Possibility thinking in Urban Design

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1 Scale articulation

Shortly after the publication of an urbanist (Doxiadis)[a] in Science I started my study of architecture and urban design at the University of Technology in Delft. I chose that study of the largest human artefacts in contrast to the profession of my father, a nuclear physicist. His inaugural speech as a professor in fine mechanics at that University[b] emphasised the importance of scale articulation in choosing categories, variables and parameters to describe the phenomena used to design the smallest human artefacts of the time. He could use diamonds and gold, I had to apply concrete and steel. So, scale articulation became my first fascination in studying architecture and urbanism. I started to collect maps of urban areas at different levels of scale to study the gradual change of the legend (the 'vocabulary of the drawing'), the 'material' describing a building component, a building, a complex of buildings, a neighbourhood, a district, a town, a conurbation or a region and its dispersion in the drawing. So, I appreciated Doxiadis' distinction in levels of scale, but his intervals varied. His publication fed hope to transform urbanism into a real science. However, design is more than empirical science as I learned soon. It does not study reality, truth or probability alone ('empirical research'), it studies possibility of which probability is only a subset. This article attempts to demonstrate how useful it may be to distinguish levels of scale with intervals of a factor 3 distinguishing different disciplines in urbanism or 'regional physics'.

1.1 Levels of scale

Inner and outer boundary of concern

The order of size determines the applicable design and management means. The reach of scale of an object of study has an upper and a lower limit, here called frame and grain or granule (see *Fig. 1*), best indicated by their approximate radiuses R and r. The proportion r/R determines the resolution of the study, the extent to which the study goes into detail compared to its largest measure drawn (for example r/R = 10% indicates a rough sketch, 1% a drawing, 0.1% a blue print). It also indicates the tolerance, the intended precision of location. For example: a line drawn in a sketch of r = 1m may be interpreted within a range of 1m around the depicted line.

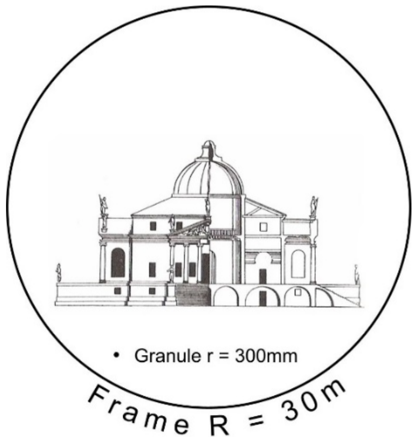


Fig. 1 A frame 100x grain of a drawing representing a building

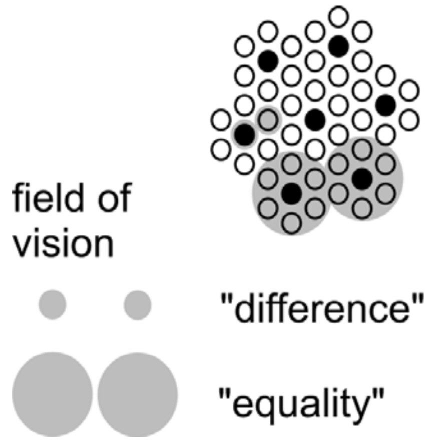


Fig. 2 Scale paradox

[a] Doxiadis, C.A. (1968) *Ekistics; an introduction to the science of human settlements* (New York) Oxford University Press
Doxiadis, C.A. (1968) *Man's Movement and his City* (Science) 162: 326-334
[b] Jong, D.d. (1961) *Grenzen van Fijnmechanische Techniek* (Delft) TH Delft Inaugural speech

Scale paradox

The reach of scale is so important, because conclusions on a specific level of scale could be opposite to conclusions drawn on another level of scale (scale-paradox, see *Fig. 2*). The scale paradox means a scientific ban on applying conclusions drawn on one level of scale to another without any concern (scale confusion). However, that does not yet mean conclusions at one level of scale could never be extrapolated into other levels. *Fig. 2* only shows the *possibility* of changing conclusions by a change of scale. It demonstrates the possibility of a reversal of conclusions already by a factor 3 larger radius. And, there are 10 decimals between the Earth and a grain of sand. That gives approximately 22 possibilities of confusing conclusions. If a scale paradox can be demonstrated for concepts of difference and equality as such, it may apply to any distinction of spatial categories or classes.

Domains with different categories, types and legends

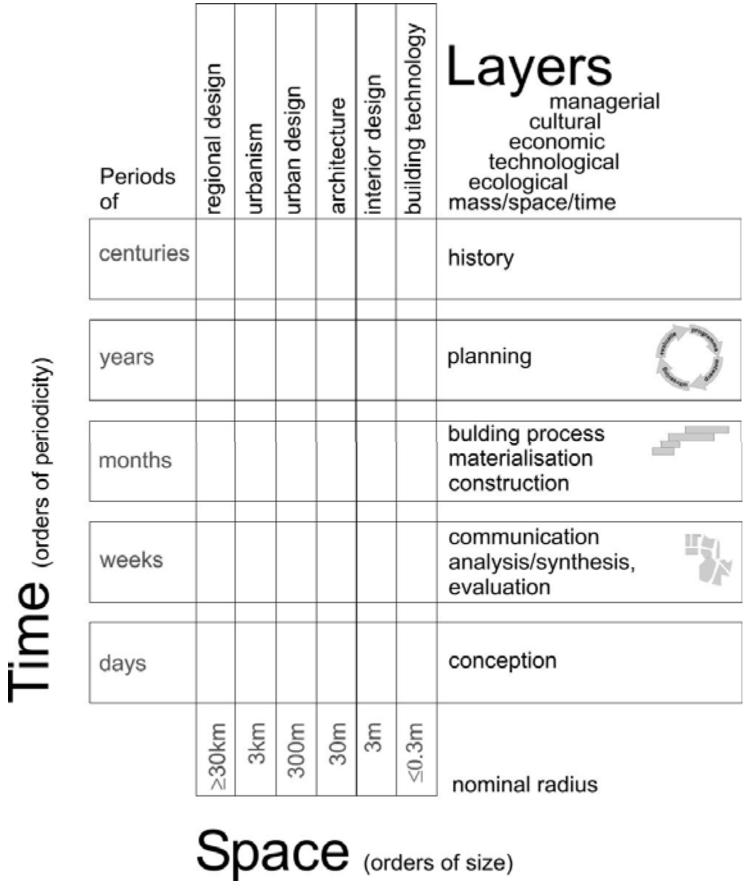


Fig. 3 The domain of Urban and Architectural design

On every level of scale you need other distinctions of categories and subsequently different typical combinations of their classes: the types and legends to be studied or designed.

You can recognize that necessity in the common disciplines urbanism, architecture and building technology (see *Fig. 3*). The types and legends of architectural disciplines are different from those of urbanism or building technology.

Less mainly recognized are the different time scales you can distinguish on every spatial level of scale. Architectural history is something else than urban or technological history. And, history is something else than planning, building process, communication process or the process of conception. This is where building management comes in as a separate discipline. So, the same kind of argumentation on spatial articulation of scale could be developed for temporal distinctions. What seems true or right in terms of weeks may be false or wrong in terms of months.

Moreover, these distinctions do have different physical and social 'layers' to be discussed in section 1.2.

Many spatial orders of size possibly causing confusion

In *Fig. 2* confusion of spatial scale is already possible by a linear factor 3 difference in level of scale (approximately 10 in surface). That is why for spatial design and management I articulate orders of size by a linear factor of approximately 3. So, to avoid any confusion, I need to distinguish at least 22 levels of scale to define what is object and context, beginning with the global context and preliminary ending with that of the physical chemistry of materials (see *Fig. 4*). Most of these levels are not relevant for a study at hand, but they *are* there, most of them buried in hidden (ceteris paribus) suppositions.

Global(10000km)	Continental(3000km)	Subcontinental(1000km)	National(300km)	Sub national(100km)	Regional(30km)	Sub regional(10km)	Town(3km)	District(1km)	Neighbourhood(300m)	Ensemble(100m)	Building complex(30m)	Building(10m)	Building segment(3m)	Building part(1m)	Building component(300mm)	Super element(100mm)	Element(30mm)	Sub element(10mm)	Super material(3mm)	Material(1mm)	Sub material(<1mm)

Fig. 4 Levels of scale (expressed in R) to be aware of in any spatially relevant study

Scale confusion plays a role in many disciplines, but it is often hidden in tacit suppositions using terms as function and structure.
Managers of a small enterprise may propagate integration, managers of a large enterprise specialisation.
If a street has houses, all different from each other, an urbanist may say: “This street is a homogeneous mixture, not to be distinguished from any other one.”.
An architect, however, may say: “How did you get there? Every house is different!”.
A macro-economist may propagate spending, a micro-economist saving.
A watchmaker may recommend the use of precious diamonds and gold, a contractor the use of cheap concrete and steel.
An ecologist may stress communities, a biologist individual survival strategies.
The universe obeys the Second Law of Thermodynamics, but life is based on local disobedience inside at the cost of the outside world.
A ball is convex from the outside, but concave from the inside. A house has an internal and an external function.

In urban design you must be prepared for contradictory advice from specialists, experienced at different levels of scale or with different political convictions. Politics negotiates the question ‘What shall we do individually’(liberal), and what together (socialistic)?’. Political parties tacitly suppose different levels of optimal cooperation: the family (Christian Democrats), the municipality, larger parts of the nation, the nation, the continent or even the world (green parties). Culture is ‘a set of tacit suppositions in communication’. Conclusions often stem from scale-bound (e.g. human scale) suppositions, hidden in a subculture. These are difficult to detect. The self-image of individuals and groups is a balance between the urge of distinction and the urge to be an appreciated member of a community. Identity is ‘continuity in itself and difference from the rest’. But where begins ‘the rest’?
Providing identity to streets, neighborhoods, districts, and so on, is the core of urbanism.
Economy is the art of survival through competition and cooperation, but at which level of scale and in which respect turns competition into cooperation?
Technology combines and separates materials, but at which level of scale applies the one or the other?
In ecology, any species needs partners of the same species, but these are also their competitors. What is the optimal size of their biotopes and territories?
Atoms and planetary systems look alike, but what happens in between? In order to understand a bacteria or a jaguar, you apparently need more than physics.[c]

[c] Gell-Mann, M. (1994) *The Quark and the Jaguar* (London) Abacus

Nominal values of a radius R to name levels of scale

Levels of spatial scale are often named by the ratio of a drawing to reality such as ‘1:100’. However, it depends on the size of the paper what kind of object you have in mind. On an A4 paper 1:100 you can draw an object of approximately 10m radius (30m^2 surface); on an A2 paper it could show an object of 30m radius (300m^2 surface). That is why I prefer to name the order of size by its approximate radius R in supposed reality chosen from the set {… 1, 3, 10, 30, 100m …}. An ‘elastic’ element from that nearly logarithmic series is used as the *name* (nominal value) of the order of size of an urban, architectural or technical category ranging between its neighbours. To be more precise: the ‘nominal’ radius R=10 is the median of a probability density distribution of the logarithm of radiuses between (rounded off) R=3 and R=30, with a standard deviation of 0.15.

I chose a series of radiuses rather than diameters because an area with a radius of {0.3, 1, 3, 10km} fits well with {neighbourhood, district, quarter, and conurbation} or loose {hamlet, village, town, and sub-region} in everyday parlance. They fit also very well to a hierarchy of dry or wet connections according to their average mesh widths (see page 32). Moreover, a radius immediately refers to the most indifferent directionless form of circles or globes indicating both surfaces and volumes by one linear value.

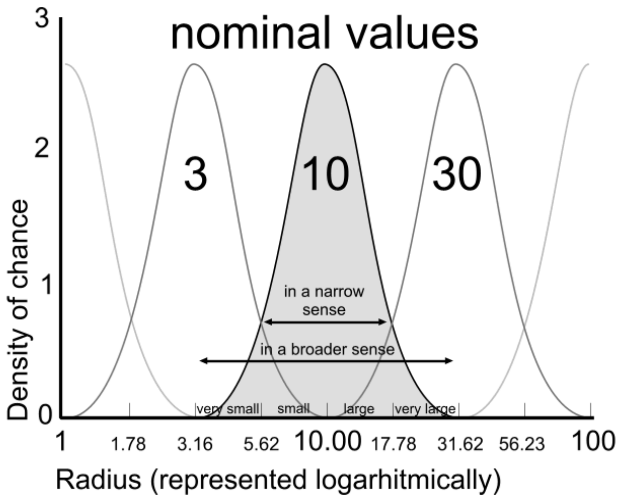


Fig. 5 *Boundaries of urban categories*

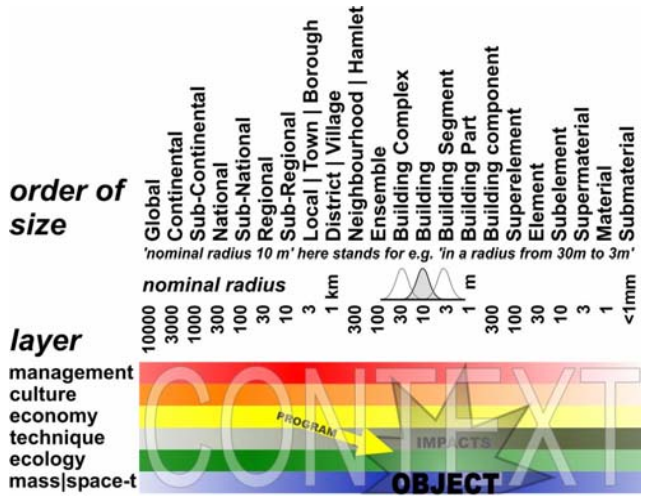


Fig. 6 Locating an undetermined spatial object of design study within its context

Impacts on different levels of scale

Any object of study will have impacts on different levels of scale, hitting interests of stakeholders and users operating at that level (for example from government administrators to manufacturers of building materials). If the object of study is still variable (such as a possible object of design study compared to a probable object of empirical research), an analysis of context should be the first step (see page 82).

Context analysis could start by locating these supposed impacts on the level of scale they apply, as far as they could be relevant to the study at hand, not overlooking any level (see *Fig. 6*). You can ‘locate’ them before you specify them. The scheme does not specify these impacts. It solely shows their order of size and layer (‘location’). It is even possible to consider these context factors before you choose a specific object of study at a specific location. So, the scheme can help outlining your object of study from outside inwards.

Desirable impacts determine a programme of requirements. Perhaps you can find stakeholders at the level and layer of desirable impacts, wanting to pay for your study. If there are negative impacts, you should not exclude people responsible on that level to minimise or compensate such effects through your study.

1.2 Scale sensitive physical and social layers

The basic layer of physics

At a purely physical level of mass and space in time, accumulation or concentration (C) of masses versus sprawl or deconcentration (D) is an essential design factor. What is called ‘mass’ should be specified (for example built-up area), but concentration and deconcentration (changing state of dispersion) of any legend unit in a drawing are characteristics of form and composition at any level of scale. They can differ per level of scale (see Fig. 7 and Fig. 8). An existing or expected scale sequence such as $D_{10m}C_{30m}D_{100m}C_{300m}$ or its reverse $C_{10m}D_{30m}C_{100m}D_{300m}$ (call it ‘accords’) names different global characteristics of form.
I will firstly elaborate the ‘state of dispersion’ more in detail, because it is relevant for other layers as well.

States of dispersion

Form as a primary object of design, supposes a state of distribution of an arbitrary legend unit, for example ‘built-up area’.

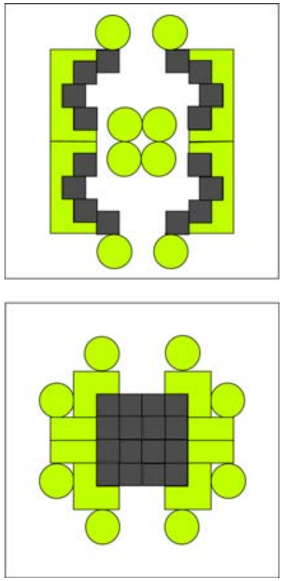
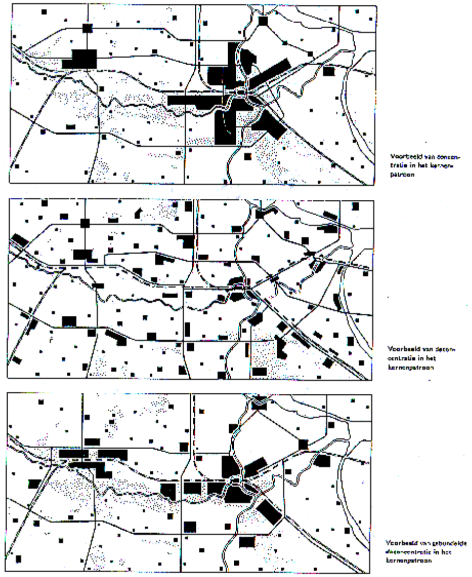


Fig. 7 *Opposite states of distribution within a frame R = 100m*



RPD[a]

Fig. 8 *Accumulation (C), Sprawl (D), ‘Bundled Deconcentration’ (DC) within a frame R = 30km*

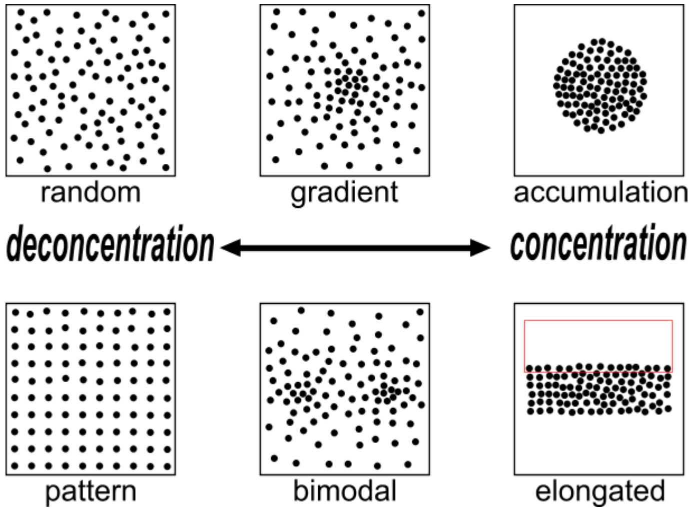


Fig. 9 *States of distribution in the same density (100 dots in the same square) at one level of scale*

Scale articulation is important in order to distinguish different states of distribution. That is not the same as density. Considering the same density, different states of dispersion are possible (Fig. 9**Fout! Verwijzingsbron niet gevonden.**) and that is the case on every level of scale again (Fig. 10).

[a] RPD (1966) *Tweede Nota inzake de Ruimtelijke Ordening in Nederland* ('s-Gravenhage) Rijksplanologische Dienst

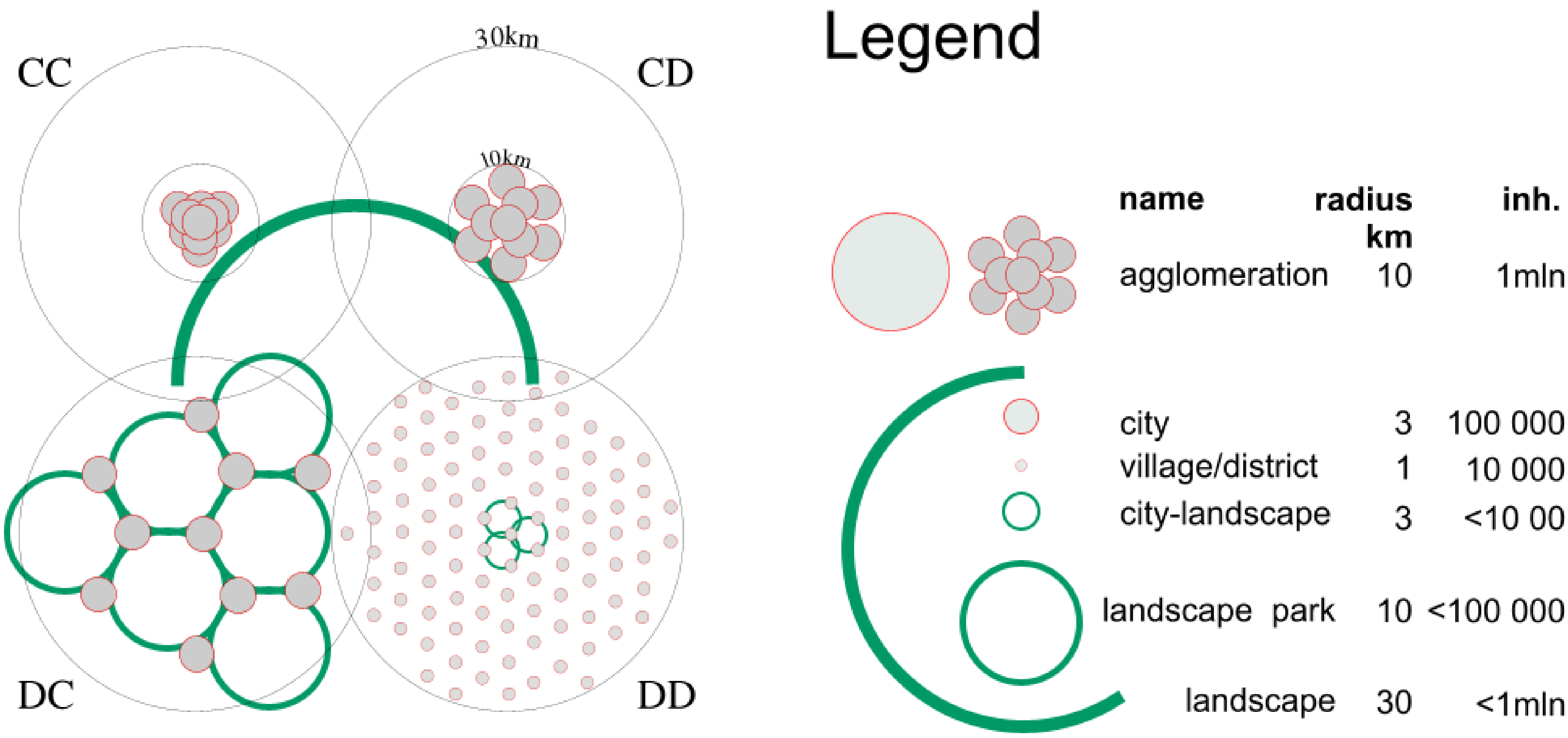


Fig. 10 One million people in two states of distribution on two levels of scale (accords CC, CD, DC and DD).

Fig. 10 shows the use of the words concentration (C) and deconcentration (D) for *processes* into states of more or less accumulation respectively. Applied on design strategies in different levels of scale I would speak about 'accords' (*Fig. 10*).

In Fig. 10 the *regional density* is equal in all cases: approx. 300inh./km^2.
However, in case CC the built-up area is concentrated on both levels ($C_{30km}C_{10km}$) in a high *conurbation density*: (approx. 6000inh./km^2).
In the case CD people are deconcentrated only within a radius of 10km ($C_{30km}D_{10km}$) into an average conurbation density of approx. 3000 inh./km^2.
In the case $D_{30km}C_{10km}$ the inhabitants are concentrated in towns (concentrations of 3km radius within a radius of 10km), but deconcentrated over the region. In the Netherlands since 1966[a] this was called 'Bundled deconcentration' (substantially determining the national urban lay-out in the next decades).
The *urban density* remains approx. 3000 inh./km^2. In the case $D_{30km}D_{10km}$ they are dispersed on both levels.

[a] RPD (1966) *Tweede Nota inzake de Ruimtelijke Ordening in Nederland* ('s-Gravenhage) Rijksplanologische Dienst

1.3 Ecology at different levels of scale

	abiotic	biotic	Dutch university
environmental study	environment	society	
autecology	habitat	population	Wageningen
synecology	biotope	biocoenosis	Nijmegen/Wageningen
cybernetic ecology	abiotic variety	biotic variety	Delft
system dynamics ecology	ecotope	ecological group	Leiden
chaos ecology	opportunities	survival strategies	

Fig. 11 Kinds of ecology in decreasing anthropocentrism

nominal	abiotic	biotic	discipline
kilometres radius			
10000	earth	biomen	environmental ecology
1000	continent	areas of vegetation	
100	geomorfological unit	plant-geographical or flora-districts	landscape ecology
10	landscape	formations	
metres			
1000	hydrological unit, biotope	communities	synecology
100	soil complex, ecotope	ecological groups	systems ecology
10	soil unit and transition	symbiosis	cybernetic ecology
millimetres			
1000	soil structure and ~profile	individual survival strategies	chaos ecology
100	coarse gravel	specialisation	biology
10	gravel	integration	
1	coarse sand 0,21-2	differentiation	
micrometres (μ)			
100	fine sand 50-210	multi-celled organisms	micro biology
10	silt 2-50	single-celled organisms	
1	clay parts < 2	bacteria	
0,1	molecule	virus	

Fig. 12 Ecologies arranged to their primarily supposed range of scale (Jong, 2002)

According to some internationally authoritative text books (Andrewartha[a]; Krebs[b]; Begon[c]) ecology is at least the science of distribution and abundance of organisms. From the PHD thesis of Mechtild de Jong[d] I conclude there are six kinds of ecology in the Netherlands in the previous century, competing for governmental assignments (see *Fig. 11*).
In the present-day Dutch target species policy, supported by the European Birds and Habitat Directive, synecology now is most successful. However, climate change changes its description of biotopes, biocoenoses, the distribution and abundance. Cybernetic ecology focuses on steering mechanisms (separations and connections, structure), their distribution and abundance, suitable for *creating* or restoring living conditions (technical ecology).

However, all ecologies from *Fig. 11* are scientifically meaningful if arranged to the scale of their most appropriate application (see *Fig. 12*). So, microbiology applies on levels of scale and size measurable in micrometers. Chaos ecology stressing individual opportunities and survival strategies or biology stressing cooperation and competition of specialised functions (organisms or organs) applies on levels measurable in millimetres, and so on. *Fig. 12* shows a preliminary distinction of levels of scale and ecologies supposed to be most appropriate at each level of scale.

Scale articulation of other layers

To avoid scale confusion, scale articulation is important in distinguishing different technical (from fine mechanics until regional design) and economic (from micro- until macro economy) layers as well. It is self-evident that nano technology is something else than urbanism, micro-economy is something else than macro-economy. And, the culture of a household is something else than a national culture, municipal administration is something else than national administration. But, how far should scale-articulation of disciplines go, and what about distinctions in time span? It is a pressing question for urban, architectural, industrial and related technical design.

[a] Andrewartha,H.G.(1961)Introduction to the Study of Animal Populations(Chicago)University of Chicago Press
[b] Krebs,C.J.(1994)Ecology The Experimental Analysis of Distribution and Abundance(New York)Harper Collings College Publishers
[c] Begon,M.;J.L.Harper;C.R.Townsend(1996)Ecology(Oxford)Blackwell Science
[d] Jong,M.D.Th.M.d.(2002)Scheidslijnen in het denken over natuurbeheer in Nederland - Een genealogie van vier ecologische theorieën(Delft)DUP Science

1.4 Ten levels of composition to be explored

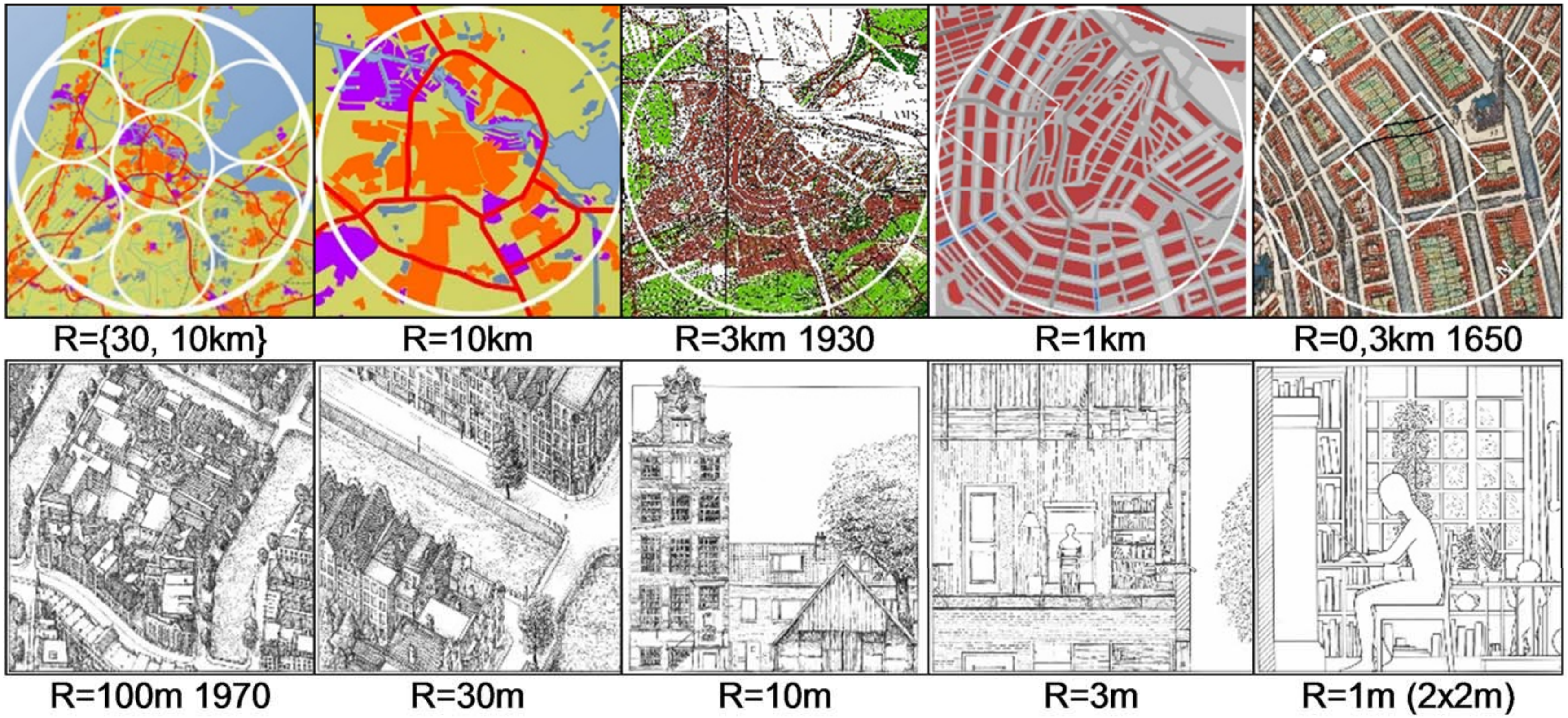


Fig. 13 Ten levels

Look for differences at any level of scale. Distinguish components in the composition. Look for characteristic, connecting, striking and crucial details.

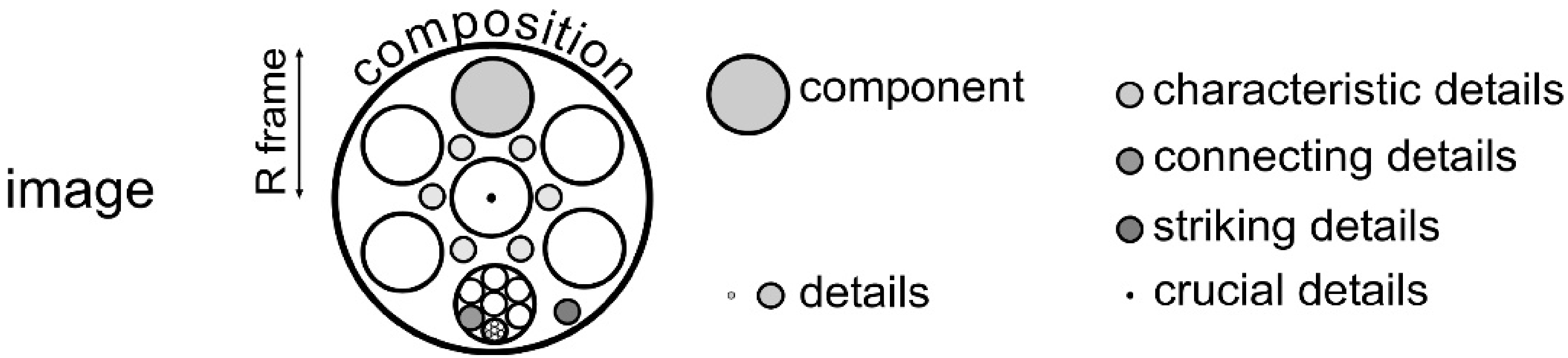


Fig. 14 Composition

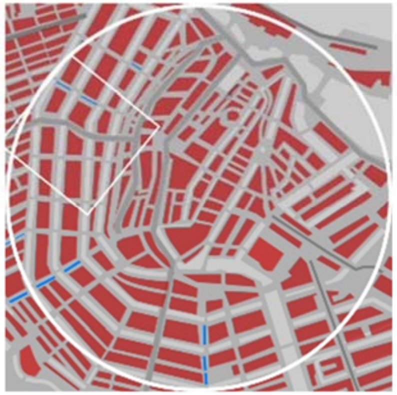
1.5 Name variables with values useful in a legend

Fig. 15 Variables

Fig. 1 Example 6x6km 1930[a]

	0	3km
Ecology_{3km}	lifeless	many species
Housing_{3km}	attached	detached
Agriculture_{3km}	fields	settlements
Technology_{3km}	energy	information
Economy_{3km}	consumption	supply
Meeting_{3km}	home	work
Culture_{3km}	traditional	experimental
Management_{3km}	laissez-faire	initiative
...	...	...

Fig. 2 Example 2x2km



	0	1km
History_{1km}	-300 000 000yr	+10yr
Occupation_{1km}	natural	urban
$\text{Network Density}_{1km}$	0.7km/km^2	7km/km^2
Intensity_{1km}	0hrs/yr	8 760hrs/inh*yr
Pollution_{1km}	clean	contaminated
Routing_{1km}	points	surfaces
Image_{1km}	homogeneous	heterogeneous
...	...	...

1.6 Use dotmaps indicating form, surface *and* quantity

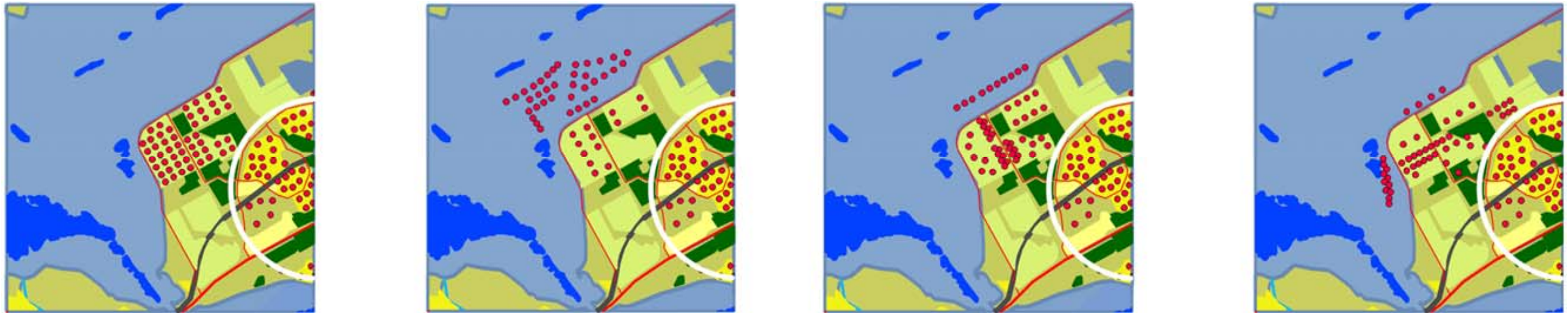
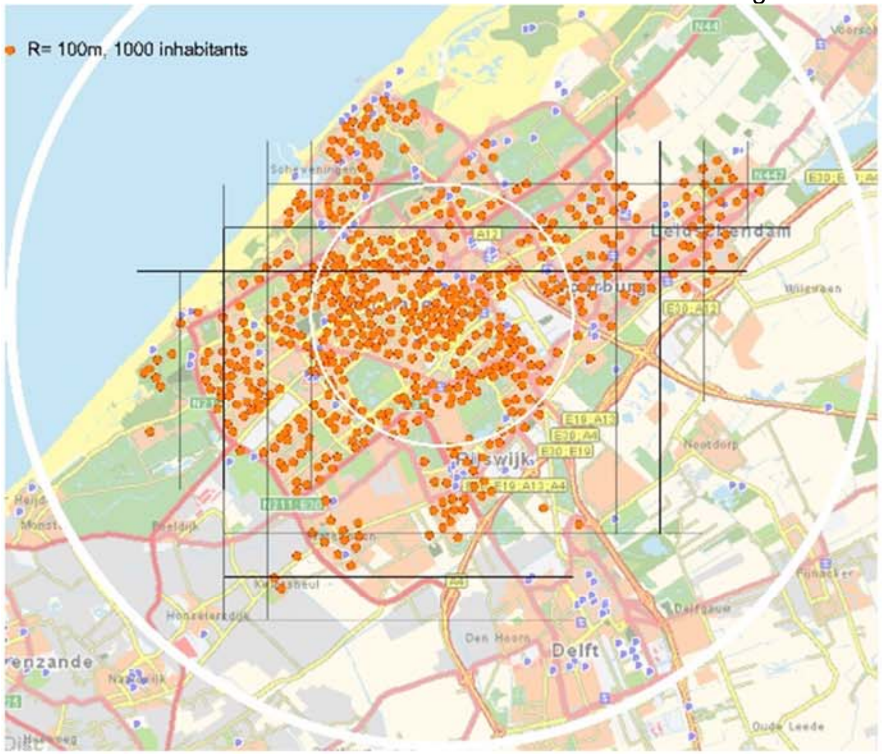
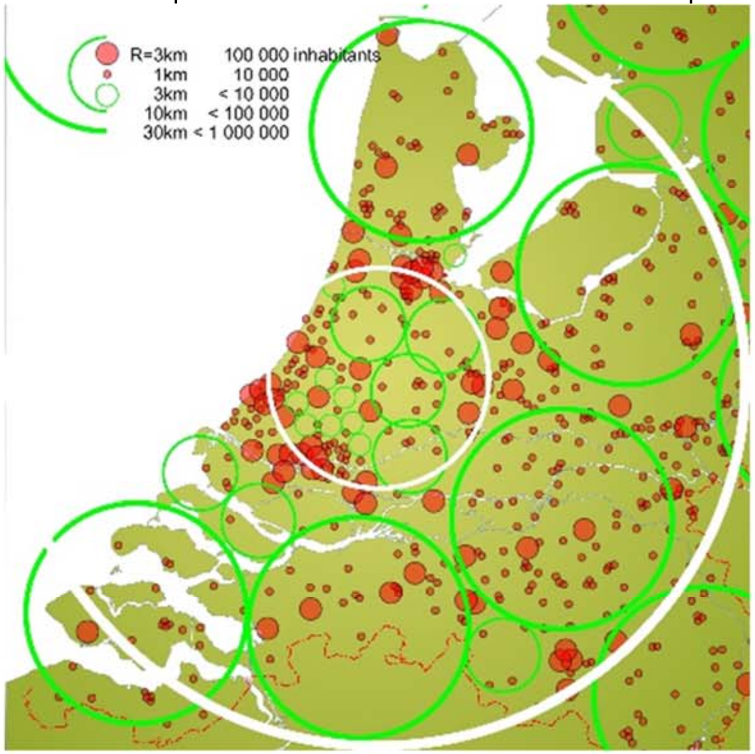


Fig. 16
Dotmaps

Designs for 50 000 inhabitants represented through 50 dots with a radius of 100m each: 50 x 1 000 x 30 m^2 *floor* space distributed differently.
In a larger frame dots of 1km radius represent 10 000 inhabitants x 300m^2 *urban* space.





1.7 The size of dots in a dotmap

‘Nominal measures’: '3' means something in between 1 and 10 (‘10’ something in between 3 and 30, etc.)

Frame	Radius	Surface	Inhabitants	**Dots**	Net dot radius	Floor space	Gross dot radius	Urban space
	m	$\pi R^2/10\,000$ ha	inh	inh/dot	m	m^2	km	ha
Ensemble	100	3	300	1	3	30		
Neighbourhood	300	30	3 000	10	10	300		
District	1 000	300	30 000	100	30	3 000		
Town	3 000	3 000	300 000	1 000	100	30 000	1	30
Conurbation	10 000	30 000	3 000 000	10 000	300	300 000	3	300
Urban region	30 000	300 000	30 000 000	100 000	1 000	3 000 000	10	3 000

300 dots represent 100 inhabitants per hectare

Fig. 17 Nominal sizes of dots

1.8 Some sources

Jong, T. M. d. and D. J. M. v. d. Voordt, Eds. (2002). *Ways to study and research urban, architectural and technical design* (Delft) Delft University Press

Jong, Taeke M. de (2012) Diversifying environments through design (Delft) TUD academic PhD thesis

Jong, T.M.d.; Dekker, J.N.M.; Posthoorn, R. [eds.] (2007) *Landscape ecology in the Dutch context: nature, town and infrastructure* (Zeist) KNNV-uitgeverij

Morrison, P.; Morrison, P. (1982) *The powers of ten* (New York) Scientific American Books, Inc.

RPD (1966) *Tweede Nota inzake de Ruimtelijke Ordening in Nederland* ('s-Gravenhage) Rijksplanologische Dienst

2 Exercise 1, R=100m ensemble form

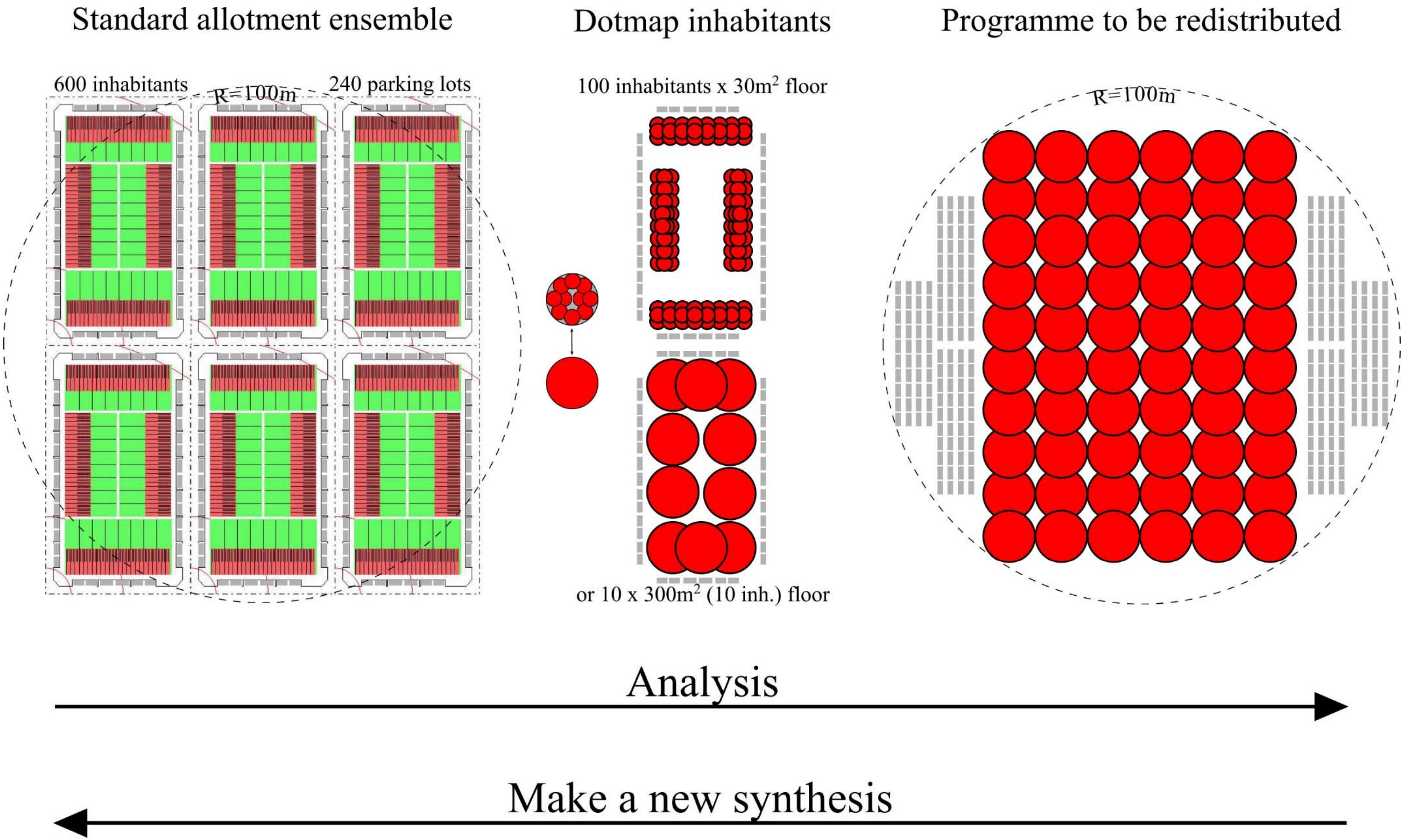


Fig. 18 Exercise 1, R=100m ensemble form

3 Urban islands in a network

This chapter compares the impact of design operations on the size and form of an urban island. Public pavement is expensive.
It has to be paid from the lots a municipality can sell, surrounded by that public space (municipal land development).
The housing allotments below, include a substantial area of expensive parking spaces as well.
They are made by the computer programme Standaardverkaveling.exe.[a] keeping some limitations for comparability:

1. centre lines of surrounding roads on a multiple of 30m (preliminary main grid);
2. roadways everywhere 6m wide, not needed everywhere, but including a reservation for wider roads of higher level in the network elsewhere;
3. parking standard everywhere more than 1 parking place per dwelling along the road, starting at least 5m from road corners, only drawn along roads North and South (indicated as ‘N’ and ‘S’[b]) in the drawing of the urban island (an urban ensemble completely surrounded by roads);
4. sidewalks seldom smaller than 2m wide;
5. no front gardens yet;
6. dwellings 5x10m, 2 floors high with roof timbers of 3m on lots of 100m^2 housing 2.25 inhabitants in rows not exceeding 40m to avoid extra dilatation;
7. path around the back 1m wide;
8. green areas are drawn East and South filling up the main 30m grid. They show the space saved by design operations, but can be used to enlarge the lots for sale as well, diminishing public space (pavement + green).

These starting points can be changed easily in Standaardverkaveling.exe. However, for the time being they are kept constant below to study the change in allotment performance by design transformations.

[a] Try it yourself, the programme is downloadable from http://team.bk.tudelft.nl > Publications 2003
[b] The North an South sides of an urban island are best suitable for parking for two reasons. Their surface enlarges the North-South distance between outer walls of dwellings, giving more acces to sunlight, and the shadow of North walls is welcome to parked cars.

3.1 Mirroring the smallest urban island

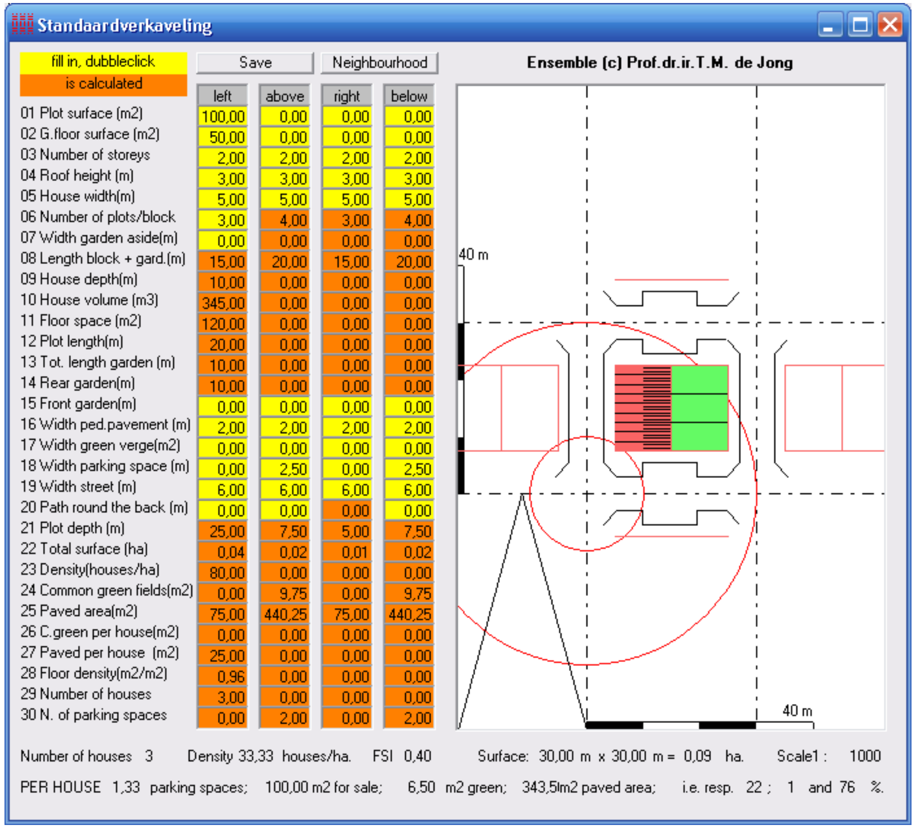


Fig. 19 30x30m

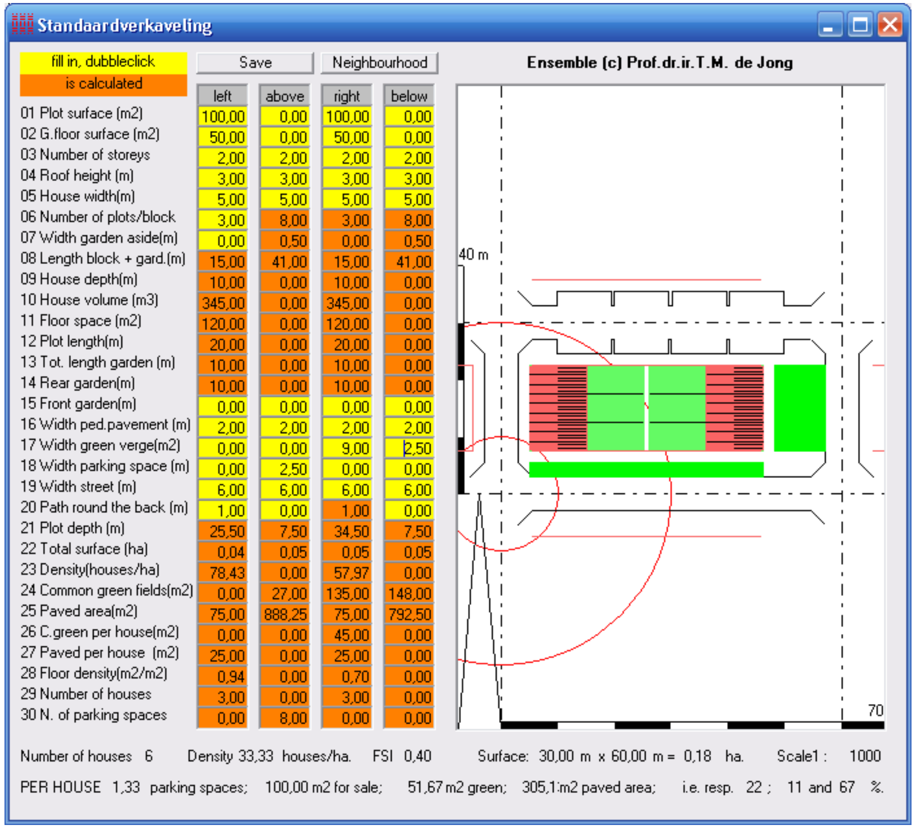


Fig. 20 30x60m W-E mirroring

The smallest urban island token in consideration here has a grid measure of 30x30m. The consequence of small urban islands is an excessive surface of public pavement (here 76%!), leaving relatively little for sale (here maximally 22%) paying for that public space.

The effect of a first design transformation, W-E mirroring, elongates the urban island reducing public pavement (here into 67%). The gained surface produces a green margin of 9m drawn East and 2.50m drawn South. Now, at that length, one side with parking places is enough to reach more than 1 parking place per dwelling.
The shadow of the N side is best suitable for parking. Now, W and E roads are used for entrance to houses at both sides and back gardens get more privacy. The lots for sale differentiate in morning~ and evening sun lovers.

In *Fig. 20* greenery is drawn East to get an idea of road profiles and crossings without greenery in the corner left below in the drawing, where circles are drawn with a radius of 10 and 30m. For children in the afternoon and in the summer evening green area can better be designed in the West as well to have sunny playgrounds. That does not change the counted figures left and below of the drawing.

3.2 Taking sun into account

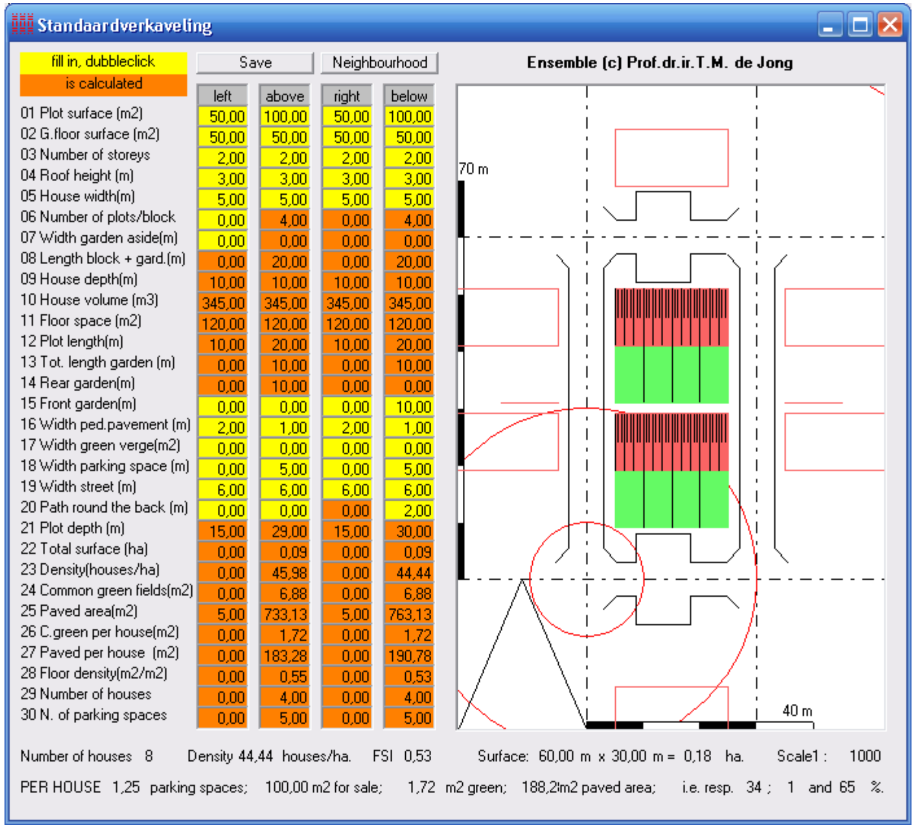


Fig. 21 60x30m N-S Turning and multiplying

N-S turning and repeating gives both blocks South gardens. Now, the short sides of the urban island are used for parking, forcing cross-parking to reach >1 parking places per dwelling. The path round the back is enlarged at the expense of sidewalks to give proper front access to the Southern block.

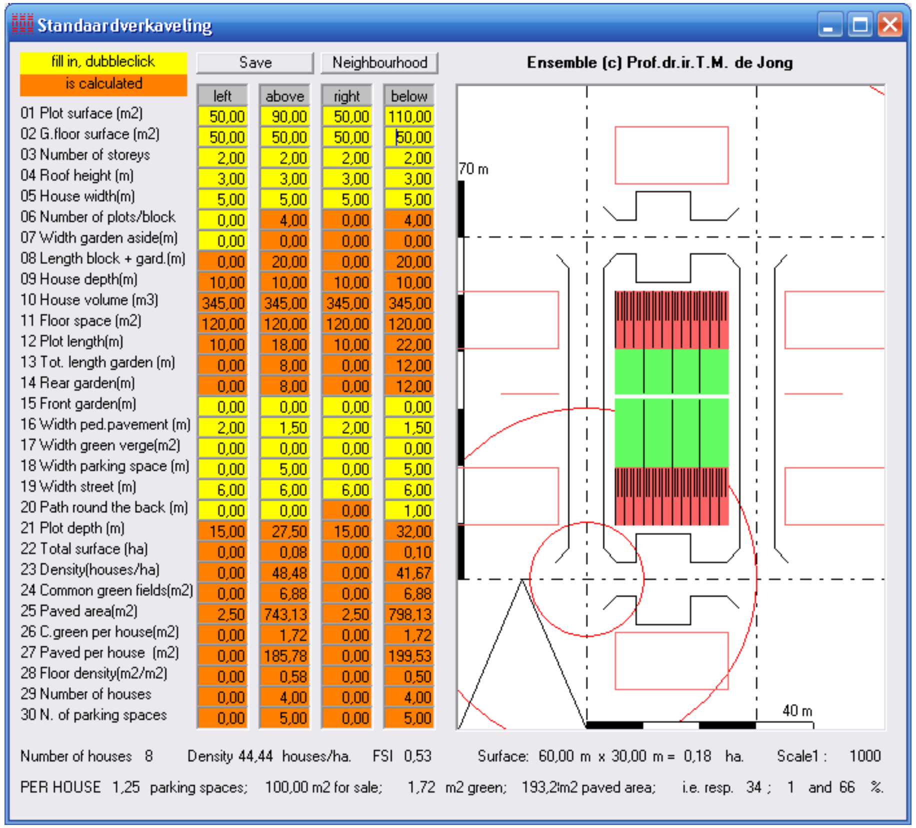


Fig. 22 60x30m N-S mirroring

N-S mirroring introduces North gardens, drawn longer here to get a partly sunny view on the N garden still. It differentiates the lots for sale in size and suggests a different dwelling type for sun lovers with south gardens and artistic life style with Northern light rooms such as studios.

3.3 Elongating

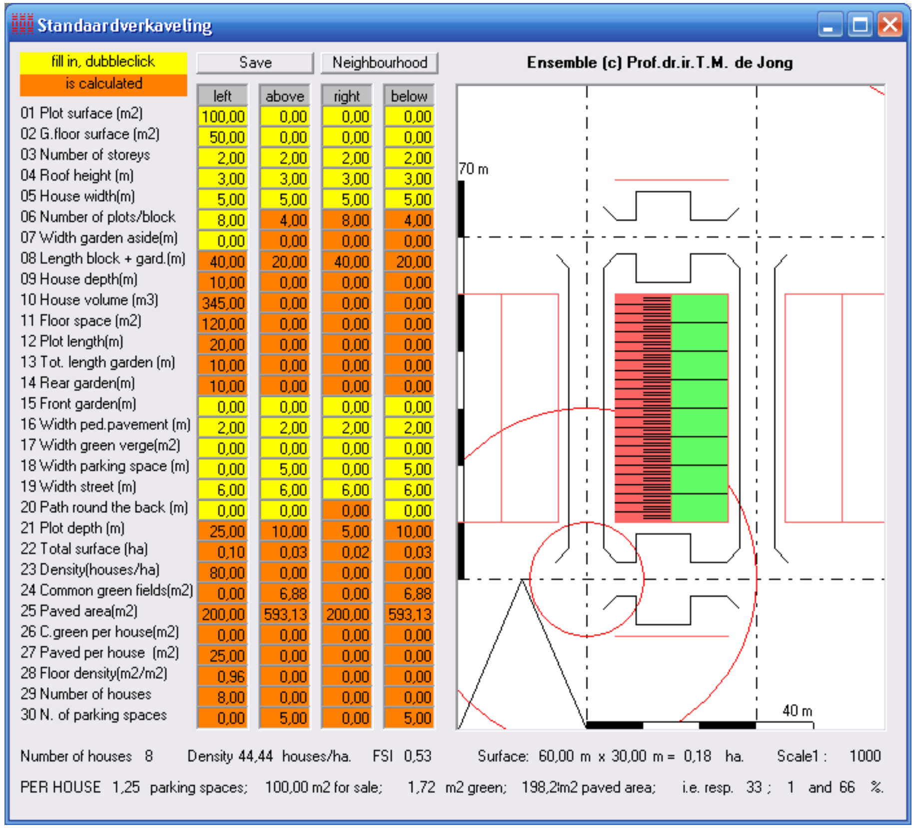


Fig. 23 60x30m elongating

To reach the same capacity of *Fig. 22* by one sided elongating avoids the path round the back utilizing the side walk, giving back a proper size to the sidewalks N and S. East gardens are suitable for people who such as morning sun in the garden and in the sleeping room. Pavement is still 66%.

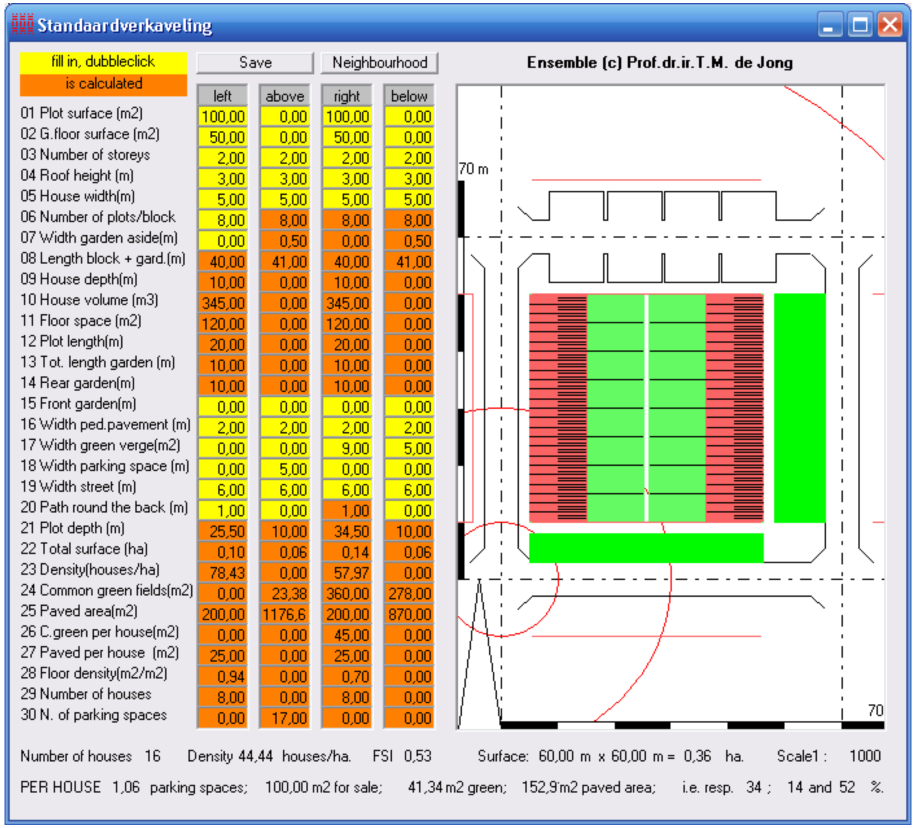
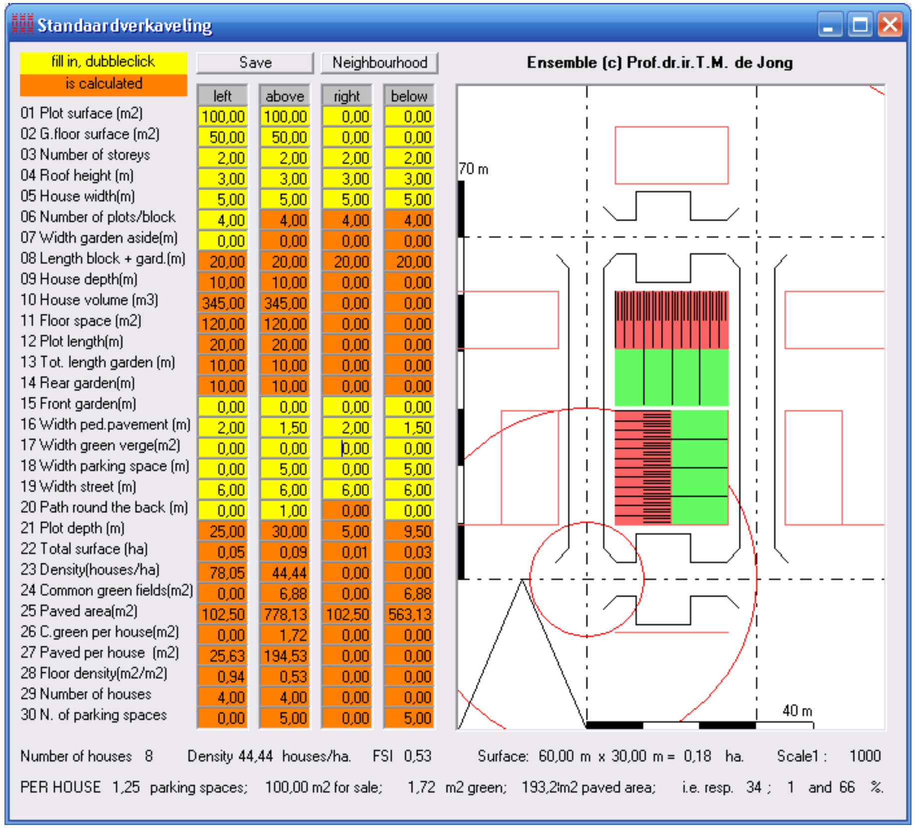


Fig. 24 60x60m mirroring

Mirroring gives evening people a chance as well and both gardens more privacy. It differentiates use and plantation. The enlargement of the urban island again reduces the amount of pavement, now into 52% in favour of the margins possibly used as green area: 9m East and 5m South.

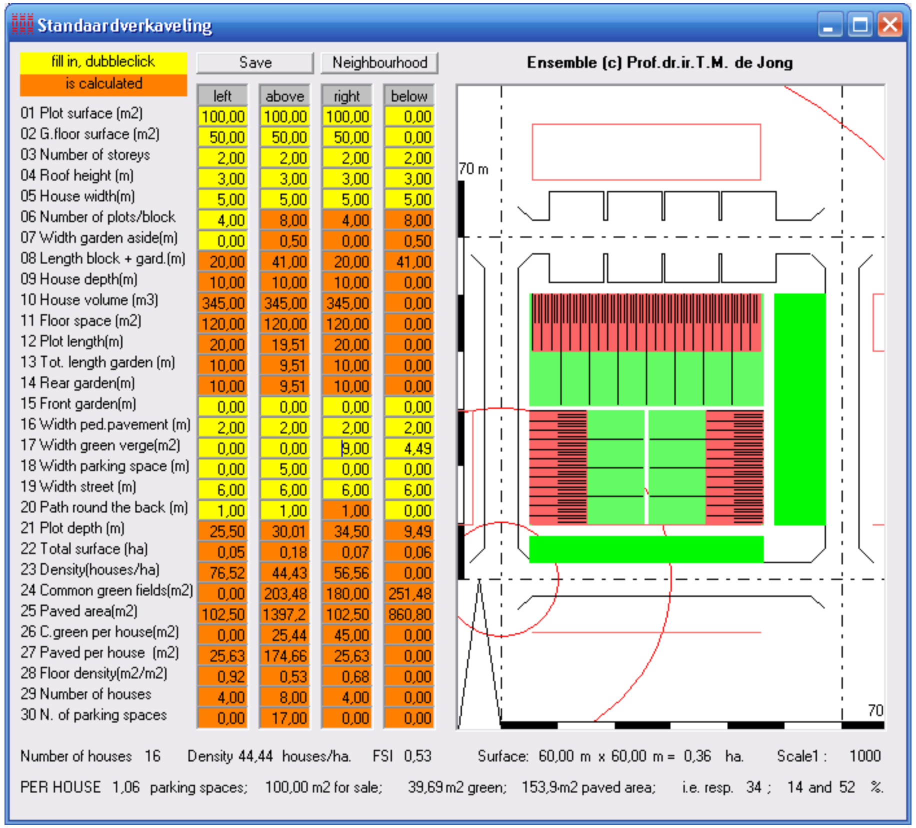
3.4 L-shape and U-shape



	left	above	right	below
01 Plot surface (m2)	100,00	100,00	0,00	0,00
02 G.floor surface (m2)	50,00	50,00	0,00	0,00
03 Number of storeys	2,00	2,00	2,00	2,00
04 Roof height (m)	3,00	3,00	3,00	3,00
05 House width(m)	5,00	5,00	5,00	5,00
06 Number of plots/block	4,00	4,00	4,00	4,00
07 Width garden aside(m)	0,00	0,00	0,00	0,00
08 Length block + gard.(m)	20,00	20,00	20,00	20,00
09 House depth(m)	10,00	10,00	0,00	0,00
10 House volume (m3)	345,00	345,00	0,00	0,00
11 Floor space (m2)	120,00	120,00	0,00	0,00
12 Plot length(m)	20,00	20,00	0,00	0,00
13 Tot. length garden (m)	10,00	10,00	0,00	0,00
14 Rear garden(m)	10,00	10,00	0,00	0,00
15 Front garden(m)	0,00	0,00	0,00	0,00
16 Width ped.pavement (m)	2,00	1,50	2,00	1,50
17 Width green verge(m2)	0,00	0,00	0,00	0,00
18 Width parking space (m)	0,00	5,00	0,00	5,00
19 Width street (m)	6,00	6,00	6,00	6,00
20 Path round the back (m)	0,00	1,00	0,00	0,00
21 Plot depth (m)	25,00	30,00	5,00	9,50
22 Total surface (ha)	0,05	0,09	0,01	0,03
23 Density(houses/ha)	78,05	44,44	0,00	0,00
24 Common green fields(m2)	0,00	6,88	0,00	6,88
25 Paved area(m2)	102,50	778,13	102,50	563,13
26 C.green per house(m2)	0,00	1,72	0,00	0,00
27 Paved per house (m2)	25,63	194,53	0,00	0,00
28 Floor density(m2/m2)	0,94	0,53	0,00	0,00
29 Number of houses	4,00	4,00	0,00	0,00
30 N. of parking spaces	0,00	5,00	0,00	5,00

Fig. 25 60x30m L-shape

Introducing perpendicular blocks provides streetcorners with front entrances in 2 directions. That gives the beginning of an urban look and safety by private control of public space on both roads involved. To improve that effect design solutions for corners, not implemented here, would be nice. Such solutions will struggle with smaller or no gardens in the corner.



	left	above	right	below
01 Plot surface (m2)	100,00	100,00	100,00	0,00
02 G.floor surface (m2)	50,00	50,00	50,00	0,00
03 Number of storeys	2,00	2,00	2,00	2,00
04 Roof height (m)	3,00	3,00	3,00	3,00
05 House width(m)	5,00	5,00	5,00	5,00
06 Number of plots/block	4,00	8,00	4,00	8,00
07 Width garden aside(m)	0,00	0,50	0,00	0,50
08 Length block + gard.(m)	20,00	41,00	20,00	41,00
09 House depth(m)	10,00	10,00	10,00	0,00
10 House volume (m3)	345,00	345,00	345,00	0,00
11 Floor space (m2)	120,00	120,00	120,00	0,00
12 Plot length(m)	20,00	19,51	20,00	0,00
13 Tot. length garden (m)	10,00	9,51	10,00	0,00
14 Rear garden(m)	10,00	9,51	10,00	0,00
15 Front garden(m)	0,00	0,00	0,00	0,00
16 Width ped.pavement (m)	2,00	2,00	2,00	2,00
17 Width green verge(m2)	0,00	0,00	9,00	4,49
18 Width parking space (m)	0,00	5,00	0,00	0,00
19 Width street (m)	6,00	6,00	6,00	6,00
20 Path round the back (m)	1,00	1,00	1,00	0,00
21 Plot depth (m)	25,50	30,01	34,50	9,49
22 Total surface (ha)	0,05	0,18	0,07	0,06
23 Density(houses/ha)	76,52	44,43	56,56	0,00
24 Common green fields(m2)	0,00	203,48	180,00	251,48
25 Paved area(m2)	102,50	1397,2	102,50	860,80
26 C.green per house(m2)	0,00	25,44	45,00	0,00
27 Paved per house (m2)	25,63	174,66	25,63	0,00
28 Floor density(m2/m2)	0,92	0,53	0,68	0,00
29 Number of houses	4,00	8,00	4,00	0,00
30 N. of parking spaces	0,00	17,00	0,00	0,00

Fig. 26 60x60m U-shape

Mirroring the L-shape produces U-shaped allotments with one open side, here avoiding North gardens. It has the same advantages as previous mirroring transformations, in this case reducing pavement from 66% in *Fig. 25* into 52% and introducing green margins of 9m East and 5m South. S gardens go 0.5m around the back now, giving space for ivy-covered side façades avoiding grafitti.

3.5 Closed urban islands

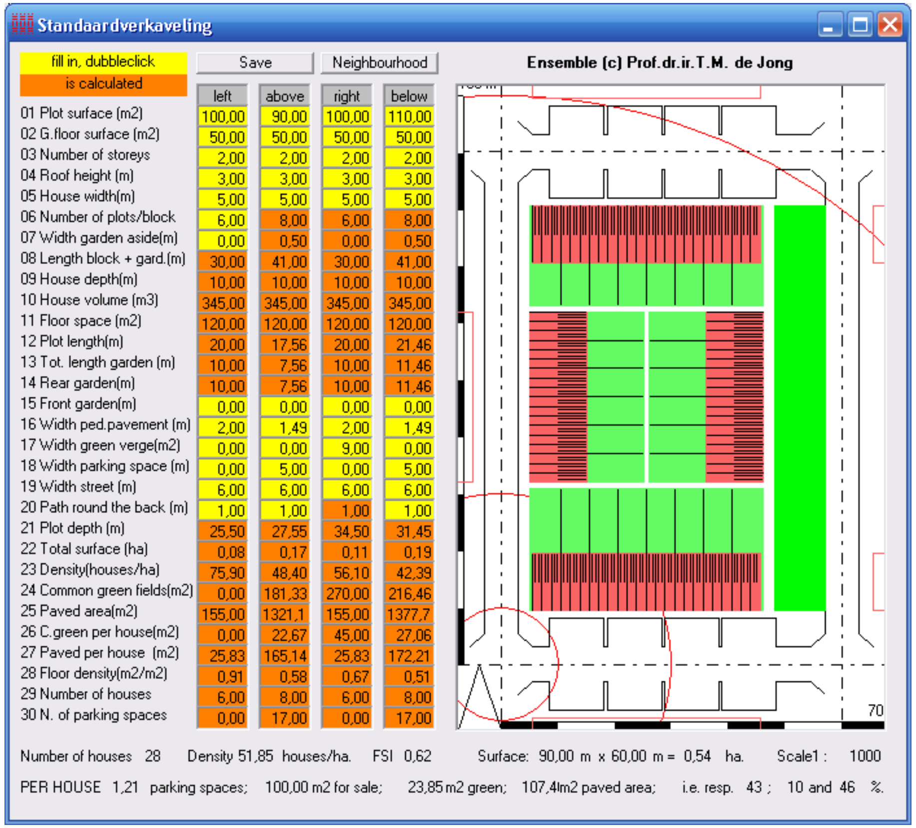


Fig. 27 90x60m Closing

Closing the urban island with front entrances on every surrounding street produces a usual allotment type of 90m length, leaving a 9m green margin East to fill the urban grid of multiples by 30m. Limiting parking places to N and S urges cross parking at both sides to have more than 1 parking place per dwelling leaving little space for sidewalks.

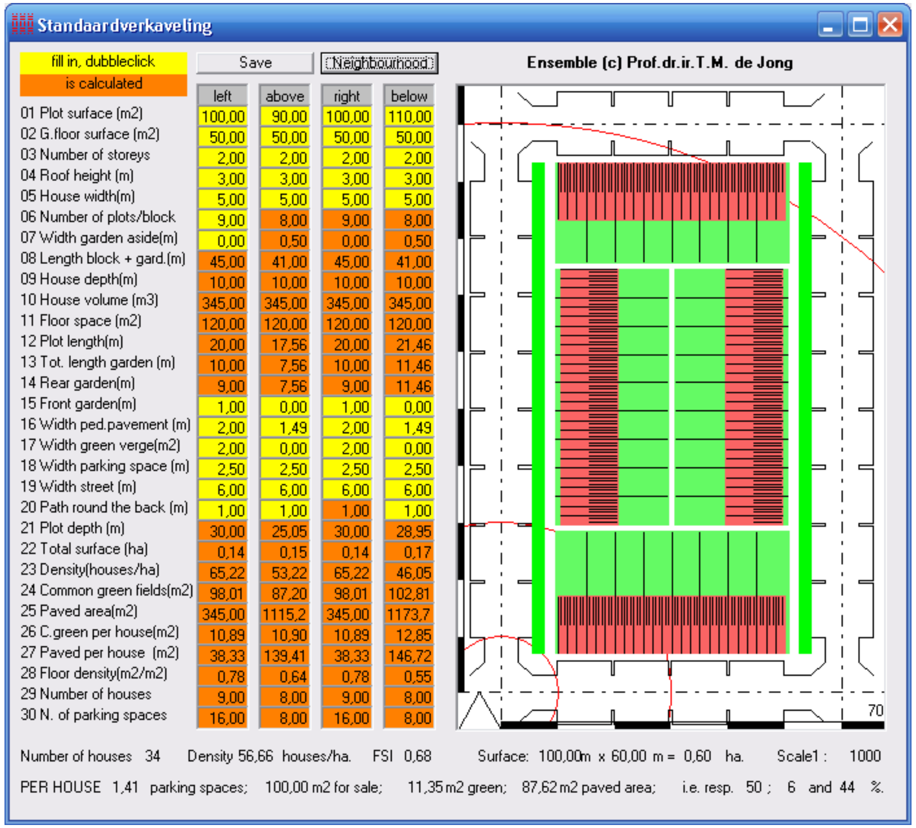


Fig. 28 Elongating and adapting 100x60m

N-S elongating to 100m is easy by adding 2 houses West and East. However, the shortage of parking places then forces parking at all sides. By giving up cross parking N and S, there is space for 6 extra houses in total. The reduction of pavement is 2% only, but the number of parking places is 1.4 per dwelling. This time the green margin is distributed W and E to make trees possible.

In *Fig. 28* we leave the starting points of page 1 behind and start to look at a higher level. On that level new spaces for mobility are needed. By the way, the elongated blocks of *Fig. 28* exceed 40m and need an extra dilatation, which is expensive.

3.6 A neighbourhood

If we multiply the module (**M**) of *Fig. 28* (100x60**m**) 5 times E-W and 3 times N-S (*Fig. 29*) we reach the mesh width (300mx300m) for neighbourhood roads (30m width of pavement). We now have 15 modules together surrounded by larger neighbourhood roads requiring extra space.
These ‘neighbourhood islands’ we call ‘neighbourhood quarters’, because 4 of them make a neighbourhood.

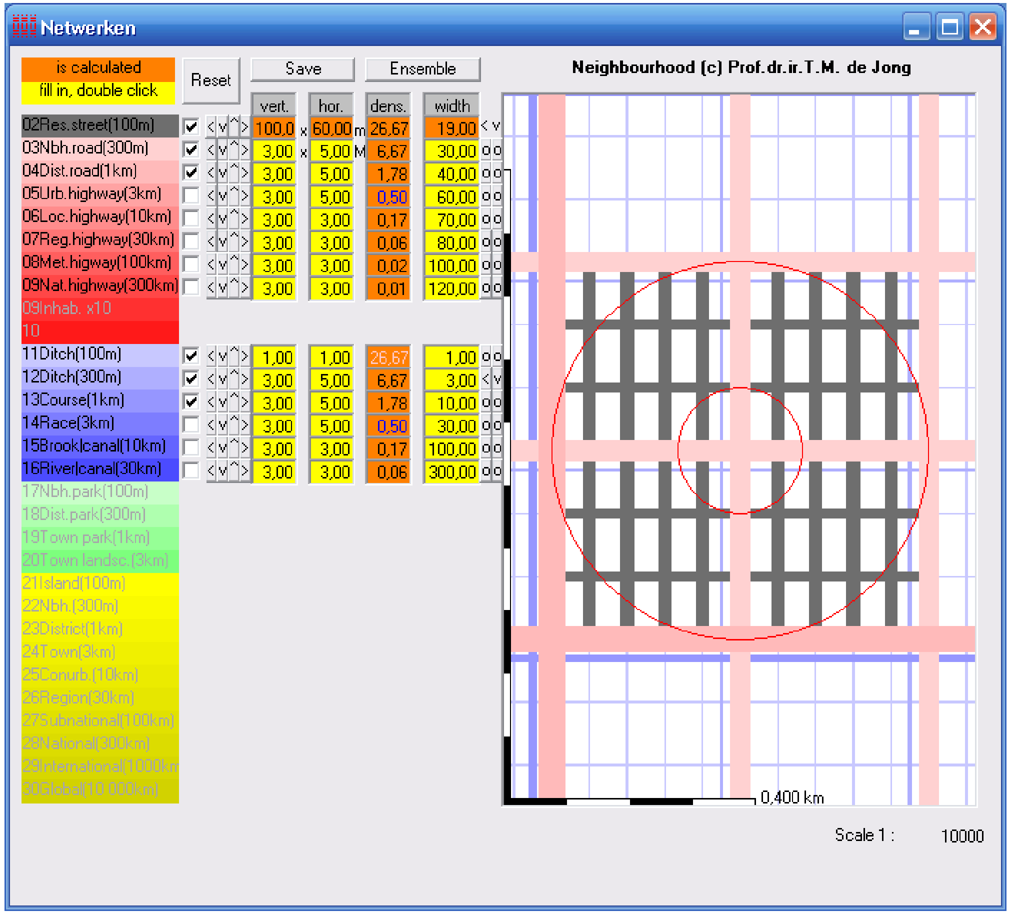


Fig. 29 A neighbourhood, multiplying Fig. 28

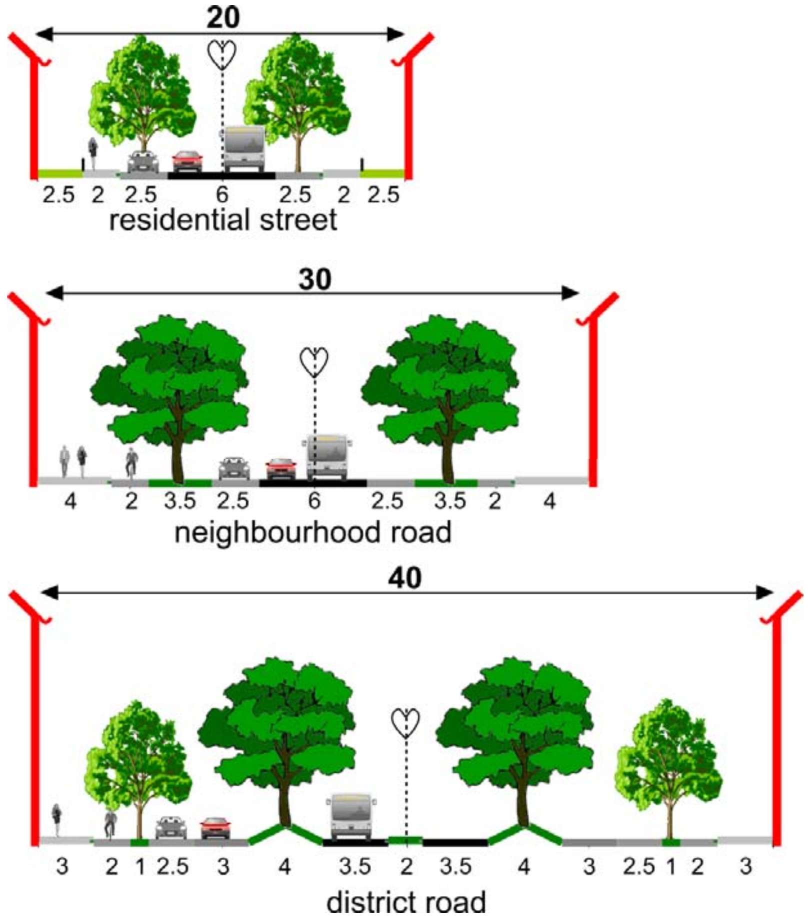


Fig. 30 Profiles

Suppose every urban island contains some 75 people going out 4 times a day of which 3 by car. Suppose 1/3 of the car trips the driver is accompanied by a passenger, 1 trip is done by walking or cycling.[c] So, a block produces 75x2x2≅300 car movements per day, because they are not only going out, they are coming back as well. That normally means 30 car movements per hour per island. Let them use two of four streets around the block. So, a residential street has some 15 car movements per hour and much more in peak hours. And there are visitors as well.

The neighbourhood of *Fig. 29* does not only need extra space for pavement of neighbourhood roads, but also for neighbourhood facilities such as green, water, a school, shops and offices. Moreover, it has to accommodate facilities of higher level such as district roads (40m wide). They produce car movements as well, but in the same time they make part of the modules involved unsuitable as residential area. Moreover, not all modules will reach 56 dwellings per ha or a floor space ratio (FSI) of 68% reached in *Fig. 28*, because many lots are larger than 100m^2. Suppose there are 1000 inhabitants per neighbourhood, it produces 1000x2x2≅4000 car movements per day using half of the neighbourhood roads available. So, a neighbourhood road has some 2000 car movements per day or 200 per hour and much more in peak hours. And there are visitors as well.

[c] CBS …

4 Exercise 2, R=300m neighbourhood form

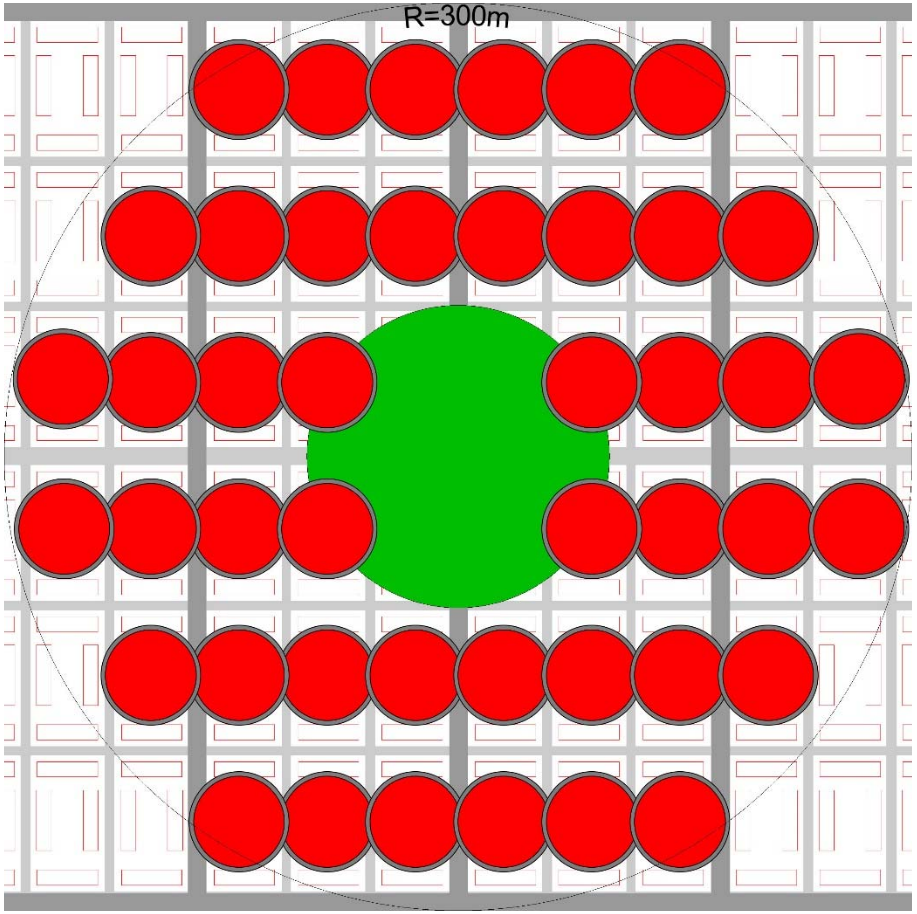


Fig. 31 Exercise 2, R=300m neighbourhood form

Redistribute 44 dots of 100 inhabitants (r_1=30m_{floor}+3$m_{parking}$).

Replace one dot r_1 as neighbourhood centre.

Any dot r_1=30m can be split up into 10 dots of 10 inhabitants (r_2=10m).

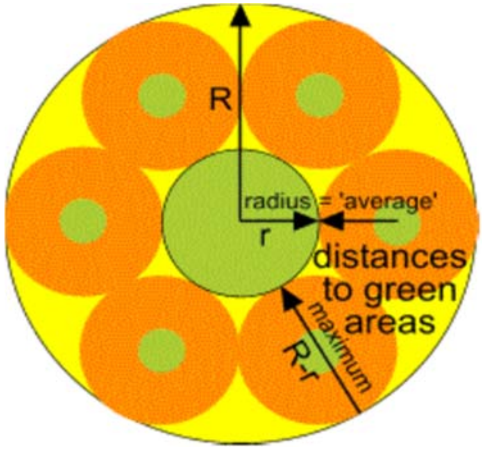
Add a neighbourhood park r_3=100m.

Widen 5 residential roads (5 x 600m long and 6m width) into neighbourhood roads (12m width).

Scale 1:5000

Surfaces can be calculated roughly as 3 x R^2 or 3 x r^2 (m^2):
R=300m means 3 x 90 000m^2 = 270 000m^2 or roughly 30ha,
r_3=100m means 3 x 10 000m^2 = 30 000m_2 or roughly 3ha,
r_1=30m means 2700m^2 or roughly 0,3ha.

5 Standard Green Structure



In order to compare standards of green surface and their distance to the inhabitants, both are expressed in a radius.
The surface is expressed in the radius of a circle with the same surface = π times radius^2.
The distance from the boundary of the urban area involved (radius R) to the boundary of the green surface (radius r) is the maximum distance R-r.
The 'average' distance is supposed to be half R-r (depending on different densities).
But, greenery standards expressed in m^2 per inhabitant are still incomparable. They suppose densities within R.
A 'Standard Green Structure' recalculates densities into a radius for comparison.

Fig. 32 Standard Green Structure

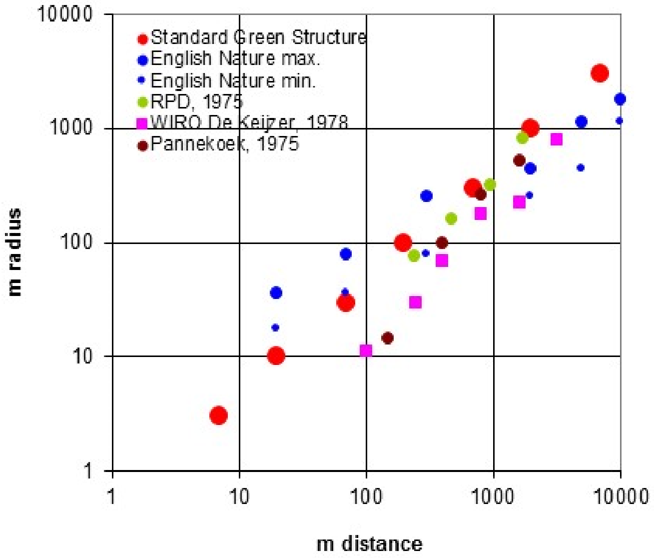


Fig. 33 Different standards

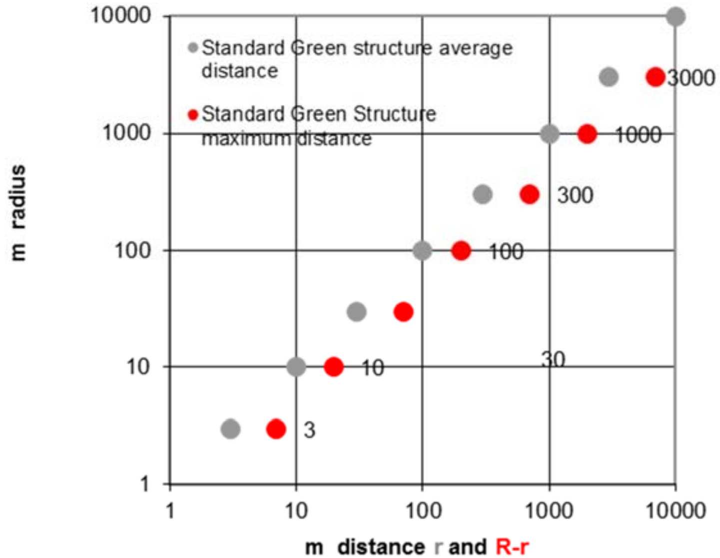


Fig. 34 Shifting from average into maximum distance

If we take the average distance to the green area the same as its radius, then we call that distribution of green areas over these levels 'Standard Green Structure'. However, other standards are often based on the maximum distance. So, for comparison we have to shift the dots half R-r to the right (red dots). In the figure left we now can observe that 'English Nature max.' proposes larger green areas at a distance below 1000m and smaller areas further away. The figures are calculated in Fig. 35.

nominal radius r(m)		within R(m)	max. distance m	Gross density inh./ha	Green land use m^2/inh.	# number of green areas
10000	landscape park	30000	20000			
3000	urban landscape	10000	7000	32	28	1
1000	town park	3000	2000	59	19	6
300	district park	1000	700	88	10	36
100	neighbourhood park	300	200	164	7	216
30	small public green	100	70	246	4	1296
10	common garden	30	20	455	2	7776
3	balcony/garden	10	7	682	1	46656
					72	

Fig. 35 Standards green surface and distance

Densities are added according to the Standard Green Structure.

6 Exercise 3, R=1km district

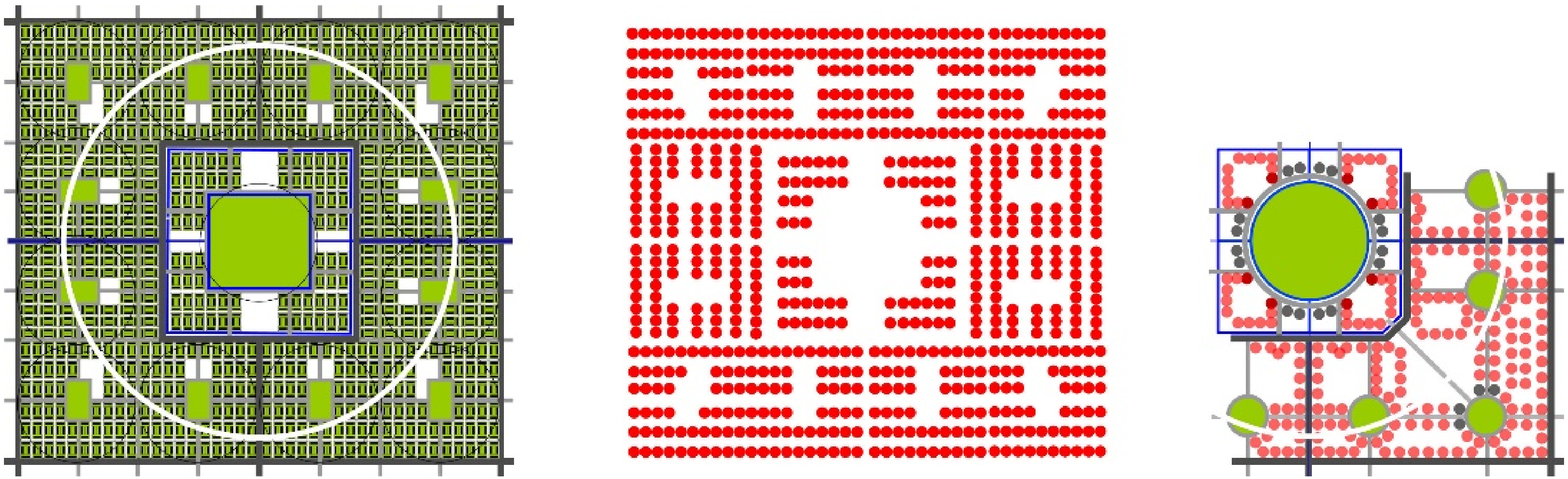
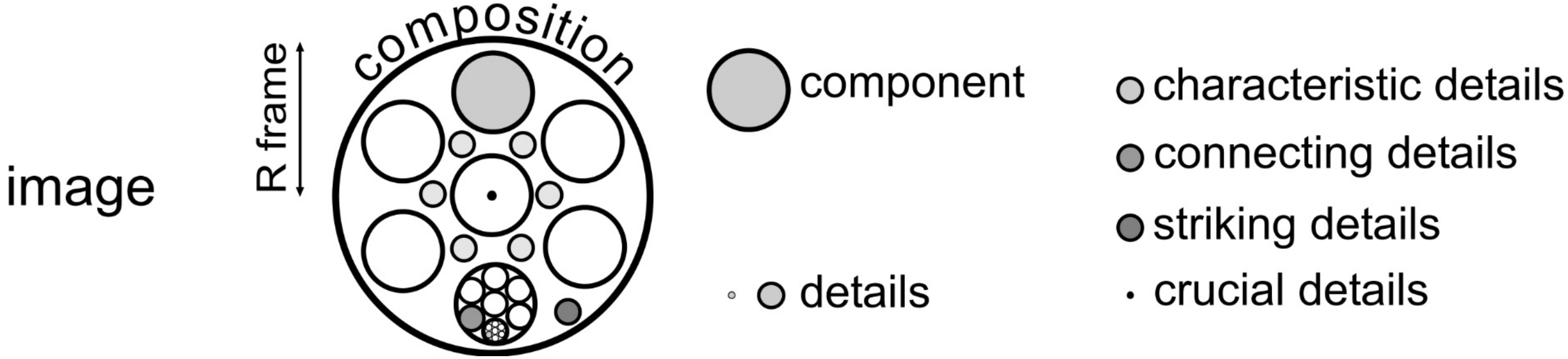


Fig. 36 Exercise 3, R=1km district

Redraw the next component of R=1km (70 000inh.), r_1=30m (100inh.), r_2=100m green, r_3=300m green.

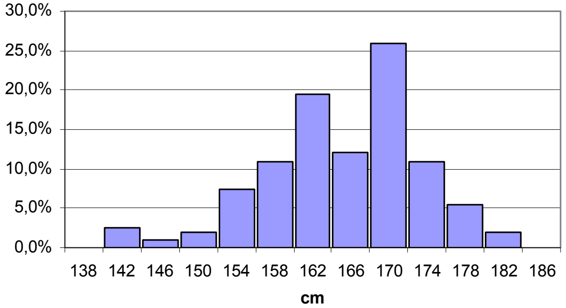


Equal to Fig. 14 Composition on page 9

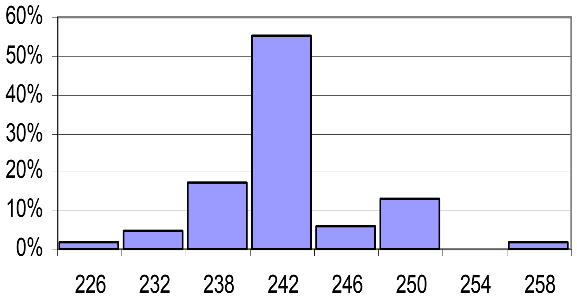
7 Mobility space

7.1 The street

Any kind of traffic has characteristic measures. Design measures are deduced from the distribution of actual measures (see *Fig. 37*).
Normally the 5% largest measures are left aside for design.



A.S.V.V(2004) p. 77-78
Fig. 37 Dispersion of real car widths in 2004; 95% < 1.80m



ANWB-Verkeerskunde (1980) nummers 6 en 10
Fig. 38 Width of parking places in 1980

However, these measures can change in time and occasionally not apply. So, you need margins. For example, in *Fig. 38* the parking space for a car is much wider than the width of an average car, because at parking places people have to step in and out at both sides. Moreover, taking the largest turning circle of cars you need space to turn in, not only in width, but also in length. So, a street with cross parking should be wider than the 95 percentile of car lengths (5m). That is why car parking requires a quarter of pavement in the urban surface.

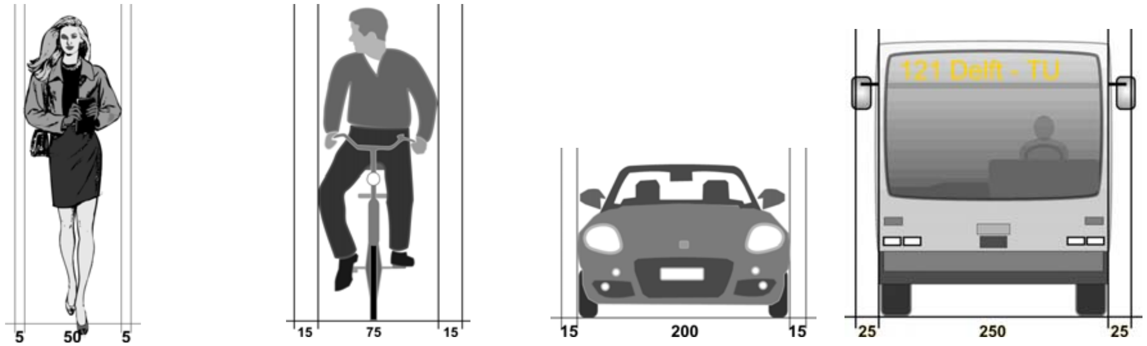
Fig. 39   1.20m for a pedestrian

Fig. 40   2.40m for a parked car

In The Netherlands normal paving-stones used on side walks are an unit of measure easy for reference if you are walking on the street or taking photographs (0.30x0.30m). From *Fig. 39* you can learn a kerb is half a tile wide and for walking you need at least two tiles if you don't have luggage. From *Fig. 40* you can learn that the parking spaces of our Faculty are 2.40m wide.

7.1.1 A residential street

In a residential street occasionally you need space for larger vehicles such as moving vans, ambulances, vans of police, fire department or service vehicles, often necessary in residential areas.
Pedestrians carrying luggage or pushing baby buggies need 1.5x more space than without such loads as shown in *Fig. 41*.



Pedestrian	*Cyclist*	*Car 30 km/h*	*Bus 50 km/h*
50 + 2 x 5 ≅ 60 cm	*75 + 2 x 15 ≅ 100 cm*	*200 + 2 x 15 ≅ 230 cm*	*255 +2 x 25≅ 300 cm*

Fig. 41 Primary profile spaces needed

A usual residential street gives way to two loaded pedestrians walking both ways (for instance one with luggage and one with a baby buggy passing each other, say 2m paved surface with 6 tiles of 0.30m + a 0.15m kerb + 0.05m margin) as sidewalks. On the roadway two vans should be able to drive both ways with a margin because they swing a little when they move (say 6m). If you draw sidewalks at both sides the pavement will count 2+6+2=10m. That is easy to remember for residential streets without parking places (as in *Fig. 38*). With parking places and gardens it could be =20m (*Fig. 42*), but we do not yet take them into account. We will do that at page 1 and further.

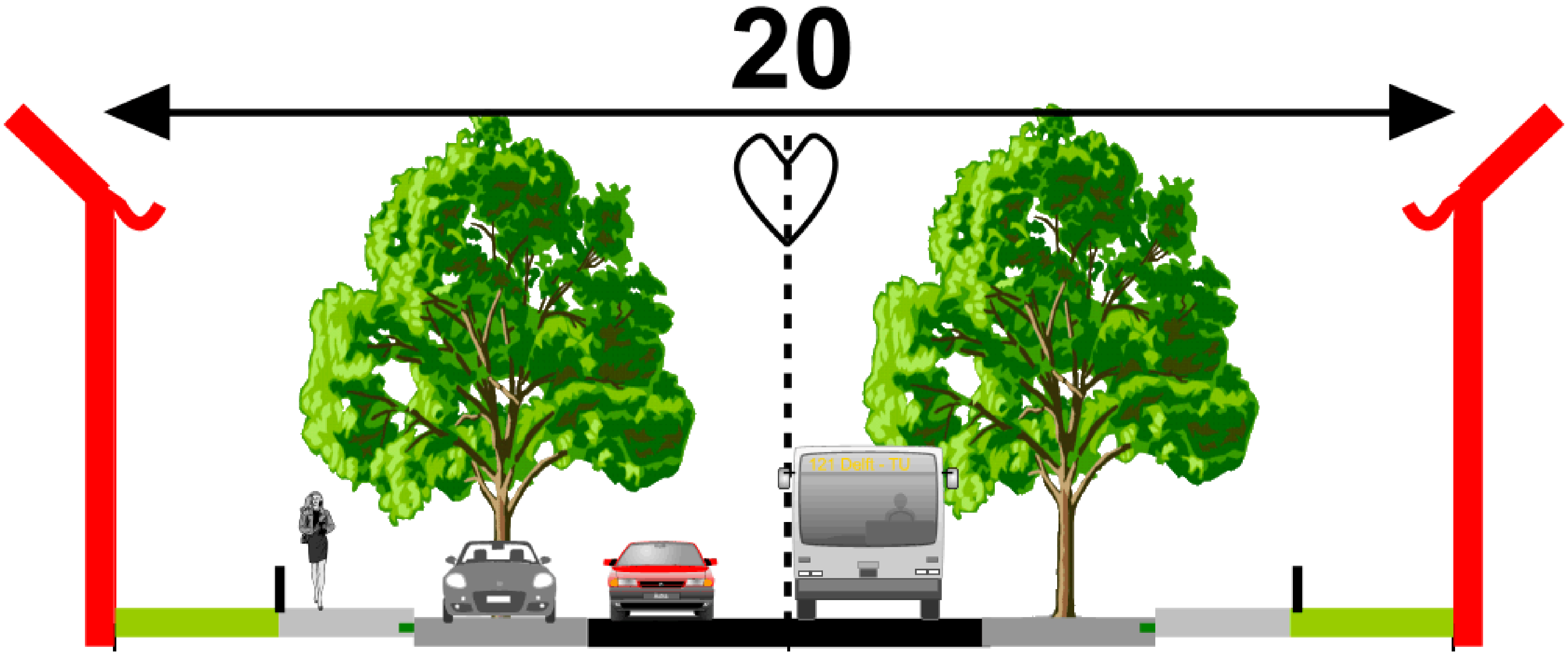


Fig. 42 A residential street (2.5 + 2 + 2.5 + 6 + 2.5 + 2 + 2.5 = 20m)[a]

However, you do not need that width of pavement all along the road. People can wait when they see someone approaching from the other side. Pavement can locally be narrower (for example 1+3+1=5m), slowing down the cars or just wider (for example 3+6+3=12m) to make more speed or to give children and pedestrians more space on the sidewalks. A roadway of 6m width, has two ‘lanes’ for both directions. You can remove one locally. You can halve the sidewalks locally as well, but do not remove at one side one of them unnecessarily, otherwise pedestrians have to cross the road. If you do not have to give way to large cars or speeds higher than 30km/h the lane can get the minimum width of 2.30m. For even lower velocities without large vehicles the pavement is suitable for mixed use with pedestrians, say 1.90+0.60≅2.50m.

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[a] Simple quick profile drawings can be generated by Excel with a worksheet http://team.bk.tudelft.nl/Databases/Databases.htm > Wegprofielen maken met excel .xls

7.1.2 Space for speed

For higher design velocities you should take more margin for swinging. For normal cars at 30km/h you need 2.25m per lane, and 0.30m extra is no luxury. But at 50km/h you need 2.75m per lane, and at 70km/h 3.25m.[b] Along walls or obstacles, drivers keep even more distance (obstacle fright) to prevent damage.

Drivers also keep distance to cars ahead. The higher the velocity, the more distance they will keep. Above 30km/h that growing distance even decreases the capacity of the road (*Fig. 43*)!
That means, to keep the same capacity you need more lanes.

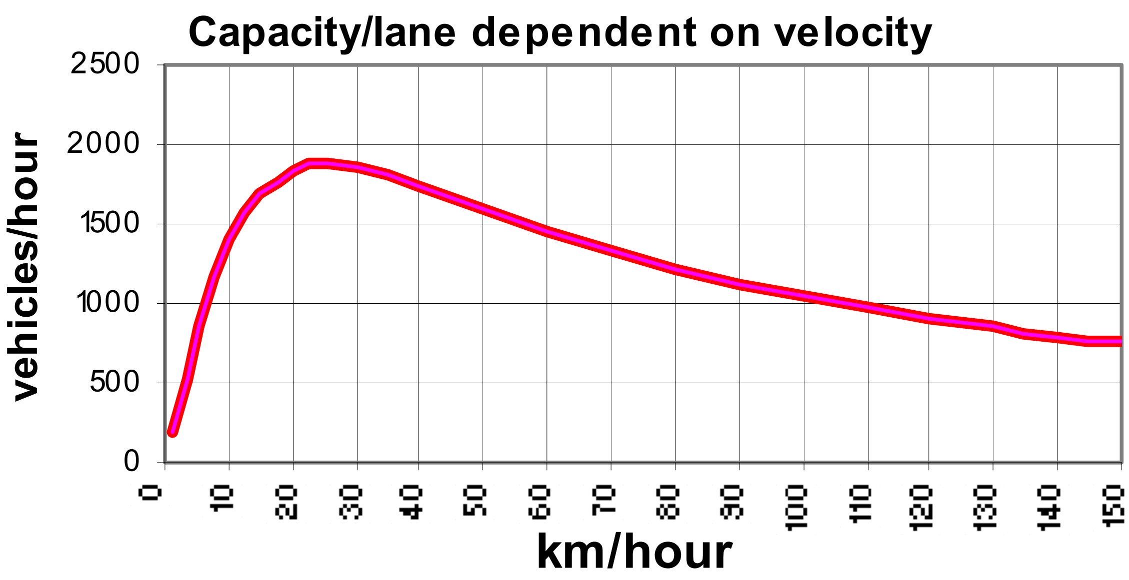


Fig. 43 A higher speed decreases the capacity of the road

Roads designed for more than 2 000 cars per hour in one direction (that is approximately 20 000 per day) need at least three lanes.
Moreover, at 50km/h you have to give separate way to cyclists along the road and at 70km/h at crossings as well if you accept the Dutch appointments ‘Duurzaam Veilig”.

[b] ASVV …

7.1.3 Roads of a higher level

If you leave your home to go for a ride, you start on a ‘residential street’ (some 20m wide) via a larger ‘neighbourhood road’ (say 30m) reaching an even larger ‘district road’ (say 40m) and so on.
On the average every third road of each level you can make a turn to a road of a higher level (see *Fig. 44*, do not take it too serious, it is a rule of thumb)[a]. The question arises at which mutual absolute distance you have to draw them in urban design. To keep it simple, we take 30m for the smallest residential paths, 100m for residential streets, 300m for neighbourhood roads, and 1000m for district roads (*Fig. 44*).

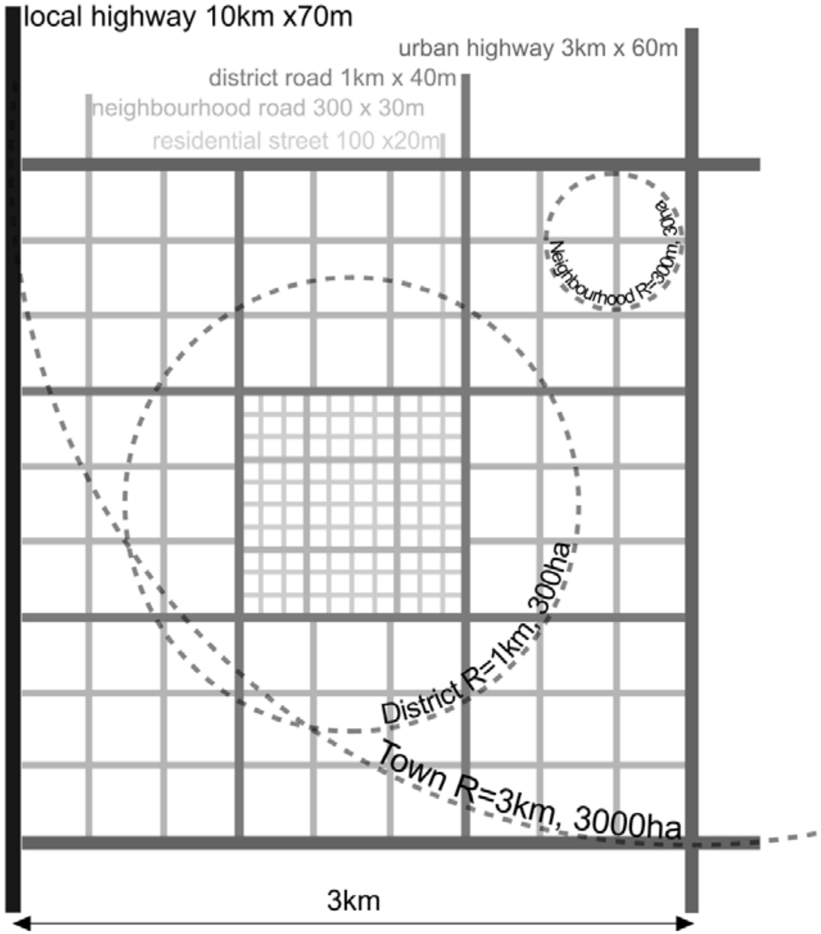


Fig. 44 Four orders in a network hierarchy

[a] Nes, R. v. and N. J. v. d. Zijpp (2000). Scale-factor 3 for hierarchical road networks: a natural phenomenon? (Delft) Trail Research School Delft University of Technology.

7.1.4 Road hierarchy

Going on like that, we can make a table with approximate measures (in reality they will vary around that measure) for any type of road in a hierarchy (*Fig. 45*, do not take it too serious: it is a rule of thumb).

Category	1	2	3	4	5	6	7	8
	residential path	residential street	neighbourhood road	district road	urban highway	highway	regional highway	metropolitan highway
Dutch direkt bediend gebied	erf	ensemble	buurt	wijk	stad	agglo-meratie	regio	metropoli-taine regio
English directly served area	estate	ensemble	neigh-bourhood	district	town	conur-bation	region	metropoli-tan region
m radius | mesh | crossing distance	**30**	**100**	**300**	**1000**	**3000**	**10000**	**30000**	**30000**
directly served inhabitants	10	100	1000	10000	100000	1000000	3000000	10000000
number of dwelling layers	1	2	3	4	6	7	8	10
Profile								
Left half until median strip								
profile key								
m facade height	2,75	5,50	8,25	11,00	16,50	19,25	22,00	27,50
m private use	1,00	2,50						
m sidewalk	0,50	2,00	4,00	3,00	3,00	3,00	3,00	3,00
m cycle track1			2,00	2,00	3,00	3,00	3,00	3,00
			3,50	1,00	1,50		1,75	
m park1	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50
m parallel road				3,00	3,00	3,00	3,00	3,00
m park2								
				2,00	3,00	3,00	3,00	4,50

Category	1	2	3	4	5	6	7	8
m cycle track 2								
				2,00	3,00	3,00	3,00	4,00
m hard shoulder					2,50	2,50	2,50	2,00
m lanes	1,00	3,00	3,00	3,50	6,50	13,00	16,25	26,00
m park 3								
m median strip				2,00	4,00	4,00	4,00	4,00
Right half from median strip mirrored	5,00	10,00	15,00	19,00	28,00	33,00	38,00	48,00
m total	**10,00**	**20,00**	**30,00**	**40,00**	**60,00**	**70,00**	**80,00**	**100,00**
m pavement	8,0	15,0	23,0	28,0	41,0	54,0	60,5	79,0
Physical infrastructure								
m width between facades	10	20	30	40	60	70	80	100
km/hour design velocity	10	30	50	70	90	110	130	150
m minimum lane width	1,75	2,25	2,75	3,25	3,25	3,25	3,25	3,25
number of lanes	1	2	2	2	4	8	10	16
Capacity (possible use)								
vehicles/h capacity per lane	500	1000	1500	2000	2000	2000	2000	2000
vehicles/hour capacity	**500**	**2000**	**3000**	**4000**	**8000**	**16000**	**20000**	**32000**
vehicles/24 hour capacity	5000	20000	30000	40000	80000	160000	200000	320000
Use | Intensity								
residential								
directly served inhabitants	10	100	1000	10000	100000	1000000	3000000	10000000
car rides/inhabitant/day	2,00	2,00	2,00	1,00	0,20	0,10	0,05	0,02
%surrounding infrastructure used	50%	50%	50%	50%	50%	50%	50%	50%
light vehicles/24 hour intensity	20	200	2000	10000	20000	100000	150000	200000
cargo								
kg cargo/inhabitant per day	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
kg cargo/vehicle	10	100	1000	1000	1000	1000	1000	1000
cargo vehicles/24 hour intensity	2	2	2	20	200	2000	6000	20000
service								
service visit/inhabitant/day	0,01	0,01	0,01	0,02	0,01	0,00	0,00	0,00
service vehicles/24 hour intensity	0,20	2,00	20	400	2000	2000	6000	20000
total								

Category	1	2	3	4	5	6	7	8
vehicles/24 hour intensity	22	204	2022	10420	22200	104000	162000	240000
vehicles/hour intensity	**2**	**20**	**202**	**1042**	**2220**	**10400**	**16200**	**24000**
vehicles/hour peak intensity								
% use by car = intensity/capacity	0,4%	1,0%	7%	26%	28%	65%	81%	75%
dB(A) noise on façade[a]	66	59	62	74	80	84	90	96
% devaluation houseprice by noise[b]	10%	5%	7%	22%	34%	40%	48%	54%

Fig. 45 Approximate characteristics of a road hierarchy as a model

In *Fig. 45* '**m radius**' is a nominal measure (read 300m and think 'something between 100m and 1000m' or 'neighbourhood', with a diameter of approximately 600m) for the area involved. It applies the mesh width of the theoretical network as well, the distance between crossings of roads of the same level (turn distance). '**Directly served inhabitants**' is as elastic as the nominal radius (read 1000 inhabitants and think 'something between 100 and 10 000 inhabitants'). The '**Profile key**' gives a possible division of half the profile including the median strip, summarised without the median strip, supposing the other half is mirrored. So, the total distance between façades is two times half the profile.

The '**km/hour design velocity**' shows which speed of cars is supposed determining the '**minimum lane width**' of the lanes out of which the roadway is composed. The '**number of lanes**' is determined by the expected number of cars per hour calculated in line '**vehicles/hour intensity**'.
The actual intensity is something else than the capacity, the maximum possible intensity without congestion, for example in peak hours. They are compared in the **% use by car** = intensity/capacity. Above a certain percentage (60%?) you can expect congestion in peak hours.

The **light vehicles/24 hour intensity** is calculated here by multiplying the number of directly served inhabitants, the number of car rides/inhabitant per day and the **%surrounding infrastructure** used as we did already on page 21 for residential and neighbourhood roads. There we mentioned already 'there are visitors as well'. In the neighbourhood it does not count so much, but on roads of higher level cargo transport and service traffic is more important. How to count that? Here we found a very simple, but perhaps not very reliable way. We estimate the **kg cargo/inhabitant/day** and divide it by an estimated **kg cargo/vehicle** to get the number of **cargo vehicles/24 hour**. In a comparable way the number of **service visits/inhabitant** per day produces the **service vehicles/24 hour intensity**. Summing these lines produces the **number of vehicles/24 hour intensity**, which divided by 10 produces, **vehicles/hour intensity**. The **dB(A) noise on façade** depends on many things such as intensity and distance to the façade. It is a rough estimate, but it determines **% devaluation of house prices** by noise.[b]

All assumptions are arbitrary and can be changed in the similar spreadsheet 'Traffic networks.xls'. This spreadsheet draws the adapted profiles as well.

[a] calculated according to SRM1
[b] It is calculated with a formula given in the thesis of Ruiter, E. P. J. (2004). The Great Canyon. Reclaiming land from urban traffic noise impact zones. (Zoetermeer) Peutz b.v.

7.1.5 From a model back into a real city

This chapter started by real measures of cars (*Fig. 37*), derived models about a hierarchy of roads with different capacity and intensity (induction from particular into general). Now, we have to check how reliable these models are, knowing that reality always differs (deduction form general into particular).
A complete survey should take more cases to check the theory. Here we take one case only and we do not check all assumptions (hypotheses). In *Fig. 46 The urban area around Dordrecht*, we find 6 levels of roads. The resolution does not permit to see residential paths (1). But we see residential streets (2, white) , neighbourhood roads (3, yellow), district roads (4, same colour, but somewhat thicker), urban highways (5, purple), highways (6, red), regional highways (7, red and orange). We have drawn circles of nominally 3, 1 and 0.3km around parts we nowadays call city, district and neighbourhood. Let us start with Papendrecht. It has some clear squares of approximately 500x500m neighbourhood roads while our model states 300x300m. Should we adapt our model?

Fig. 46 The urban area around Dordrecht

Elsewhere (for example in the central part), there are smaller mesh widths (sometimes 100m). The model fits better the average. Moreover, we appointed: “read 300m and say ‘something between 100m and 1000m’ “. So, reality deviates within the appointed tolerance of the model. If our model fits the average, we can say: “Papendrecht has a relatively large mesh width for its neighbourhood roads”.

But perhaps there is more going on. Do some of the drawn residential streets have neighbourhood road characteristics? To decide that, we need to enlarge the detail (*Fig. 47*). No, the map is correct, all streets with the square of neighbourhood and district roads are approximately 20m wide from façade to façade, perfectly according to what we stated in *Fig. 45*. The neighbourhood roads fit the prediction to be some 30m wide as well. However, the district road is not 40m, but 50m wide. There are two possible reasons.

There is something more to learn from *Fig. 46* after all. We supposed there would be a district road every 1km, but in Papendrecht we see only one within a radius of 1km (diameter 2km). However, there is interference with the network of rivers clarifying why the second one is not realized. A second one here would not have enough use to legitimate the cost. The river limits its bearing surface. The model supposes a homogeneous topography while reality is heterogeneous. Nevertheless the density of district roads is low comparing to the model, so the remaining one needs more capacity.

Fig. 47 A Papendrecht detail

Fig. 48 A central Dordrecht detail

Fig. 49 Dordrecht some 350 years ago[a]

From Papendrecht we learn also that a district road appearing in a grid of neighbourhood roads can take over a neighbourhood function (superposition, we will discuss that in paragraph 7.3). That is another reason to increase its capacity and thereby its width.

So, we keep the model for the time being, because it keeps us attentive on regularities in the existing urban tissue to be applied in urban design.

By the way, *Fig. 47* and *Fig. 48* illustrate how much surface can be occupied by non residential functions, as we stated in paragraph 3.6. *Fig. 49* shows what we call a city changes in time. Holland's oldest city in the 17^{th} century (Dordrecht) and Amsterdam were very large that time but now we call their surface (R=1km) a district. All other cities in the Atlas of Blaeu[a] from 1652 are even smaller. They had a radius R=300m (walking distance). That is what we now call a neighbourhood. On Bleaus maps you see closed urban islands everywhere with closed corners as well. The urban density was much higher than we are used to nowadays. One of the factors of decreased density is the mobility space we need for cars and their parking lots. The way the urban islands became open allotments in the 20th century is described by Castex and Panerai.[b] What would be the cause?

---

[a] Blaeu, J. (1652). Toonneel der Steden van Holland - Westvriesland - Utrecht. (Amsterdam)

[b] Castex, J., J.-C. Panerai, et al., Eds. (1990). De rationele stad. Van bouwblok tot wooneenheid. Met een nawoord van Henk Engel. Teksten architectuur (Nijmegen) SUN.

7.2 Two networks

There are other networks than roads (dry connections), for example the wet connections we add in this chapter. And they interfere, as we saw in Papendrecht. More kinds of networks such as those of pedestrians, cyclists, public transport, rail and their characteristics we will elaborate later.

7.2.1 Names and scale

Everybody knows many names of wet and dry connections, regardless of their function (*Fig. 50*). They seem to fit nearly logarithmically on a constant difference of scale multiplying the mesh width each time approximately by 3. That rather precise scale articulation has practical backgrounds.[c]

NETWORK		BLUE LEGEND		BLACK LEGEND	
density	mesh/ exit interval		NAME	nominal width	NAME
km/km²	km nominally	width 1%		m	
0.002	1000	≥10000	**sea**		
0.007	300	3000	**lake**	120	**continental highway**
0.02	100	1000	**stream/pond**	100	**national highway**
0.07	30	300	**river/waterway**	80	**regional highway**
0,2	10	100	**brook/canal**	70	**local highway**
0.7	3	30	**race**	60	**urban highway**
2	1	10	**watercourse**	40	**district road**
7	0.3	3	**ditch**	30	**main street**
20	0.1	1	**small ditch**	20	**street**
70	0.03	0.3	**trench**	10	**path**

Fig. 50 Names of networks on the higher levels of scale

However, in reality it is sometimes more, seldom less than 3 and often the highest and lowest orders are missing. For example clay grounds do not need trenches and sandy grounds start their drainage by brooks. In the same way rural areas do not need streets every 300m. In The Netherlands they start with roads every 1km as you can check on topographical maps

[c] Nes, R.v. and Zijpp, N.J.v.d. (2000) Scale-factor 3 for hierarchical road networks: a natural phenomenon? (Delft) Trail Research School Delft University of Technology.

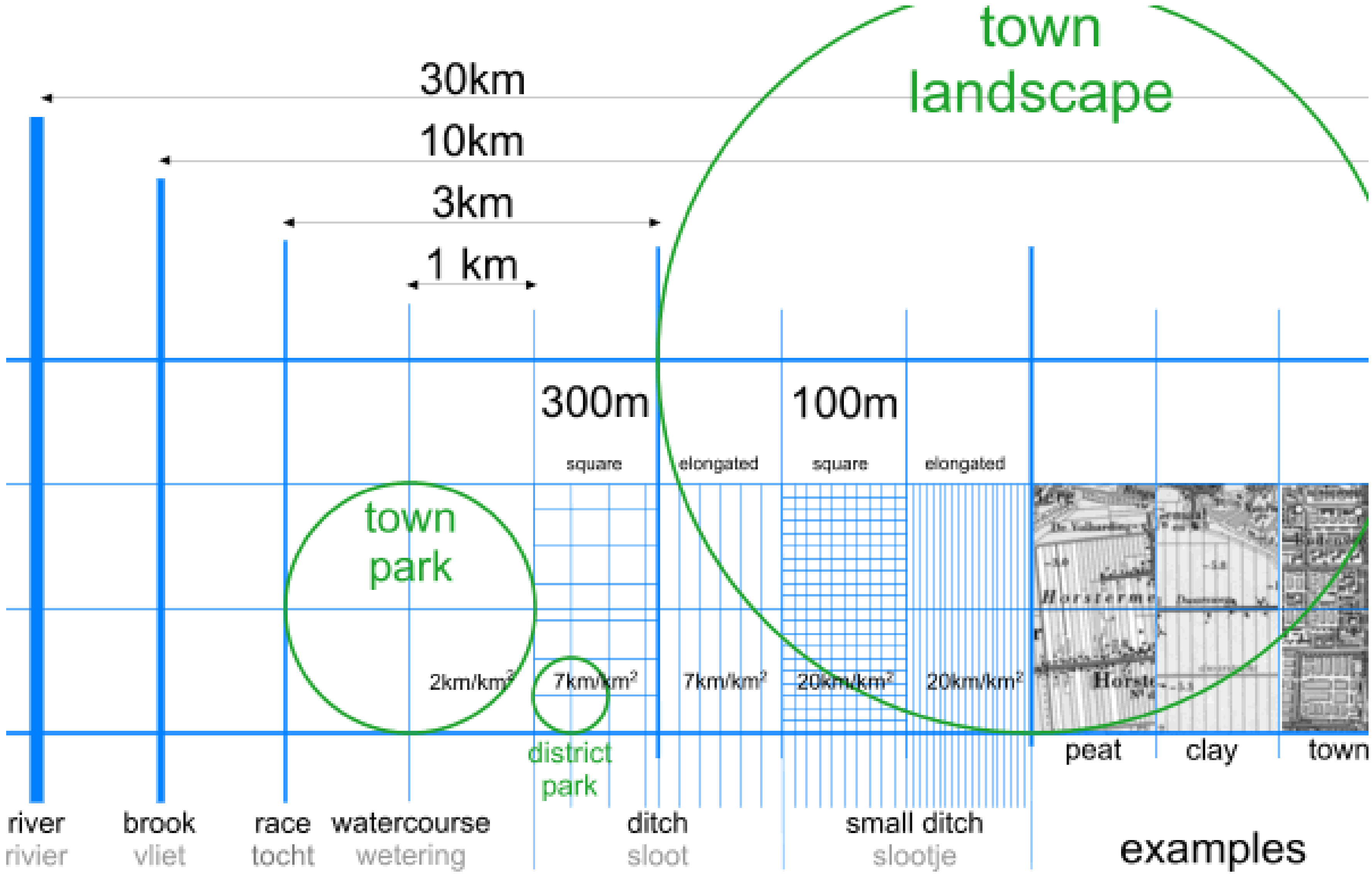


Fig. 51 The styling of wet connections

Fig. 52 The styling of dry connections

7.2.2 Functional charge of networks

These neutral names get their time-bound character by changing function. Dry and wet networks get their contemporary meaning by ‘functional charge’ in Fig. 53. Their density implicates the level of investment.

Nominal mesh width	***30m***	***100m***	***300m***	***1km***	***3km***	***10km***	***30km***	***100km***
Density (km/km^2)	*70*	*20*	*7*	*2*	*0.7*	*0.2*	*0.07*	*0.02*
wet connections								
name	**trench**	**small flooded ditch**	**a flooded ditch**	**watercourse**	**race**	**brook**	**river**	**lake**
indicative width 1%		*1m*	*3m*	*10m*	*30m*	*100m*	*300m*	*1000m*
other names			stream	stream	stream	stream		
		urban canal	urban canal	urban canal	urban canal	industrial canal/waterway	canal	canal
functions			draining			drainage pool (from polders)		

Nominal mesh width	***30m***	***100m***	***300m***	***1km***	***3km***	***10km***	***30km***	***100km***
dry connections								
name	**path**	**street**	**main street**	**road**	**urban highway**	**local highway**	**regional highway**	**national highway**
an exit every ...km	*10m*	*30m*	*100m*	*300m*	*1km*	*3km*	*10km*	*30km*
indicative width	*10m*	*20m*	*30m*	*40m*	*60m*	70m	80m	100m
functions	pavement	opening to a hamlet	neighbourhood street	district road, village road, country road	urban highway, main road	urban highway	provincial highway	national highway
	footpath	residential walk	walking route	cycle route	cycle ride			
Duurzaam Veilig (long-term safety)	Woonpad, free of cars	Woonstraat, restricted entry for cars	Erftoegangs-weg, sojourn function	Gebieds-Onsluitings-Weg, opening to an area	Stroomweg, throughway			
public					bus	express	fast bus	Interliner

Nominal mesh width	***30m***	***100m***	***300m***	***1km***	***3km***	***10km***	***30km***	***100km***
railway line					tram	lightrail	regional	national
a supportive base					*300m*	*1km*	*3km*	*10km*
functions						*the underground/metro*	*local train*	*intercity train, Argus*
					hybrid systems	*hybrid systems*	*hybrid systems*	

Fig. 53 *The time-related functional charge of networks*

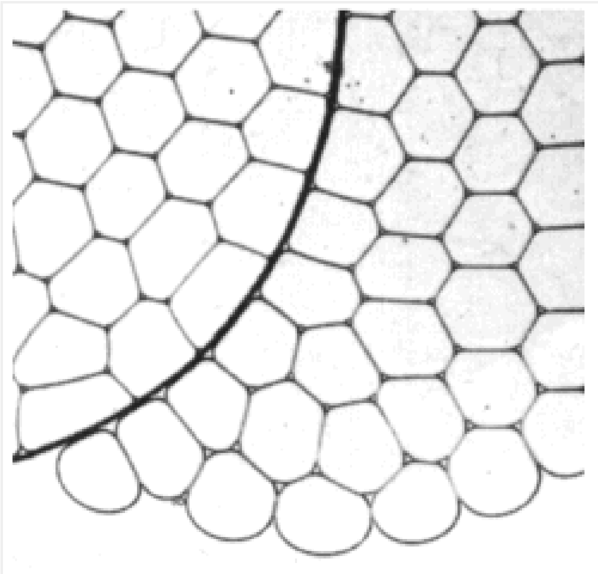
7.2.3 Rectangularity forced by connections of a higher level

The most efficient enclosure is made by surrounding the enclosed area with a minimum length of road. As well known, the result is a circle. But in a continuous network, it is approximated by a hexagonal system. This minimal ratio between periphery and area is demonstrated 3D by many natural phenomena[a] (cells in a tissue) where preference is given to a minimal ratio between outer area and inner content. A good example is a cluster of soap bubbles. A cluster of soap bubbles forced into a thin layer produces a two-dimensional variant. The bubbles arrange themselves in polygons with an average of six angles.

However, if one pulls a thread through them, the nearest bubbles will re-arrange themselves again into an orthogonal pattern (*Fig. 54*). Urban developments from radial to tangential can also be interpreted against this background. The interlocal connections pull the radial system straight, as it were. The additional demand for straight connections over a distance longer than that between two side roads (here called a 'stretch') introduces rectangularity. Every deflection from the orthogonal system then is less efficient.

This can be clarified by engaging in a thought experiment: Imagine a rectangular framework with hinged corners that is completely filled with marbles. If one re-shapes this framework into an ever narrower parallelogram, then there will be space for fewer and fewer marbles, so, in every case, the rectangular shape proves to be optimal, in this respect. The only network that could compete with this, which has lines running from a rectangular lattice, is a triangular lattice, but it is immediately clear that it is inferior because of its unfavourable periphery/area ratio. For instance, the parallelogram in the thought experiment that became ever more skew, matches an angle of 60° in an equilateral triangular lattice. Apart from the disadvantage caused by deviating from the right angle, an extra connecting line is needed to cut the parallelogram into two equilateral triangles.

[a] d'Arcy Thomson, W. (1961). On growth and form. (Cambridge UK) Cambridge University Press.



Hildebrandt and Tromba (1989) [b]

Fig. 54 The formation of right angles

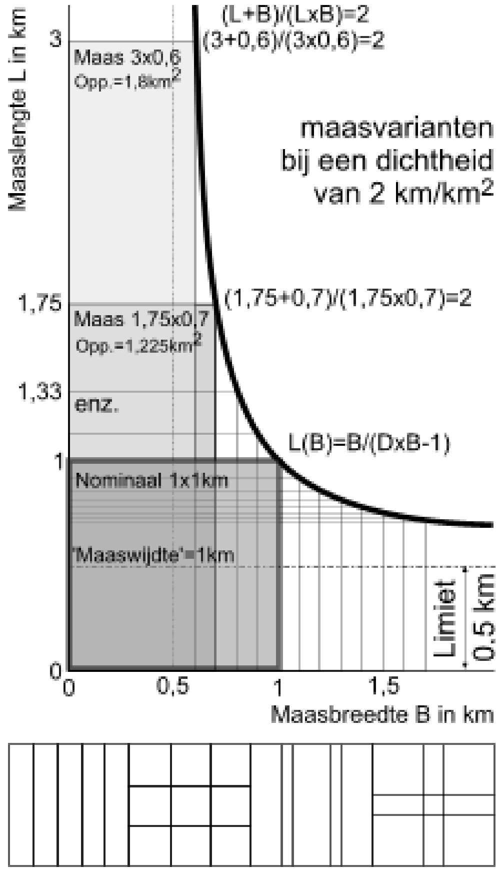


Fig. 55 Length (L) and width (W) of the mesh for a given net density of (D=2)

Fig. 55 shows a sequence of relationships between mesh width and length in rectangular meshes with a net density of 2 km per km^2 (the same density means the same investment!).

Length and width of *squares* are 2/density. The same density also occurs in a pattern of roads that go infinitely in one direction every 0.5 km. Thus, when the length and width of the mesh 1/d = 0.5 km, the ratio between length and width is at its limit. In that case, where the net density is 2 km per km^2 there can be no 'crossroads' any more. This consideration only applies to an orthogonal system.

[b] This figure is taken from: Stefan Hildebrandt and Anthony Tromba, *Architectuur in de natuur, de weg naar de optimale vorm* (Mathematics and optimal form), Wetenschappelijke Bibliotheek Natuur en Techniek, Maastricht/Brussel, 1989, ISBN 90 70157 81 0.

7.3 Superposition of levels

In connection with the red and blue legend one can imagine their superposition as follows:

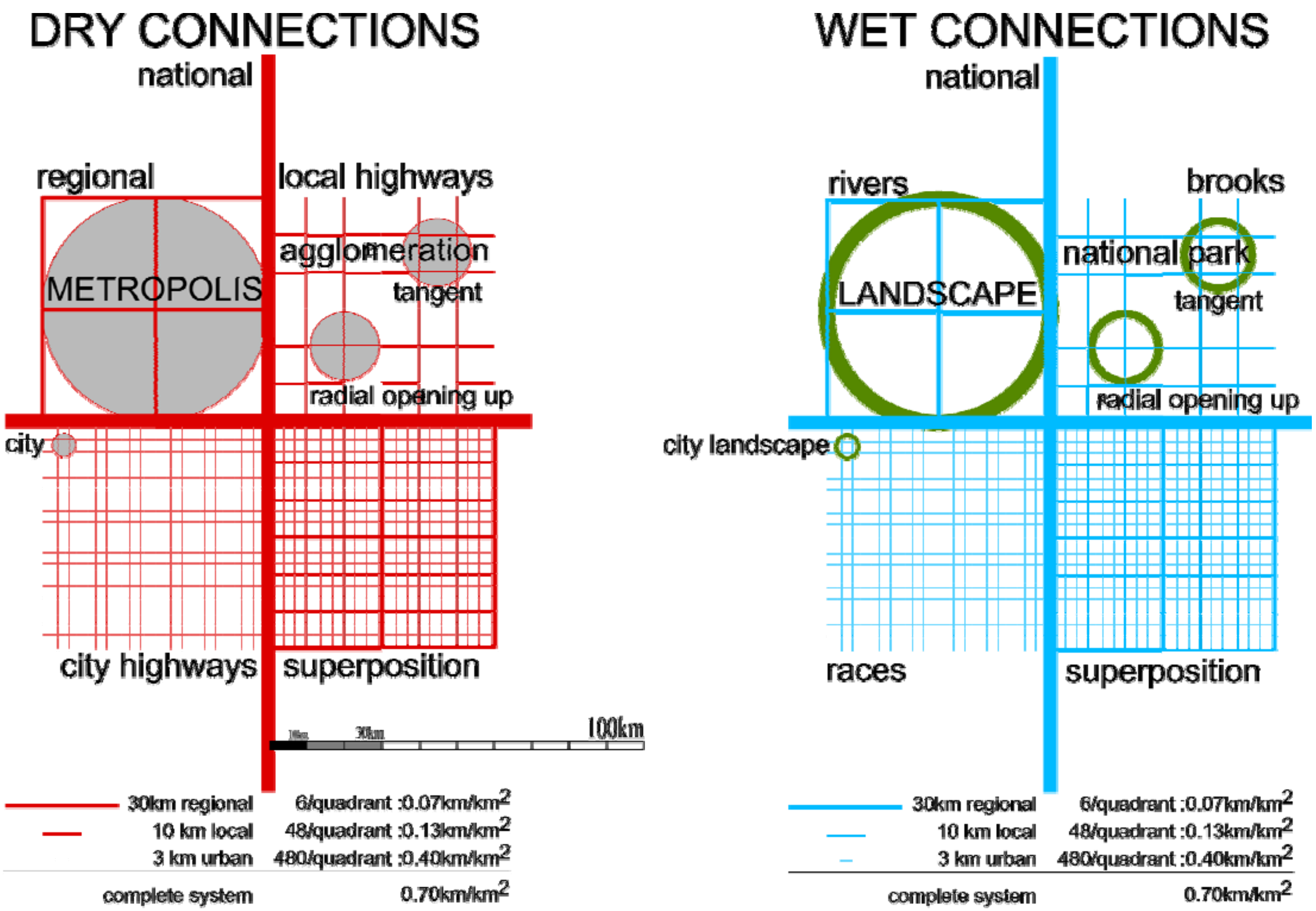


Fig. 56 *Superposition of networks*

Urban area is radially crossed or tangentially surrounded by infrastructure.
By superposition of the higher order over the lower order, the density of the lower order decreases.
By superposing the wet connections over or under the dry connections, both networks interfere (interference, see page 46).

7.3.1 Interference of different networks

When one lays different (dry and wet) networks over each other, an interference occurs that defines the number of crossings, and, because of this, the level of investment in civil engineering constructions (Fig. 57).This can be done in different ways. Separating instead of bundling them fragments space more. The diversity of interference has important impacts on ecology and cultural identity.

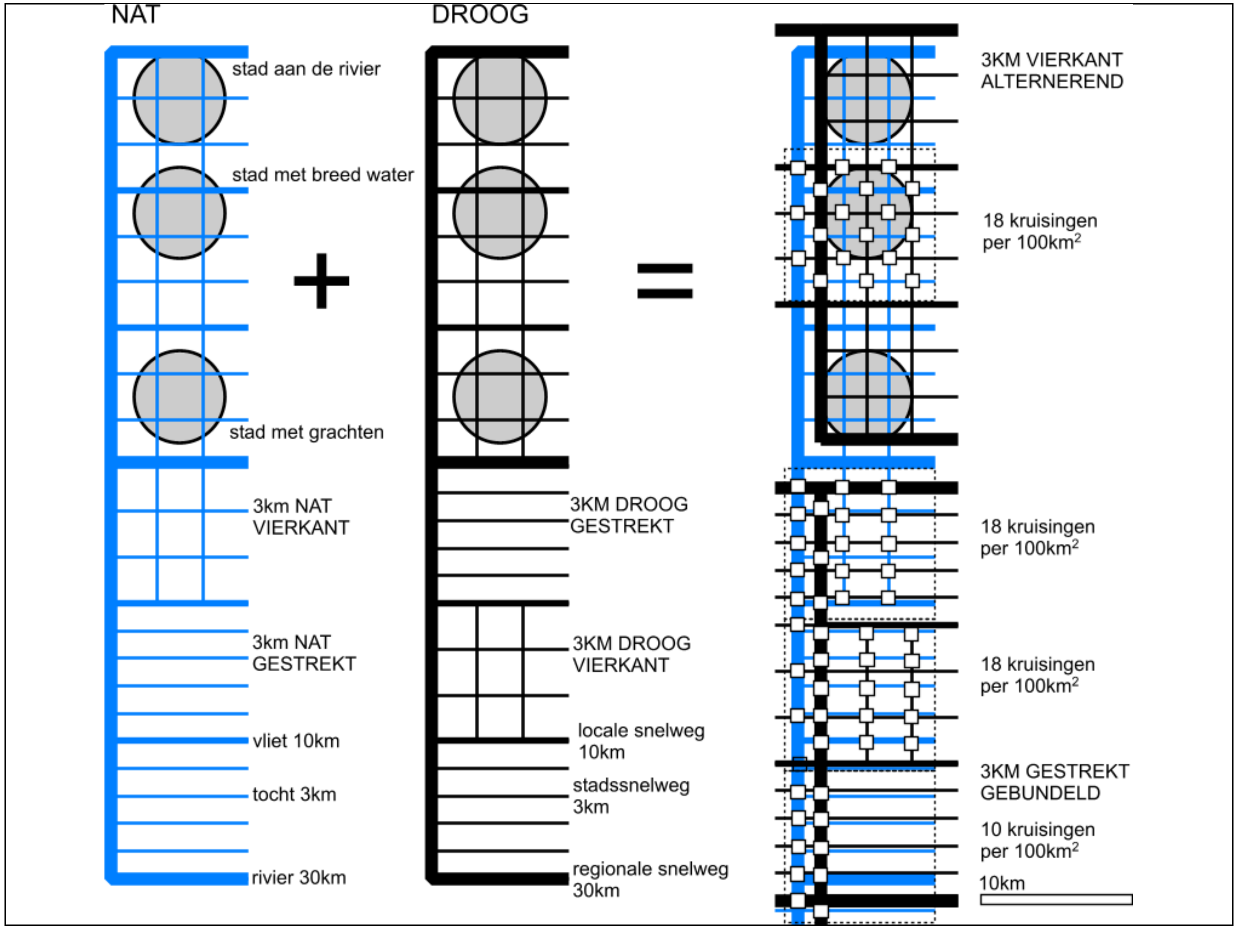
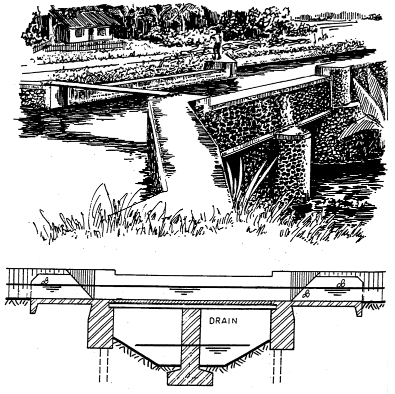


Fig. 57 Interference between wet and dry networks.

The position of urban areas with respect to orders of magnitude of water and roads dictates their character to a large extent. The elongation (stretching) of networks reduces the need for engineering constructions when their meshes lie in the same direction. If one bundles them together, this also helps to prevent fragmentation. The aim of the 'Two network strategy', on the other hand, is to position water, as a 'green network', as far way as possible from the roads (in an alternating manner). However, this has the effect of increasing fragmentation by roads and watercourses.

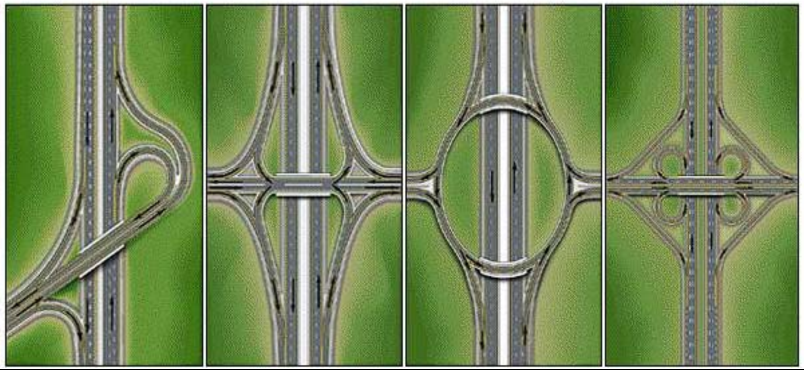
7.4 Crossings

Mutually crossings of waterways seldom separate their courses vertically (*Fig. 58*) as motorways do (*Fig. 59*).



Ankum (2003) page 160

Fig. 58 Crossing of separated waterways



Standaard and Elmar (?)

Fig. 59 Crossings of highways

More often their water levels are separated by locks or become inaccessible for ships by weirs or siphons.

However, crossings between ways and waterways have to be separated vertically in full function anyhow. And they often occur.

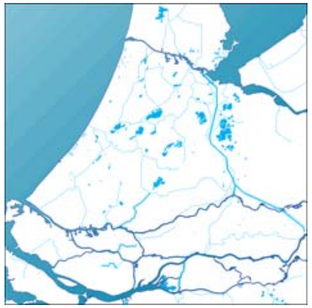


Fig. 60 Rivers, canals and brooks

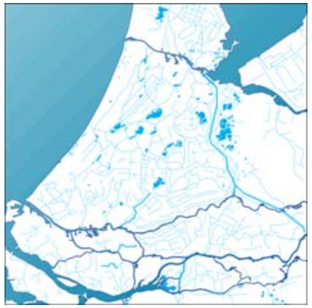


Fig. 61 Superposition races

Fig. 62 Interference with highways

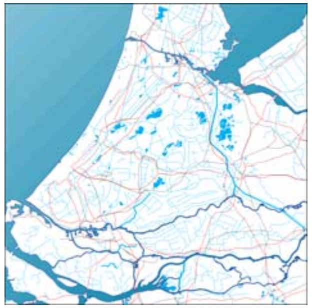
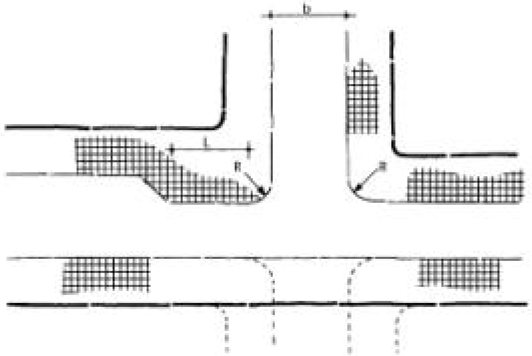


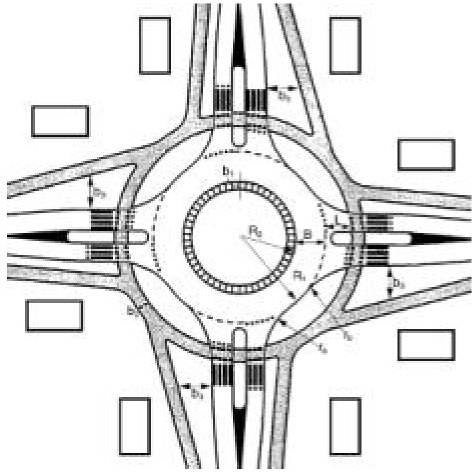
Fig. 63 Interference with highways and railways

7.4.1 The same kind and level



A.S.V.V.(2004): 12.3.1

Fig. 64 R=300m Erfontsluitingsweg Kruispunt - voor gemengd verkeer

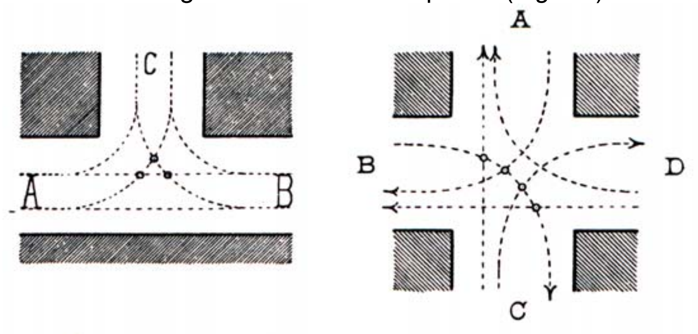


A.S.V.V.(2004): 11.2.3

Fig. 65 R=1km GOW Enkelstrooksrotonde - met vrijliggend fietspad en fietsers in de voorrang

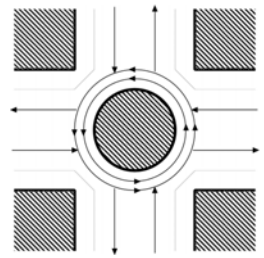
7.4.2 Limitating crossing movements

Camillo Sitte[c] already showed T crossings have less conflict points (*Fig. 66*). Modern roundabouts translate a normal crossing in 4 T-crossings.



Camillo Sitte (1889) Der Städtebau nach seinen künstlerische Grundsätzen

Fig. 66 Less conflict points in T-crossings



Bach en De Jong (2004)

Fig. 67 An actual roundabout

Before roundabouts came into use, attempts were made to design safer T-crossings on town (R=3km) and district (R-1km) level.

---

[c] Sitte, C. (1991). <u>De stedebouw volgens zijn artistieke grondbeginselen</u>. (Rotterdam) Uitgeverij 010.

B. van Gent (1999), p. 2/6;
Bach 40827k ZoetermBas v Gent55.jpg
Fig. 68 Sketch Zoetermeer 1969

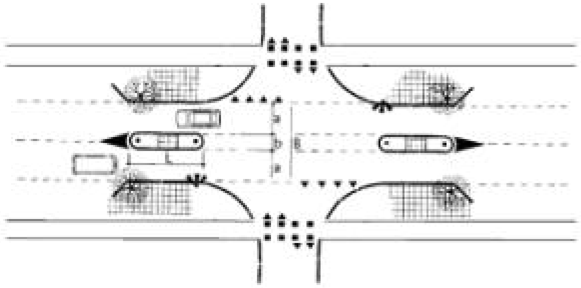
Uit: CDRom de nationale Stratengids van Nederland met kaarten van de Topografische Dienst te Emmen (Den Haag) Citydisc; Bach 40827k ZoetermeerBasisKaart.jpg
Fig. 69 Actual situation

B. van Gent (1999), p. 2/30
Bach 40827 ZoetermeerBuurtOntw.jpg
Fig. 70 Sketch for district Driemanspolder-West (Meerzicht)

Uit: CDRom de nationale Stratengids van Nederland met kaarten van de Topografische Dienst te Emmen (Den Haag) Citydisc
Fig. 71 Actual situation

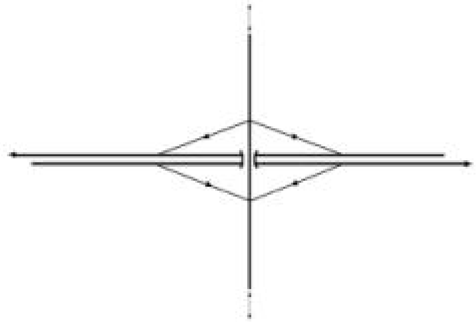
However, gaining safety this way produced faster driving. So T-crossings did not produce more safety after all. Moreover, non-perpendicular T-crossings make orientation more difficult. Roundabouts are safer.

7.4.3 Crossings of the same kind and different level



A.S.V.V.(2004): 11.2.5

Fig. 72 Middengeleider - bij kruispunt R=1km GebiedsOntsluitingsWeg – R=300m Erftoegangsweg



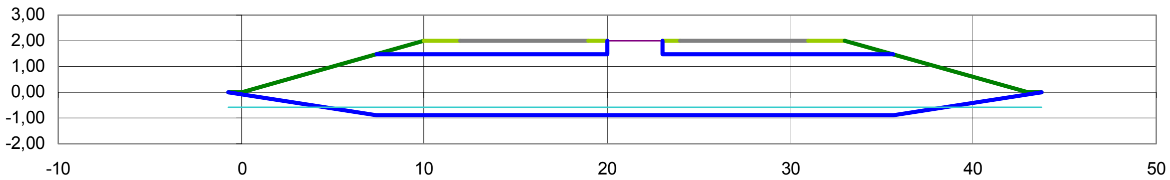
A.S.V.V.(2004): 10.1

Fig. 73 Haarlemmermeeroplossing - bij kruispunt R=3km Stroomweg – R=1km GebiedsOntsluitingsWeg

7.4.4 Tunnels

3D crossings need slopes. *Fig. 74* in its first calculation shows a highway on 2m with slopes on both sides, totally 43m wide. The tunnel can be made on –1m, so the slopes meet nearly on 0m making the total width 44.4m.

		talud	zijberm	rijbaan	middenberm	daglichtschacht	middenberm	rijbaan	zijberm	talud
First calculation										
m hoogte wegdek	2,00									
m breedte met taluds	**43,00**	10,00	2,00	7,00	1,00	3,00	1,00	7,00	2,00	10,00
m tunnelhoogte	2,40									
brugdek	0,50									
m totale breedte met 2 normale fietshellingen	**44,40**									



Second calculation

m hoogte wegdek	0,10									
m breedte met taluds	**24,00**	0,50	2,00	7,00	1,00	3,00	1,00	7,00	2,00	0,50
m tunnelhoogte	2,40									
brugdek	0,60									
m totale breedte met 2 normale fietshellingen	**197,13**									

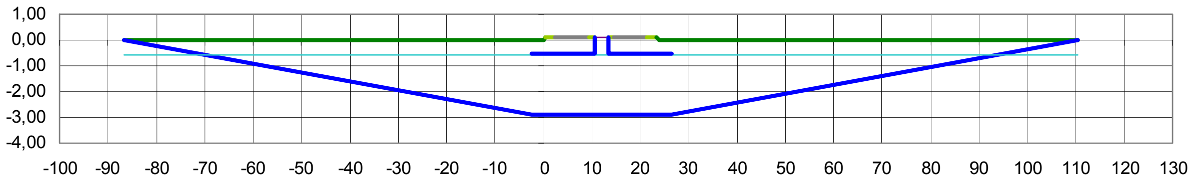


Fig. 74 Two calculations of slopes in a tunnel for cyclists below a highway

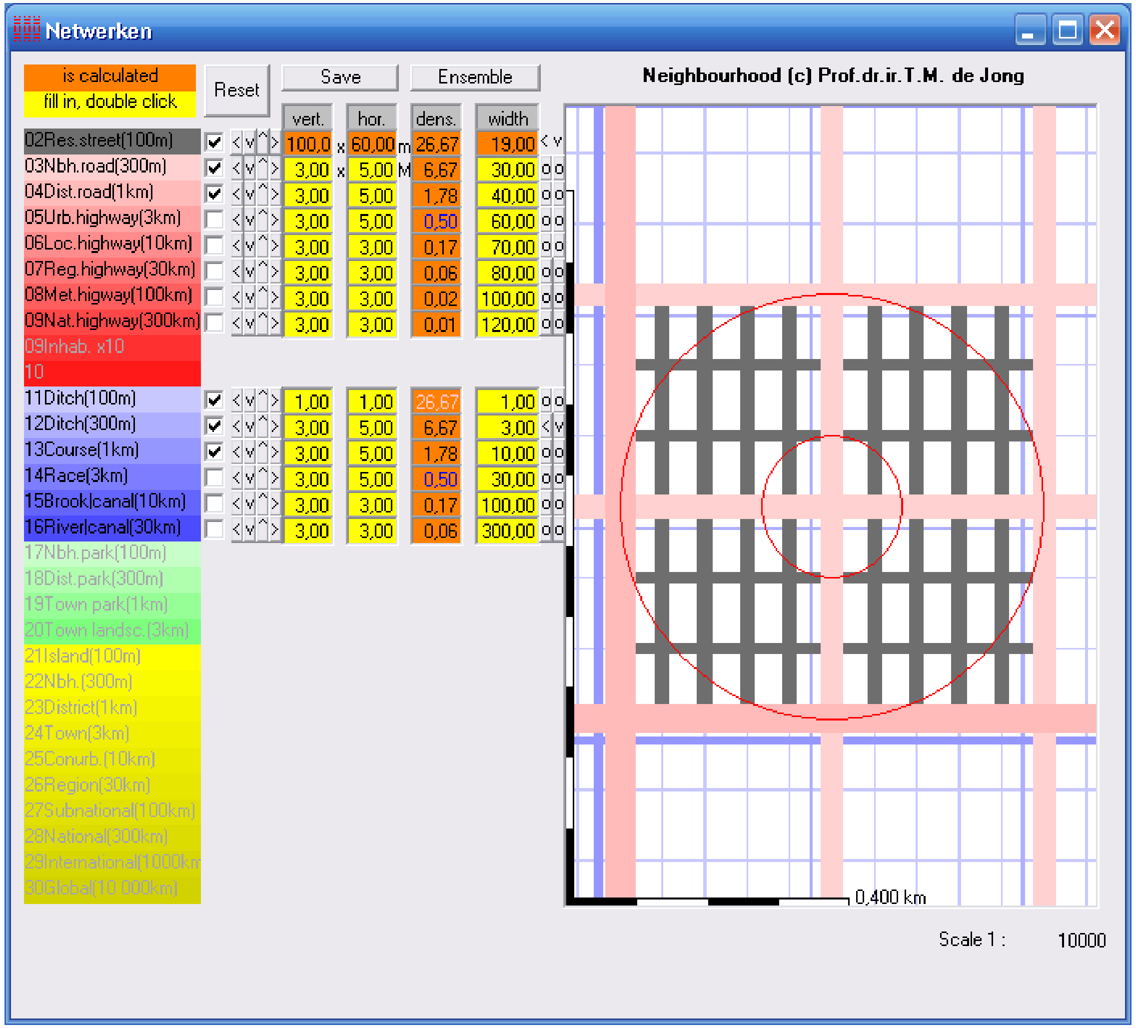
However, *Fig. 74* in its second calculation shows a highway on 0.1m height without slopes. You have to dig out the tunnel until –2.9m. By doing so, you need cycle slopes of more than 80m at both sides. The tunnel construction extends to 197.13m width. Imagine the problems to keep it dry, imagine the costs, imagine the problems you raise designing the adjacent neighbourhoods.

7.4.5 Crossings of different kind and level

Fig. 75 Neighbourhood street crossing canal and railroad in Utrecht

Especially when the canal is a belt canal with a higher level then the other waterways many complications arise. Extra space is needed for weirs, dikes and sluices, perhaps even locks and many slopes not useful for building. The slope the city highway gets from crossing the high belt canal could force to make a tunnel instead of a bridge. Anyhow, several expensive bridges will be necessary and some of them will be dropped from the budget, causing traffic dilemmas elsewhere.
The slope behind the bridge in *Fig. 75* is not steep enough to get a tunnel under the railway high enough for busses (2.60m here is too low).

7.4.6 Count your crossings (costs)



Jong (2001)

Fig. 76 Interference of dry and wet networks in different orders causing crossings of different kinds

Fig. 76 shows how different dry and wet networks in different orders cause crossings of different kinds. Trenches and ditches become drains or (underneath roads) culverts in the urban area, but main ditches (3m wide) and water courses (10m) or even larger waterways have to be crossed by bridges.
From 6 different kinds of interfering crossing in *Fig. 76*, counts 35 crossings in 5 types.
And there are superposed crossings as well.

	residential streets (20m wide)	neighbourhood streets (30m wide)	district roads (40m wide)
main ditches (3m wide)	16	8	4
water courses (10m wide)		5	2

Fig. 77 Five types of interfering crossings supposed in Fig. 76

7.5 Managing surface

7.5.1 Ensembles (R=100m)

Fig. 78 and *Fig. 79* show two allotments of 100 dwellings (225 inhabitants) in rows of 10 on 1.8 ha. So, there are 56 dwellings/ha and FSI= 56% while the floor space per two storey dwelling is 100m². From total area 62% surface is for sale and 38% is public space including 1 parking place per dwelling and roadway pavement of 3.2m wide.

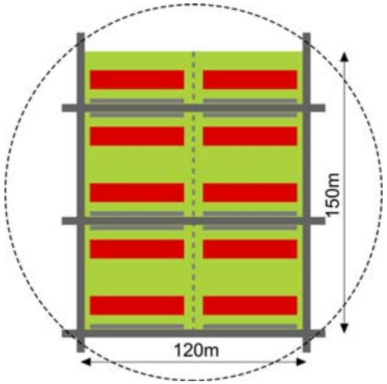


Fig. 78 100 dwellings along residential streets with parking in front of the house: 15% pavement, 23% green area

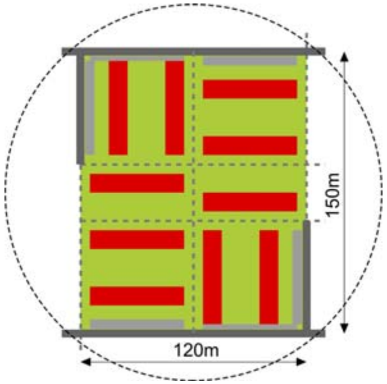


Fig. 79 Reduced pavement by residential paths, parking at 1 minute walk: 10% pavement, 28% green area

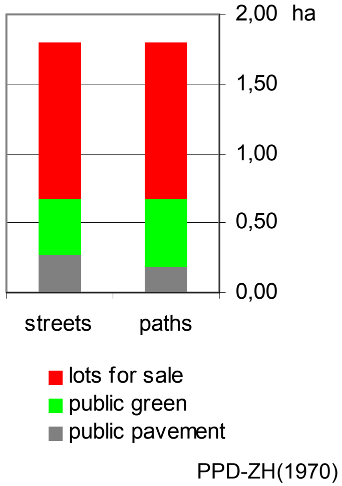


Fig. 80 Reduction of street pavement, increase of green area comparing Fig. 78 and Fig. 79

However, in *Fig. 79* parking is concentrated at the boundaries. People have to walk 1 minute more than in *Fig. 78* to reach their cars, partly living at residential paths, saving 1/3 of pavement! That reduces municipal costs (or ground prices and taxes for private persons) substantially. By doing so, there is 1/5 more green area (5% green of total area), resulting in a much greener look without cars. That area could become public green, but it can be sold as well reducing municipal costs again.
The disadvantage is, you cannot easily come close to your home with luggage, moving vans and other vehicles. And you cannot see your car from your home.

7.5.2 Neighbourhoods (R=300m)

Multiplying a module such as *Fig. 79* by 8 around a centre, produces a neighbourhood of 1800 inhabitants, enough for some facilities such as a school (1ha black square in *Fig. 81* to *Fig. 83*) , playgrounds, some shops and enterprises or public facilities. By locating parking spaces at the boundaries of the ensembles, at daytime some residential parking space can be used by users of the facilities, avoiding extra facility parking space.

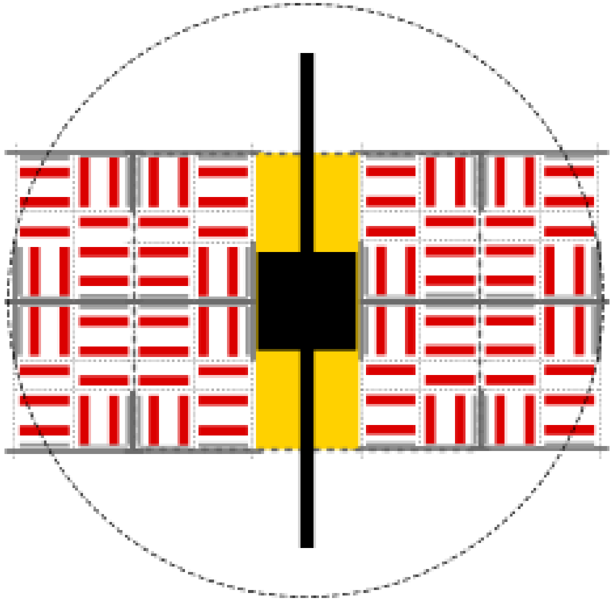


Fig. 81 300m central road

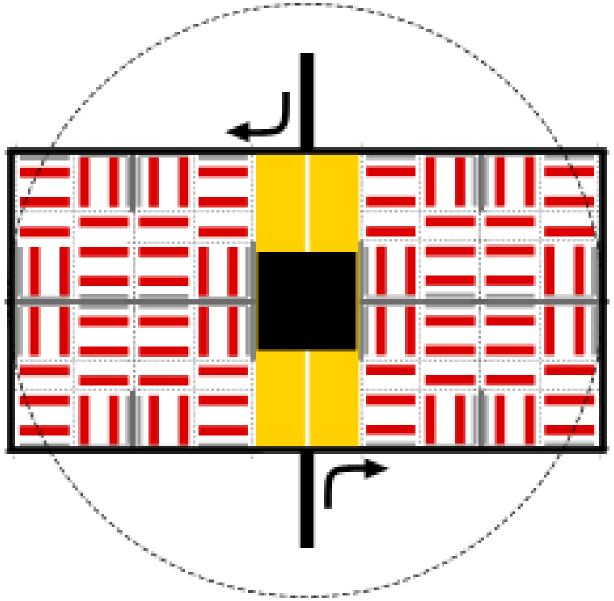


Fig. 82 1800m peripheral one way road substituting 600m residential street

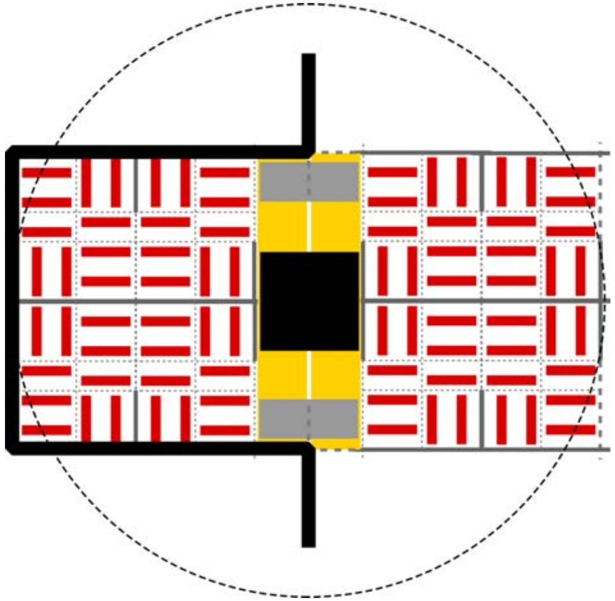


Fig. 83 900m peripheral road substituting 300m residential street, central parking

A central neighbourhood road costs least pavement, but it divides the neighbourhood and the school in two parts (*Fig. 81*). A peripheral road costs much more road length, unless it is part of a grid used for adjacent neighbourhoods as well. A one way solution (*Fig. 82*) may half pavement and barrier effect. A one sided peripheral road leaves the other side open to the field. Concentrated parking on neighbourhood level could mean a 5 minute walk to your car (*Fig. 83*). However, these choices are often subordinate to the environment, mostly a district grid (*Fig. 84*).

7.5.3 Districts (R=1km)

Multiplying the module from *Fig. 81* by 4 (7200 inhabitants) the surface fits in a 1x1km grid of district roads (40 wide), leaving open a 30m surrounding margin and a centre (*Fig. 84*). That centre can be used for additional district green, facilities or housing (4ha black square), utilizing concentrated residential parking in day time. The grid permits to leave out 1200 m neighbourhood streets according to the model of *Fig. 45*, but asks 8x90=720m extra residential roads to give access to all ensembles.

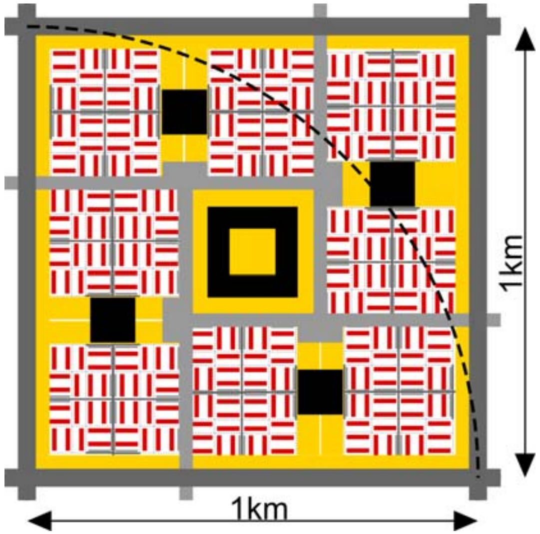


Fig. 84 A small district or district quarter

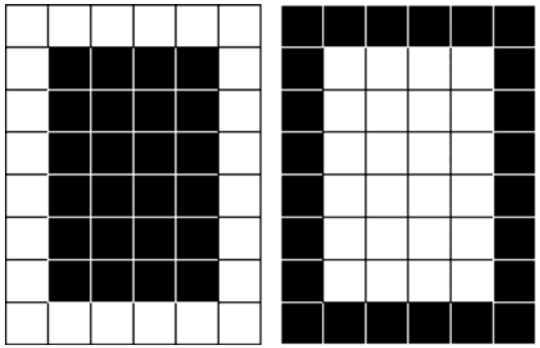


Fig. 85 Same built-up area optically full or empty[a]

Fig. 85 shows the optical principle of leaving the centre open, applied in *Fig. 84* on the level of the quarter and its centre: the same surface left (4x6=24) gives a more spacious effect located in the periphery (6x8-4x6=24 as well). On an even smaller scale that principle *Fig. 82* shows another principle of central squares: do not make a crossing, give access roads along the square a view on larger buildings (here schools). Berlage designing the Mercator square in Amsterdam called it the ‘turbine principle’. The resulting T-crossings refer to Camillo Sitte as cited before.

7.5.4 District grids

Fig. 84 showed how a regular grid of district roads and neighbour streets solves some problems arising if you look at an isolated neighbourhood only. The most famous urban grid is built in Barcelona, designed by Cerdà (1867).[b] He designed urban islands in squares of normally 133x133m (*Fig. 86*).
A neighbourhood contained 25 islands (R=300m!) with bevelled 16m high building blocks making small squares on all crossings (*Fig. 87*). The islands are enclosed by residential streets of 20m wide (*Fig. 88*), neighbourhoods by neighbourhood roads of 30m wide (*Fig. 89*), district (4 neighbourhoods) by district roads of 50m wide with a large median strip (*Fig. 90*). A district had a market.

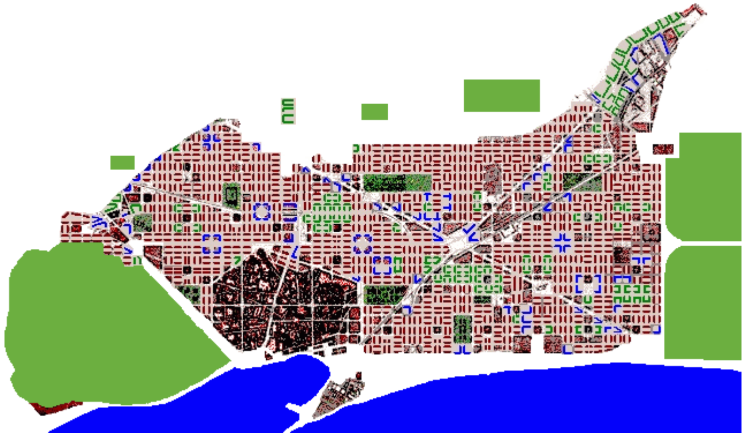


Fig. 86 Plan Cerdà (1867) in Barcelona

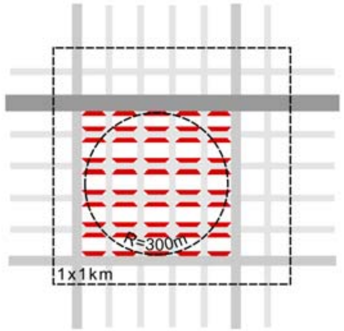


Fig. 87 A Cerdà neighbourhood

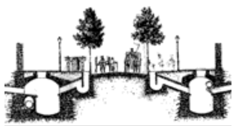


Fig. 88 Streets 20m

Fig. 89 Roads 30m

Fig. 90 District roads 50m wide

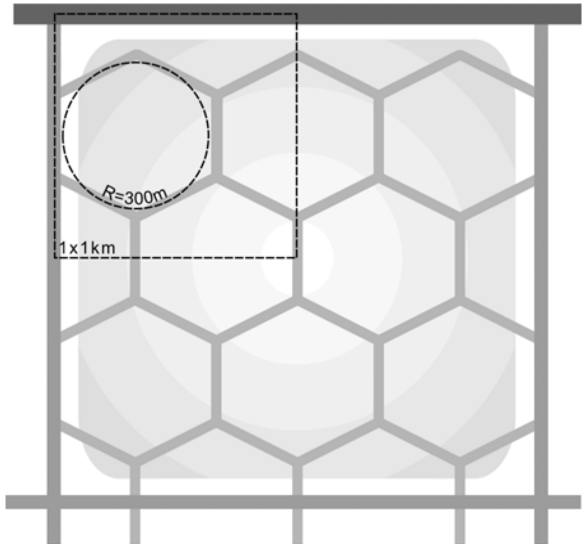


Fig. 91 The Buchanan grid put in a square 2x2km

The hexagonal grid proposed by the American traffic expert Buchanan (1963)[c], drawn at the same scale in *Fig. 91* is in sharp contrast, but it produces neighbourhoods at the same scale R=300m.
Bach (2006) sums up the advantages of a rectangular grid concerning its flexibility giving next examples here all drawn at the same scale in a square of 1x1km.

[a] Tummers, L. J. M. and J. M. Tummers-Zuurmond (1997). Het land in de stad; de stedebouw van de grote agglomeratie. (Bussum) THOTH.
[b] Cerdà (1867) Teoria General de la urbanizacion y aplicacion de sus principios y doctrinas e la reforma y ensanche de Barcelona, see also for Dutch readers http://odin.let.rug.nl/~kastud/barca/c/inl.html
[c] Buchanan, C. (1963). Traffic in Towns. The specially shortened edition of the Buchanan report. (Harmondsworth, Middlesex, England) Penguin Books.

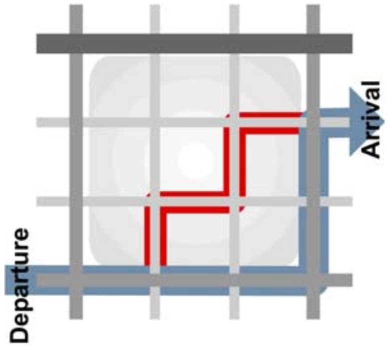


Fig. 92 Making a short cut as long as the detour

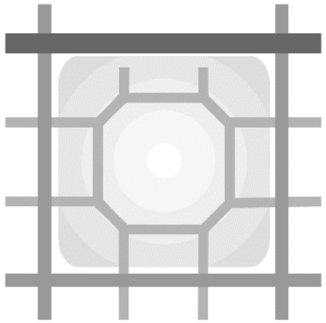


Fig. 93 Easily providing a centre

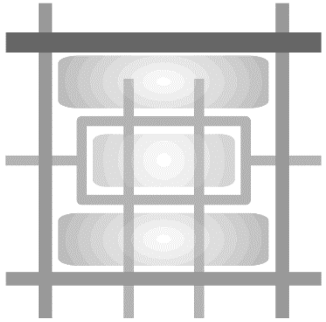


Fig. 94 Easily diminishing access crossings

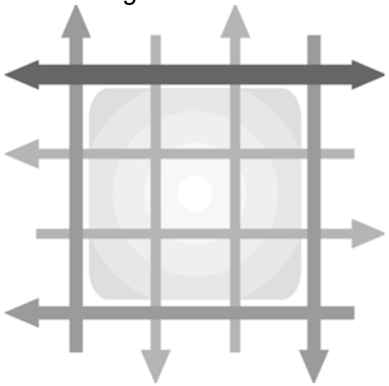


Fig. 95 Easily introducing one way traffic

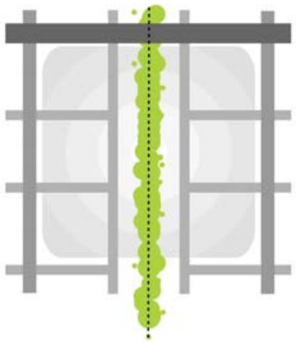


Fig. 96 Easily giving way to other networks such as cycle paths


Fig. 97 Easily accepting ongoing green lines

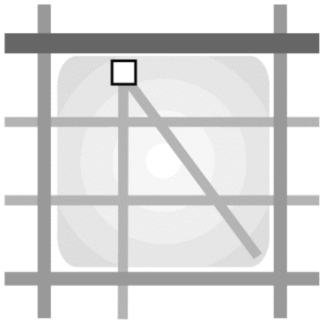


Fig. 98 Exceptions draw special attention

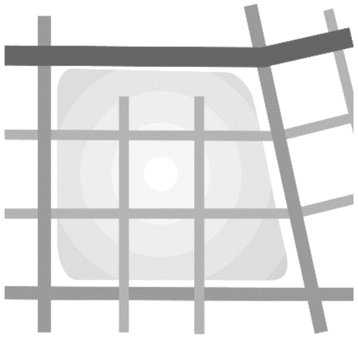


Fig. 99 Easy hinging to other grids

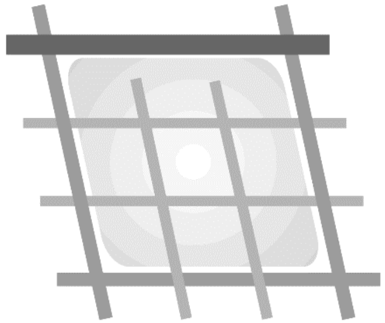


Fig. 100 Crooked grids keep easy orientation

As discussed on page 41 by thought experiment, the content of a crooked grid (*Fig. 100*) is less than a rectangular one, while its outline is the same as the square. So, it will cost more pavement per inhabitant.

7.5.5 Towns from spider to fly in a web

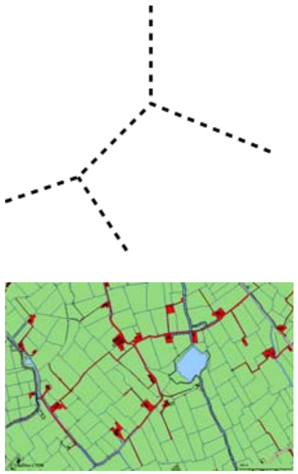
Provincie Utrecht (1866)

Fig. 101 Utrecht from radials in 1866 …

CityDisc (2001) Stratengids (Den Haag) CDrom

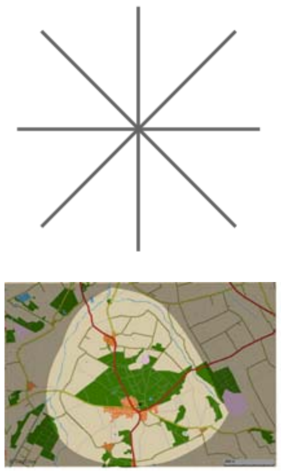
Fig. 102 via tangents into a large-scale grid.

7.5.6 Network types per level of scale



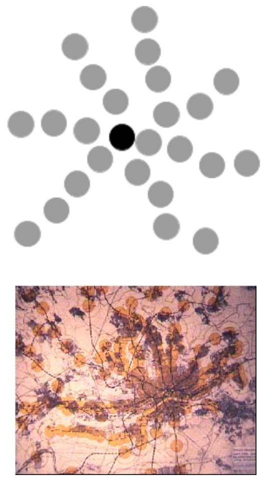
R=1km

Fig. 103 Shortest path



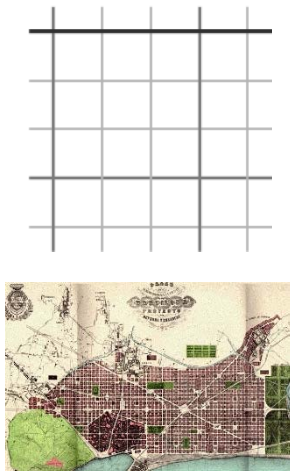
R=3km

Fig. 104 Radial



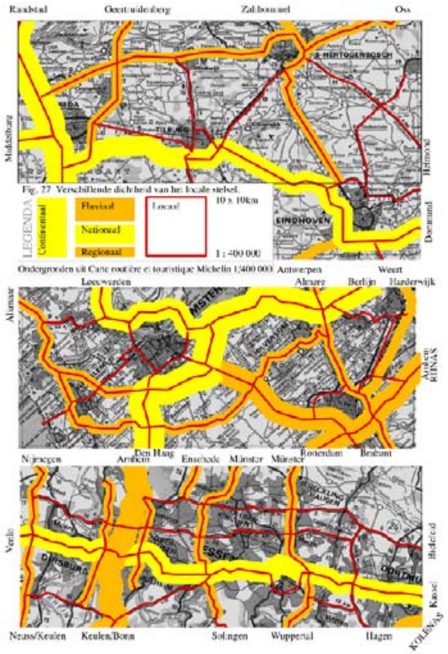
R=10km

Fig. 105 Stops

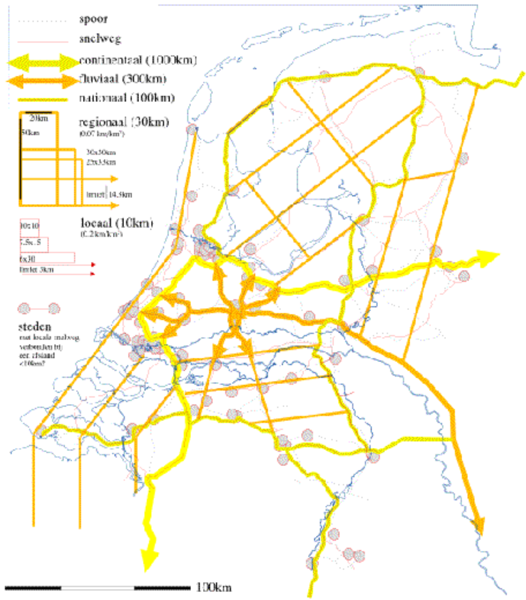


R=0.1-10km

Fig. 106 Grid

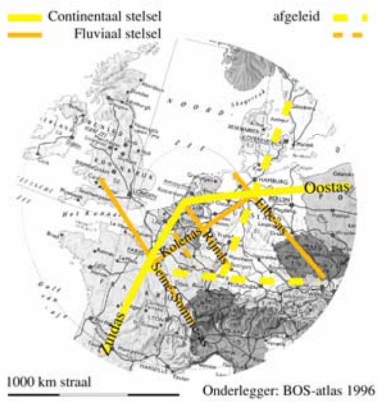


R=30km
Fig. 107 Regional networks



R=100km
Fig. 108 National networks

R=300km
Fig. 109 Fluvial networks

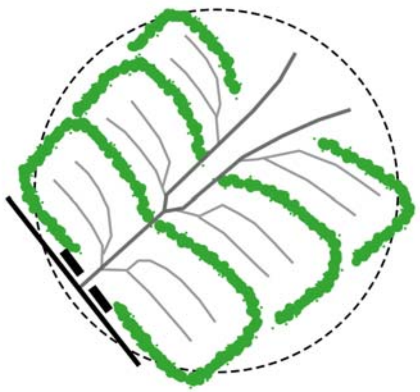


R=1000km
Fig. 110 Continental networks

7.6 Slow traffic connecting urban life

The pedestrian is the basal connector of urban life and all other kinds of its traffic. Not taking care for the pedestrian fragments the residential area, the neighbourhood, the district and the town. It increases casualties promoting the car and these processes strengthen each other. So, care for the pedestrian is the core of urban design. That (p)art of urban design is discussed thoroughly by Bach (2006). So, in this chapter we only summarize some highlights from his work. The cycle increases the velocity reached by human power in flat countries, extending what we call slow traffic, elongating its tracks.

7.6.1 Pedestrians



R=300m

Fig. 111 Reichow: car first

R=300m

Fig. 112 Runcorn: pedestrian first

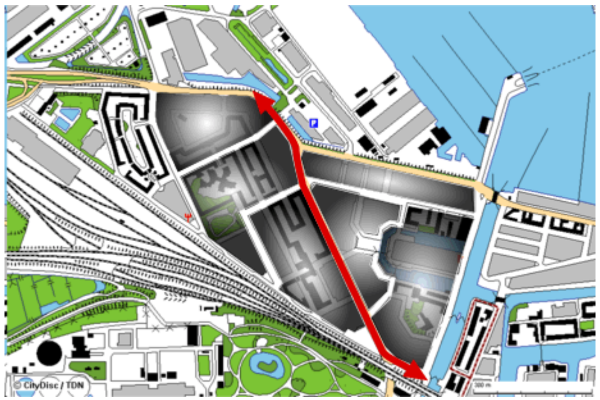


Fig. 113 Cars dividing a neighbourhood

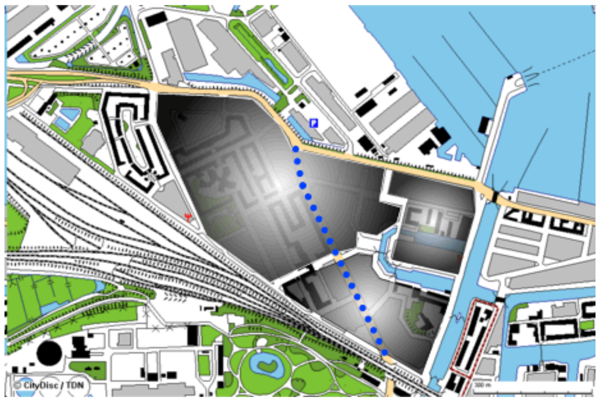


Fig. 114 Traffic calming

7.6.2 Cyclists

Cyclists and pedestrians take the shortest way. So, they introduce radial lines and new crossings in car oriented grids that force detours.

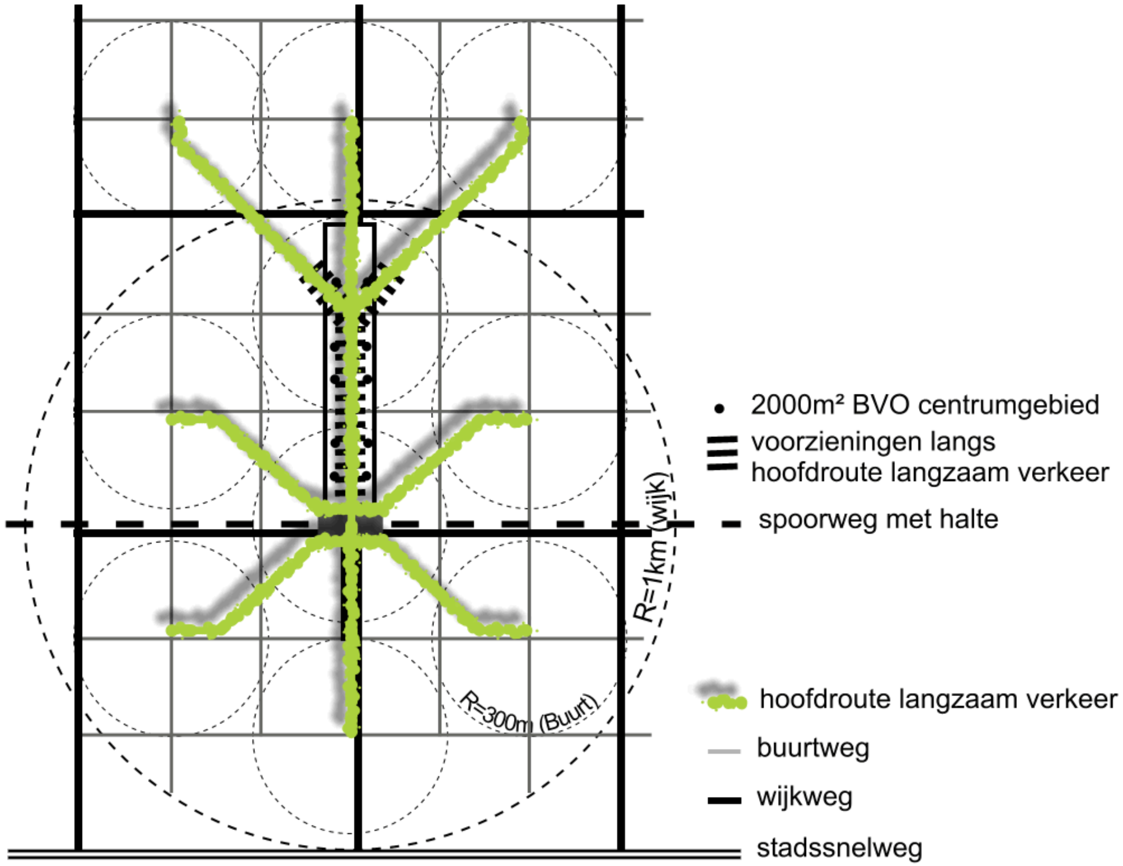


Fig. 115 Radial with a minimum of crossings

7.7 The 4th network: public transport

7.7.1 Busses and stops

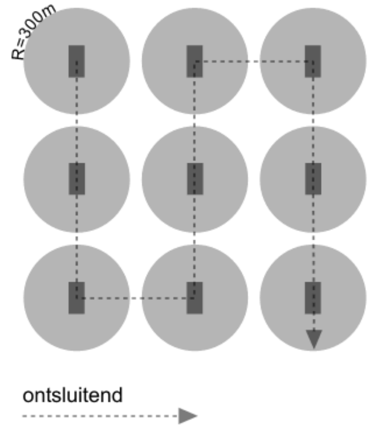


Fig. 116 Collecting travellers

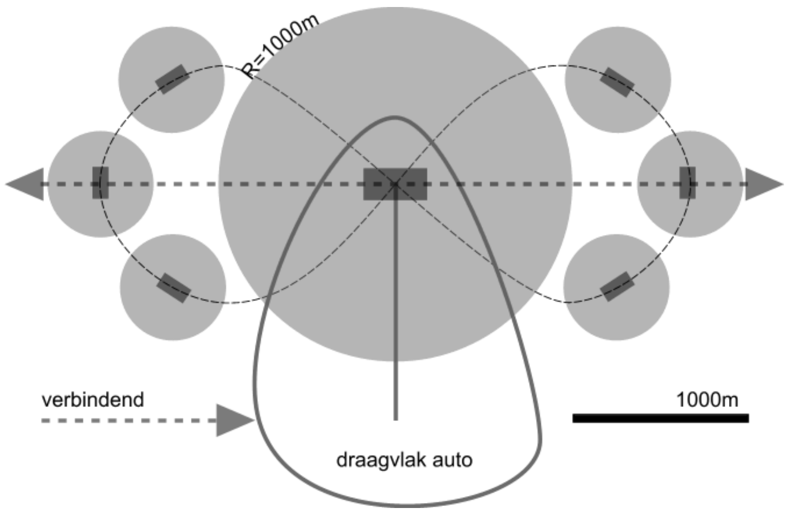


Fig. 117 Connecting travellers

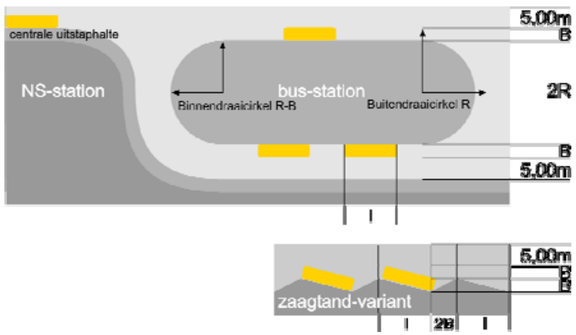


Fig. 118 An island type of central bus station

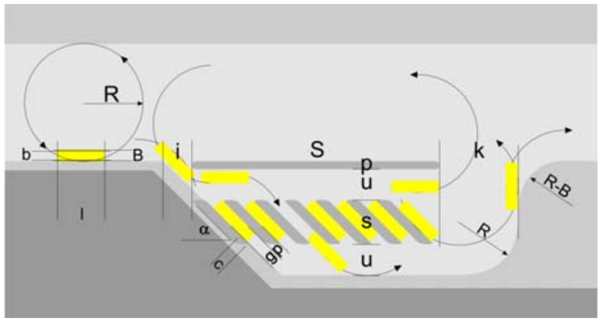


Fig. 119 A herringbone type of central bus station

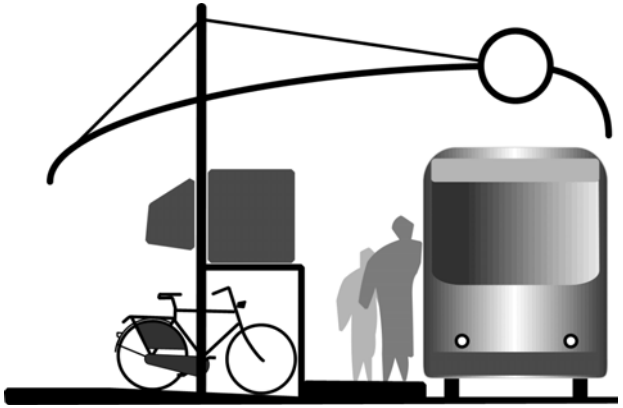


Fig. 120 Bachs (2006) bus stop concerning passengers' demands

Fig. 121 An artists' bus stop

Fig. 122 A Curitiba bus stop

7.7.2 Tramways and metro

		bus	tram	fast tram	(semi)metro	NS-sprinter
	min.	0,0	0,0	0,0	0,0	0,0
km radius served area		**0,3**	**0,3**	**0,5**	**0,6**	**0,8**
	max.	0,4	0,4	0,6	0,8	1,0
	min.	0,3	0,3	0,4	0,7	1,5
km stop distance		**0,4**	**0,4**	**0,6**	**1,1**	**1,8**
	max.	0,5	0,5	0,7	1,4	2,0
	min.	12	12	18	30	40
km/h velocity		**16**	**16**	**22**	**35**	**45**
	max.	20	20	25	40	50
	min.	2	2	4	5	7
km average ride		**4**	**4**	**7**	**10**	**14**
	max.	6	6	10	14	20
minutes ride		**15**	**15**	**20**	**16**	**18**
stops per ride		**10**	**10**	**13**	**9**	**8**
	min.	1000	1667	3333	8000	13333
passengers per hour		**2000**	**3333**	**6667**	**16000**	**26667**
	max.	3000	5000	10000	24000	40000
passengers per stop		**200**	**333**	**524**	**1768**	**3457**

Fig. 123 Some characteristics of urban public transport

Light rail combines all velocities.

From *Fig. 123* you can draw pictures such as *Fig. 124*.

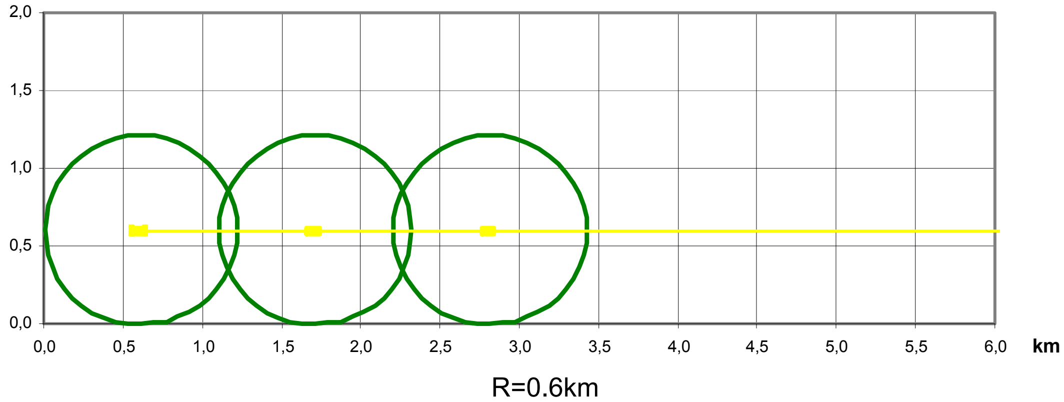


Fig. 124 A metro with 0.6km radius of served area around a stop and 1.1 stop distance from Fig. 123

Supposed you know the line length of *Fig. 124* (for example 10km), you can calculate the number of stops (9+1) and the km^2 served area (10πR^2 minus overlaps) of all stops together. Supposed you know the number of served inhabitants per hectare (100) and the %inhabitants expected to use metro (14%, see *Fig. 123*) you can calculate the number of passengers per day (15144, *Fig. 125*). That will determine whether the line is exploitable or not.

			inh. / dwelling	dwellings/ha	m^2 Floor Space /dwelling	%FS (100%*FSI)
km line length	10					
distance between stops	1.1					
number of stops (9+1)	10					
km² served area	11					
inh./ha	100	for example:	2,3	43	100	43%
number of served inhabitants	110195					
14% passengers per day	15144					

Fig. 125 Calculating the profit of the metro line from Fig. 124

7.7.3 Railways and Stations

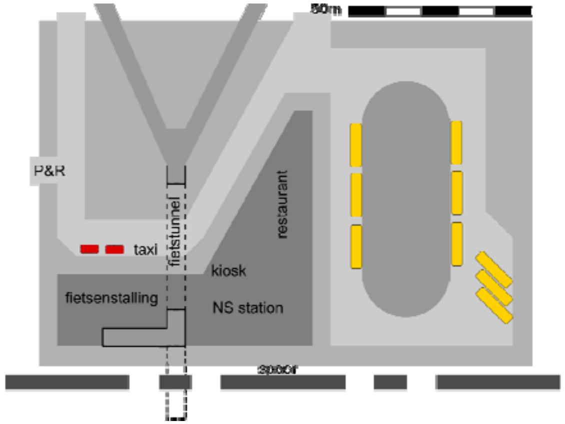


Fig. 126 A railway station accessible for cyclists, pedestrians and busses

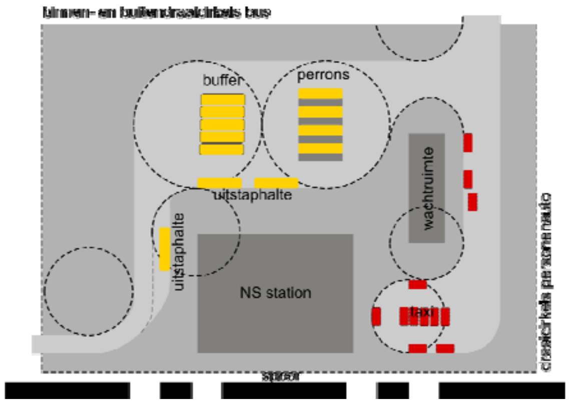


Fig. 127 A railway station for cars based on inner and outer turning circles of busses and cars

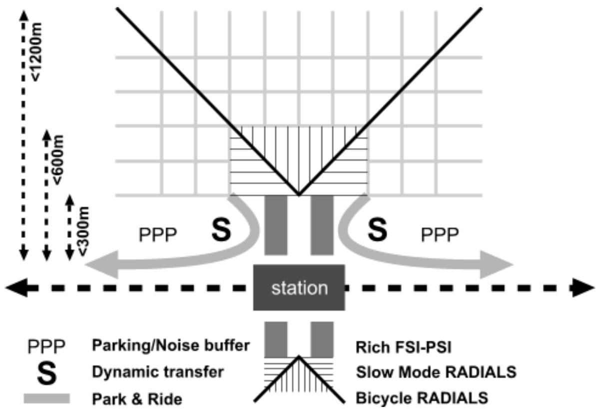


Fig. 128 Approaching the railway station according to Bach (2006)

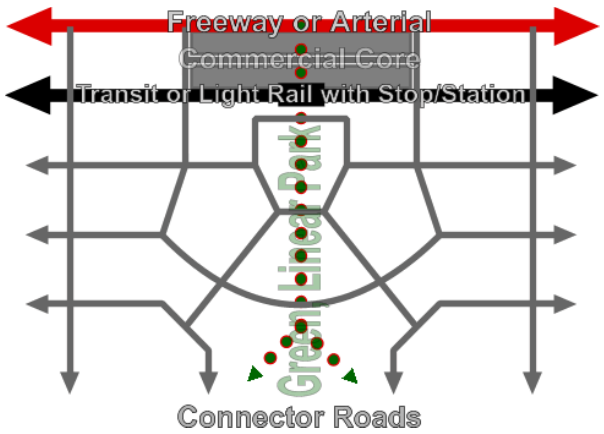


Fig. 129 Approaching the railway station according to Calthorpe

8 Exercise 4, R=3km town, city

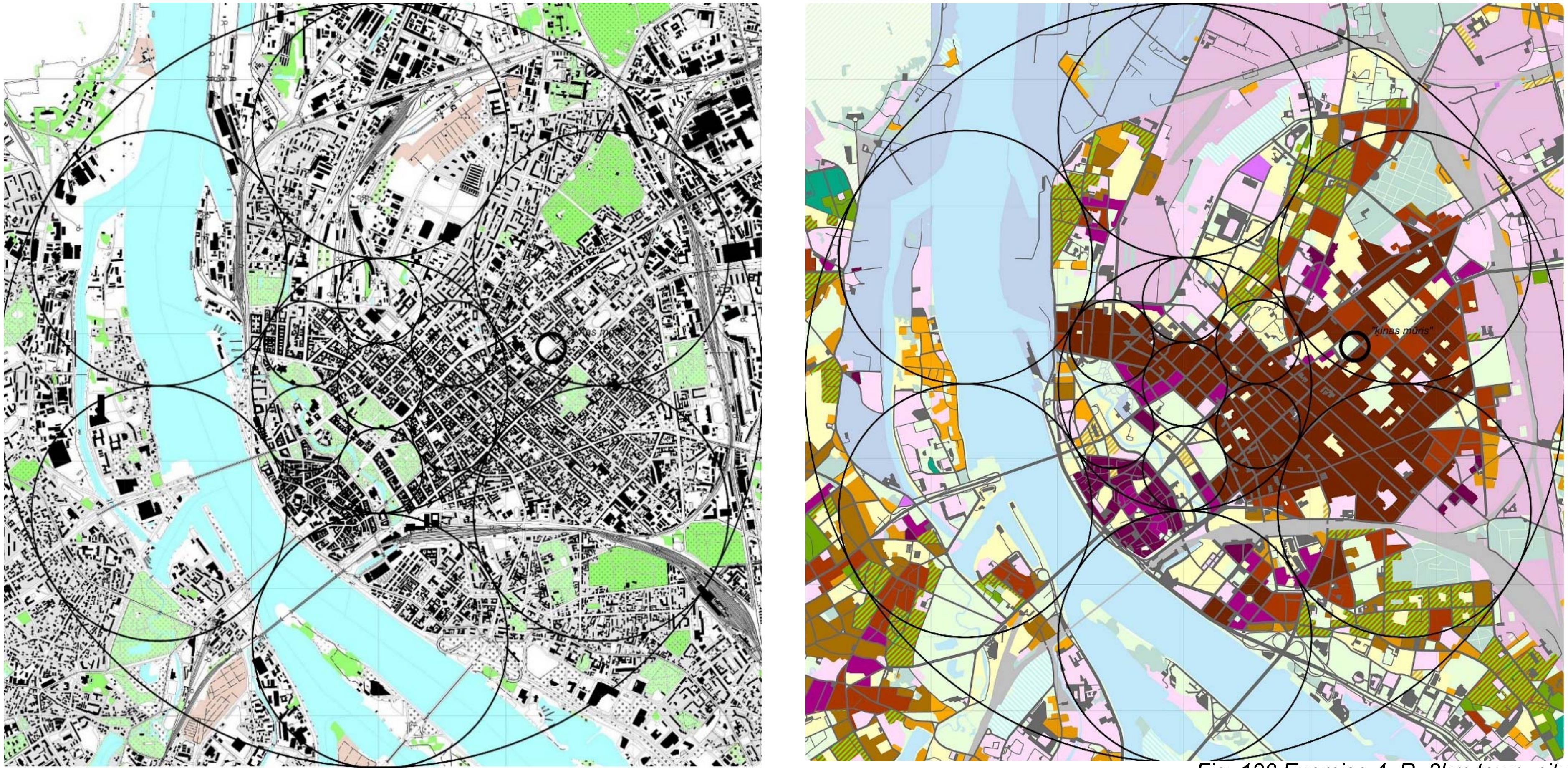


Fig. 130 Exercise 4, R=3km town, city

Characterise the components of the city with a name explaining their identity. Draw dots of standardised size (r={100m, 300m}) for non-residential functions (see page 69).

9 Sprawl and accumulation in a Chinese suburb

A town in China, GuiYang, wanted to develop a mountainous area in its East. An English bureau made a master plan of dispersed highrise around a central mountain. We proposed instead, to give this mountain a ‘crown’.

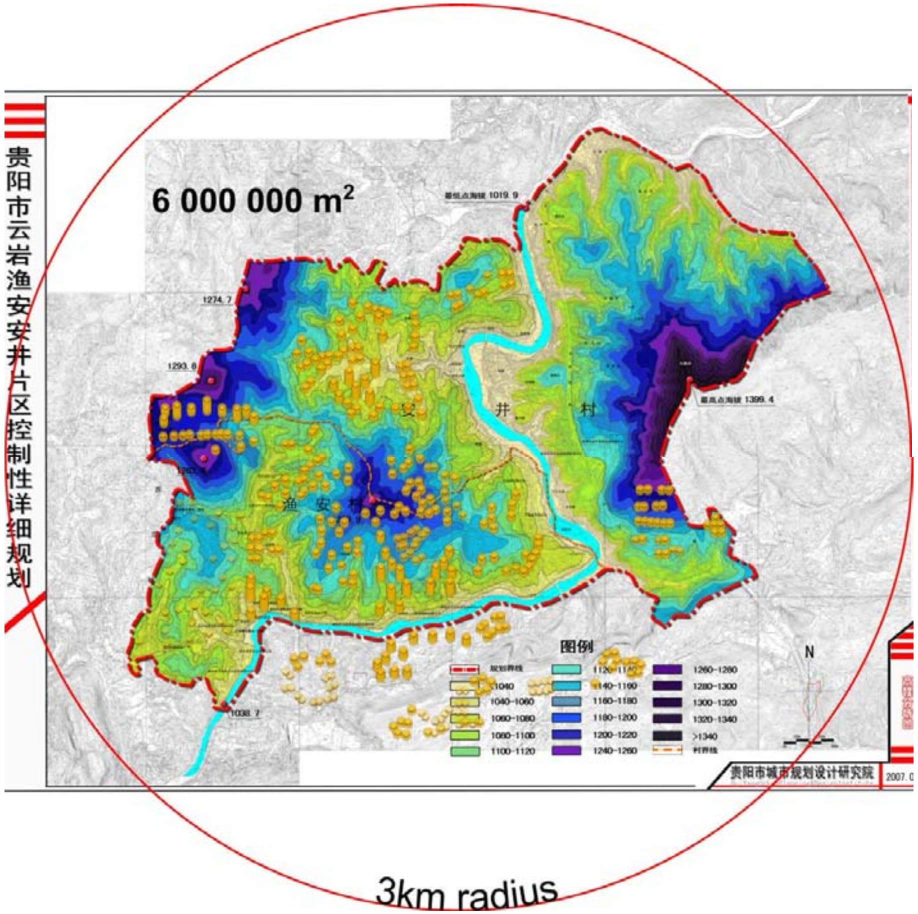


Fig. 131 Sprawl of built-up area according to the master plan

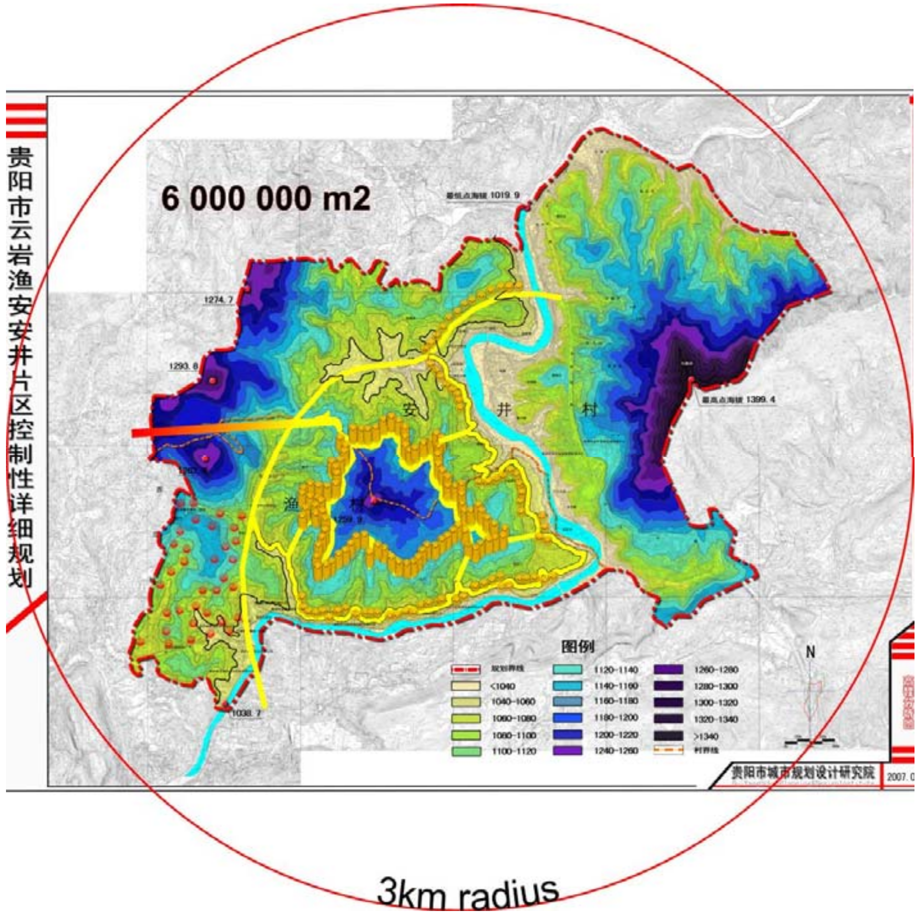


Fig. 132 Accumulation of built-up area according to a thought-experiment

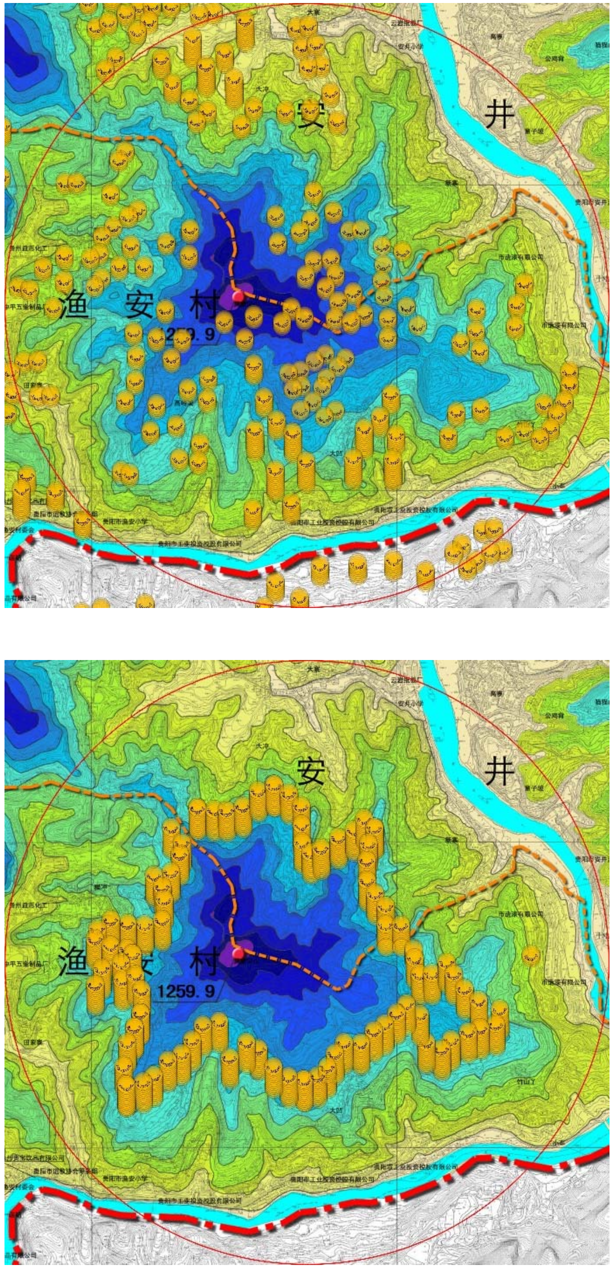


Fig. 133 *Sprawl and accumulation R=1km*

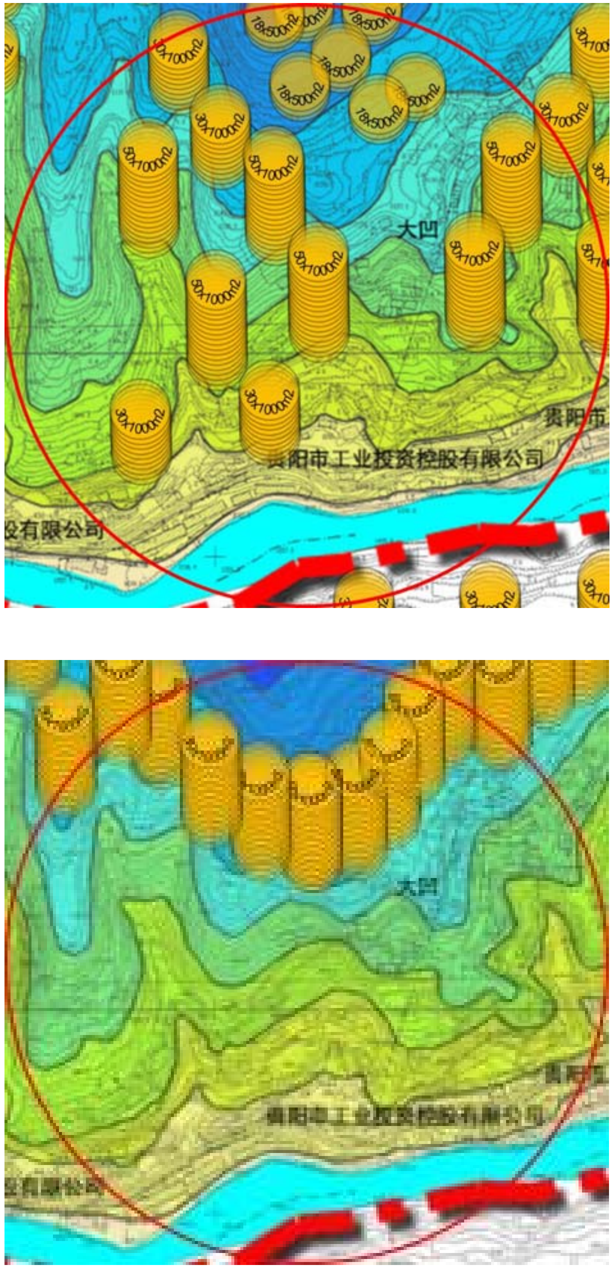


Fig. 134 *Sprawl and accumulation R=300m*

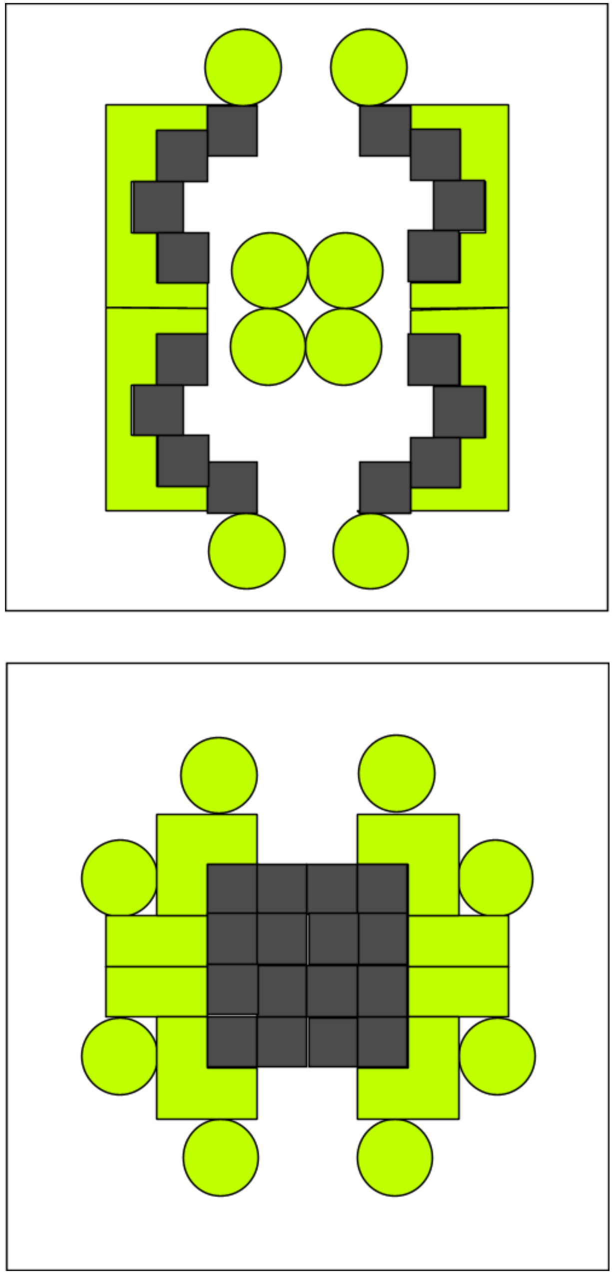
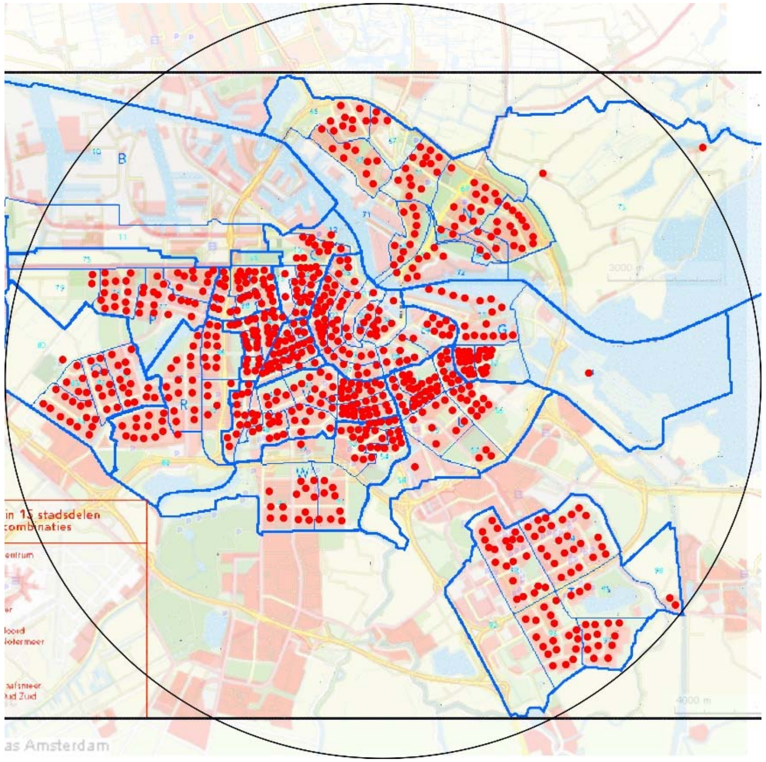


Fig. 7 *page 6 Sprawl and accumulation R=100m*

10 Exercise 5, R=10km conurbation



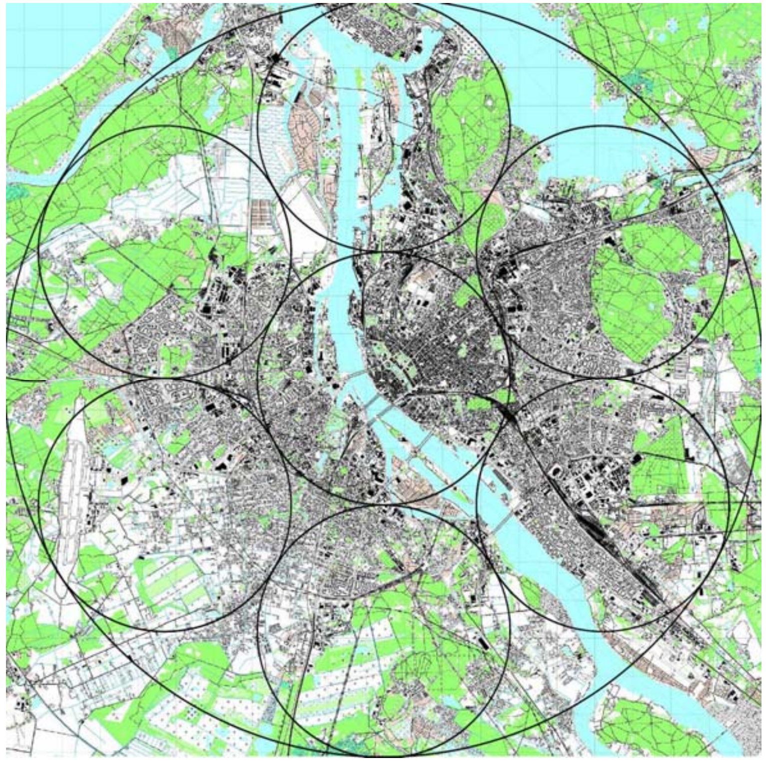


Fig. 135 Exercise 5, R=10km conurbation

Make a dotmap R=10km, r=100m (1000 inhabitants) of Rīga using municipal data of inhabitants per district, and a map showing the built-up areas.

11 Non-residential functions

Type of enterprise	**Required number of inhabitants (The Netherlands 2000)**	***Keeping distance from residential areas***
Management and business consultancy	ensemble	
Animal production	ensemble	*x*
Construction of residential and non-residential buildings	ensemble	*x*
Building completion	ensemble	*x*
Wellness and other services; funeral activities	ensemble	*x*
Shops selling other goods	ensemble	*x*
Paramedical practitioners and other human health activities without accommodation	ensemble	
Support activities in the field of information technology	ensemble	
Architects, engineers and technical design and consultancy	ensemble	
Growing of non-perennial crops	ensemble	*x*
Other education	ensemble	*x*
Accounting, tax consultancy, administration	ensemble	
Restaurants	ensemble	*x*
Advertising agencies and sale of time and space for advertising	ensemble	
Sale of motor vehicles and trailers, also if combined with repair	neighbourhood or hamlet	*x*
Wholesale of consumer goods (no food)	neighbourhood or hamlet	*x*
Medical and dental practice activities	neighbourhood or hamlet	
Construction installation	neighbourhood or hamlet	*x*
Roofing and other specialised construction activities	neighbourhood or hamlet	*x*
Retail sale not via stores and markets	neighbourhood or hamlet	*x*
Shops selling other household equipment	neighbourhood or hamlet	*x*
Support activities for agriculture and post-harvest crop activities	neighbourhood or hamlet	*x*
Wholesale of other machines, equipment and supplies for manufacturing and trade	neighbourhood or hamlet	*x*
Bars	neighbourhood or hamlet	*x*
Other specialised wholesale	neighbourhood or hamlet	*x*
Renting of real estate	neighbourhood or hamlet	
Legal activities	neighbourhood or hamlet	
Freight transport by road	neighbourhood or hamlet	*x*

Specialised shops selling food and beverages	neighbourhood or hamlet	*x*
Social work activities without accommodation (not for elderly and disabled)	neighbourhood or hamlet	
Cleaning activities	neighbourhood or hamlet	*x*
Market sale	neighbourhood or hamlet	*x*
Wholesale on a fee or contract basis	neighbourhood or hamlet	*x*
Intermediation in and management of real estate	neighbourhood or hamlet	
Wholesale of food and beverages	neighbourhood or hamlet	*x*
Activities auxiliary to insurance and pension funding	neighbourhood or hamlet	
Landscape service activities	neighbourhood or hamlet	*x*
Photography and photo and film developing	neighbourhood or hamlet	
Other specialised business services	neighbourhood or hamlet	
Shops selling reading, sports, camping and recreation goods	neighbourhood or hamlet	*x*
Temporary employment agencies and job pools	neighbourhood or hamlet	
Sports activities	neighbourhood or hamlet	*x*
Financial intermediation, consultancy etc. (not for insurance and pension funding)	neighbourhood or hamlet	*x*
Wholesale of information and communication equipment	neighbourhood or hamlet	
Industrial and fashion design	neighbourhood or hamlet	
Manufacture of furniture	neighbourhood or hamlet	*x*
Wholesale of agricultural products and live animals	neighbourhood or hamlet	*x*
Repair of consumer goods (no computers, communication equipment, motor vehicles and motorcycles	neighbourhood or hamlet	*x*
Treatment and coating of metals; machining	neighbourhood or hamlet	*x*
Construction of roads, railways, bridges and tunnels	neighbourhood or hamlet	*x*
Passenger transport by road	neighbourhood or hamlet	*x*
Specialised repair of motor vehicles	neighbourhood or hamlet	*x*
Market research and public opinion polling	neighbourhood or hamlet	
Canteens and catering	neighbourhood or hamlet	*x*
Support activities for transport	neighbourhood or hamlet	*x*
Translators and interpreters	neighbourhood or hamlet	
Employment placement agencies	neighbourhood or hamlet	
Postal activities without universal service obligation and couriers	neighbourhood or hamlet	
Demolition and site preparation	neighbourhood or hamlet	*x*
Buying and selling of own real estate	neighbourhood or hamlet	
Printing and service activities related to printing	neighbourhood or hamlet	*x*
Mixed farming	neighbourhood or hamlet	*x*

Retail sale in non-specialised stores	neighbourhood or hamlet	*x*
World view and political organizations, interest and ideological organizations, hobby clubs	neighbourhood or hamlet	
Inland freight water transport	neighbourhood or hamlet	*x*
Arts	neighbourhood or hamlet	
Investment funds	neighbourhood or hamlet	
Repair of fabricated metal products, machinery and equipment	neighbourhood or hamlet	*x*
Development of building projects	neighbourhood or hamlet	
Growing of plants for ornamental purposes	neighbourhood or hamlet	*x*
Publishing of books, magazines etc.	neighbourhood or hamlet	
Data processing, hosting and related activities; web portals	neighbourhood or hamlet	
Hotels and similar accommodation	neighbourhood or hamlet	
Shops selling consumer electronics	neighbourhood or hamlet	
Manufacture of bakery, pastry and farinaceous products	neighbourhood or hamlet	*x*
Travel agencies and tour operators	neighbourhood or hamlet	
Sale of motor vehicle parts and accessories	neighbourhood or hamlet	*x*
Manufacture of structural metal products	neighbourhood or hamlet	*x*
Renting of consumer goods	neighbourhood or hamlet	
Renting of holiday bungalows and apartments; youth hostels and tourist camps	neighbourhood or hamlet	
Research and development on natural sciences and engineering	neighbourhood or hamlet	
Non-specialised wholesale	neighbourhood or hamlet	*x*
Combined office administrative services and specialised office support	neighbourhood or hamlet	
Veterinary activities	neighbourhood or hamlet	*x*
Renting and leasing of machinery and equipment and of other goods	neighbourhood or hamlet	*x*
Growing of perennial crops	neighbourhood or hamlet	*x*
Manufacture of products of wood, cork, straw and plaiting materials	neighbourhood or hamlet	*x*
Camping sites	district or village	*x*
Private security	district or village	
Social work activities without accommodation for the elderly and disabled	district or village	
Manufacture of medical instruments and supplies	district or village	*x*
Credit granting and other financial intermediation	district or village	
Manufacture of wearing apparel, except fur apparel	district or village	*x*
Motion picture and television programme production and distribution	district or village	
Primary and special education	district or village	*x*
Other recreation	district or village	*x*

Manufacture of other general-purpose machinery	district or village	*x*
Sale and repair of motorcycles and related parts	district or village	*x*
Manufacture of plastics products	district or village	*x*
Manufacture of other textiles	district or village	*x*
Petrol stations	district or village	*x*
Building of ships and boats	district or village	*x*
Manufacture of jewellery, bijouterie and related articles	district or village	*x*
Secondary education	district or village	*x*
Lending of cultural goods, public archives, museums, botanical and zoological gardens and nature reserves activities	district or village	*x*
Other business support activities	district or village	*x*
Technical testing and analysis	district or village	*x*
Construction of utility projects	district or village	*x*
Manufacture of other fabricated metal products	district or village	*x*
Repair of computers and communication equipment	district or village	*x*
Other telecommunications activities	district or village	*x*
Research and development on social sciences and humanities	district or village	
Manufacture of other special-purpose machinery	district or village	*x*
Electric power generation; transmission and distribution of gas and electricity	district or village	*x*
Inland passenger water transport and ferry-services	district or village	*x*
Leasing of intellectual property and similar products, except copyrighted works	district or village	
Public administration	district or village	
Organisation of conventions and tradeshows	district or village	
Warehousing and storage	district or village	*x*
Fishing	district or village	*x*
Sea and coastal water transport (cargo and tank ships, tug boats)	district or village	*x*
Sound recording and music publishing	district or village	
Business, employers and professional membership organisations	district or village	
Forging, pressing, stamping and roll-forming of metal; powder metallurgy	district or village	*x*
Renting of motor vehicles	district or village	*x*
Manufacture of glass and glass products	district or village	*x*
Installation of industrial machinery and equipment	district or village	*x*
Slaughterhouses and processing of meat	district or village	*x*
Residential and day care for mental retardation and mental health	district or village	*x*
Manufacture of other food products	district or village	*x*

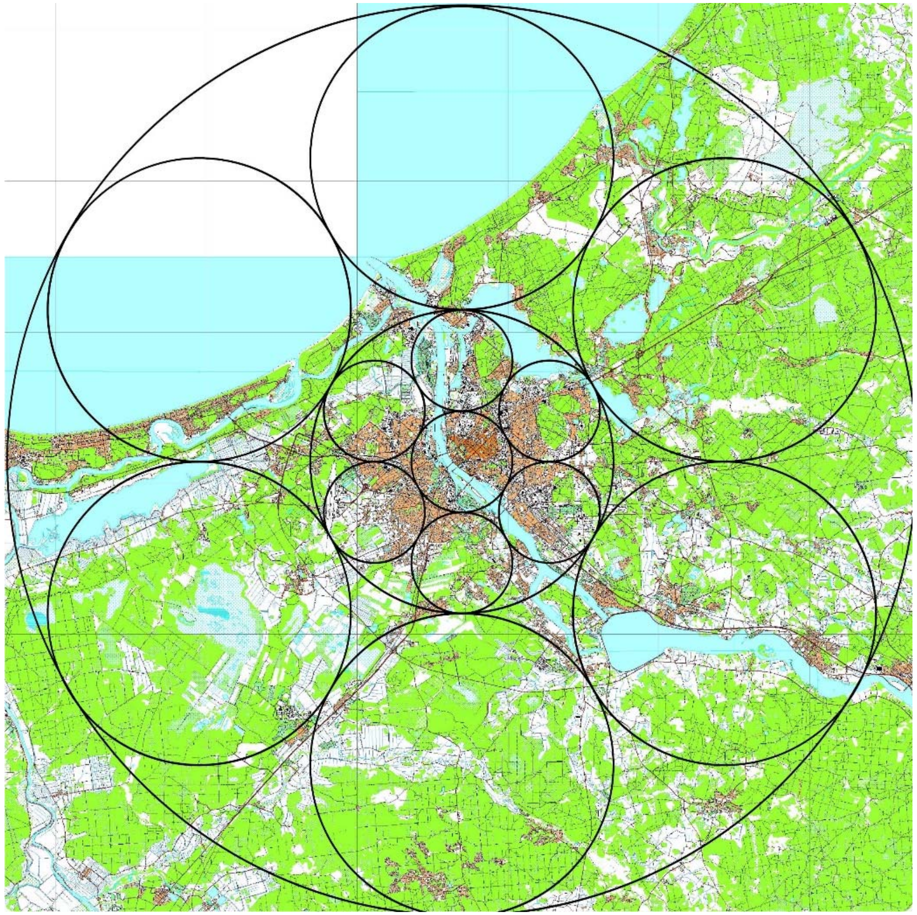
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	district or village	*x*
Manufacture of other products n.e.c.	district or village	*x*
Educational support activities	district or village	
Manufacture of articles of concrete, cement and plaster	district or village	*x*
Manufacture of engines, turbines, pumps, compressors, taps, valves and driving elements	district or village	*x*
Manufacture of instruments for measuring, testing and navigation; watches and clocks	district or village	*x*
Tourist information and reservation services	district or village	
Hospitals	district or village	*x*
Residential and day care for the disabled and elderly	district or village	
Manufacture of cutlery, tools and general hardware	district or village	*x*
Stone dressing	district or village	*x*
Lotteries and betting	district or village	
Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus	district or village	*x*
Manufacture of articles of paper and paperboard	district or village	*x*
Higher education	district or village	
Manufacture of other electrical equipment	district or village	*x*
Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	district or village	*x*
Waste collection	district or village	*x*
Silviculture	district or village	*x*
Reproduction of recorded media	district or village	
Materials recovery	district or village	*x*
Manufacture of agricultural and forestry machinery	district or village	*x*
Manufacture of dairy products	district or village	*x*
Manufacture of electric lighting equipment	district or village	*x*
Social assistance with residential care to children and other persons (no elderly and disabled)	district or village	
Waste treatment and disposal	district or village	*x*
Remediation activities and other waste management	district or village	*x*
Passenger air transport	district or village	*x*
Manufacture of musical instruments	district or village	*x*
Manufacture of games and toys	district or village	*x*
Insurance (no reinsurance)	district or village	
Finishing of textiles	district or village	*x*
Manufacture of electronic components and boards	district or village	*x*
Manufacture of other porcelain and ceramic products	district or village	*x*

Wired telecommunications activities	district or village	*x*
Sawmilling and planing of wood	district or village	*x*
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness; dressing	district or village	*x*
Aquaculture	district or village	*x*
Callcenters	district or village	*x*
Manufacture of prepared animal foods	district or village	*x*
Manufacture of soap and detergents, cleaners, perfumes and toilet preparations	district or village	*x*
Construction of other civil engineering projects	district or village	*x*
Manufacture of beverages	town	*x*
Manufacture of transport equipment n.e.c.	town	*x*
Manufacture of pharmaceutical preparations	town	*x*
Manufacture of machine tools	town	*x*
Manufacture of sports goods	town	*x*
Mining of stone, sand and clay	town	*x*
Manufacture of computers and peripheral equipment	town	*x*
Manufacture of parts and accessories for motor vehicles	town	*x*
Sea and coastal passenger water transport and ferry-services	town	*x*
Processing of potatoes, vegetables and fruit	town	*x*
Pension funding	town	
Manufacture of consumer electronics	town	*x*
Manufacture of optical instruments and photographic equipment	town	*x*
Security systems service activities	town	
Sewerage	town	*x*
Processing of fish	town	*x*
Manufacture of motor vehicles	town	*x*
Residential nursing care	town	
Logging	town	*x*
Casting of metals	town	*x*
Manufacture of paints, varnishes and similar coatings, printing ink and mastics	town	*x*
Public services	town	*x*
Manufacture of other chemical products	town	*x*
Investigation activities	town	
Support activities for petroleum and natural gas extraction	town	*x*
Manufacture of grain mill products, starches and starch products	town	*x*

Manufacture of footwear	town	*x*
Manufacture of rubber products	town	*x*
Manufacture of domestic appliances	town	*x*
Manufacture of basic precious and other non-ferrous metals	town	*x*
Manufacture of reservoirs of metal and of boilers and radiators for central heating	town	*x*
Manufacture of communication equipment	town	*x*
Radio broadcasting	town	*x*
Manufacture of abrasive products and non-metallic mineral products n.e.c.	town	*x*
Monetary intermediation	town	
Other information service activities	town	*x*
Manufacture of irradiation, electromedical and electrotherapeutic equipment	town	*x*
Support activities to forestry	town	*x*
Manufacture of wiring and wiring devices	town	*x*
National postal activities under universal service obligation	town	
Manufacture of basic iron and steel and of ferro-alloys	town	*x*
Manufacture of aircraft	town	*x*
Manufacture of clay building materials	town	*x*
Trade unions	town	
Manufacture of refined petroleum products	town	*x*
Manufacture of tubes, pipes, hollow profiles and related fittings of steel	town	*x*
Payrolling	town	
Other mining and quarrying	town	*x*
Manufacture of vegetable and animal oils and fats	town	*x*
Weaving of textiles	town	*x*
Manufacture of knitted and crocheted apparel	town	*x*
Television broadcasting	town	*x*
Extraction of crude petroleum	town	*x*
Preparation and spinning of textile fibres	town	*x*
Manufacture of pulp, paper and paperboard	town	*x*
Manufacture of man-made fibres	town	*x*
Collection, purification and distribution of water	town	*x*
Hunting	town	*x*
Other first processing of steel	town	*x*
Manufacture of magnetic and optical media	town	*x*

Compulsory social security	town	
Extraction of natural gas	town	*x*
Manufacture of pesticides and other agrochemical products	town	*x*
Manufacture of basic pharmaceutical products	town	*x*
Wireless telecommunications activities	town	*x*
Manufacture of tobacco products	conurbation	*x*
Manufacture of batteries and accumulators	conurbation	*x*
Manufacture of railway rolling stock	conurbation	*x*
Passenger rail transport (no tram or metro)	conurbation	*x*
Fund management	conurbation	
Manufacture of refractory products	conurbation	*x*
Manufacture of weapons and ammunition	conurbation	*x*
Transport via pipeline	conurbation	*x*
Facility management	conurbation	*x*
Manufacture of articles of fur	conurbation	*x*
Manufacture of cement, lime and plaster	conurbation	*x*
Manufacture of steam generators, except central heating hot water boilers	conurbation	*x*
Freight air transport	conurbation	*x*
Satellite telecommunications activities	conurbation	*x*
Reinsurance	conurbation	
Support activities for other mining and quarrying		*x*
Manufacture of coke oven products		*x*
Manufacture of military fighting vehicles		*x*
Manufacture of gas		*x*
Steam and air conditioning supply		*x*
Freight rail transport		*x*
Other provision of lodgings n.e.c.		*x*
Software publishing		

12 Exercise 6, R=30km urban region



Characterise the components of the region with a name explaining their identity.

Name variables expressing changes of character over 30km

Name some of their values as useful legend units

Fig. 136 Exercise 6, R=30km urban region

13 The urban region of Adapazarı

The city of Adapazarı in the Turkish region of Sakarya, has been hit by an earthquake in 1999 with many casualties in the lower muddy area.

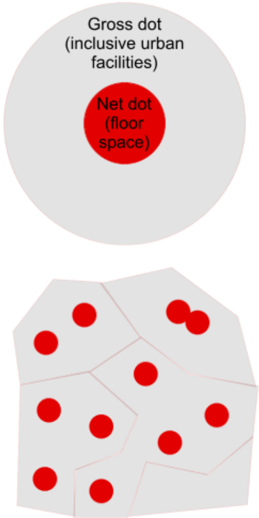


Fig. 137 The net dots of Fig. 138 cover a surface with a radius R=100m (3ha), approximately the floor surface that 1 000 inhabitants need (approximately 30m² per inhabitant).

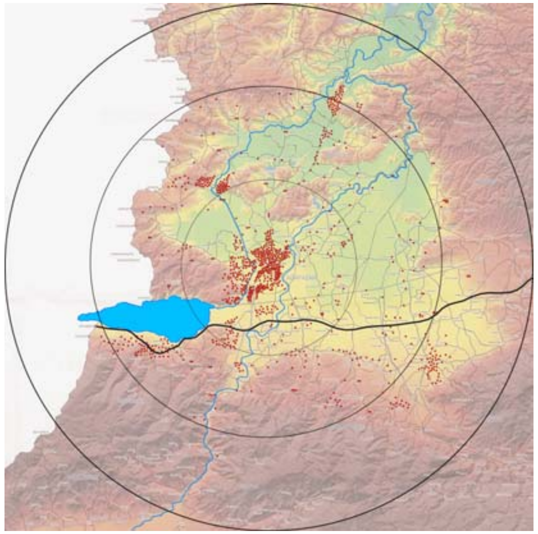


*Fig. 138 Distribution of actual population in net dots of 1 000 inhabitants.
Circles shown R=10km, R=20km and R=30km.
In this paper R=10km means 3<R<30km*

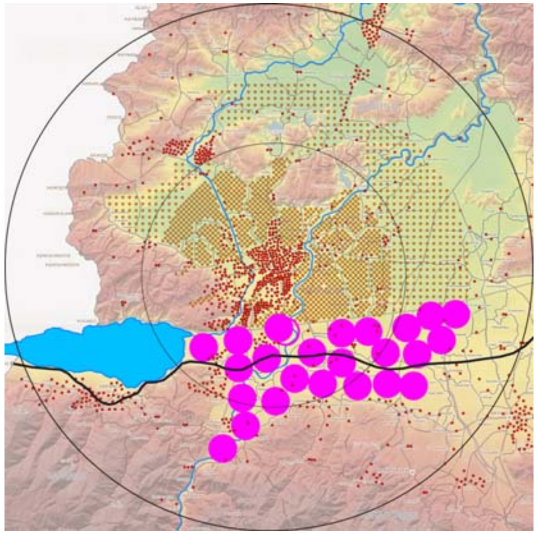
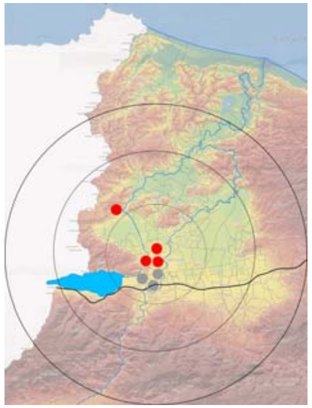


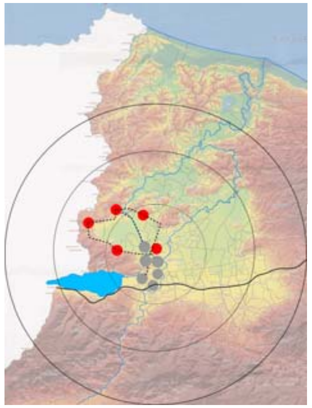
*Fig. 139 A reference high-risk scenario for 2 000 000 inhabitants 2030 without master plan and supervision concentrically grown from R=3 into R=15km.
Casualties 2030: probably 120 000 inhabitants*

An uncontrolled growth would probably cause much more casualties through the next earthquake to be expected within 30 years.
A low-risk scenario has been developed in order to avoid more casualties and to provide more identity to the residential areas of the future.



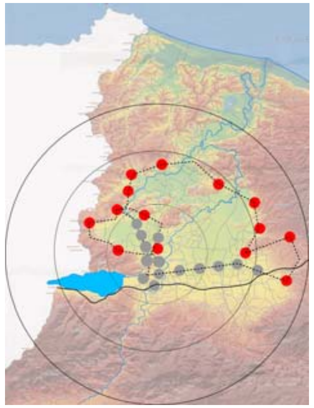
H00

Fig. 140 Actual 400 000 inhabitants.



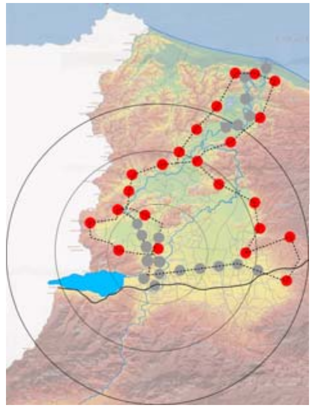
H10

Fig. 141 Partially moved grown population of 500 000 inhabitans.



H20

Fig. 142 First regional extension until 1 400 000 inhabitants.



H30

Fig. 143 Second regional extension until 2 300 000 inhabitants.

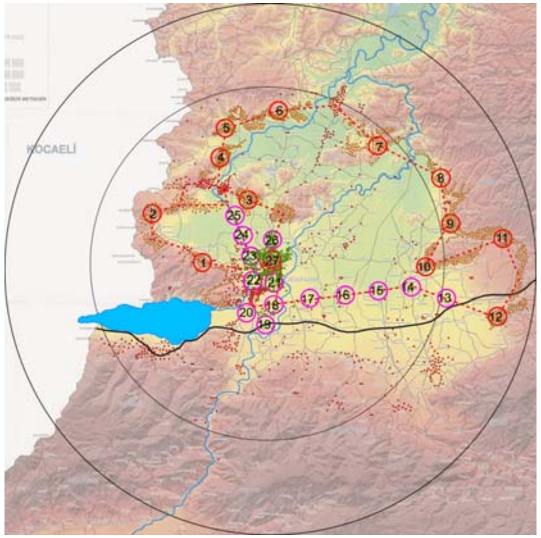
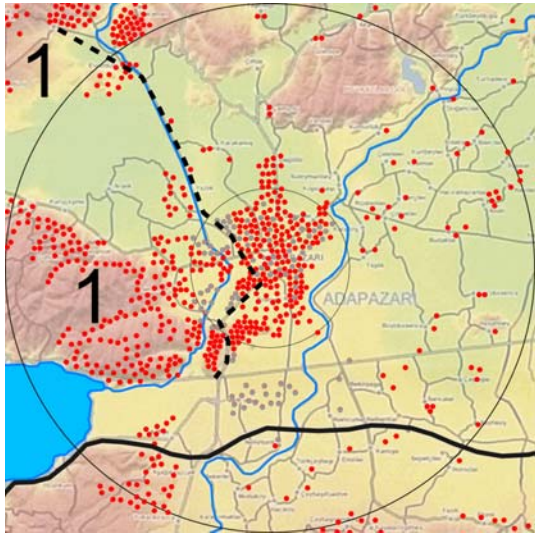
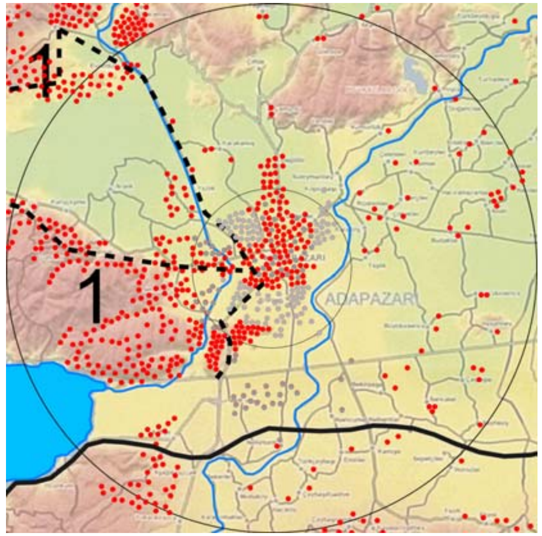


Fig. 144 The low-risk scenario divided into 27 different local identities.



E11

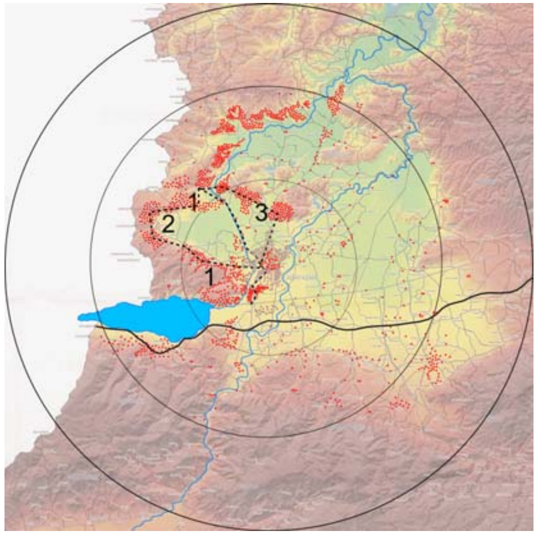
Fig. 145 First moving of 100 000 people (grey) from old Adapazarı into new locations[a].



E12

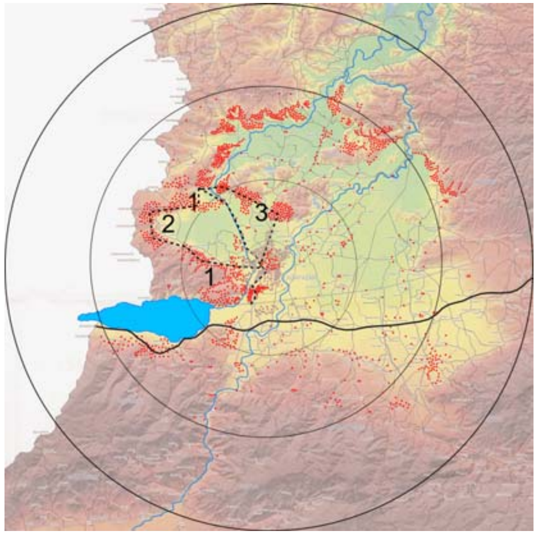
Fig. 146 Second evacuation of 100 000 people from old Adapazarı.

[a] This drawing is only meant as a quantitative inpression. It has te be improved by furter investigation. The precise location of the dots depends on possibilities of writing off, building technological and soil mechanical status and resulting risks.



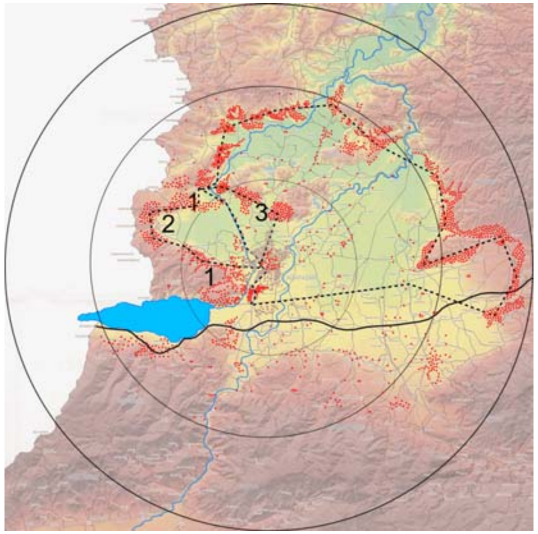
H21

Fig. 147 First shift of settlements for 300 000 inhabitants of a greater metropolitan area.



H22

Fig. 148 Second shift of new settlements for 200 000 inhabitants of a greater metropolitan area.



H23

Fig. 149 Third shift of new settlements for 400 000 inhabitants of a greater metropolitan area up to 1 400 000 inhabitants (2 000 000 inhabitants including rural areas).

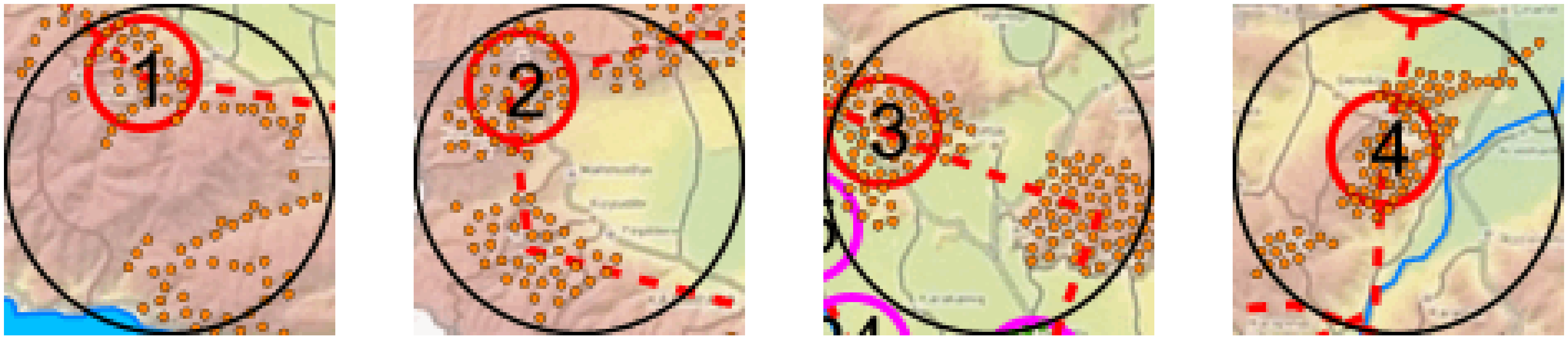
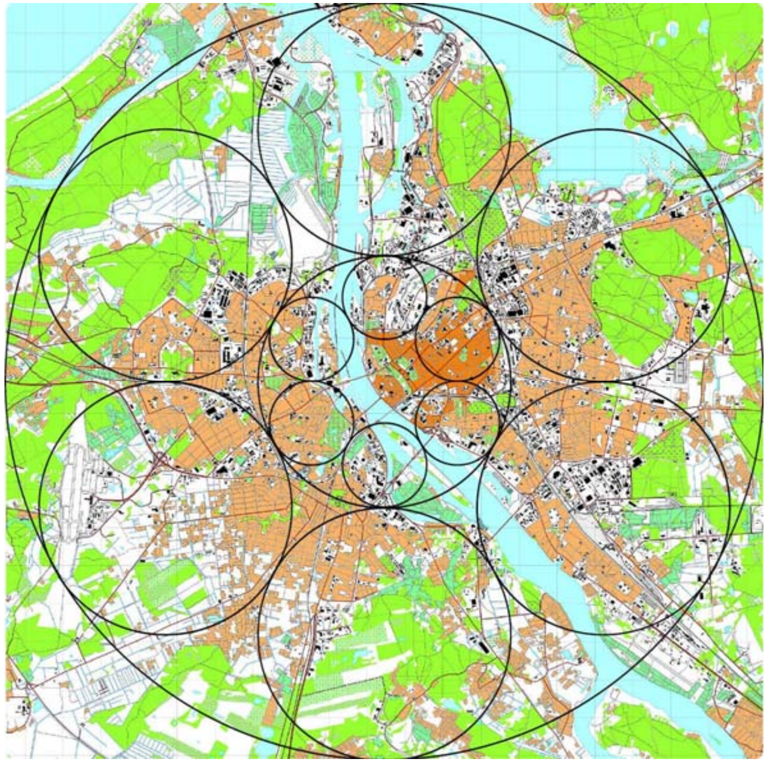


Fig. 150 The first 4 locations enlarged.

14 Exercise 7, R=10km Rīga conurbation



Compare the mesh-width of roads with the hierarchy of page 32.
Indicate areas with the number of their lowest category (1-8).
Indicate missing categories.

Compare the distribution of green with the SGS of page 23.

Write a proposal for a design study about the Rīga conurbation.

Fig. 151 Exercise 7, R=10km Rīga conurbation

15 Future Impact

In order to involve the right stakeholders, specialists and future users in a design team, you should clarify the intended and expected impacts of the project first. If the design still has to be made, then you cannot foresee its impacts completely, but you can make an inventory at which level of scale and in which respect (physical, ecological, technical, economic, cultural and managerial) the project will have its impacts. The intended impacts represent your programme of requirements for the project, but you should not neglect the unintended or even negative impacts.

The intended impacts depend on your hidden expectations about the future. So, you should not only make an inventory of the intended impacts, but also clarify these expectations. The context of the project may change in the future, and consequently the impacts of the project may change (physical, ecological, technical, economic, cultural and managerial impacts at different levels of scale). If so, then nobody can blame you afterwards if you can show your initial inventory of starting points: the intended and expected impacts in the beginning.

Once you have invited candidates for your design team, you should repeat this exercise together with them, in order to add *their* intentions and expectations about the impacts of the project if they would join the team. But how to do it?

The context figure on page 5 shows 22 levels of scale horizontally and 6 layers vertically in a matrix. The lowest layer is the physical layer of your project. Within this layer, it covers a range of scale levels between two boundaries: its frame and its grain. You may notate them in the scheme as ‘O’ and ‘o’. If you do so, then you make clear, that your work will not extend into more detail or into larger levels of scale than you have promised.

However, the impacts of the project may influence any level and layer. The intended impacts cannot be foreseen completely, but you can locate them in the appropriate levels and layers with a ‘P’, because they represent the locations (and people!) where parts of the programme of requirements may stem from. These positions may also indicate who wants to pay for these positive impacts: who wants to contribute in funding your project.
Do not neglect the unintended or even negative effects. Locate them in the scheme as ‘I’ (Impact as such), and invite also people that can undergo or estimate these impacts.

Once you have made this inventory of intended and possible impacts, or at least on which level and layer they play a role, you should realise that they are based on (often hidden) expectations about the future context. And, this context may (and it will !) change in the future. It is worth the effort to clarify these expectations beforehand, because they also can change, causing reduced or reinforced motivations within your team. But, how to do it?

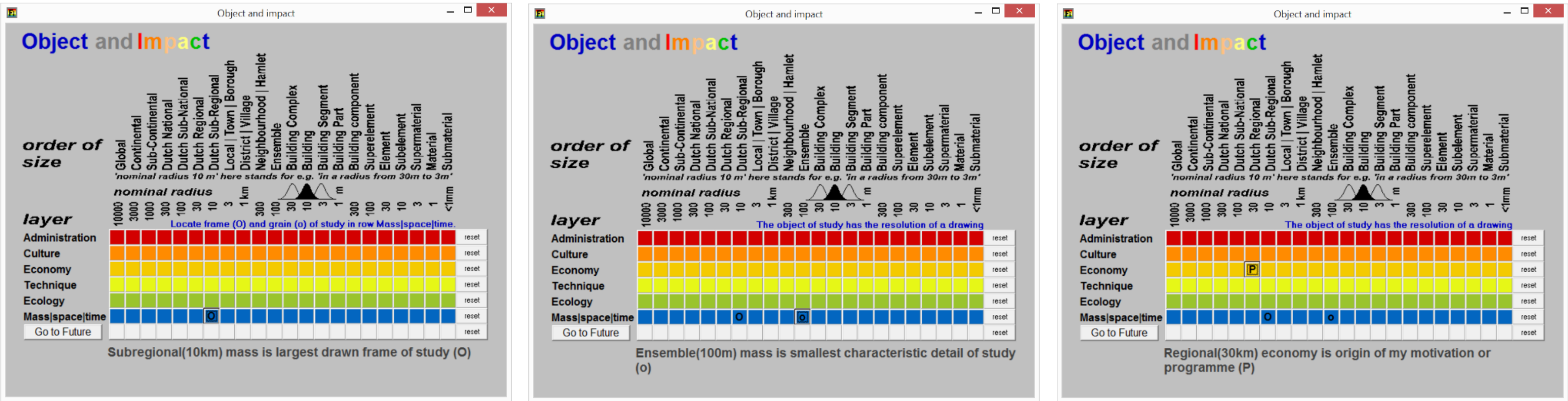
In order to make an inventory of the expectations behind the intentions, you can use the same matrix. Restrict yourself to the locations used in the first matrx, make a second matrix, and ask what the candidates expect there. Do they expect a laissez-faire management (notate ‘?’) or a more (pro)active management with own initiative (‘!’) . This can differ on different levels of scale. National, municipal, local, project- and supply- management may differ in this respect.
This clarification of expectations puts the intentions in a perspective of reality and feasibility, and this counts even more for the other layers. But, which are the appropriate extremes in cultural, economic, technical, ecological and physical for your questionnaire?

For the cultural extremes I would notate ‘<’ for ‘traditional’ and ‘>’ for ‘innovative’.
For the economic extremes I would notate ‘-’ for ‘decline’ and ‘+’ for ‘growth’.
For the technical extremes I would notate ‘/’ for ‘separating functions’ and ‘X’ for ‘combining functions’.
For the ecological extremes I would notate ‘|’ for ‘more heterogeneity and ‘=’ for ‘more homogeneity’.
For the physical extremes I would notate ‘C’ for ‘concentration’ and ‘D’ for ‘dispersion or sprawl’.

In order to make fast inventories this way, I made the computer program ‘FutureImpact’.

15.1 The FutureImpact computer program

If only economy counts, an individual or public session with the computer program may look as is depicted below.



Second screen:

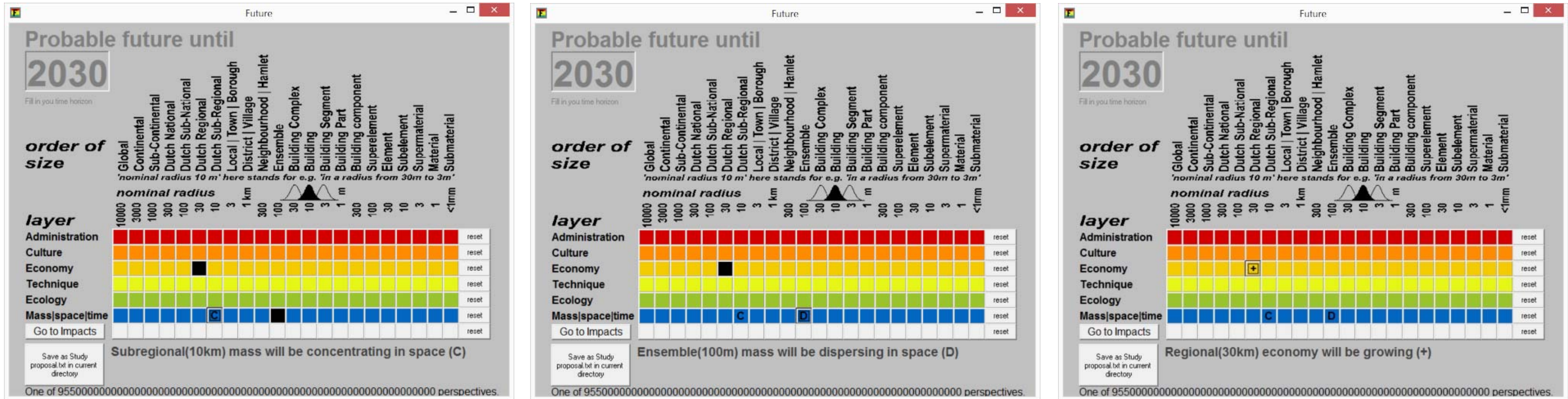


Fig. 152 The FutureImpact computer program

If you push the button left below, than an adapable .txt concept proposal is made in the map where the program itself is located on your computer.

15.2 A study proposal generated by the computer program

This text is an adaptation of the .txt file generated by the program This .txt file is primarily intended for students, but it can be adapted easily.

Jong (2014) Proposal for a design study about the Rīga conurbation (Delft) DUT Faculty of Architecture

CONTENTS
<as soon as you have added a heading style to each heading in Word, you can automatically insert a list of contents here>

1 OBJECT OF STUDY AND ITS CONTEXT

1.1 OBJECT OF MY STUDY
The object of study has the resolution of a drawing for 2030 on conurbation (R=10km) scale with smallest details on Ensemble(r=100m) level.

1.2 PROBABLE FUTURE CONTEXT: FIELD OF PROBLEMS
My assumptions about the probable future context of the object of study until 2030 are:

Future 2030	Global(10000km)	Continental(3000km)	Subcontinental(1000km)	National(300km)	Subnational(100km)	Regional(30km)	Conurbation(10km)	Town(3km)	District(1km)	Neighbourhood(300m)	Ensemble(100m)	Buildingcomplex(30m)	Building(10m)	Buildingsegment(3m)	Buildingpart(1m)	Buildingcomponent(300mm)	Superelement(100mm)	Element(30mm)	Subelement(10mm)	Supermaterial(3mm)	Material(1mm)	Submaterial(<1mm)	
management																							
culture																							
economy						+																	
technique																							
ecology																							
physics							C				D												

management is initiating (!) or executing or controlling initiatives (?)
culture is innovative (>) or traditional (<)
economy is growing (+) or declining (-)
technique is internally specializing subfunctions (/) or internally combining subfunctions (X)
ecology is internally differentiating into heterogeneity (|) or internally leveling into homogeneity (=)
physics is concentrating in space (C) or dispersing in space (D)

As far as this future is not desirable it will generate a field of problems (Jong and Priemus(2002)).
As relevant probable but undesired development (emerging problems) I consider: a less attractive region if population increases.

1.3 DESIRED IMPACTS OF MY STUDY: FIELD OF AIMS
My study derives its motivation, intention, aims or even programme of requirements from fields indicated by a P in the next table:

Impacts 2030	Global(100000km)	Continental(3000km)	Subcontinental(1000km)	National(300km)	Subnational(100km)	Regional(30km)	Conurbation(10km)	Town(3km)	District(1km)	Neighbourhood(300m)	Ensemble(100m)	Buildingcomplex(30m)	Building(10m)	Buildingsegment(3m)	Buildingpart(1m)	Buildingcomponent(300mm)	Superelement(100mm)	Element(30mm)	Subelement(10mm)	Supermaterial(3mm)	Material(1mm)	Submaterial(<1mm)	
management																							
culture																							
economy						P																	
technique																							
ecology																							
physics							O				o												

Legend:
largest drawn frame of study (O) and smallest characteristic detail of study (o)
affected without intention (I) or origin of my motivation or programme (P)

It also indicates which actors (problem owners) will be primarily favoured by realising the results of my study:
Actor on the layer and level of growing (+) Regional(30km) economy is the economic department of the region.
It possibly will support an assignment and a programme of requirements to change undesired developments.

1.4 MY DESIGNERLY REFERENCES: FIELD OF MEANS
Examples within a similar context below fascinate me professionally: …
A **programme of requirements** of these examples would contain next elements: …
From these images I derive next **types of composition**, components and details, relevant in my study:…
<search for relevant key words in T. M. d. Jong and D. J. H. v. d. Voordt Ways to research and study urban, architectural and technical design (Delft) Delft University Press, refer properly to chapters and draw relevant types. Make a typological inquiry into the images with sketches and explanations>
From these images I derive next possible **generating conceptions** directing my study: …
<read Leupen (2002), search for relevant key words in T. M. d. Jong and D. J. H. v. d. Voordt Ways to research and study urban, architectural and technical design (Delft) Delft University Press, refer properly to chapters. Write and draw possible conceptions that can give your study direction in all its phases>
To elaborate and evaluate such types and conceptions for my study next kinds of **models** could be used:
<search for relevant key words in T. M. d. Jong and D. J. H. v. d. Voordt Ways to research and study urban, architectural and technical design (Delft) Delft University Press, refer properly to chapters. Read Klaasen (2002); describe verbal, mathematical, spatial, mechanical or other models useful for your study>
To use such models I will need data and assumptions. **Sources** where I can find data are: …
<name sources where you can find data for your study within the available time>
For **data** I cannot find within the available time, I will make assumptions such as:…
<name assumptions you are not going to research in further detail>
They are supposed to be elaborated in other studies.
Key words: <describe possibly useful methods for your study; change next lines as reminders into your own words>
<search for relevant key words in T. M. d. Jong and D. J. H. v. d. Voordt Ways to research and study urban, architectural and technical design (Delft) Delft University Press, refer properly to chapters; change next lines as reminders into your own words>

Useful **methods** of naming and describing are: …
Useful methods of design research and typology are: …
Useful methods of evaluating are: …
Useful methods of modelling are: …
Useful methods of programming and optimising are: …
Useful methods of technical study are: …
Useful methods of design study are: …
Useful methods of study by design are: …

1.5 MY PORTFOLIO AND PERSPECTIVE: FIELD OF ABILITIES
From my previous work, next elements are useful for this project.
<give relevant examples and at least two images of your previous work, the ways you studied best (organogram) and the progress you want to make in this project>
In this project also new elements will be developed.
<make a critical analysis of your previous work, describe how to improve existing abilities or develop new ones>

2 MY STUDY PROPOSAL

2.1 LOCATION AND OTHER FUTURE CONTEXT FACTORS

The object of study has the resolution of a drawing for 2030 on Conurbation(R=10km) scale with smallest details on Ensemble(r=100m) level. The actual object will be located in Latvia.
<if you already have chosen a location, give a map and other images of the location here; if not, describe criteria for a location relevant to your study>

If the context will change as I assumed in 1.2, it will influence the location as follows: …
If economy will be growing (+) on Regional(30km) level, it will influence the location by ...
If the physical distribution will be concentrating in space (C) on Conurbation(10km) level, but not on Ensemble(100m) level, it will influence the location by improvement of conditions and facilities for new enterprises.

2.2 MOTIVATION OR PROGRAMME OF REQUIREMENTS

With regard to my assumptions about the future context (1.2) and referring to the intended impacts (1.3) as a result of this study
Regional(30km) economy usually growing (+) should be supported through the design of efficient economic concentrations.

2.3 INTENDED RESULTS, CONTRIBUTIONS AND PLANNING

I expect next products of my study: …
<write down which products this study will produce in a limited period, limiting its object to converge to that result>
It has enough limitations to be realised in next time table: …
<add here a time table>

3 ACCOUNTS

3.1 MEETING CRITERIA FOR A STUDY PROPOSAL

According to Jong and Voordt eds. (2002), page 28 - 31 this study proposal demonstrates:

A Affinity with designing.
<write down how you have proven your affinity with designing in this study proposal>

B University latitude.
<write down how you have proven your University latitude in this study proposal>

C Concept formation and transferability.
<write down how developed concepts will become understandable and tranferable to others>

D Retrievability and Accumulating capacity.
<write down how this study will be published (website, reports, expositions) to be retrievable by others and how it contributes to science>

E Methodical accountability and depth.
<write down which scientific methods are proposed in this study proposal; are they primalily empirical, designerly or do they alternate?>
<Search for relevant key words in T. M. d. Jong and D. J. H. v. d. Voordt Ways to research and study urban, architectural and technical design (Delft) Delft University Press, refer properly to chapters and name relevant types>

F Ability to be criticised and to criticise.
<write down how this study will be open to criticism by others and will improve previous studies based on your own criticism (refer to them!)>

G Convergence and limitations.
<write down how this study proposal guarantees to converge to clear cut products without loosing University latitude>

3.2 REFERENCES
<Add and remove titles.>

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.....
<add useful web links>
<add reference images and their source as iconography>

3.3 KEY WORDS

In this index an expression such as y(x), object(subject) means ‘object y as a working (function, action, output, result, characteristic) of the subject x (independent variable actor, input, condition, cause)’.

planhorizon(2030)
economy supposed growing(Regional(30km))
mass supposed concentrating(Subregional(10km)notEnsemble(100m))
frame object(Subregional(10km))
grain object(Ensemble(100m))
programme economy(Regional(30km))

16 Exercise 8, R=3km Rīga city

Re-arrange non-residential functions according to your characterisation (see page 65 and 69).

Indicate industrial areas with specialised facilities for specialised enterprises.

Indicate shopping centres on city~ and district level.

Fig. 153 Exercise 8, R=3km Rīga city

17 Shopping malls

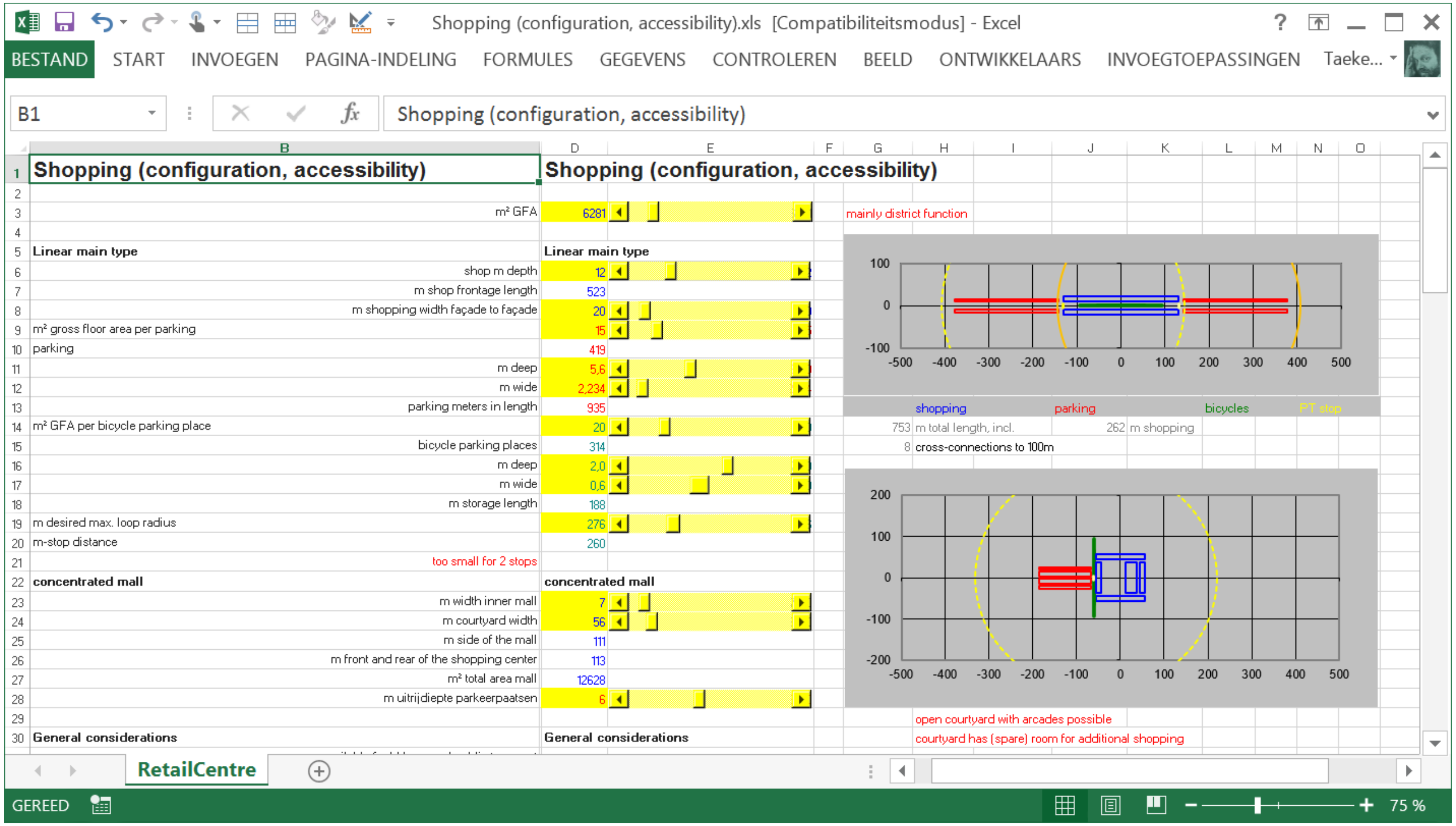


Fig. 154 Shopping malls computer simulation

18 Exercise 9, R=1km Rīga district

Draw a composition of neighbourhood components (see page 9).

Look for design means in order to make them recognisably different.

Look for proper locations of shopping and enterprises.

Diversify plantation per neighbourhood

Fig. 155 Exercise 9, R=1km Rīga district

19 Trees

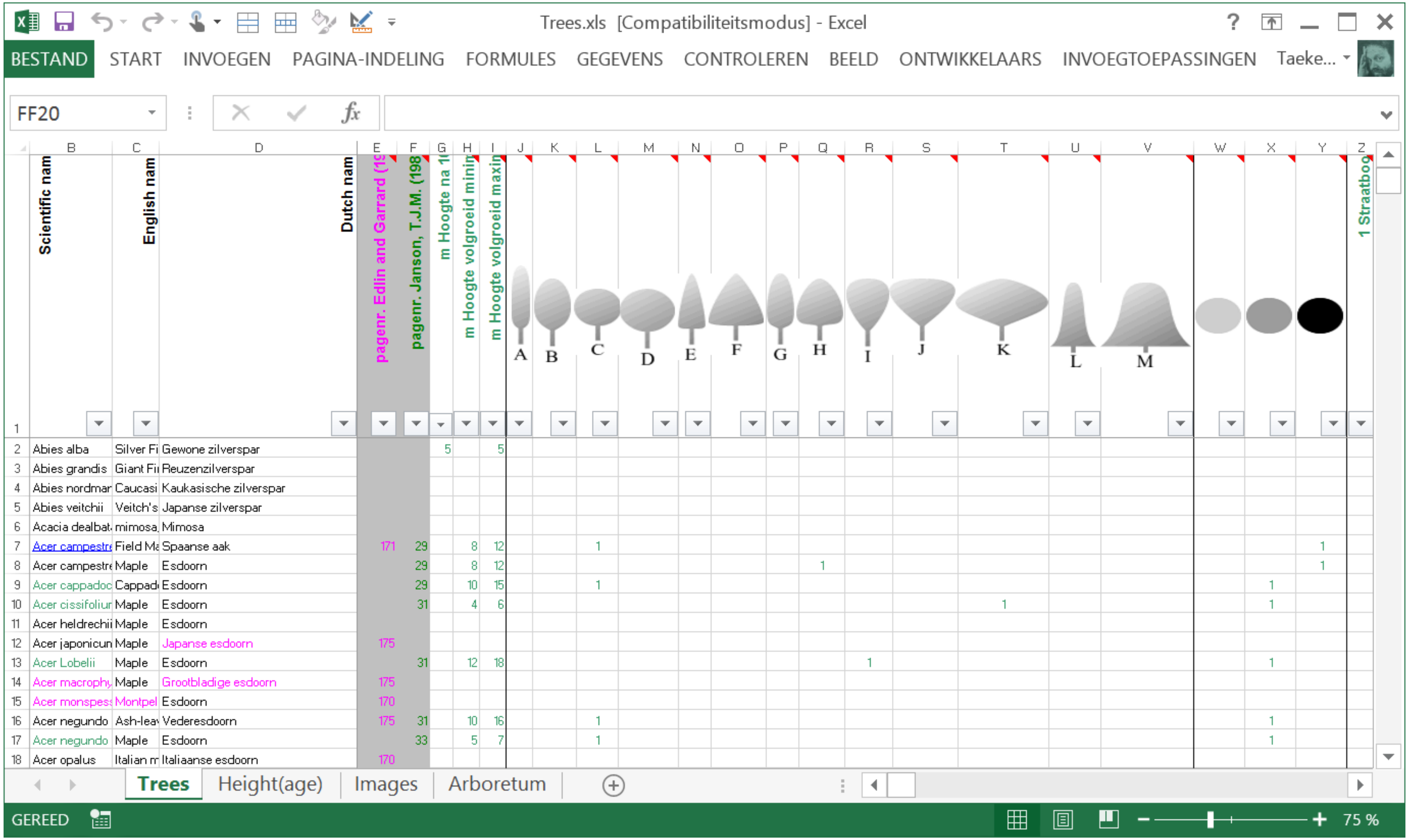
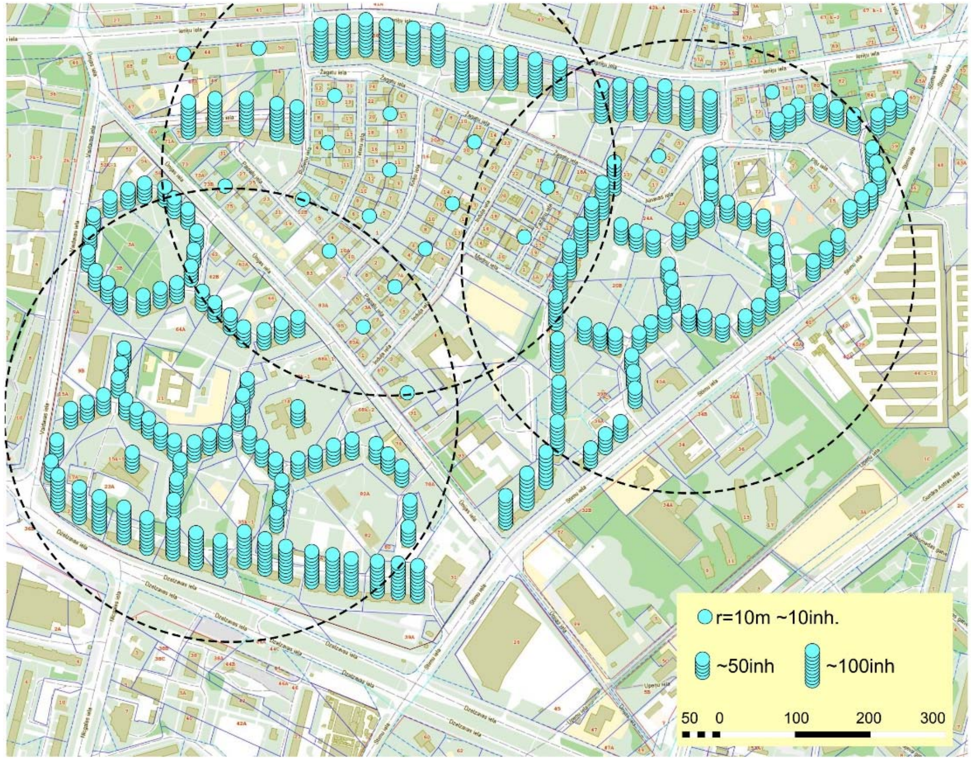


Fig. 156 Trees computer simulation

20 Exercise 10, R=0,3km Rīga neighbourhoods



Re-arrange these neighbourhoods adding 1000 inhabitants to the 13 000 drawn.

Fig. 157 Exercise 10, R=0,3km Rīga neighbourhoods

21 High-rise and sun

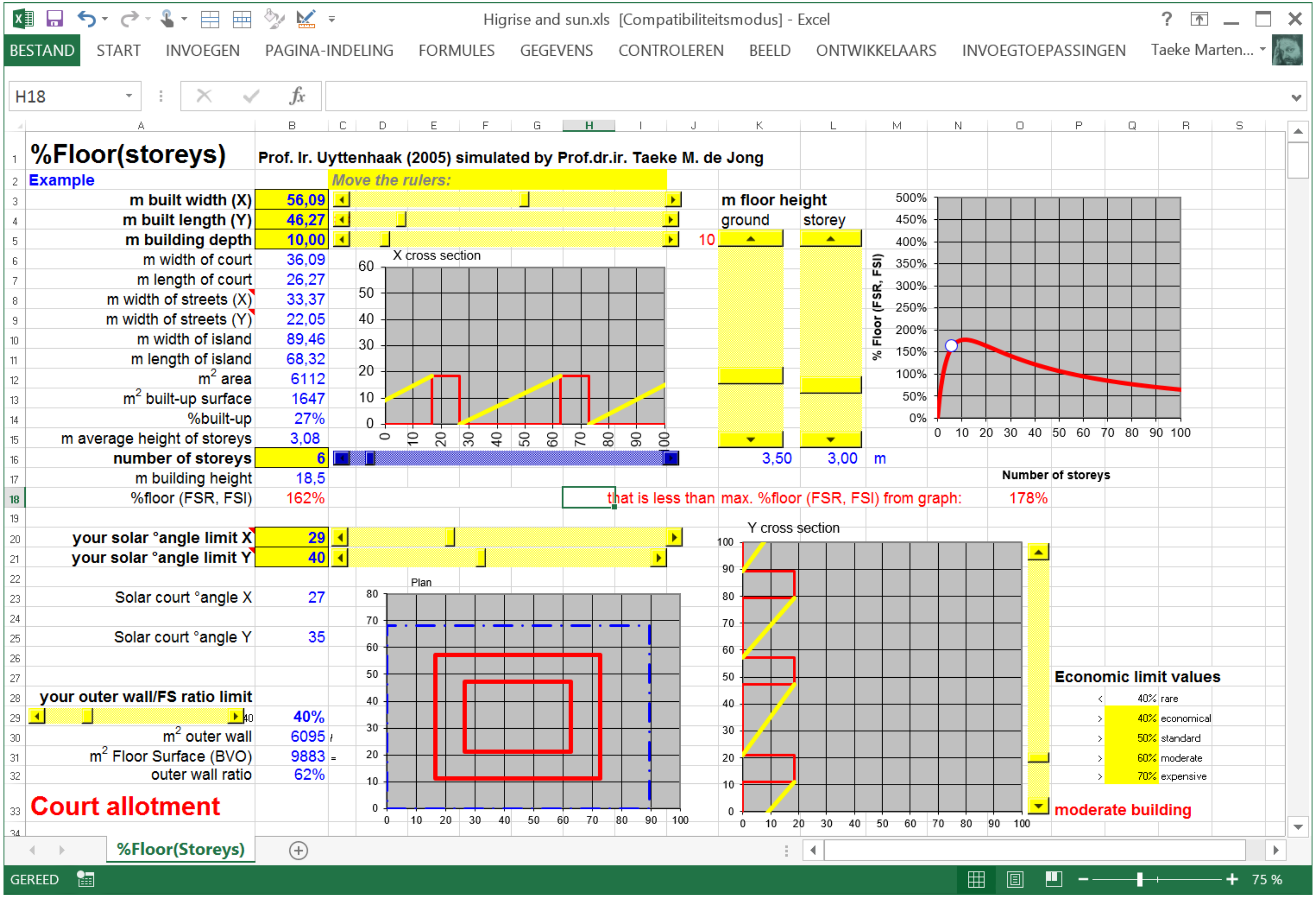
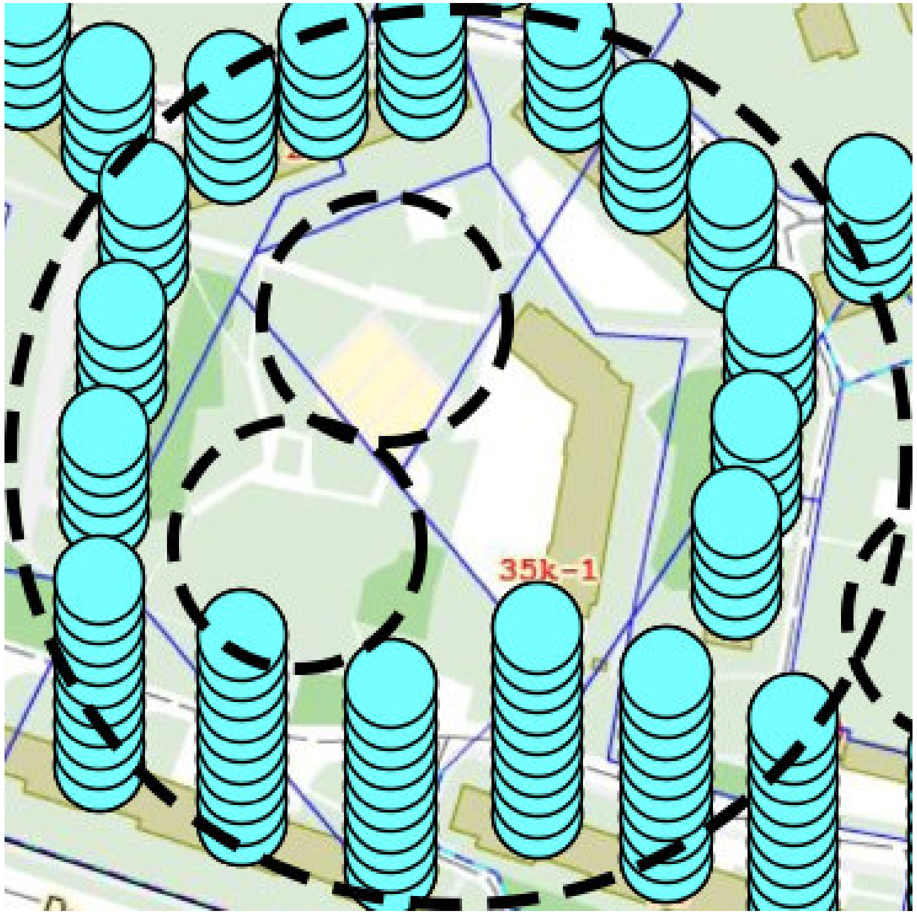


Fig. 158 Highrise and sun computer simulation

22 Exercise 11, R=0,1km Rīga ensemble



Concentrate this ensemble into less, but higher buildings.

Fig. 159 Exercise 11, R=0,1km Rīga ensemble

23 3D representations in Excel

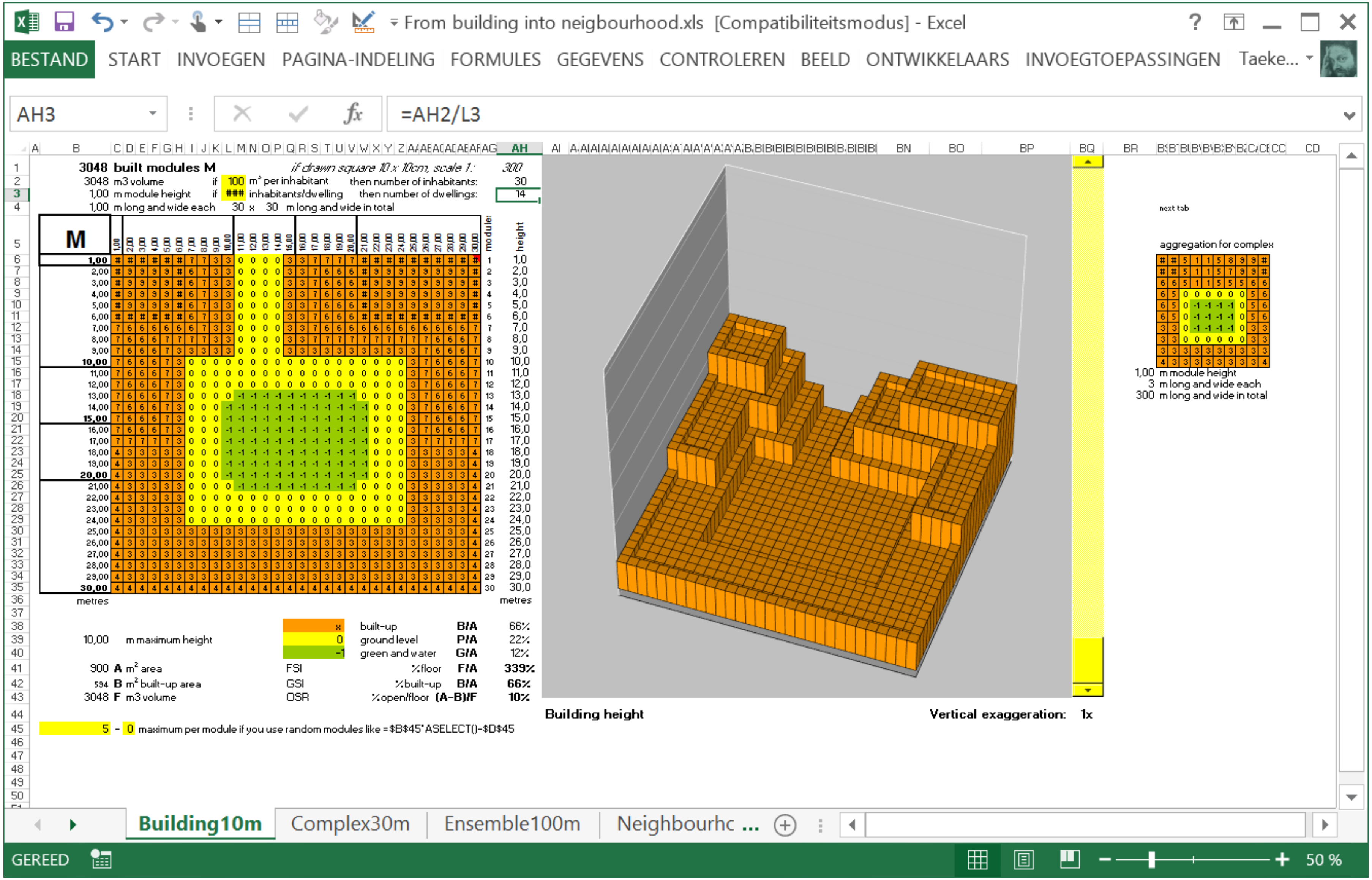


Fig. 160 From building into neighbourhood 3D Excel computer simulation