MAPPING THE URBAN SCENE
Models of the urban population in environmental impact analyses

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Abstract

The main pattern of towns and cities is analysed in the presented paper by three models. These represent the three componens of towns and cities: the urban scene, its actors and the play taking place there. All three models are based on population census data, mainly in form of population density data. These models are used then for describing the structure of a chosen city, the fluctuation of population within its area and the effect of an in time and space changing environmental source of influence on the population. The last model can also be used in the opposite direction: to analyse the effect of the population on the environment; natural or man-made - the second type of analyses of environmental impacts.

An approach...

The sight is magnificent. The Blue Planet is really blue! - the navigator thinks. He is strucked with wonder at the sight of the deep blue colours of those huge surfaces and the manyfold of green, yellow and brown colours shifting in an infinitely rich pattern. With growing amazment the navigator of the spaceship approaching the Blue Planet studies the surface of the closing planet on his viewing equipment.

The instrument shows the visible surface of the planet on a screen. The navigator examines a part of the picture closer, making use of the instrument's extremly high resolution. He discernes several dots on the investigated part of the picture - thousends and thousends of them in fact. What are those?

The navigator activates a new instrument. First he videns the scope of the instruments catchment area. The circular pictures shows now the *entire* surface of the planet - even the side he can't see. Then he transforms the pictures to 3D, thin, translucent, holographic slides. The images are created second after second and are layered upon each other and merge into each other. A 3D radiantly colorfull modell is emerging.

He examins the 3D model. The position of dots create spiralling lines in the 3D space. The dots are moving! - he realises. What are those?

A spectrometer is activated. Many of those lines represent living organisms! And most of them belong the same sort! Humans!! We found them!

The navigator looks out through the window and sees the surface of the planet darken. Night is approaching The darknes is deep now. But not everywhere. Certain part of the blackness is lit up with billions of tiny ligths. What now?

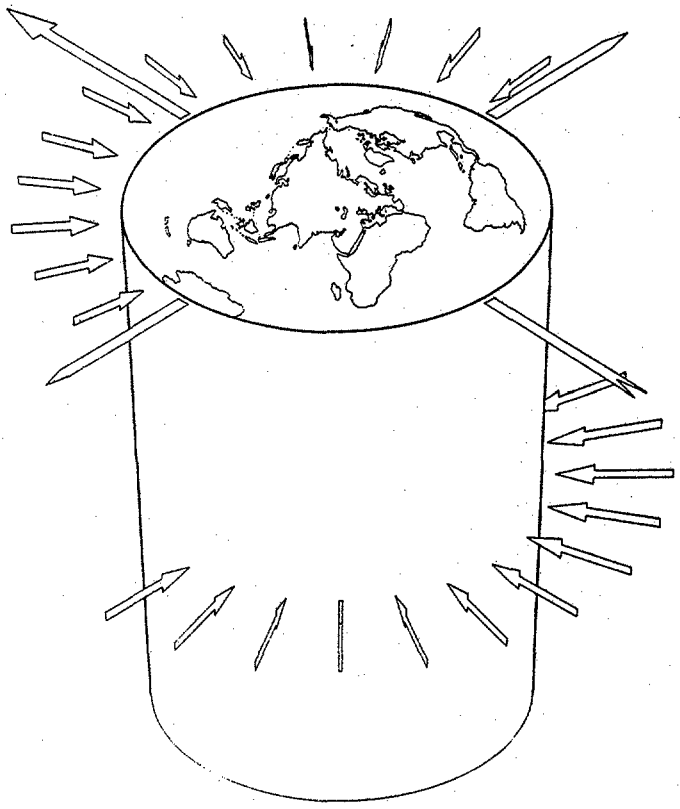

Figure 1 "....First he videns the scope of the instruments field of vision. The circular pictures shows now the *entire* surface of the planet - even the side he can't see. Then he transforms the pictures to 3D, thin, translucent, holographic slides. The images are created second by second, are layered upon the other and merge into each other. A radiantly colorfull 3Dmodell is emerging."

(Illustration from *Human Cartography,* 1987 "..*The crystallised flow of the past* - and various perspectives for observing it")

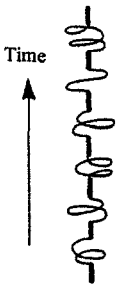

Figure 2 "...The navigator examins the 3D model. The position of dots create spiralling lines in the 3D space. The dots are moving! - he realises. What are those?"

(Illustration from *Human Cartography*, 1987. "If we now...follow the pattern formed by the life path of individual people, we will find... ...rythmically changing patterns in the shape of spirals... representing the movements of nomadic people." Vertical lines: periods of staying during the winter. Arcs: wanderings during the rest of the year. In this presentation could vertical lines show staying at home during the night and arcs movements during the day.)

The spaceship is approaching the surface. Its instruments come alive. Electricity, they signal. Those lights are created by electricity! And the lights form patterns! Intelligent live! Look there - a heavy concentration of lights! A whole carpet of them - and in the even cover an intricate mash of lights, created by chains of them! Chains creating more or less concentric pattern - and the radiating chains completing the concentric elements!

The navigator can hardly control his excitement. He activates another instrument and now he can see through darkness. There it is! The old reports weren't wrong! 3D volumes in a regular pattern appear on the new screen. They must be what those structures, that the old reports mentioned as "buildings"! We found it! A city!

But where are those humans? The whole city is quiet, without movements. O yes. It is night. The spectrometer is activated again. After a little adjustment it shows just one single type of red dots. Humans and nothing else. Thousends of glowing red dots. They dont move. Why?

The excitement spreds around the whole spacecraft. Everyone not absolutly necessary at steering of the vessel are crowded around the navigator and his instruments.

The light is returning. And now - look ! The red dots begin to move!

The movemnts at first are slow and hesitating. They are confined to smal areas within part of the buildings. Soon, however, the movements begin to follow the same lines as the chains of ligths the nigth before. "Highways and streets", the navigator recalls.

The pattern of the movements seems to be at first chaotic. The trained eye of the navigator, however discerns a pattern. Plenty of dots are moving towards a central part of the city. Other swarms are directed to a few outlying part of the area, covered by buildings. The thick carpet created by the red dots at night is now thinner but previously empty areas - not least in the middle of the city - are crowded by those red dots. What has happened?

Soon new movements begin. They are directed toward the central parts of those areas crowded by red dots at night. A new analyses shows that those streems are made up of young humans. What are they

doing there? And what are the other ones doing in the central part of the city? Those who are indicated to be grown up individuals?

The day is passing. Soon the latest movements are repeted in opposite direction and later the red dots from the center of the city move back to their starting point. The dark shadows of nigt are closing and the red dots are at rest.

...the reality

We do´t know anything about any expedition visiting our Earth from outer space, nor have we ourselfs any instrument for remote sensing of the type the introductory science-fiction-story implied. We have reason to be happy for that. We don´t need any instrument that senses and registrates the activities of individual human beings.. What we *do* need, however are instruments of thought - models and methods - showing the collected spatial pattern of distribution and activities of people. We need such information not least in urban areas not only in interest of understanding of the structure and development of towns and cities. We need those information also as departure point of planning of supply with electricity, fresh water, traffic facilities, food supply and civic services. Taking care of wastes, sewage etc needs the same type of information as well as the necessaty to evaluate the environmental consequences of all these measures. This presentation intends to briefly summarise the results of a project with the aim to develop models and methods within this field.

The main components: the scene, the actors and the play

In the fantasy-science-fiction-story the scene was indicated by the network of streets and the structures between them, the buildings. The actors are the human beings, the population living and working in the town or city. The play is made up of their movements between the place of living and working and within them. There are, however, other elements of the play: invisible environmental influences affecting the human population and invisible human influences affecting the environment - natural or man-made .

The scene

is frequently, - and traditionally - described by the density of the population.(fig 3A) The description created in this way is in many respect an efficient one. The high intensity of usage in the inner parts of towns and cities and the lowering usage intensity towards their outskirts is described with a high level of plasticity. The shortcoming of this describtion becomes obvious only when we look at the very centre of the city. The low population density there - i e the low density of *dwellers* - indicates poorly the high intensity of activities that is so characteristic for the city centre.

The high activity level is very well indicated by the density of *workers* (fig 3B). The worker density is high in the centre of cities and diminishes rapidely and regularly with increased distance from the centre. The worker density is decaying at such a high pace, that its values in the outer areas can´t be shown graphically in the 3D map. Hence the worker density indicates efficiently the centre of towns and cities, but not the areas dominated by dwellings.

The spatial pattern of worker density in towns and cities is not particularly often analysed, probably depending on the shortage of data.. The author´s studies of Swedish urban agglomerations show that the here summarised spatial pattern regularly reoccur in all studied towns and cities (Szegö 1974; 1978 summarized in 1994). In fact the level of regularity is much higher than the regularity of dweller

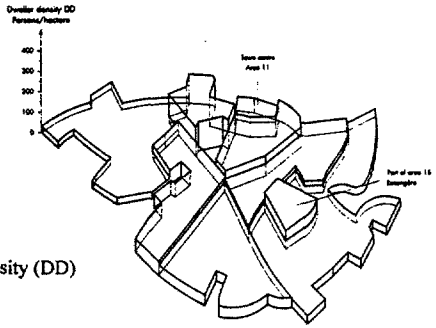

Figure A
Model of dweller density (DD)

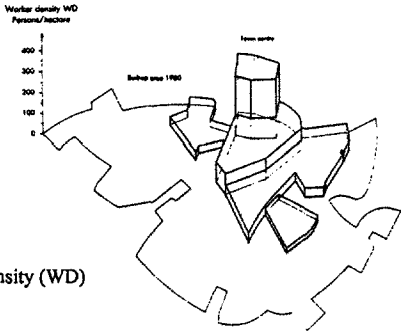

Figure B
Model of worker density (WD)

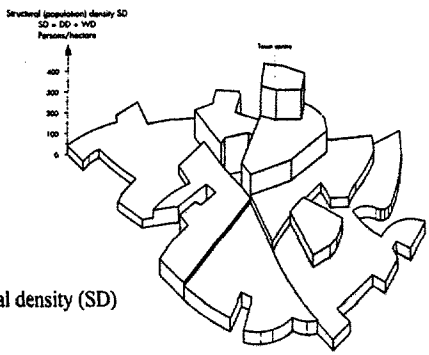

Figure C
Model of structural density (SD)

Figure 3 Dweller density, worker density and - the sum of dweller density and worker density - structural density in a city (Malmö 1980) (From *Mapping Hidden Dimensions of the Urban Scene*)

density. It seems to be probable, that the worker density has a primer roll in creating the urban structure seconded by the density of dwellers.

Neither the dweller density, nor the worker density give *alone* a complete picture of the structure of a city, only the components of it. *Together,* however, they do (fig 3C). The *sum* of *dwellers and workers* mirrors efficiently the structure of the urban scene. Hence the term *Structural (Population) Density*

$$SD = DD + WD$$

SD = Structural Density
DD = Dweller Density
WD= Worker Density

We find a high level of correlation between the spatial pattern of structural density and the physical structure in towns and cities. This is not coincidenal. The Structural Density decribes not the density of physical persons but the density of *personal spaces* e g working places and dwelling spaces. *Dwelling space* concerns the space a person has to his disposal within his dwelling. It includes also the urban space - yards, streets, squares and local green areas - belonging to each and every dwelling space. "Working space" as notion is built in analogy. All personal spaces are considered to have the same size within one and the same part of a city.

The actors,

in a city, the population, is changing its spatial distribution all the time. This change is particularly pronounced between day and night. During the night people are at home, in their dwellings and leave empty working places behind them. In the morning they return to their working places. Now are their dwelling spaces that are empty - i e the dwelling spaces of the people, who have job somewhere. During the nigth the areas dominated by dwellings have the highest momentary density of individuals (figure 4B). During the day the highest density of individuals is found in the centre of cities with their heavy concentration of working places (figure 5B).

The play

in cities is made up partly by the - well visible - movements between the night- and day distribution of the population. We experience the transition between these phases every morning's and evening's traffic congestions. There are plenty of - less visible - movements within working places and dwellings. Invisible are most of the influences that affect these populations - influences from noise, air pollution etc. There are other, more or less positive influences from sources of information, retail businesses and civic services. These affect people by their availability. Other influences have the population itself as a source and are directed towards the environment - natural or man-made. A prcedure called

Influence calculations

has been developed within this project to quantitatively evaluate the effects of these influences. These calculations are based on the assumptions that

* the strength of an influence "I" can be measured/expressed i quantiative terms

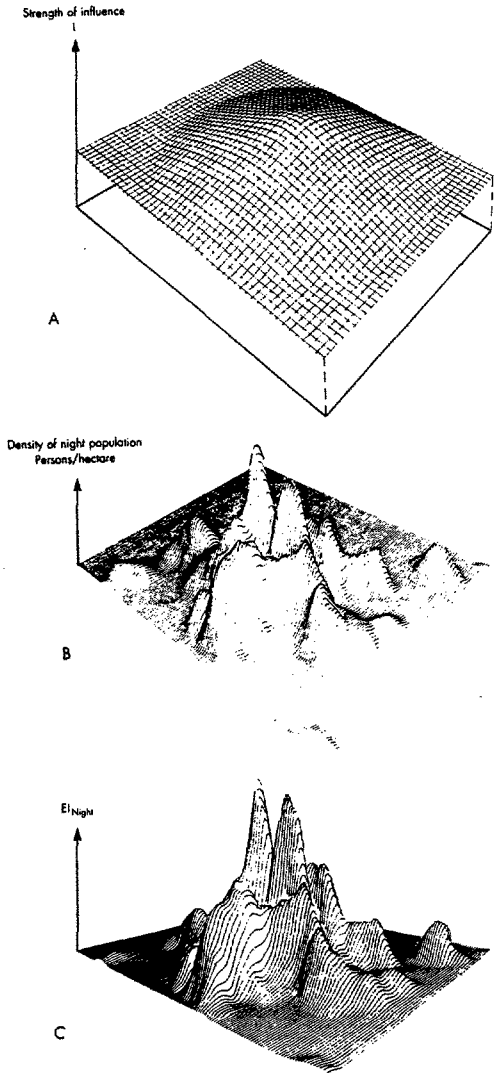

Figure 4 An invisible source - e.g. air polution - influences the population of a city during the night. Figure A: the variations of the strength of influence (I) within the built-up area of the city. Figure B: the spatial distribution of the population in the area during the same period. Figure C: the momentary effect of influence (EI)

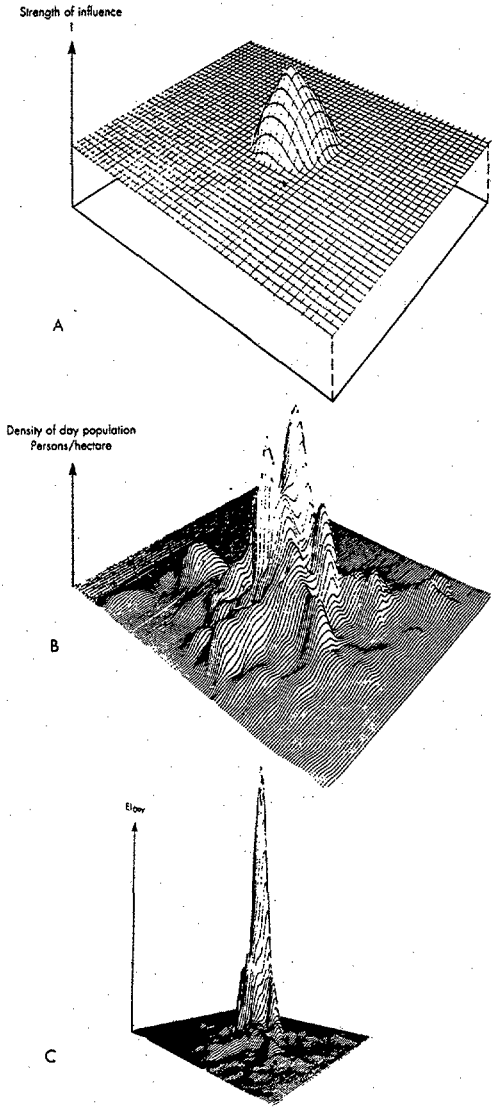

Figure 5 The strength of influence - e g the concentration of air polution - increases during the day (fig A). During the same period the people are heavely concentrated in the central parts of the city (fig B). The effect of influence culminates in the central parts of the city (fig C)

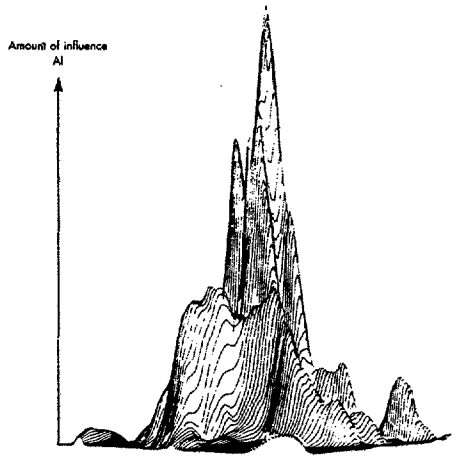

Figure 6. The amount of influence (AI), e g the time integral of the effect of influence (EI) and its spatial distribution within a city (Malmö 1980) during a 24-hours period
(Figures 3-8: from *Mapping Hidden Dimensions of the Urban Scene*, by J. Szegö,1994)

* the momentary *effect of influence* "EI" is the product of the strength of influence "I" and the number of people affected, N

$$EI = I \times N$$

* the *amount of influence* "AI" is a product of the effect of influence (EI) and its duration "T"

$$AI = EI \times T$$

If the effect of influens (EI) is fluctuating, than the amount of influence is the time integral of the effect of influence.

Only an outline of the procedure of calculation can be shown here. Figure 4A illustrates the strength of an influence - e g the concentration of an air pollution in a city - affecting the population in it. The distribution of the population is showen in fig 4B. Figure 4C displays the momentary effect of influence (EI), exerted by the influence on the population at every single moment during the night.

During the day the strenth of influence - the concentration of air pollution - increases, particularly over the centre of the city (figure 5A). The concentration of the population is also the strongest in this part of the city (figure 5B). Hence the effect of influence will also rich its highest values here (figure 5C). This centrical patter will result in an also centrical pattern of influence amount (AI) during the 24-hours period (figure 6). A more thorough presentation of the influence calculation can be found in Szegö (1994).

It is also important to consider, that the distribution of population in itself expresses influences, exerted *by* the population *on* the environment , man-made as e g infrastructure, - the water supply network and network of other utilities etc - or on the natural environment.

Summary and conclusions

The complex pattern of the structure and activities in town and cities can be modeled according to three basic components: the urban *scene*, its *actors* and *the play* going on there. All of them can be expressed with help of population census data. These models can than be used not only for analysing the current conditions in a city and their previous developments. It can also be used for analyses of future conditions, in the wake of expected developments and planning measures, which we reflect upon. Hence these models can also function as planning tools. Analysing the environment's impact on the urban population and analysing the populations's impact on the environment for the present and for future situations is a central task for urban and environmental planning. It is claimed that the presented models and methods are efficient tools when handlig those tasks.

References

This paper is built in the first place on the content of

SZEGÖ, J (1995) *Mapping Hidden Dimensions of the Urban Scene.* The Swedish Councile for Building Research. Stockholm. ISBN 91-540-5651-9

SZEGÖ, J (1987) *Human Cartography. Mapping the World of Man.* The Swedish Councile for Building Research. Stockholm. ISBN 91-540-4781-1

Comprehensive lists of references are given in those books. Other publications mentioned above

SZEGÖ, J (1974) *Befolkningstäthet, markanvändning, planering. (Population Density, Land Use, Planning)* University of Lund.

SZEGÖ, J (1978) *Befolkningstäthet, tätortstillväxt, arealbehov (Population Density, urban growth, land requirenments)*Byggforskningsrådet (R59:1978) Stockholm