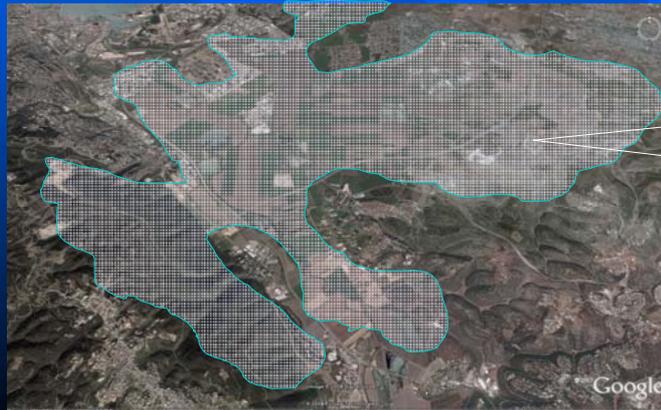
Model's principles

- The developer chooses location (x) and height (h) on a straight line.
- The decision of developer is at a specific time and is based on the characteristic time of locations and willingness to pay (WTP) at those locations.
- Every period the spatial conditions are changed and developers respond to the changes.
- The city's evolution is the outcome of decisions by many developers during many periods.



Where does the city sprawl? The land beyond the city boundary is never a natural reserve full of the wildlife...

The city sprawl into the *anthropogenic land-uses*, which are agriculture with a fraction of built-up areas, abandoned or yet uncultivated areas. Surprisingly, this major land-use type is almost ignored by the regional science. The nowadays paradigms of urban geography and ecology focus on the urban and wildlife states and miss the intermediate one



Agriculture and other anthropogenic land-uses

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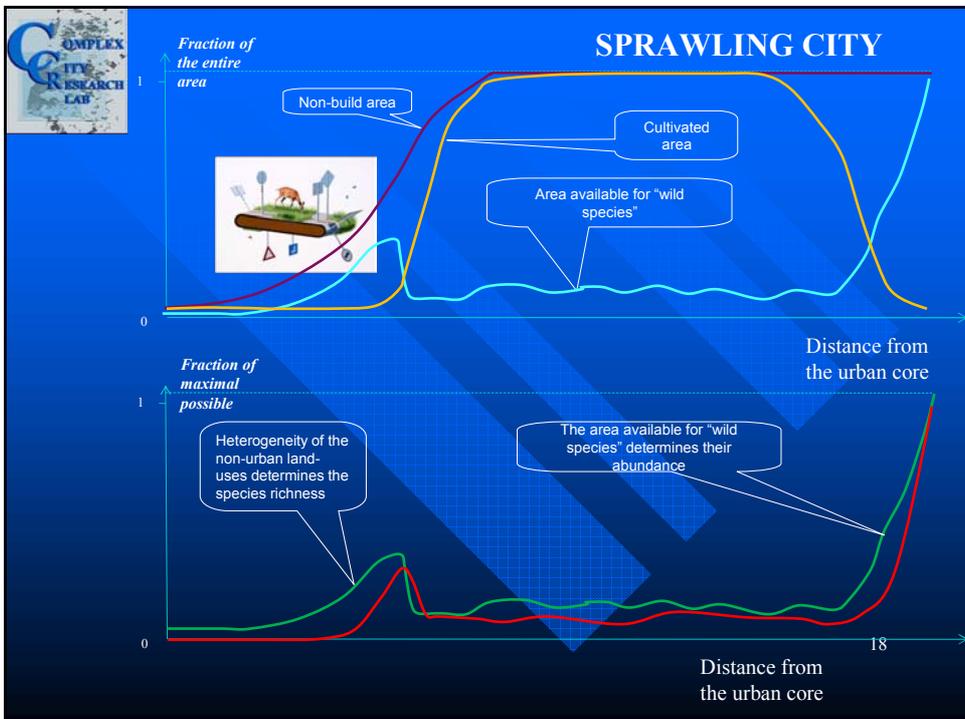
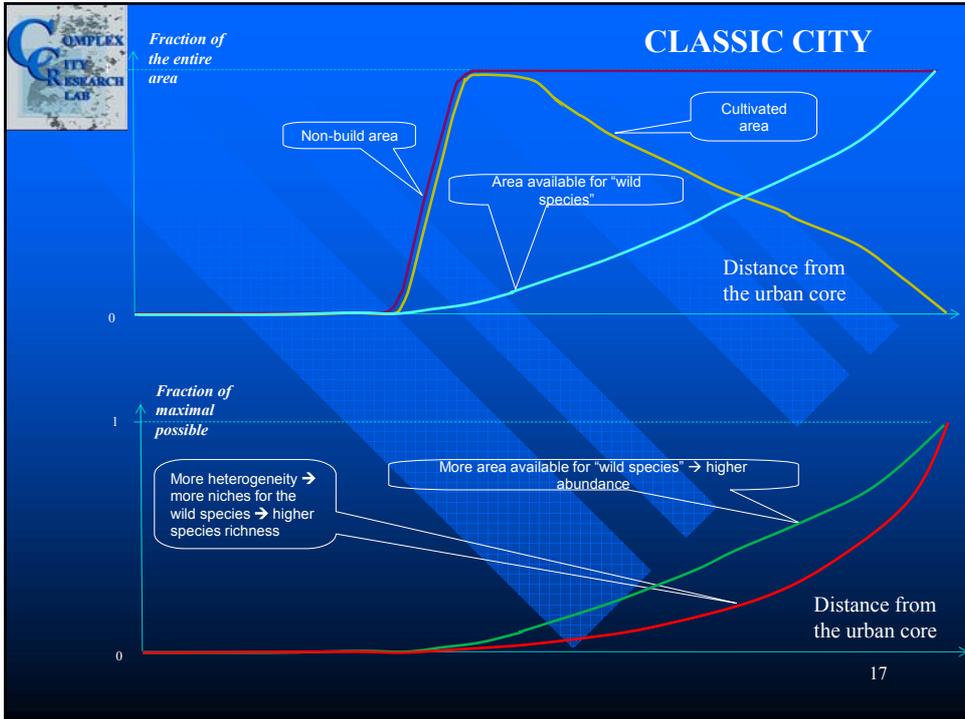


Typical regional land-uses in the western world



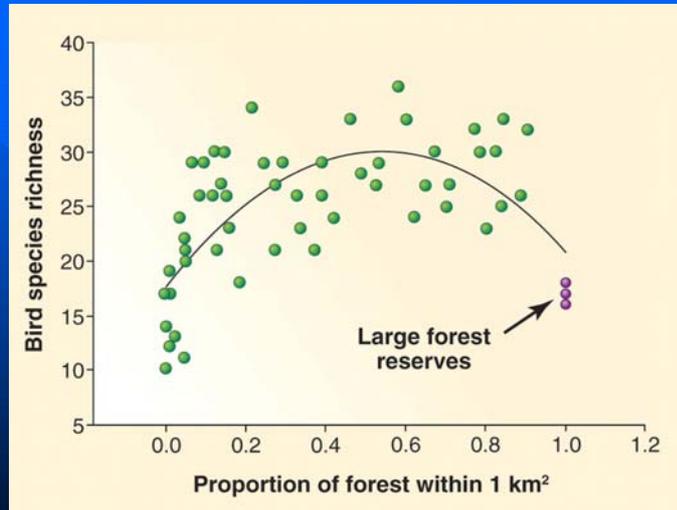
Our view of the regional land-use should thus change →

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Species richness in the peri-urban areas can be high:
Change in avian richness with progressively more forest (less human settlement) in the human-influenced landscape in Central Puget Sound region of Washington, United States



J. Liu et al., Science 317, 1513 -1516 (2007)

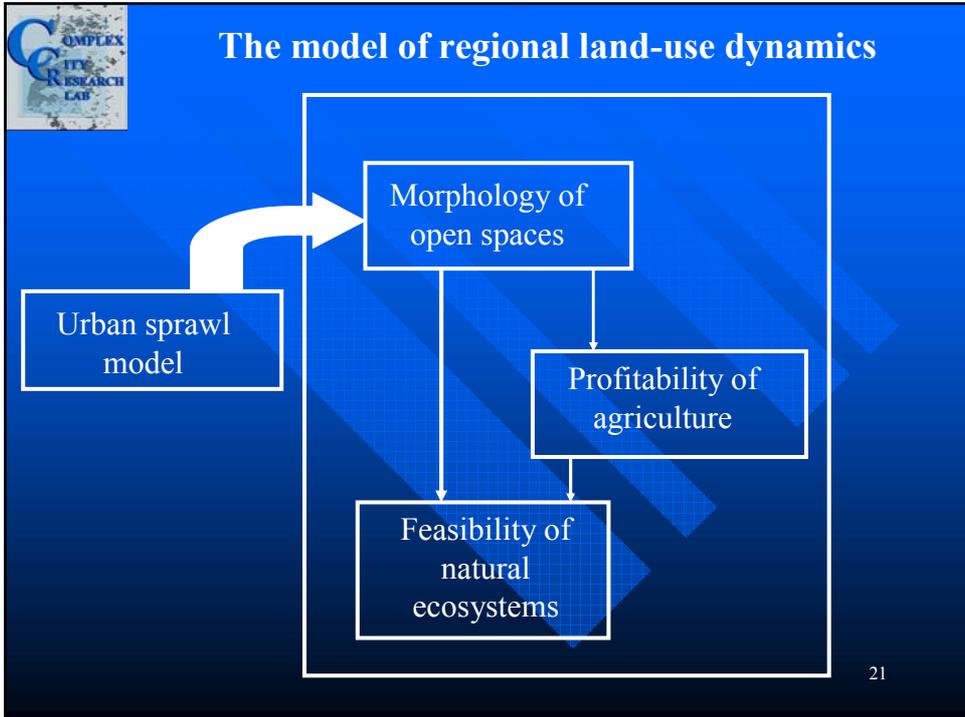
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We aim at high-resolution simulation model of regional land-use dynamics comprised of the sub-models of

- *Urban sprawling dynamics,*
- *Economics of agricultural land-use and production,*
- *Model of wildlife species distribution and abundance*

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Thank you

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