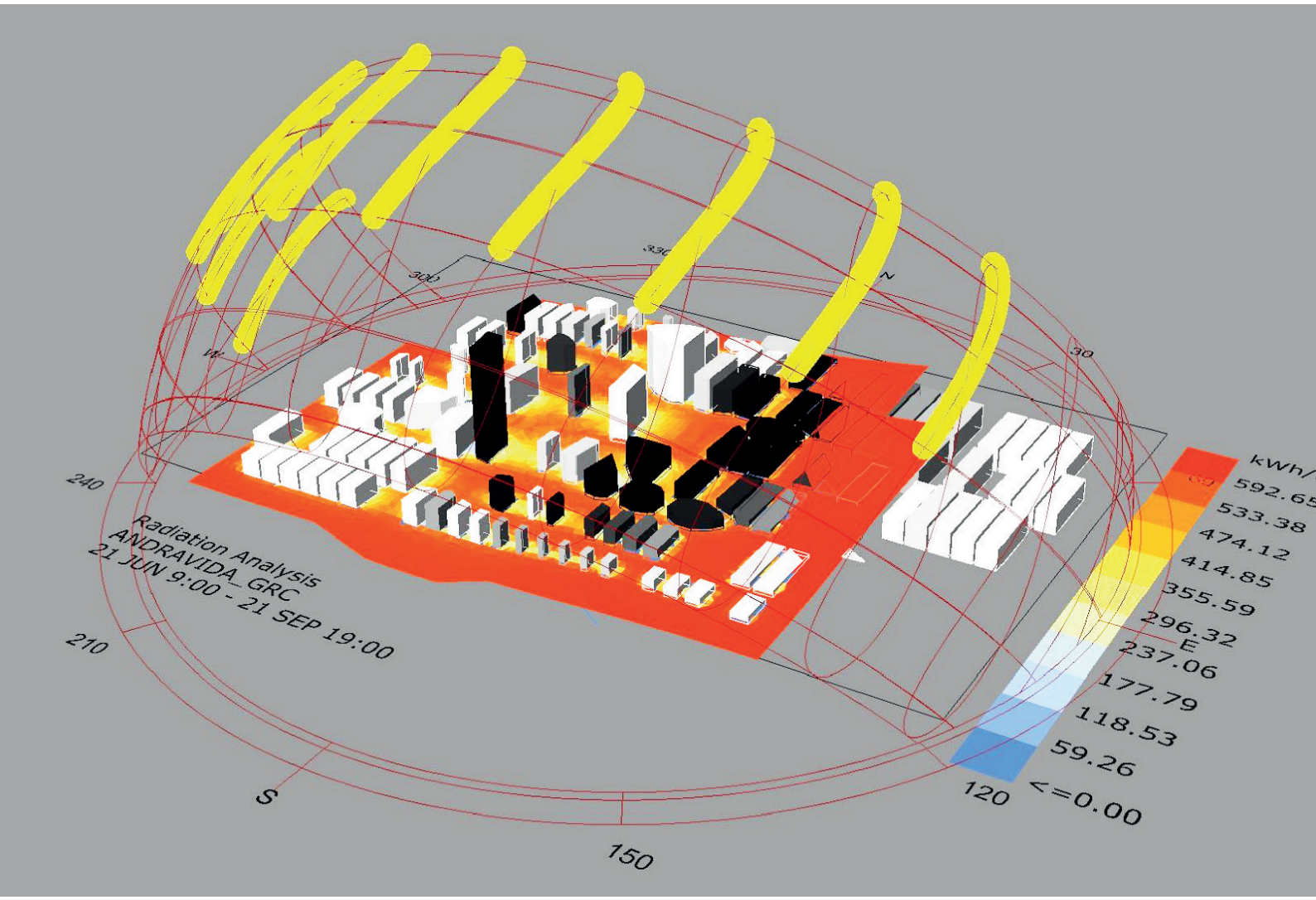
ETH zürich

Documentation of the teaching results from the fall semester 2016

Digital Urban Simulation

Peter Buš, Estefania Tapias, and Gerhard Schmitt



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Digital Urban Simulation

Documentation of teaching results

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iA
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Teaching
Peter Buš, Estefania Tapias, and Gerhard Schmitt

Syllabi
http://www.ia.arch.ethz.ch/category/teaching/hs2016-digital-urban-simulation/

Seminar
New Methods in Urban Analysis and Simulation

Students
Nima Morkoç, Diem Basile, Gianluca Genova, Patrick Zeller, Michael Fehr, Tian Zhou, Difei Yang, Laura Cowie, Carlos Pacheco, Roberta Murad Lima

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Layout Editor
Brigitte M. Clements

Contact
bus@arch.ethz.ch | http://www.ia.arch.ethz.ch/bus/

Cover picture:
Front side: Carlos Pacheco, Sunpath Curves, Zürich

Course Description and Program

Digital Urban Simulation

In this course students analyze architectural and urban design using current computational methods. Based on these analyses the effects of planning can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these corresponding methods in early planning phases.

The students learn how the design and planning of cities can be evidence based by using scientific methods. The teaching unit conveys knowledge in state-of-the-art and emerging spatial analysis and simulation methods and equip students with skills in modern software systems. The course consists of lectures, associated exercises, workshops as well as of one integral project work.

26.09.2016	Introduction into Analysis and Simulation Ex> Tool: Rhino Grasshopper
03.10.2016	Connectivity, Accessibility, Spatiality (shortest or other Path Distance Detection), Urban Networks. Ex> Tool: Rhino Grasshopper + Cheetah ConfigUrbanist addon
10.10.2016	Visibility: Space Syntax, Isovist Analysis, Urban Attractors Ex> Tool: Rhino Grasshopper + SmartSpaceAnalyzer addon (or DecodingSpaces)
17.10.2016	Urban Pattern Formation: Behavioural Patterns, Bottom-up Patterns, Urban Graininess Ex> Tool: Rhino Grasshopper + Elk | Heron + Processing examples (Agents, EmCity tool)
24.10.2016	Seminar Week
07.11.2016	Urban Climate I Ex>Tool: Rhino Grasshopper + LadyBug
14.11.2016	Urban Climate II Ex>Tool: Rhino Grasshopper + HoneyBee
21.11.2016	Energy Simulation Ex>Tool: Rhino Grasshopper + HoneyBee + LadyBug
28.11.2016	Digital Parametrics Workshop
05.12.2016	Optimization processes | Evolutionary Algorithms Ex>Tool: Rhino Grasshopper + Galapagos | Octopus
12.12.2016	Guest Lecture
19.12.2016	Final consultation
	Project Presentations, Final Critiques

Where
HIT H 31.4 (Video wall)

Supervision

Dr. Peter Bus bus@arch.ethz.ch
Estefania Tapias tapias.arch.ethz.ch

*Total 120 h = 4 ECTS
6 Exercises 25% (documentations)
Presentation 25% (project at the end)
Written documentation 50%

The most recent outline will be found on www.ia.arch.ethz.ch

Prof. Dr. Gerhard Schmitt
Chair of Information Architecture
Information Science Lab
Wolfgang-Pauli-Strasse 27, 8093 Zurich
www.ia.arch.ethz.ch

iA Chair for Information Architecture

Content

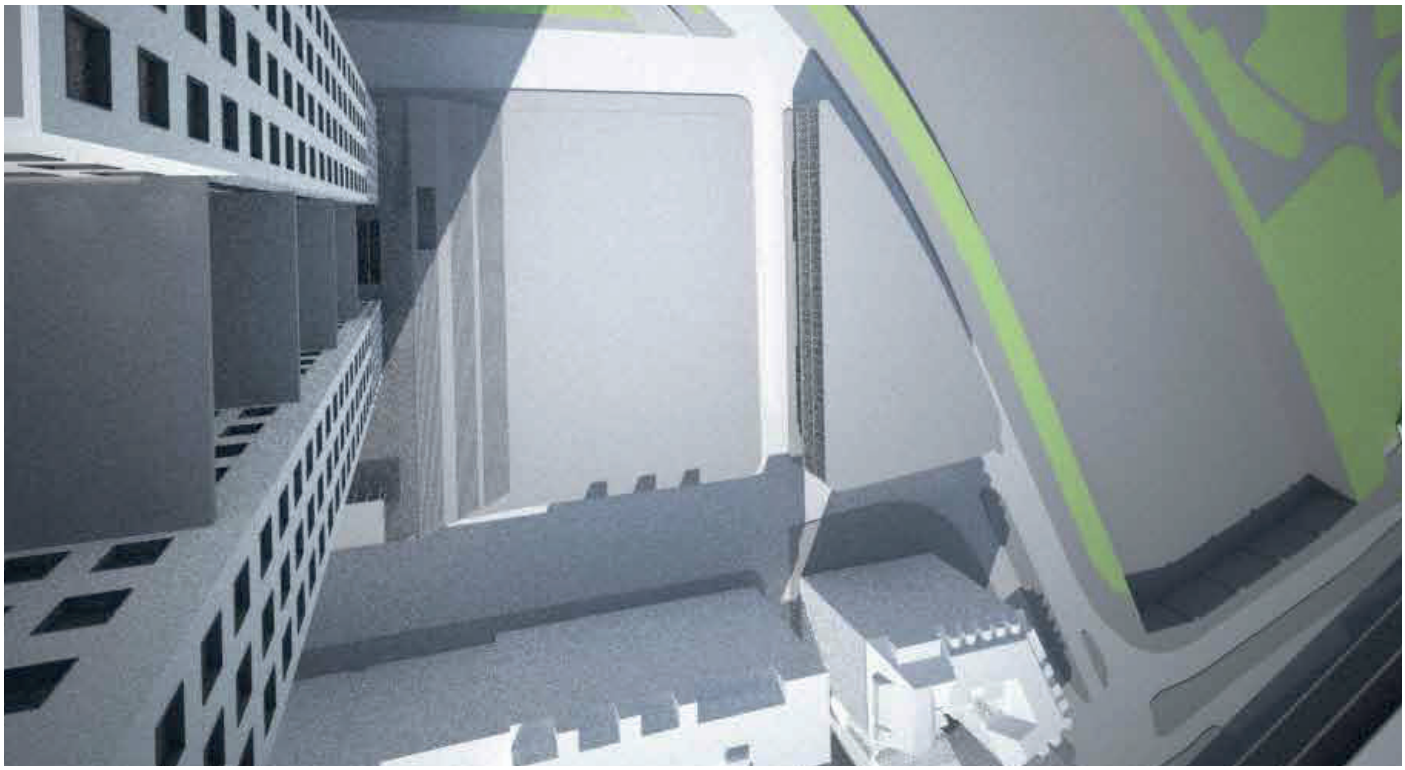
Didactic Public Sequences

Student:Nima Morkoç

Summary:

This semester I am in the design studio of guest professor Xaveer de Geyter where we are dealing with the topic ‘High-rise and public space’. The site of this project is at the Sihlquai bus station near the central station of Zürich. The point of this project is to understand a high-rise project and its impact on the city and near surrounding. In short: the project has the working title ‘didactic public sequences’ because I have explored the literal repeating of existing streets on top of each other in order to fulfil the ‘public needs’ of people instead of ‘cramming’ them into a high-rise building.

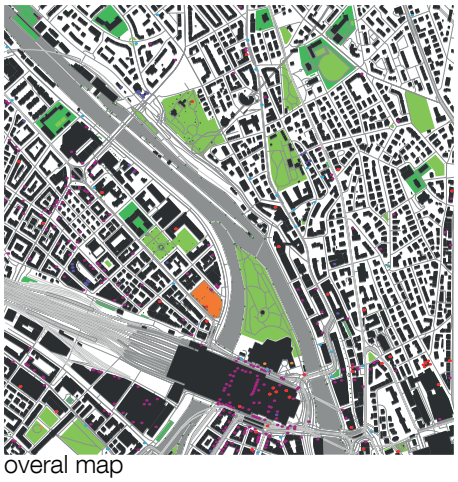
The Digital Urban Simulation course offered a new set of tools to analyse the existing and planned interventions, but also interpret them in order to make design decisions. With ELK and CONFIGURBANIST I have analysed the existing surrounding of the site, with Ladybug and Honeybee I could analyse the^planned interventions in a complex urban setting and understand the microclimates. As the design project is about the placing of a high-rise in an complex urban setting, I found most of the tools offered in this course useful, but only in combination with the knowledge to export lines and visuals from Rhinoceros to other programs such as Illustrator to make the information more ‘readable’ and presentable. In this report I will present the tools that were most useful for me and had the most impact on my design-process. In another document I will have my complete documentation with all the used tools.

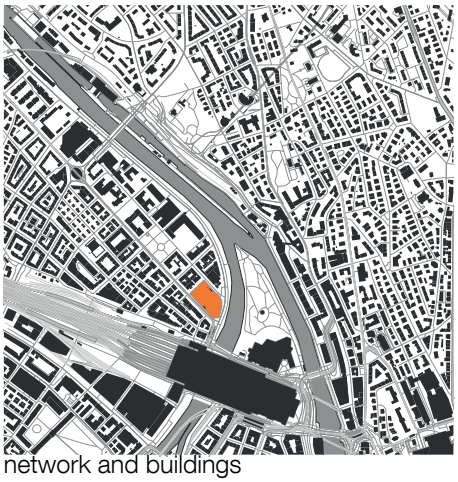


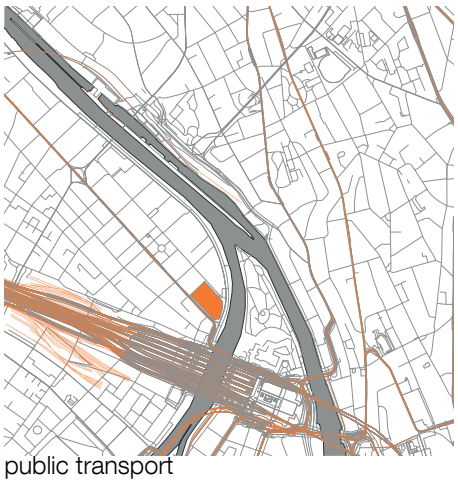
Motivation:

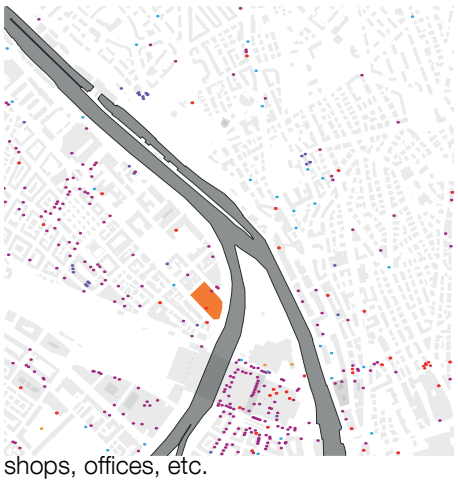
By understanding a high-rise project as an ‘high-impact’ project we can divide this into subtopics that can be measured. For example, this high-rise object has a high impact on the surrounding buildings and their sun exposure and with that comes the question of whether it is feasible or considerable to place the highrise object on a certain place. It is mostly the question of how this new building can make itself comfortable inside the city without making other buildings uncomfortable. Without analysing this and considering the surrounding built environment our cities would be lost and in some cases they are. A good design is timeconsuming. Doing a precise shadow analysis difficult to do by hand and is therefore almost never done, only roughly. Therefore it is exciting that these tools are now available to us and that they are fast to work with.


buildings and location


overal map


network and buildings

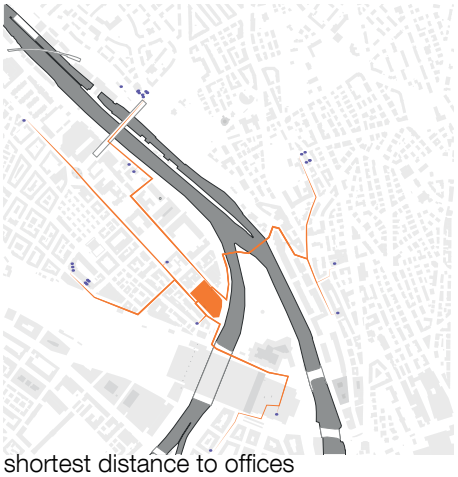

public transport


shops, offices, etc.


green public spaces and trees

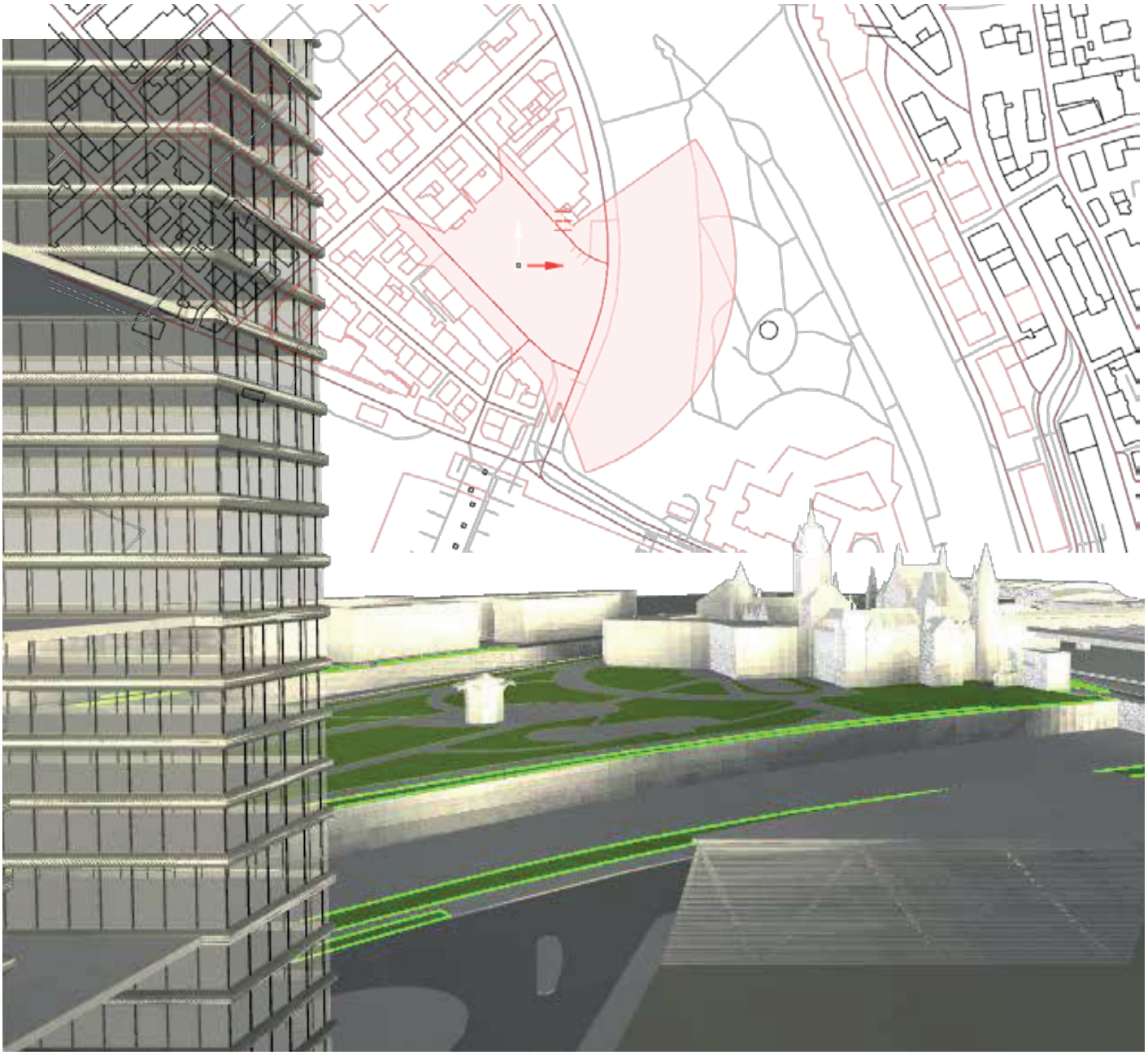

cycling


walking


shortest distance to offices

Using Openstreet maps together with the tools in ELK and Congifurbanist I created a number of maps that I could use for the analysis. After obtaining lines and points in Rhinoceros, I made more appealing visualizations with Illustrator. I find it most interesting that all offices, shops, etc. are clearly organized in the data and are easy to use, normally making these maps takes forever. I choose five of them and looked at what the shortest path would be starting from the Sihlquai bus terminal. It did not give me any design input, but it did help me to realise that making a residential building on the site creates a certain amount of actors that become part of a network on a daily basis, starting from the site and then going back.

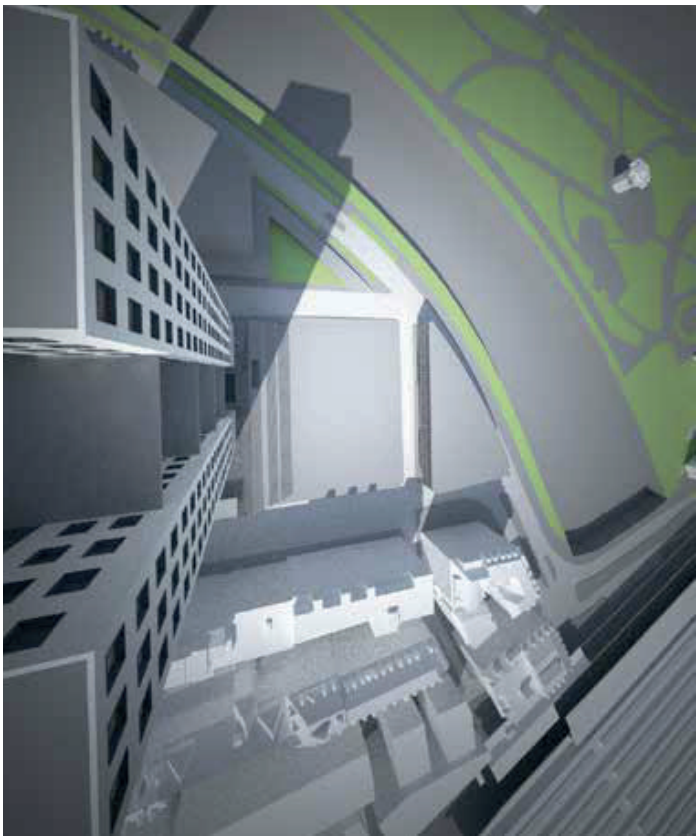


The pictures below are site photos of my design project at Sihlquai and looking at it from the HB and from the streets that connect to the bus terminal. The view towards the water is mostly open, except for obvious obstacles like trees and busses, but for this exercise I will only take the existing buildings into account as ‘obstacles’. A design decision made from this was to place the roof of the bus terminal on the edge of the site, making it accessible by stairs to have an overview of the city. Of course this was obvious, but the tool gave ´proof´ and a diagram to show this openness.

21st July

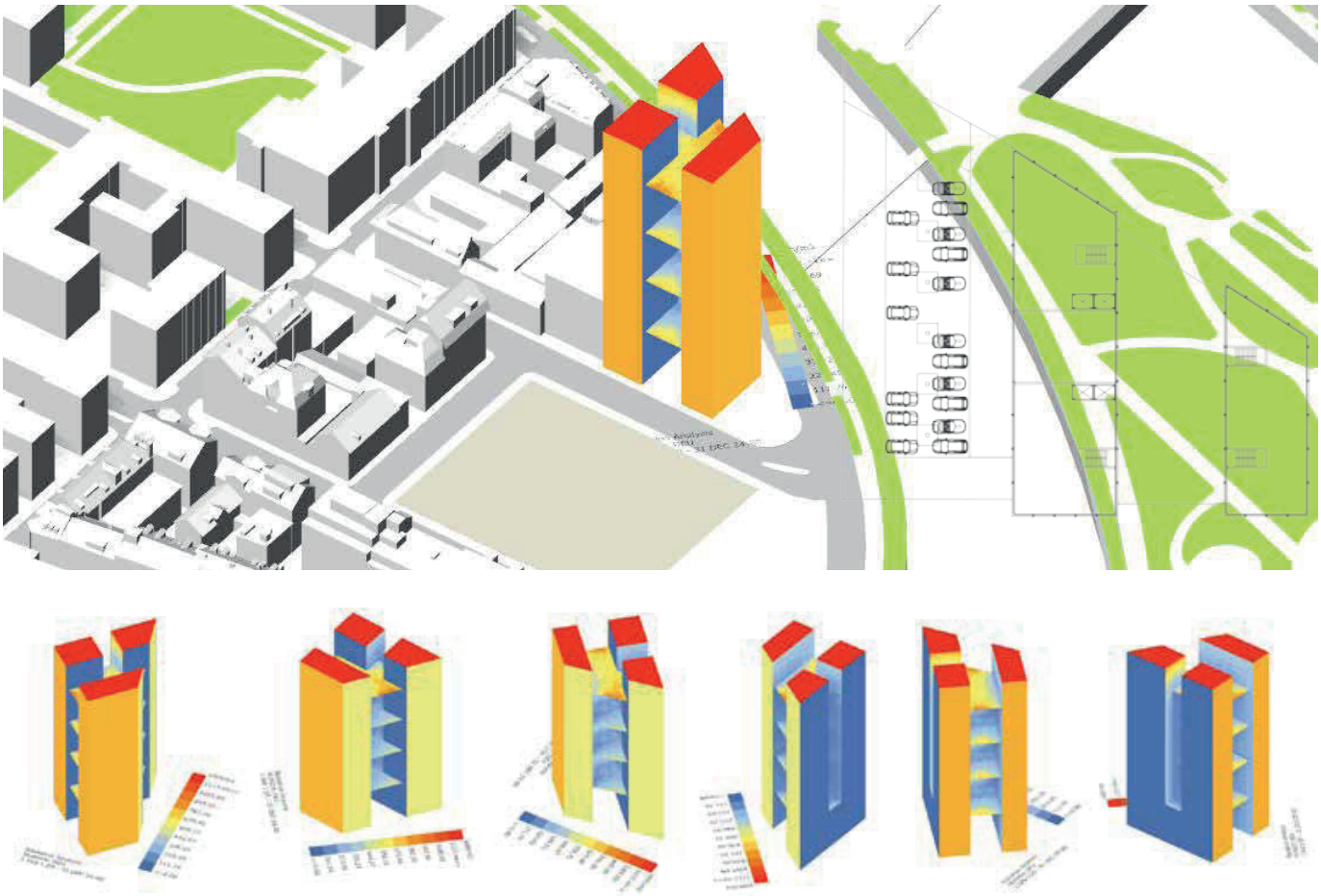
21st December



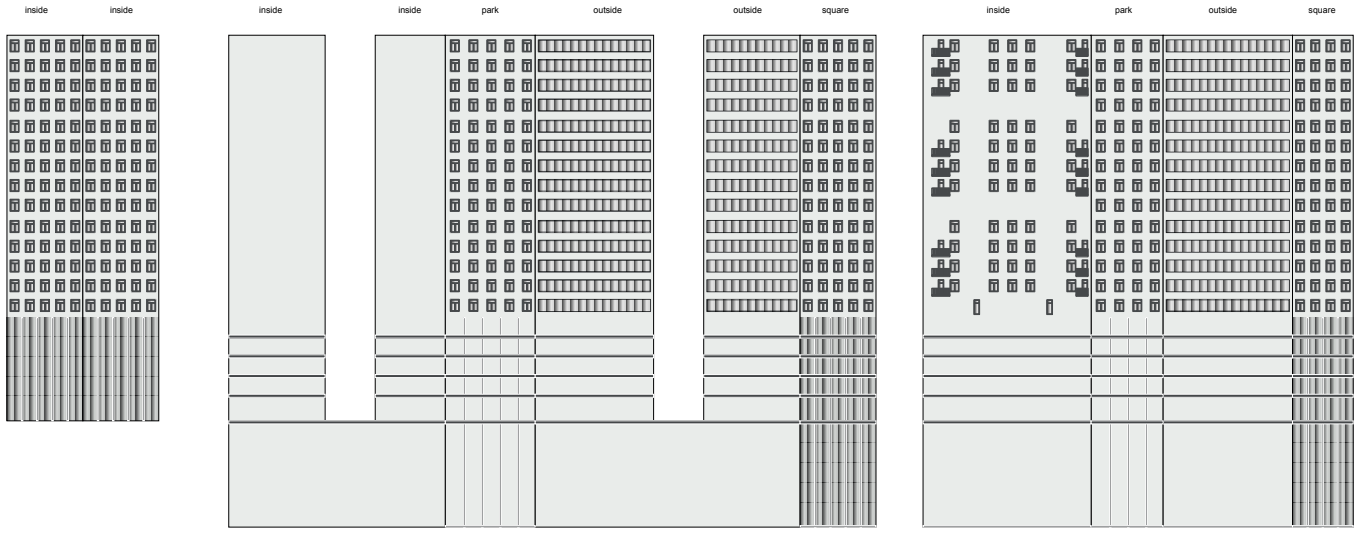
Prior to analysis

Location after Analysis

First one must let the ladybug fly. I did the shadow analysis on my skyscraper project in Zurich and that was quite useful. For this exercise I tried to put as many towers as possible on my site and see whether the square in between the busstop and the towers would still be a pleasant square. What is a shame is that one cannot see how the shadow of one mesh 'crawls' on the other meshes. But in the end it was still enough information for me to decide on chaning the location of my towers as they were putting the existing buildings in a constant state of darkness.

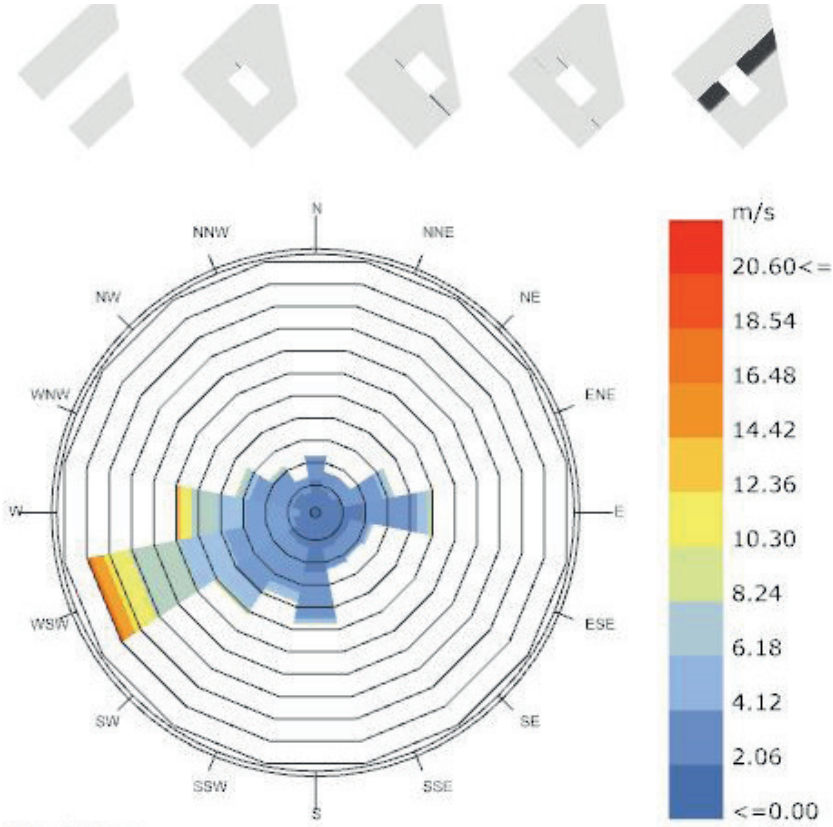


Radation analysis of latest option

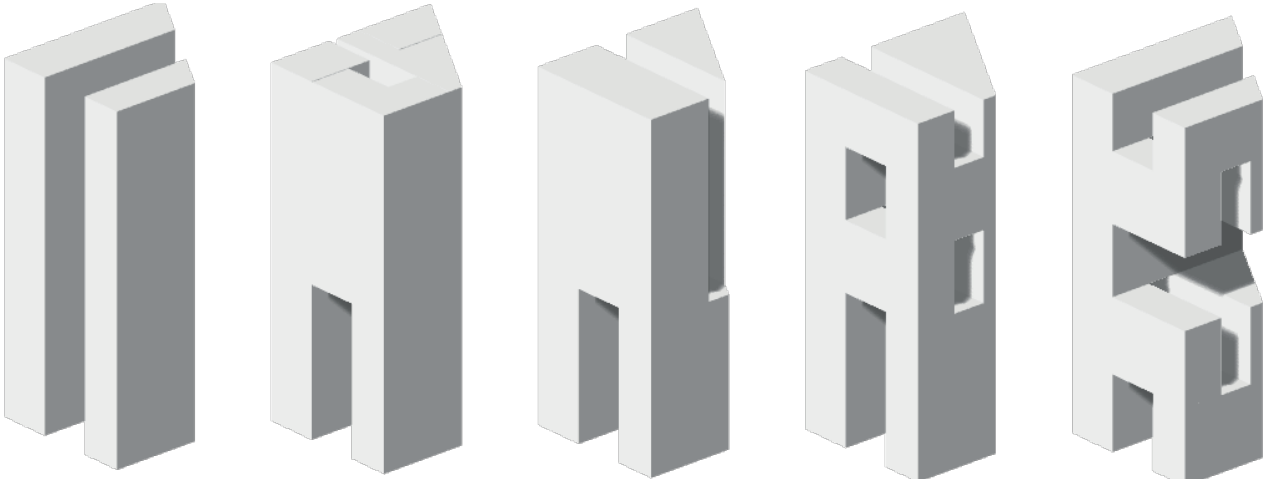


Consequence for the facades (work in progress)

In this second exercise of using ladybug and measuring urban microclimates we looked at a way to measure radiation analysis. Now this is extremely interesting, but I did not have plans of using solar panels or robotic elements in my design, so I just followed the tutorial using the surfaces of my updated building. I checked where in my building the radiation exposure is the most and had the conclusion that I should place my transportation centres (elevators and stairs) on the places with the least exposure, so on the inside. Also this analysis made me think of treating every facade differently in terms of glass-use and openness.The design is not finished yet, but in the images below one can see the work in progress.



Wind analysis



Consequence for the masses (work in progress)

The one thing that I was missing in my analysis and also wondering was the wind. As I am sort of creating tunnel-like moments in my building I can imagine that there are some problems. I could not find a “wind analysis on the internet, but I did find that Ladybug and Honeybee have a tool to understand the wind by means of wind roses. I took the Munich weather-file that I was also using for the other microclimate analysis. As the wind was indeed a problem I tried different directions for the streets to face towards and still have to choose another option.

Conclusion:

In the end there are parts of the design process still cannot be quantified with only analytical tools as a design also deals with things such as atmosphere and ‘feelings’. Nevertheless, the tools that were presented to us have been very useful, as a lot of factors in the built environment were considered (which always should be considered). Some of the analysis that I normally do were much quicker with the new tools, such as the tools provided by ELK and configurbanist that have categorized the information very well.

Other tools were also useful such as the shadow analysis, but were not that accurate as the shadows were only shown on a flat surface and did not show how the shadows ‘fall’ on other buildings. The radiation tool on the other hand gave me a few break-troughs and made me decide to design every facade separately.In the end I found that the tools give me a lot of information, but found it difficult to find the right way to visualize it. Sometimes I could bake the information and make a quick visualization, but with the example of the ‘shortest path’, it could not be baked and them I am forced to redraw the lines in another program. The design project is going to last another two weeks, but I am positive that I will at least still do the shadow and radiation analysis again and update my design to it accordingly.

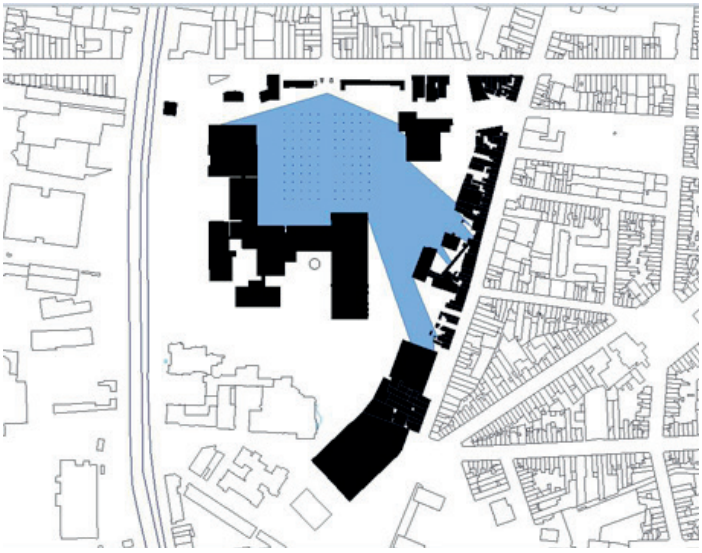
Grand Ensemble 2.0

Student: Diem Basile

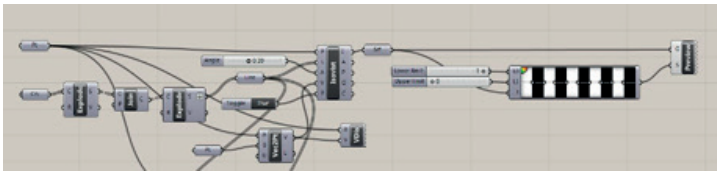
The site, situated in the south east of the belgian capital, in Anderlecht. The brief of the project is pretty open, with a difficult point, generate on the site the energy needed for 1km2 of the city, that represent 130 GWh. 100'000 visitors from all over Belgium and further horizons reunite at this place every weekend.

Towards a new waste incineration plan - bring the energy production where it is needed. The actual system of energy production with waste in Brussels follow a standard scheme, with the a single power plant situated on the outskirt of the city. The old power plant, built in 1996, will need a serious revision in 10 years. I propose to replace the actual one with a network of smaller one, closer to the enery demand and to the combustible.

Using Openstreet maps together with the tools in ELK and Congifurbanist I created a number of maps that I could use for the analysis. After obtaining lines and points in Rhinoceros, I made more appealing visualizations with Illustrator. I find it most interesting that all offices, shops, etc. are clearly organized in the data and are easy to use, normally making these maps takes forever. I choose five of them and looked at what the shortest path would be starting from the Sihlquai bus terminal. It did not give me any design input, but it did help me to realise that making a residential building on the site creates a certain amount of actors that become part of a network on a daily basis, starting from the site and then going back.

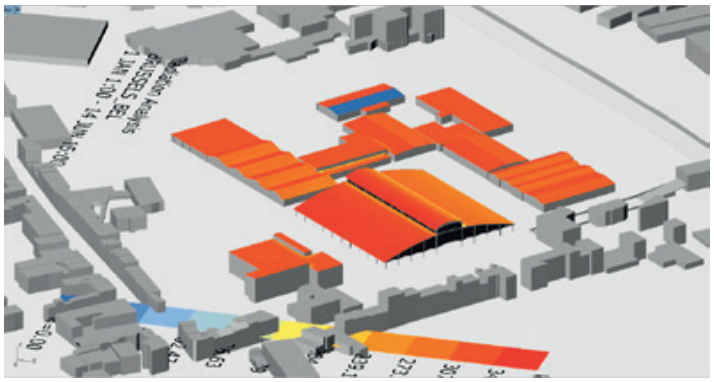


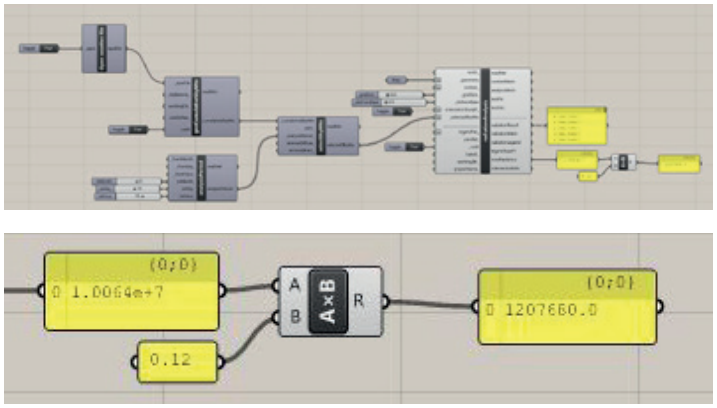
In order to find the best kind of design at a urban scale, I first analysed the range of vision and what you can see when you enter the site, by the main entrance. The first part of the site is occupied by a piece of history, the market roof of the slaughterhouse. But beyond that, as we can see, the vision is blocked by the slaughterhouses and other wharehouses.



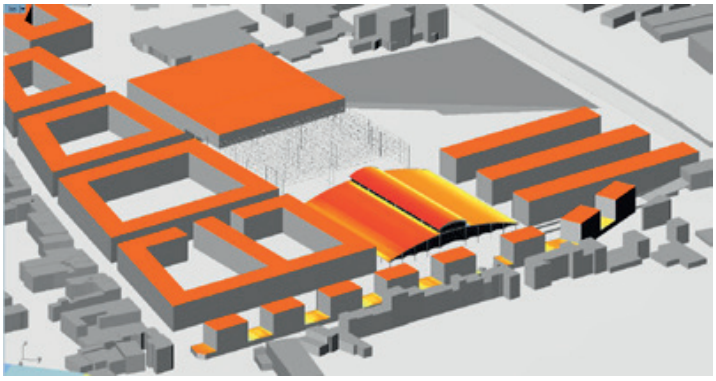
For that, I used the isovist component from decoding space.

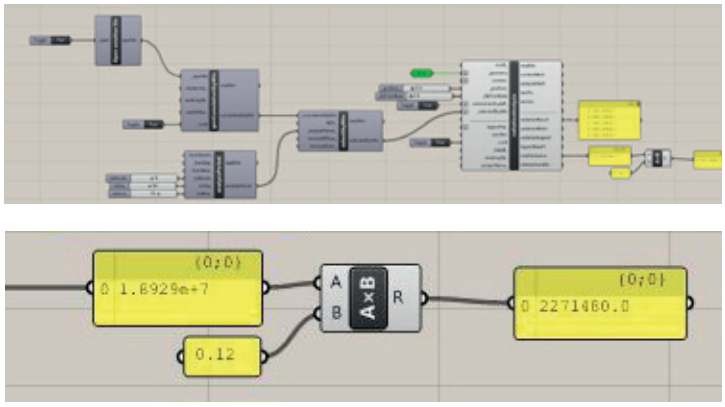
That's why the new design need more openess from the entrance of the side. This will be achieved by opening a central roadgoing through till the road in the north. As we can see, this already let you have a better look to the different building forming the site, in contrary to the old organisation.



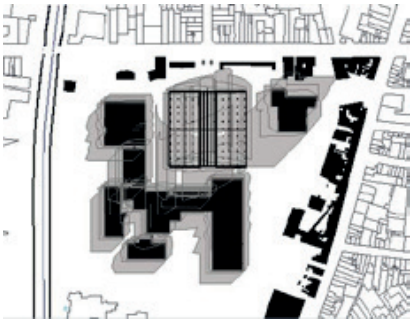


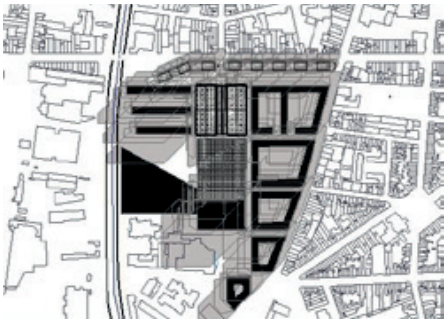
As one of the main brief of the studio is to power 1 km2 of Brussels with renewable energy, I analysed the potential of the actual building in producing this energy with the surface at disposition. As we can see, the potential of solar energy on the site with the actual roofs isn't satisfying at all for this purpose, with a potential of just 1.2 Gwh. If we extrapolate, we can rapidly see that the site itself doesn't have this kind of potential.

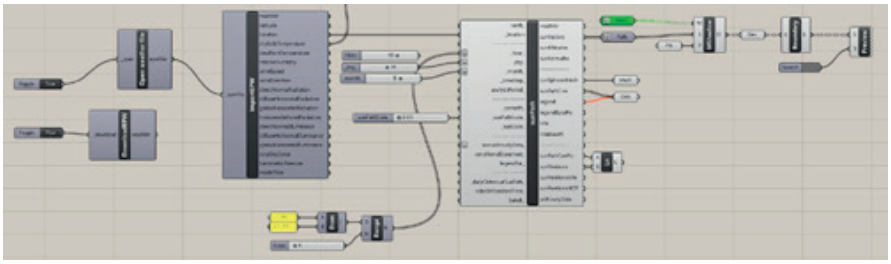




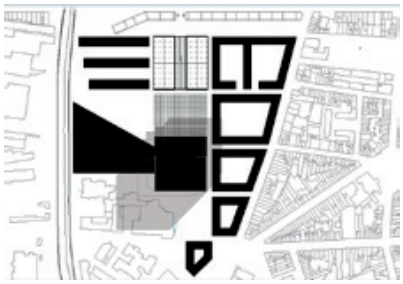
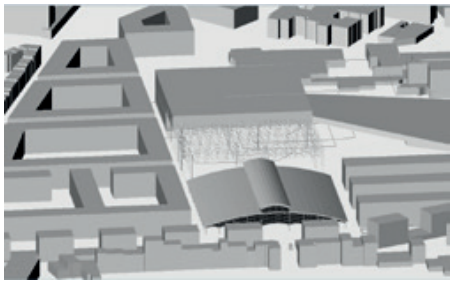
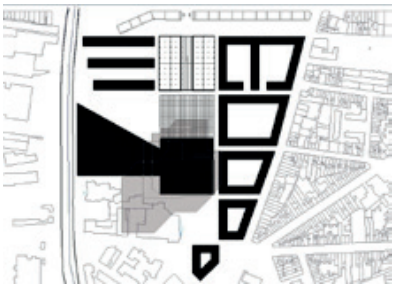
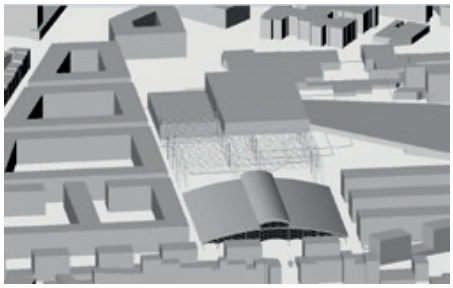
In order to power the burning systemchosen to generate the energy needed, the research towards a sustainable energy could tend to be the solar panels, as we can see, the site with the project could have enough potential for that, as it could be producing 2.3 GWh if all the roofs of the new design are covered with solar panels.



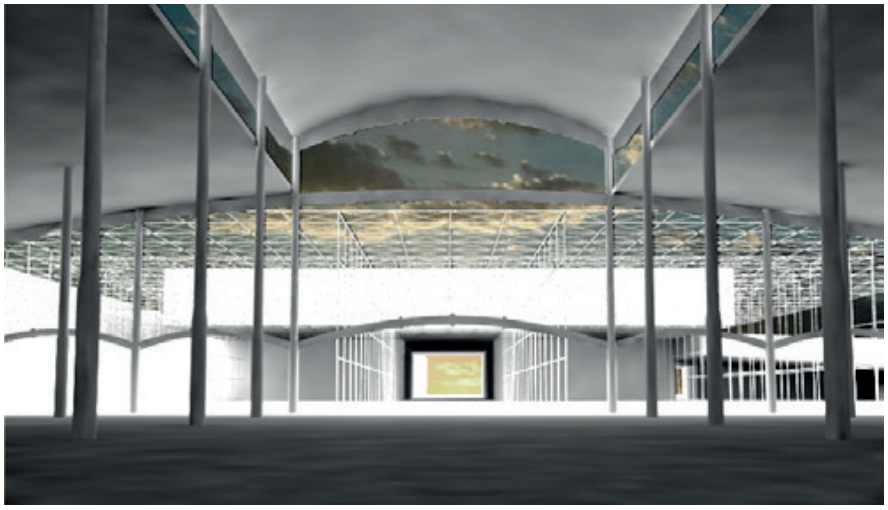




In order to optimize the design of the centre piece of the design proposal, the waste to energy power plant surmonting an open market roof helping the old one to shelter the market, the shadows could give us a direction for the maximal height of the building. The purpose in this case, is to avoid to much shade on the residential building surrounding this building.

To analyse that, I used the ladybug components allowing to calculate the place and length of the shadows in a range of hours in a day. As we can see, in the first proposal, the building is throwing shadow on the residential building next to it. In order to fix that, the right part of the buildng (on the plan), was lowered to minimize its impact on the dwelling. Unfortunately, it's not possible to go further down because of the functions it shelters.



Thank to these analyses, some important point and potential were revealed. The choice of energy possible was reduced but we now know that the site could be autonomous with solar panels. The importance of the central street was shown, as well as the height of the building according to the other. The results were for a lot of them awaited, but some were informations we couldn't have though of.

Plattenstrasse 10

Student: Gianluca Genova

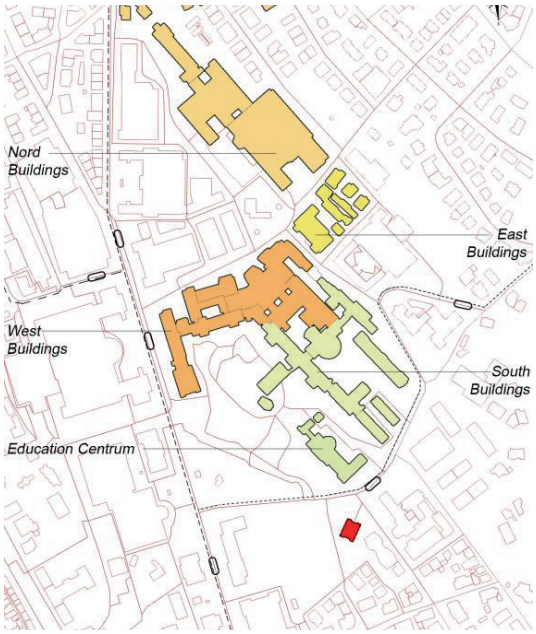
Summary:

The project building is located at hochschulquartier in Zurich. Analysis in this project has two focus points which some of them is concentrating on urban scale whereas others on building scale. Plattenstrasse 10 is recognized as one of the most significant modern constructions of Zürich, built in 1959 by Swiss architect Jakob Zweifel. The building was originally designed to provide dormitories for the hospital staff. The building has 18 above ground floors, and still today with exclusion of the ground floor, is entirely used for residential purposes.

People who are accommodating in this building are mainly working in the UZH Hospital campus. Where urban scale analysis like accessibility, path detection and isovist could be useful. There some renovation plans for the building in the future itself. For building scale analysis like shadow calculation and solar power potential can be also useful for taking further decision in this renovations.

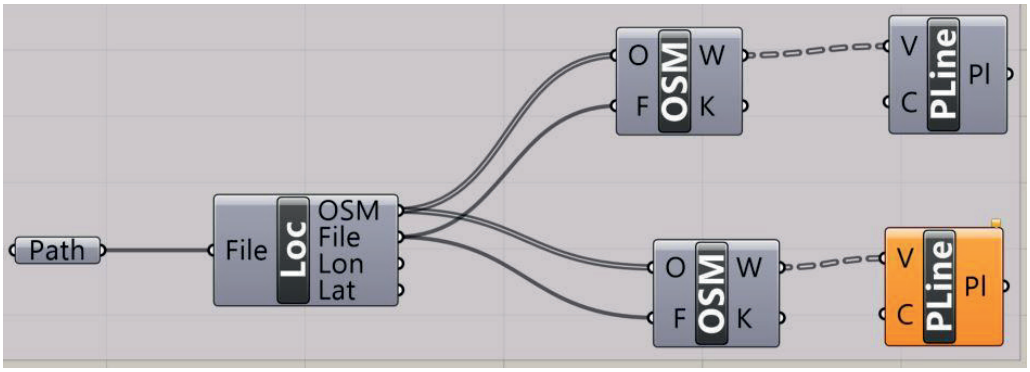
Motivation:

This particular building is my study case for my integrated design studio. In this studio we are integrating architectural and engineering aspects together to find future strategies in terms of space quality and energy efficiency not only for the Plattenstrasse 10 but also for the whole hochschulquartier. Digital Urban simulation course provide very useful tools where analysis both in urban scale and building scale can be done which can be very useful for complex task that I have in my studio. Analysis like accessibility and path detection can help me to define the future functions of the building as well as the connectivity in the master plan of the Hochschulquartier. Shadow analysis and solar power potential will give a very initial inside about the solar radiation distribution in the building and its surrounding cluster.



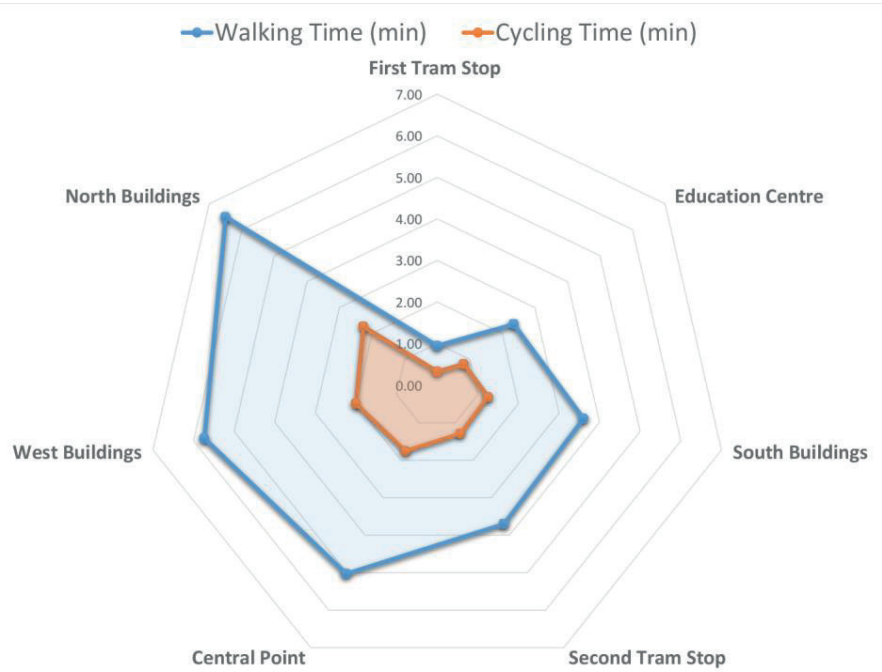
3. Analyses and Interpretation:
A) Urban Scale Analysis :Accessibility

This analysis shows the accessible buildings in curtain range by walking and with bike. The results show that all the hospital buildings are in range between 150m – 900m and the respective time varies from 3 min to 6min walking. This can help to distribute the workers to the closest accommodation facility to increase the accessibility. Also it helps to define the distances to most important services like stores, public transportation, post, bank etc.



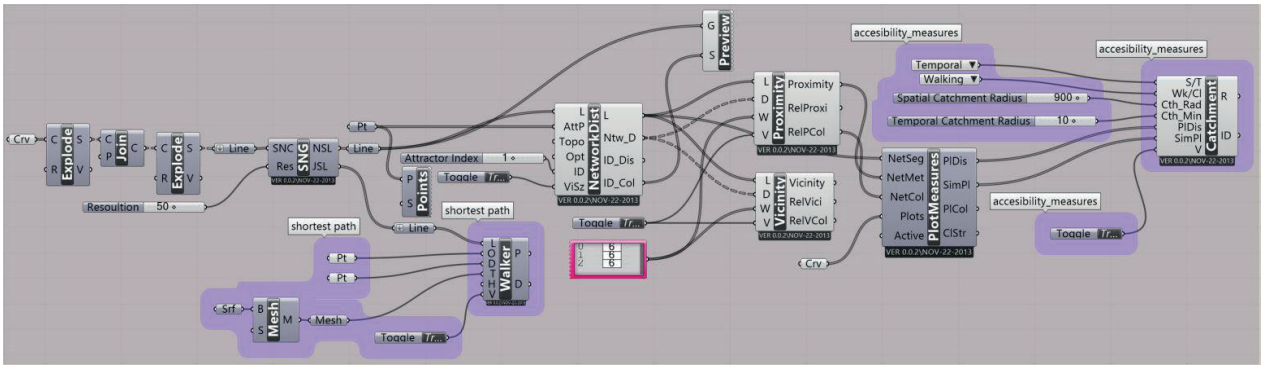
Path Detection

This analysis helps to define the distance and required time to reach curtain buildings.



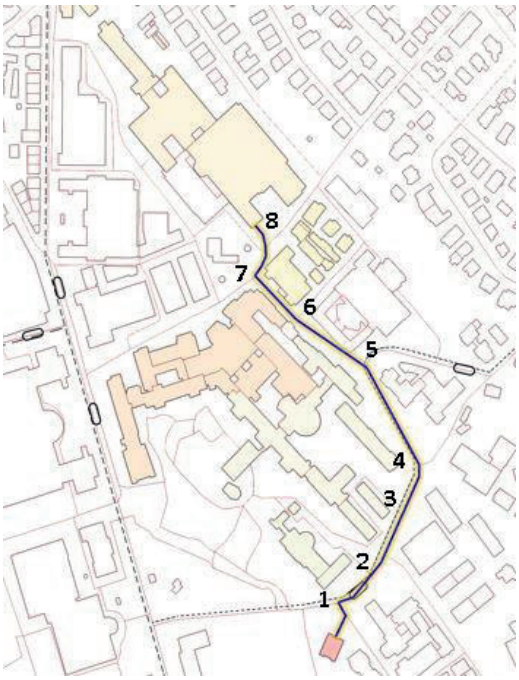
Destionation Point	Distance (m)	Walking Time (min)	Cycling Time (min)
First Tram Stop	85.62	0.95	0.33
Education Centre	211.92	2.35	0.82
South Buildings	324.66	3.61	1.26
Second Tram Stop	333.21	3.70	1.29
Central Point	452.87	5.03	1.76
West Buildings	516.24	5.74	2.00
North Buildings	584.48	6.49	2.27

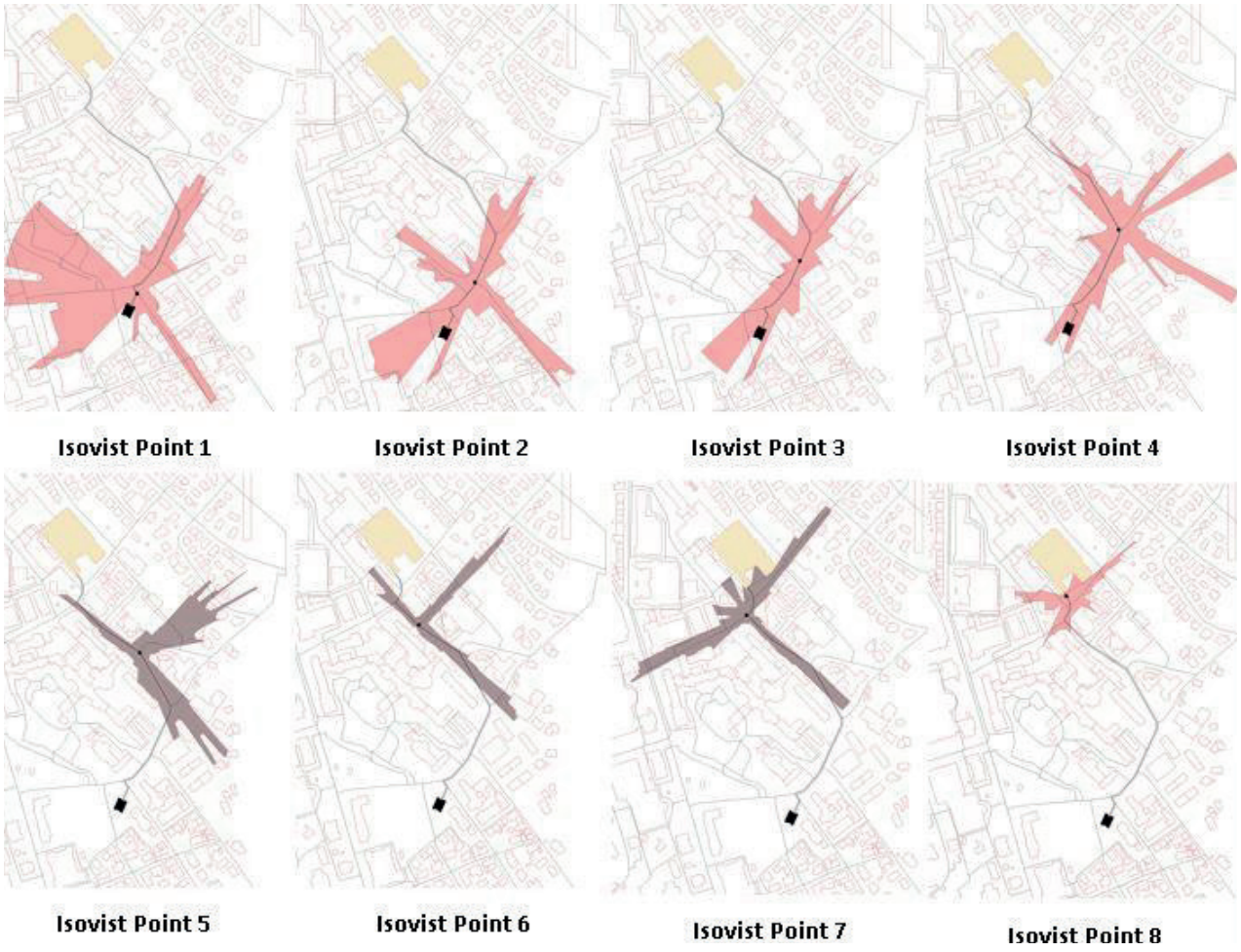
This analysis shows a nice compression between the walking time and cycling time. From the results it easily can be said that for short distances walking and for far distances cycling could be more efficient and respective paths can be considered for this uses.



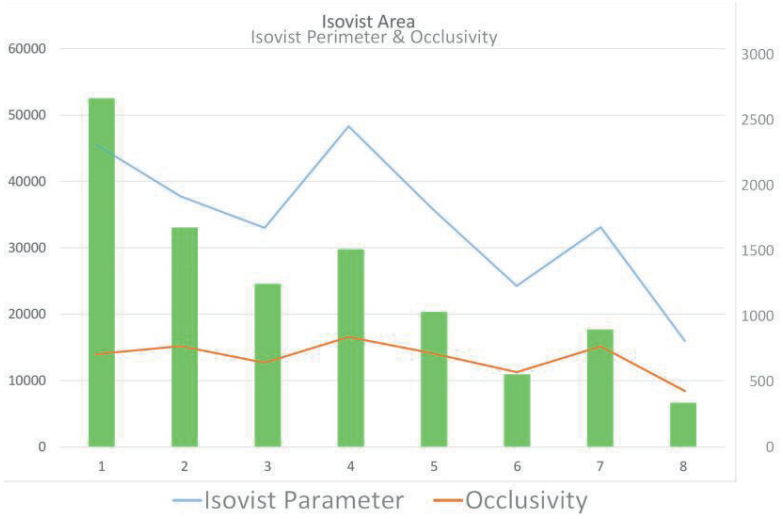
Isovist:

A single isovist is the volume of space visible from a given point in space, together with a specification of the location of that point. Isovist Analysis helps to see the visible range from one point. Introducing this analysis through the path will give a numerical data about the visible objects during the journey which can help to design the visual experience through the path.

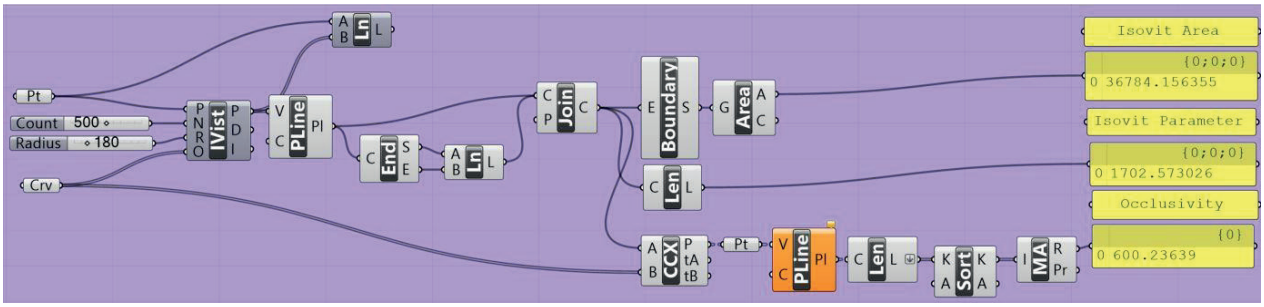




Isovist Point	Isovist Area	Isovist Parameter	Occlusivity
1	52520	2511	776
2	33027	2084	842
3	24556	1822	704
4	29773	2665	918
5	20335	1978	782
6	10910	1341	626
7	17673	1828	840
8	6629	886	470



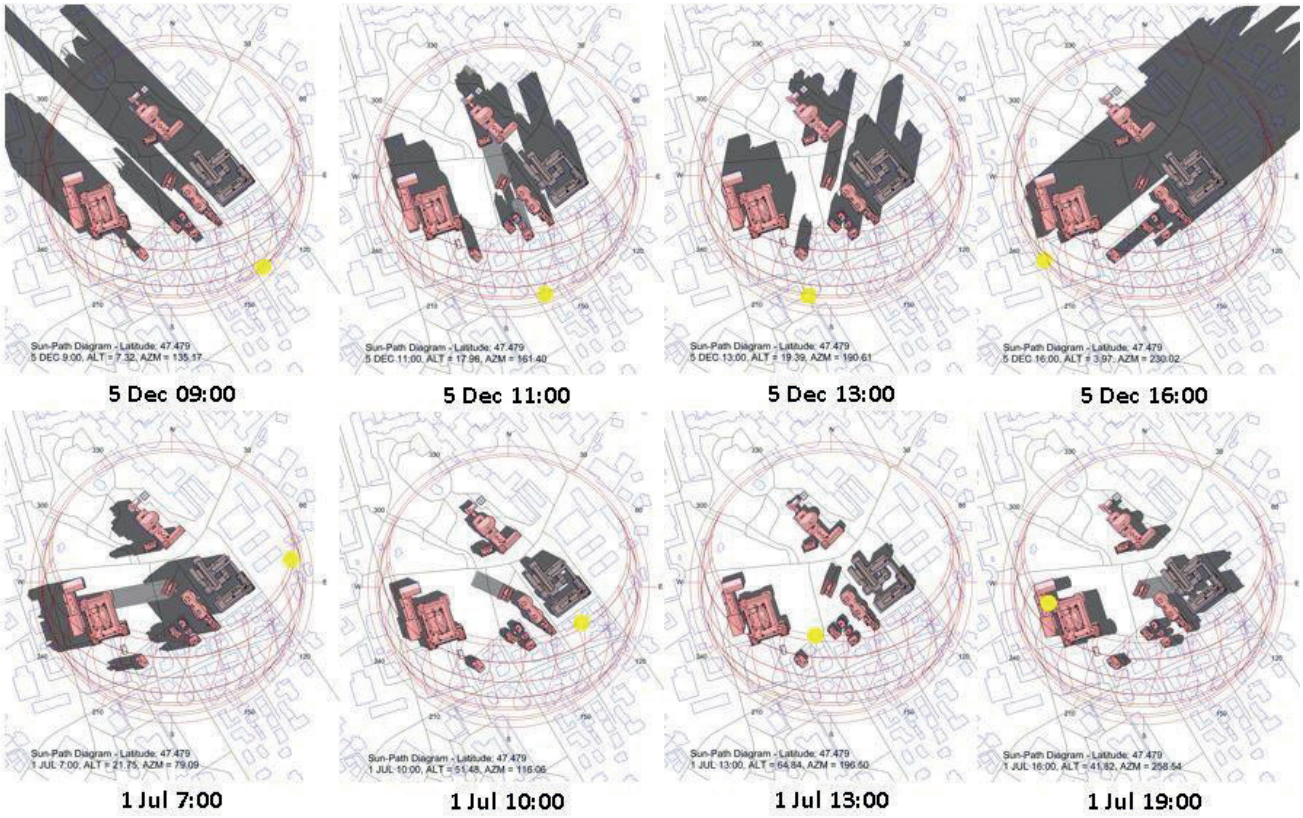
The result of isovit analysis shows that the visible range varies during the path. Just outside of the tower because of the plan there is a large visible range whereas getting closer to the Nord hospital buildings the visible range decreases between the buildings.

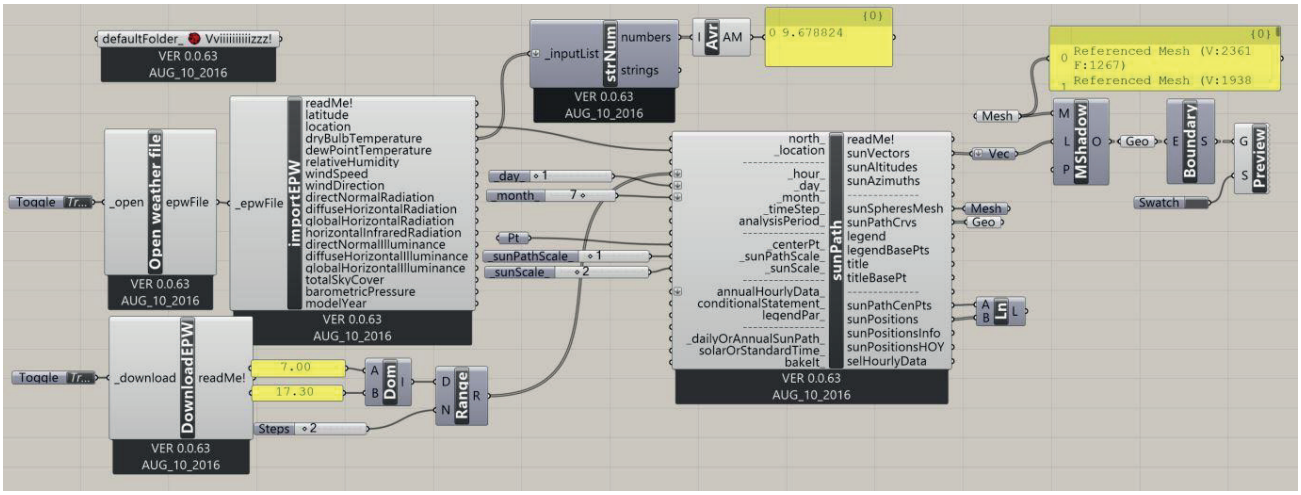


B) Building Scale Analysis

Shadows

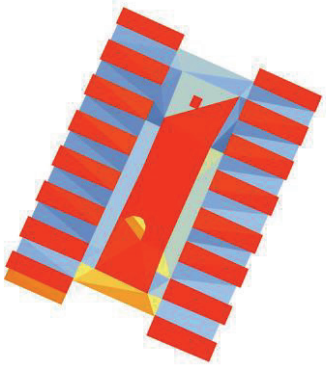
Shadow analysis is important to gather data for the building cluster to understand which building is shadowing which building during specific time and date. This kind of analysis can give us an idea if another building will shadow our PV modules during the most efficient time which will change all the energy calculations.



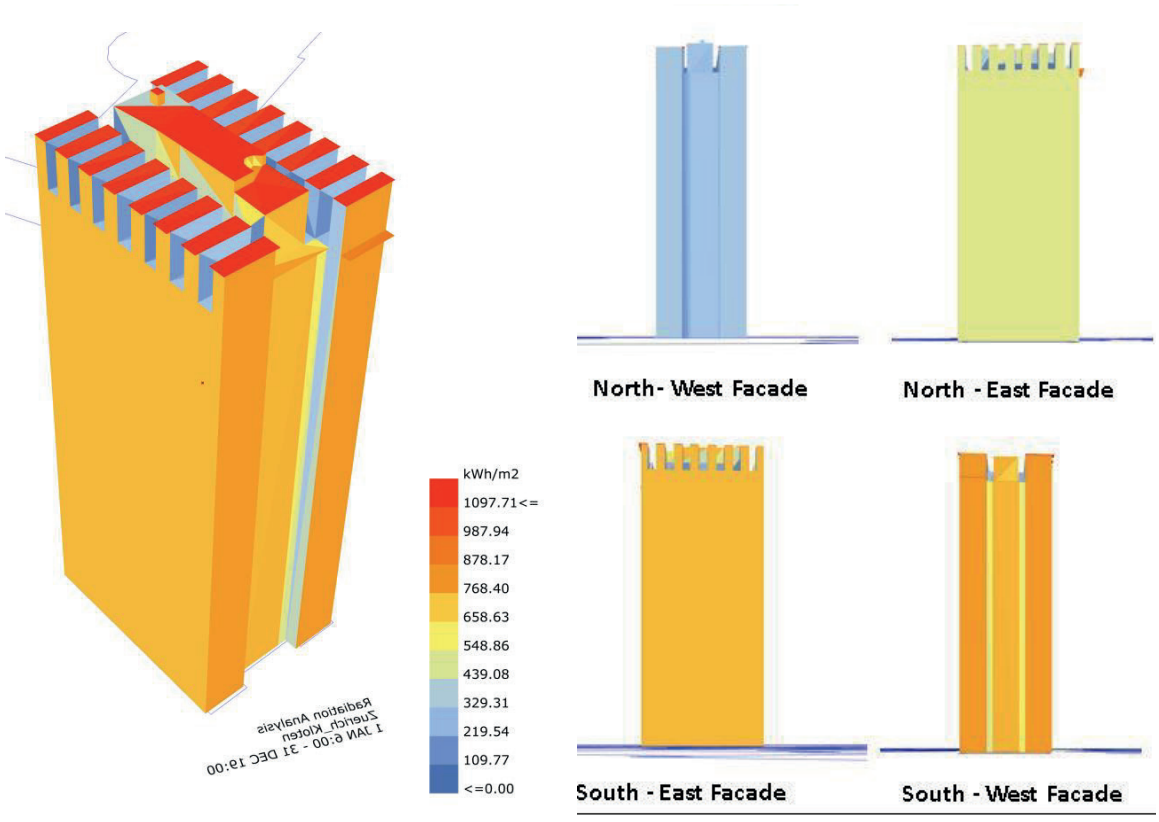


Solar Power Potential:

Solar radiation analysis helps us to be able to see incoming solar radiation to all surfaces to the building to the define time period. In the project case the time period was one whole year to be able to understand possible solar gains to the walls. This energy can be captured to produce thermal heat or electricity.



Radiation Analysis
Zuerich_Kloten
1 JAN 6:00 - 31 DEC 19:00



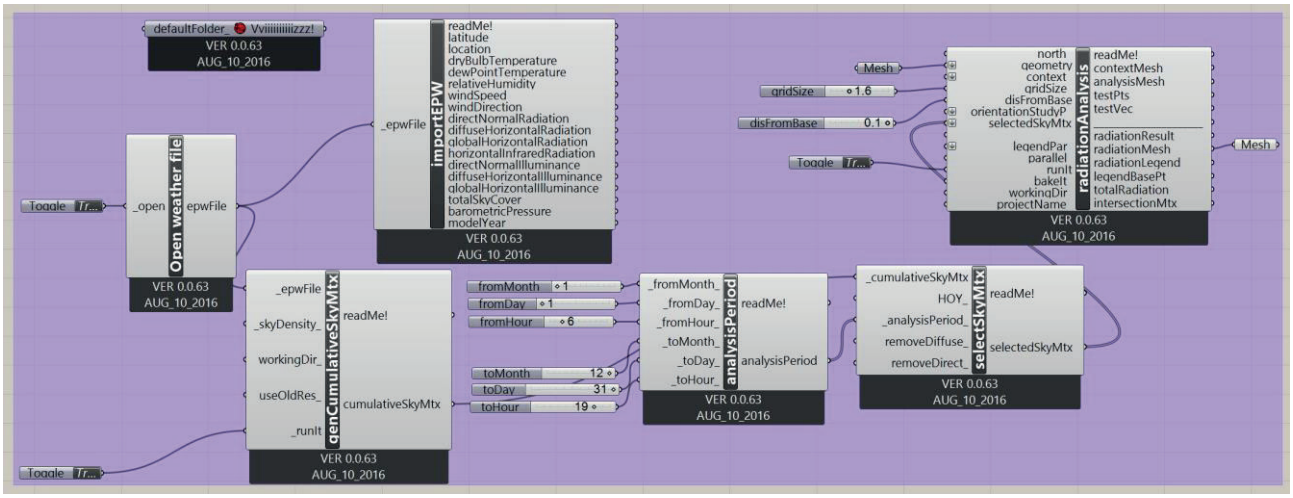
Facade	Total Area (m2)	Win/Wall R.	Wall/Facade R.	Area (m2)
South - East	1221	0.43	0.7	854.7
South - West	928	0.43	0.7	649.6
North - East	928	0.43	0.7	649.6
North - West	1221	0.43	0.7	854.7
Roof	410	1.00	0.5	205

E = A * r * H * PR

E = Energy (kWh)
A = Total solar panel Area (m²)
r = solar panel yield or efficiency(%)
H = Annual average solar radiation on tilted panels (shadings not included)
PR = Performance ratio, coefficient for losses (range between 0.5 and 0.9, default value = 0.75)

Facade	Area (m2)	Solar Radiation(kWh/m2)	Potential Radiation(Kwh)	Electricity Generation (Kwh)
South - East	854.7	658.63	562931.06	88661.64
South - West	649.6	713.515	463499.34	73001.15
North - East	649.6	439.08	285226.37	0.00
North - West	854.7	219.54	187640.84	0.00
Roof	205	1097.71	225030.55	35442.31
Total	3213.6		**1724328.16**	**197105.10**

The total possible generated electricity is compared with the whole electricity demand of the building through the year. If all potential façades would be covered with 0.21 efficient PV modules then the generated electricity would be able to cover 46% of the whole electricity demand of the building. If the same façade would be covered with solar thermal collectors then 38% of the thermal heating demand of the building would be covered.



4. Conclusion:

All the analysis which was done by these grasshopper tools helped me to integrate architectural and engineering aspects together to find future strategies in terms of space quality and energy efficiency not only for the Plattenstrasse 10 but also for the whole hochschulquartier. These tools allowed me to do analysis both in urban scale and building scale can which was very useful for complex tasks. Analysis like accessibility and path detection can help me to define the future functions of the building as well as the connectivity in the master plan of the Hochschulquartier. Shadow analysis and solar power potential will give a very initial inside about the solar radiation distribution in the building and its surrounding cluster.

Planning the Periphery

Student: Patrick Zeller

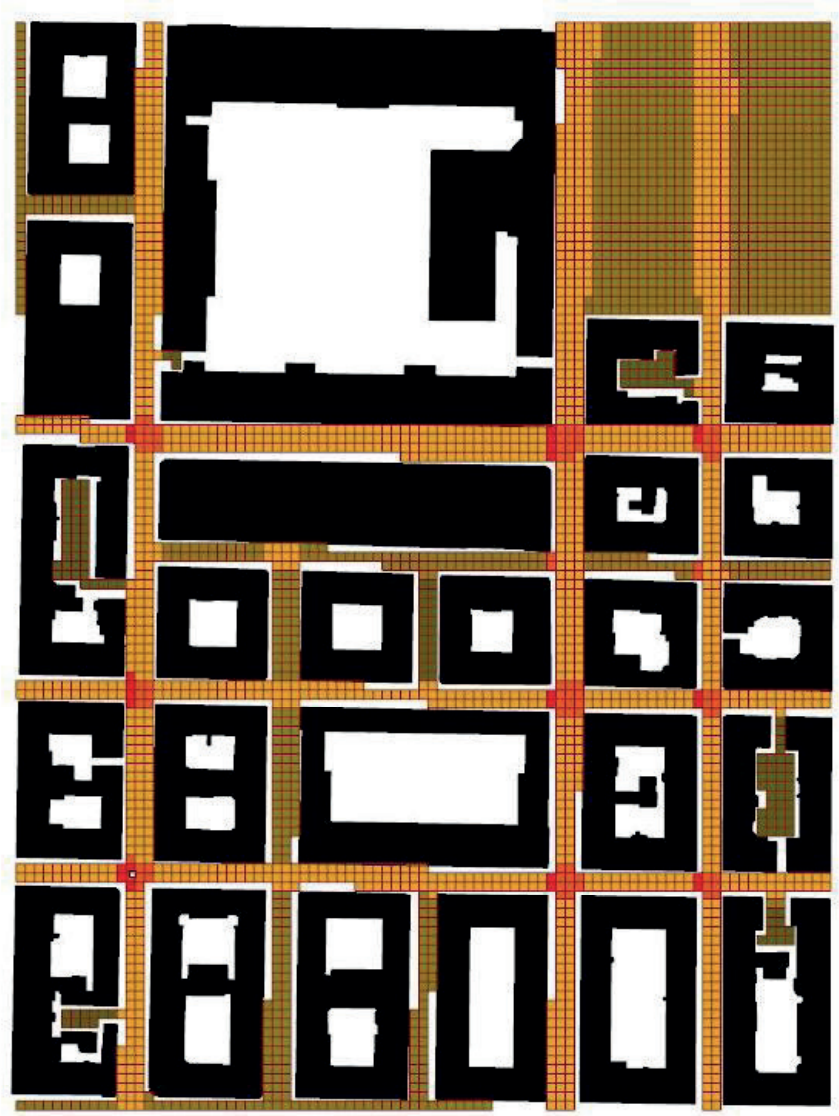
Summary:

The subject of the semester was the city of Turin. We tried to adopt the palazzo-typology, which is very typical for Turin, in a way that it would be applicable for a large site in the periphery. In a first step, a masterplan had to be developed. In a second step one building within the masterplan was designed in more detail.

Motivation:

On a project of this scale, it was clear from the beginning that I would need a systematic approach. If I would have to invent a new set of rules for every square or street, there would have been too many variables to be able to create a cohesive solution. This systematic approach had to be as objective and basic as possible, so that the masterplan would be appropriate for the entire site.

Satellite Image of the Turins Centre



Isovist field (occlusivity)

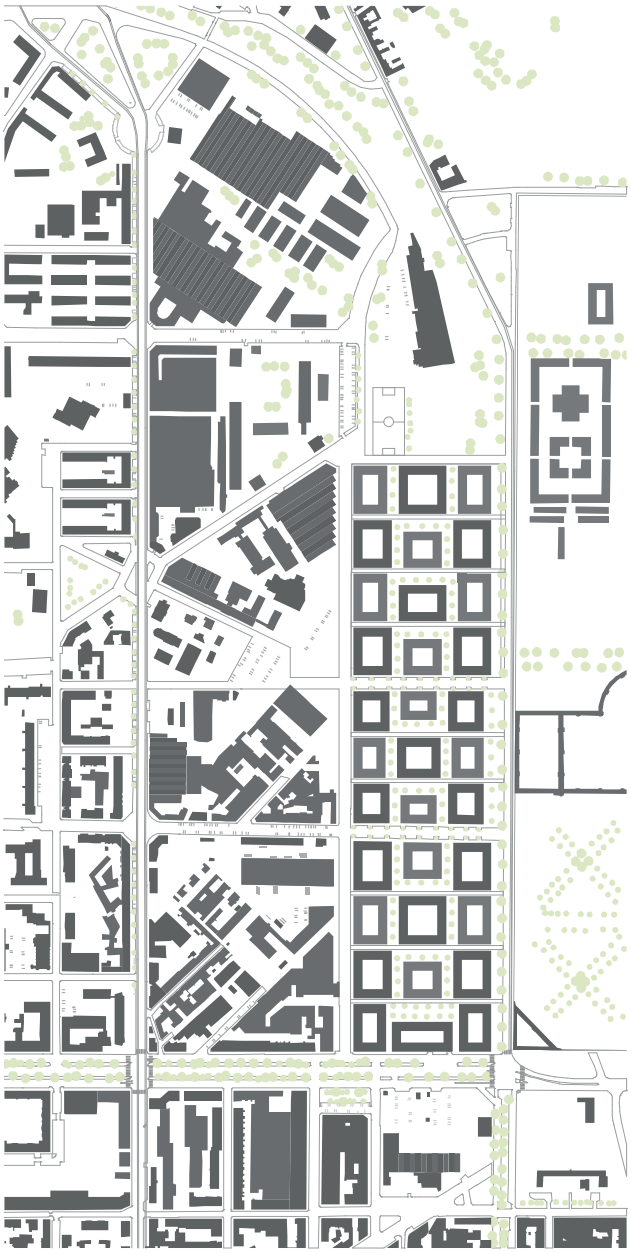
Challenges

Some of the tools that I encountered during this class would have been useful to examine the masterplan, and also the building that I designed in more detail. The aim of the masterplan was to find a balance between the domestic character of the periphery and the urban density that comes with the use of the palazzo-typology. For the final examination of this course, I tried to verify the decisions I made, using the isovist fields and some of the tools used to measure urban microclimate.

Analyses and Interpretation
The results of this verification are presented on the following pages. The aim was not to change the design of the masterplan or the building, but to verify the design deciscions.

The Site

The site is located in the periphery. It contains mostly industrial buildings. A graveyard boarders on its edge. Since the site is located far away from the city center, it seemed inapropriate to have extensive commercial use on the ground floor level. Instead, ground floor living should be made possible by the design of the masterplan.

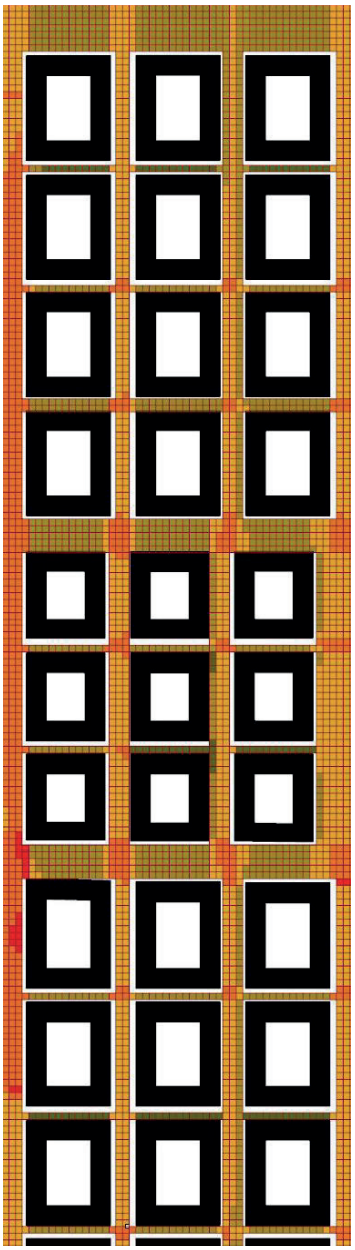


Masterplan

The masterplan for the site tries to find a balance between the domestic character of the periphery and the urban density that is inherent to the palazzo typology. The street grid is therefore divided into accesing streets and domestic streets. The accesing streets are usable by car and connect the two main streets that follow the site on the exterior. The few shops and communal spaces would be located along these streets. The domestic streets are intended to create a calm, backyard-like atmosphere. They are pedestrian streets

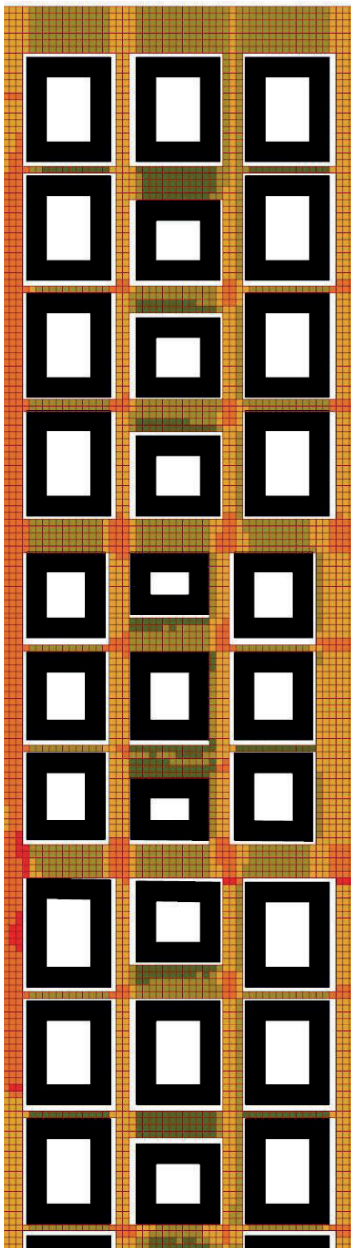
Masterplan Analysis

Here I test the steps that the masterplan went through during the semester, regarding the occlusivity values. Areas with high occlusivity (green) have a more domestic character than areas with low occlusivity (red).



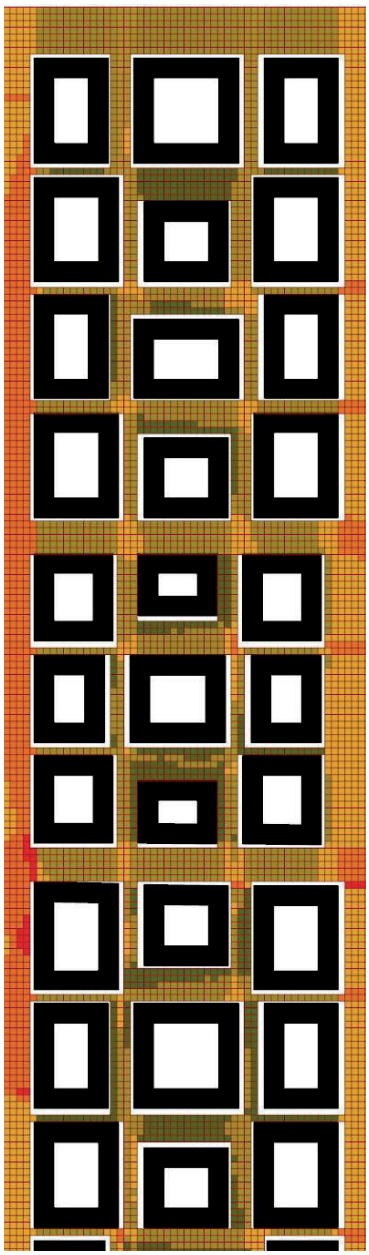
step 1

A grid of typical pallazzi is applied within a regular street grid. Measuring the occlusivity of the street grid, one can see that the resulting values are relatively low. These spaces are very open and therefore not domestic.



step 2

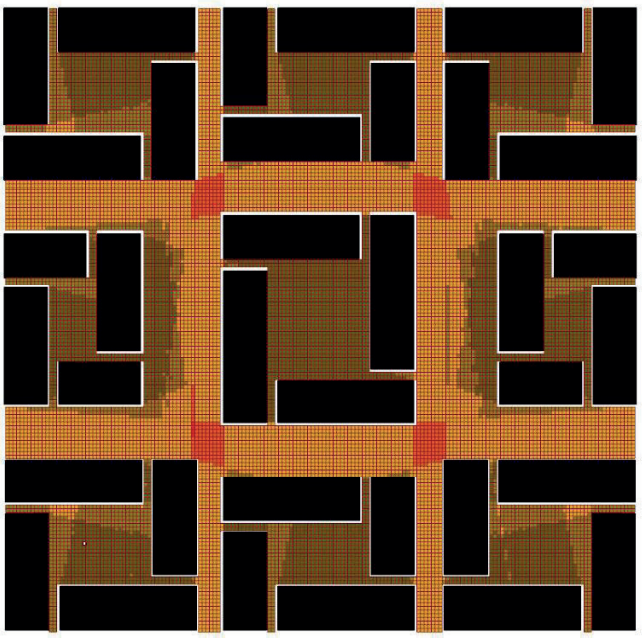
In the middle of the blocks, I introduce small squares. They are enclosed by all the surrounding buildings, thus they achieve higher occlusivity-values.



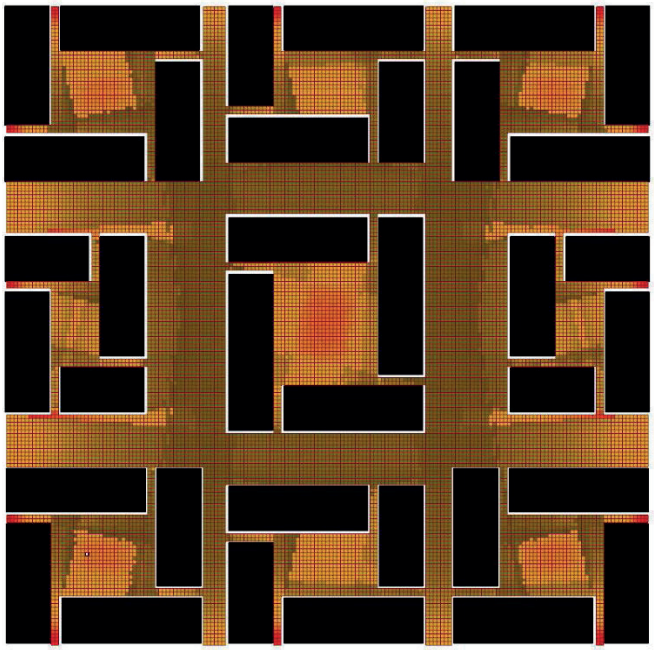
step 3

Next, I shift the fassades on the inside of the block slightly, trying to further increase the enclosure of the spaces. The results of the occlusivity confirm the intention.

Here I test an extract of my masterplan applying further measurments provided by the isovist field tool. Interpreting these results, one can see that the design of the masterplan is able to provide a wide range of spatial characteristics.

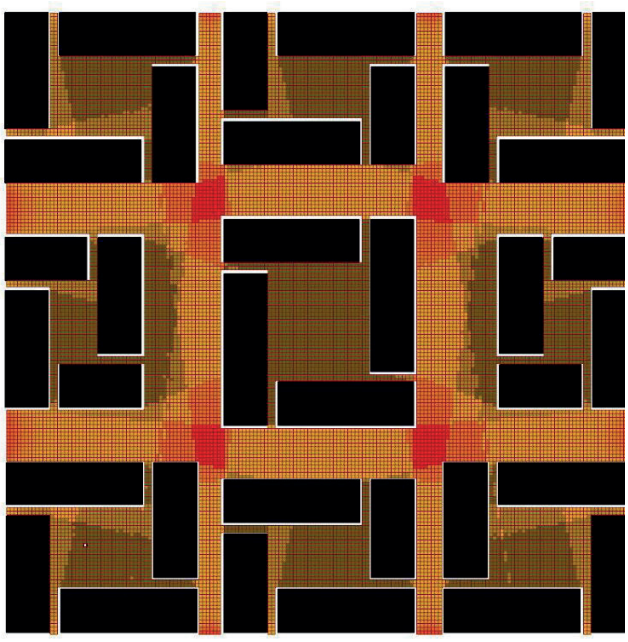


occlusivity



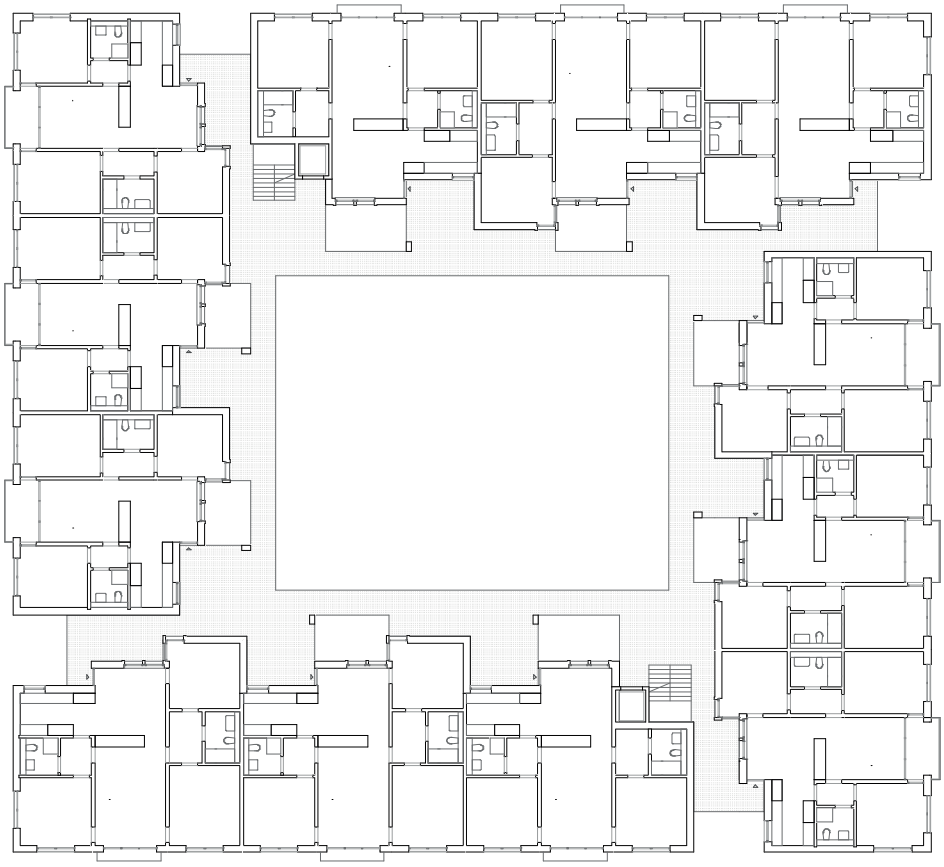
compactness

The compactness measures the ratio of area to perimeter in relation to an ideal circle. The courtyards of the blocks result in high values. I interpret these results as confirmation of the plan



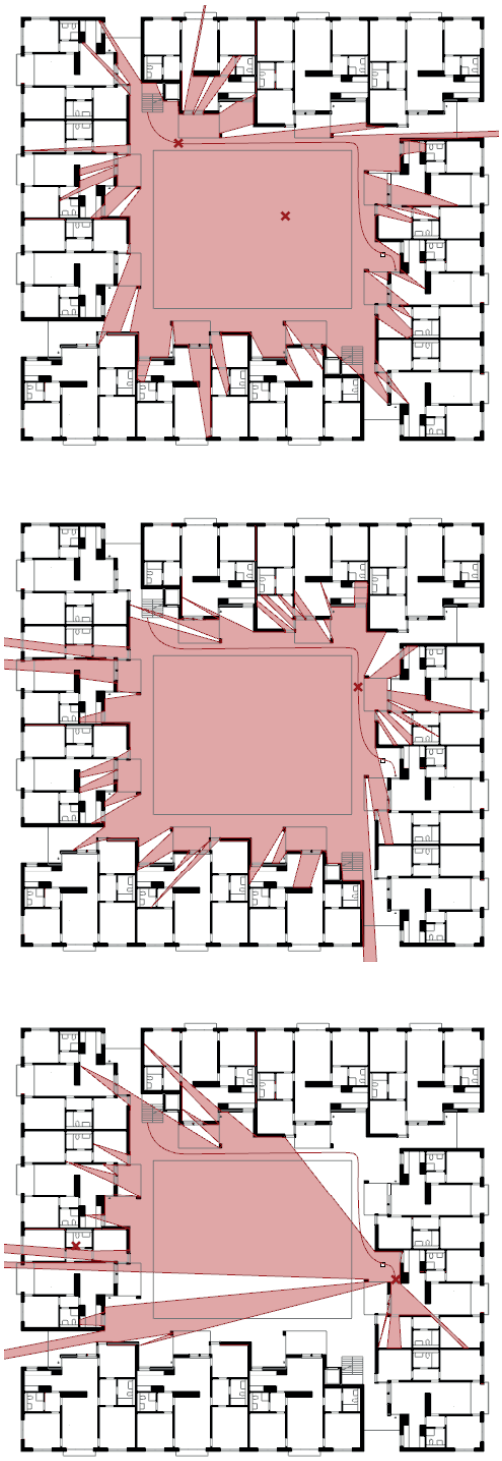
perimeter

The perimeter measures the length of the perimeter of the view field. Similar as the occlusivity, it gives information about the level of enclosement. The results are therefor similar, demonstrating how the squares and the streets with shifted facades are more enclosed.

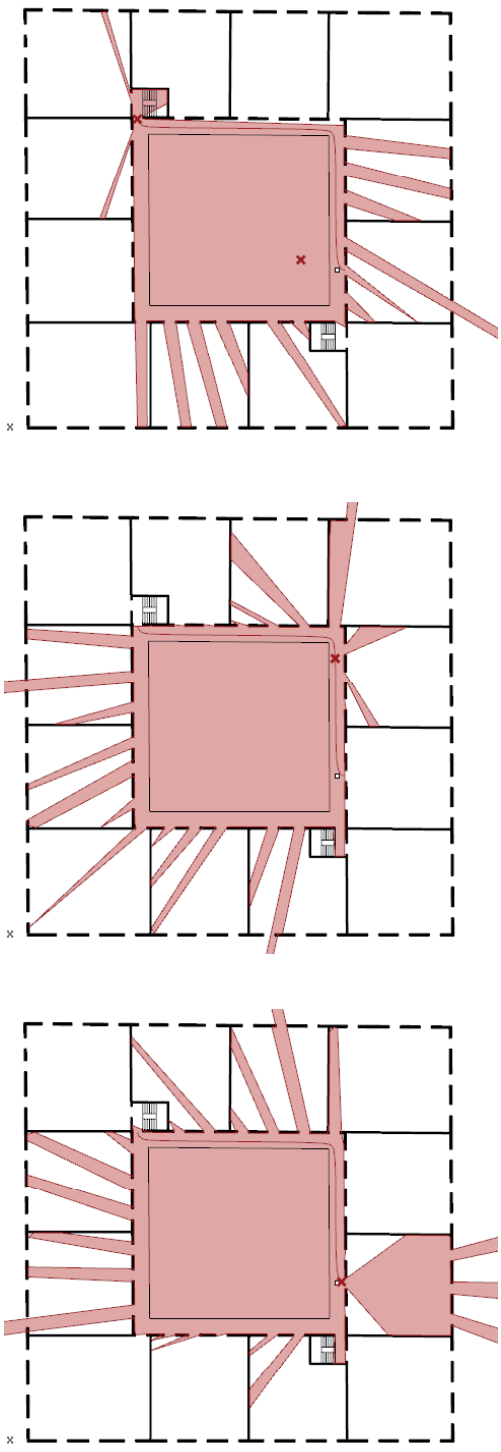


Floorplan

A defining quality of the pallazzo typology are the balconies on the inner courtyard. They often serve as an access to the appartments. For my building, I tried do use the potential of these access ways to create a neighbourly atmosphere. Important issues to consider were the light and the privacy of the appartments that can be affected by these balconies. To test the effectivnes of my design regarding these two aspects I compared my building with a typical palazzo of the city center, measuring the isovist field and the ladybug tool.



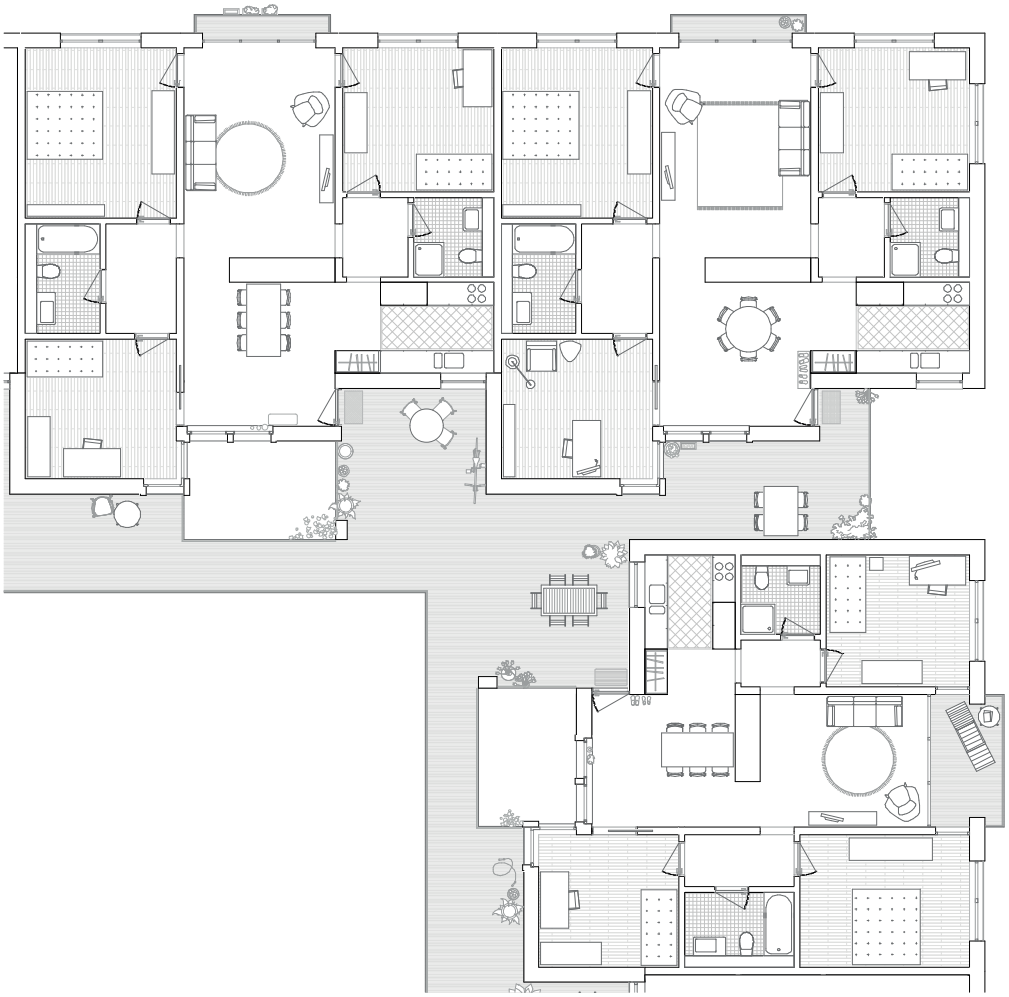
My Floorplan



Typical Palazzo

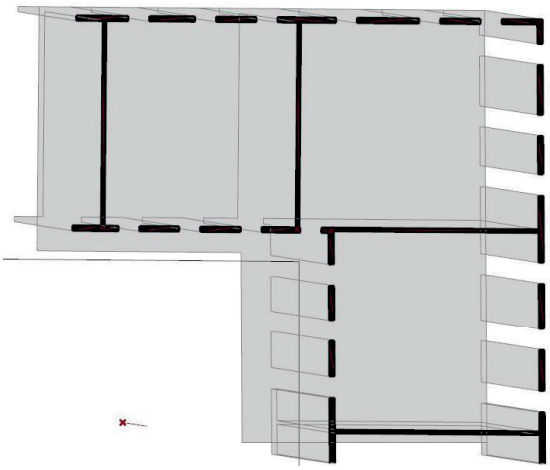
The Isovist Field

The inner fassade of my floorplan is shifted, so that the entrances of the appartments are enclosed within a small space. The functionality of this design is evidenced by the results of the isovist field measurment: Compared with the typical floor plan of a palazzo (see next page), the isovist field has a considerably smaller overlap with the interior of the appartments. Also the area of the courtyard results less covered by the view field.

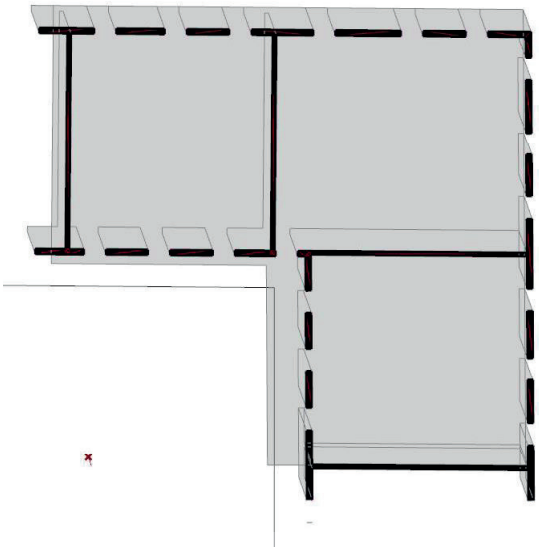


The Apartment

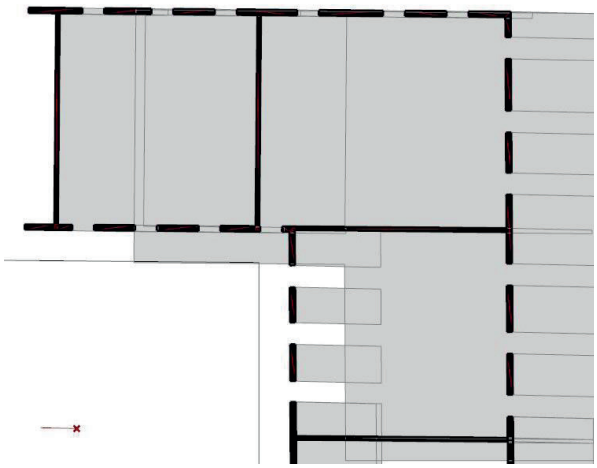
In front of the living room that faces the interior courtyard, the floor slab of the balcony is opened. These funnels provide more light to the appartments. The effect of this is measured by the urban microclimate tool, also known as ladybug.



june, 09:00 AM



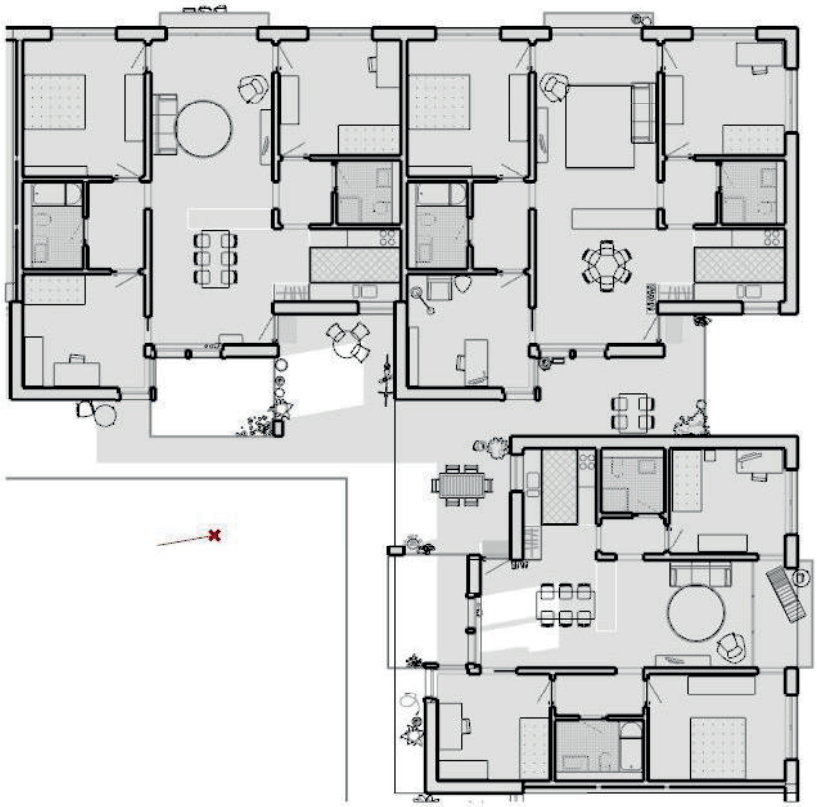
june, 12:00 AM



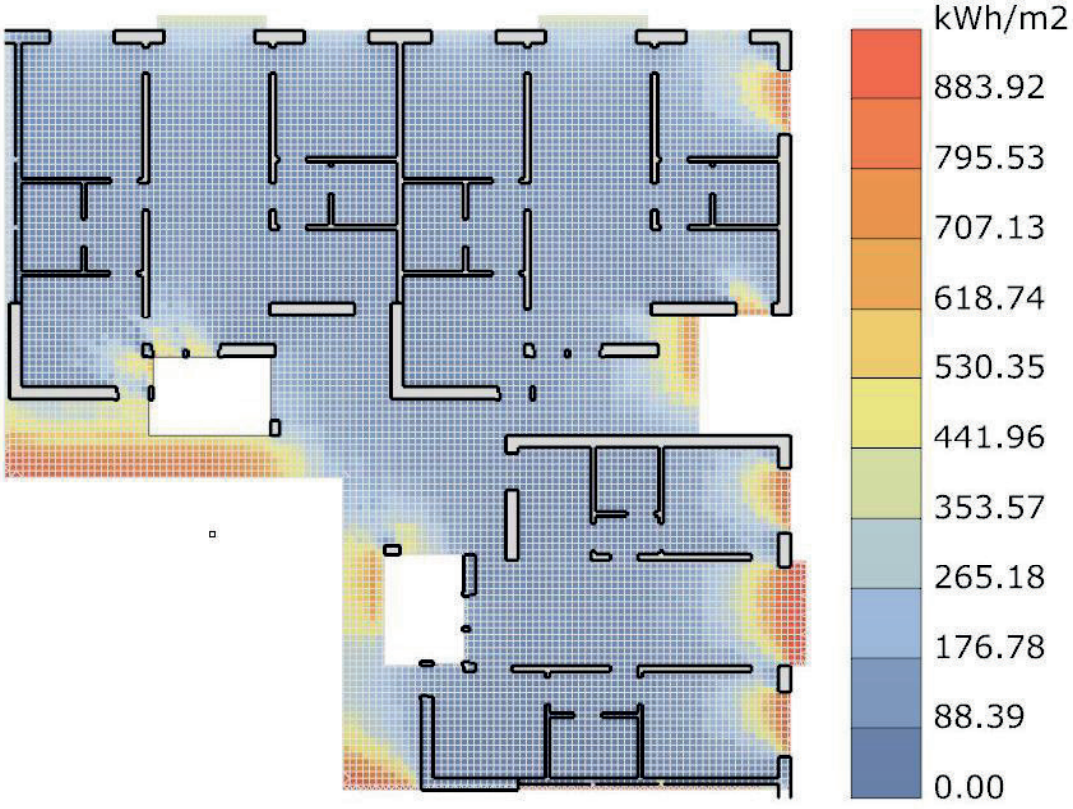
june, 17:00 AM

Illumination

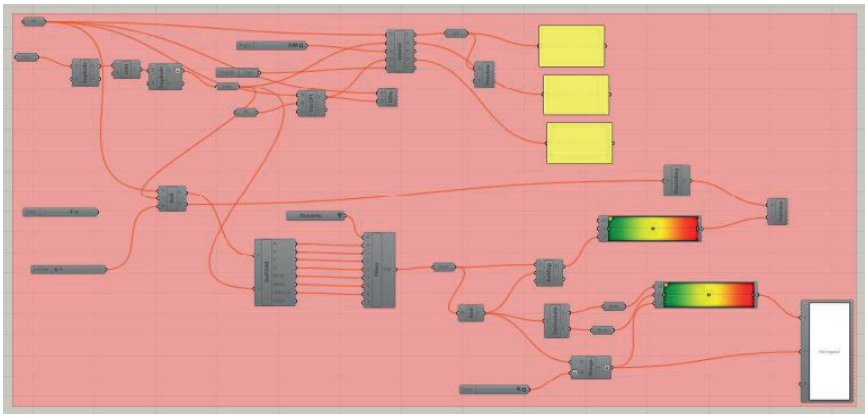
The funnel in the floor slab provides additional light to the livingroom. On the traditional floorplan of the palazzo type, the illumination is worse, as evidenced by this comparison of traditional appartments (on the right) and my appartments (on the left). The impact of these seemingly small differences can be further understood on the next page, where the sun-radiation is measured.



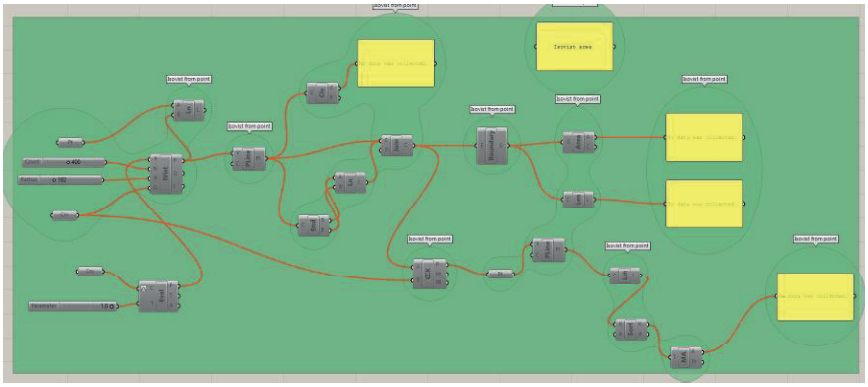
shadow on june, 16pm



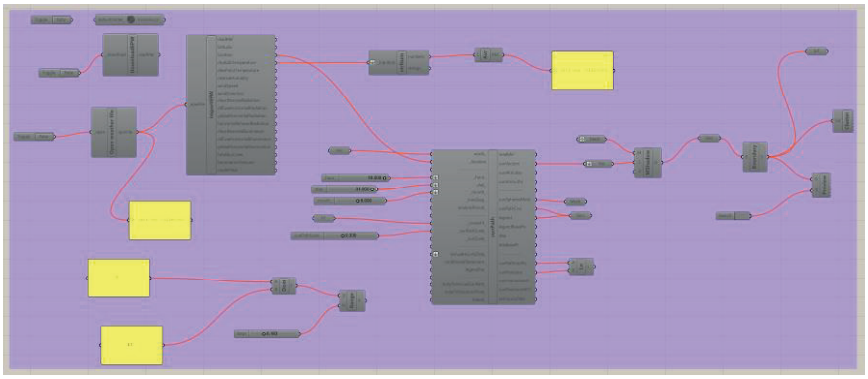
sun-radiation, time set: january - december



Grasshopper definition for the isovist fields



Grasshopper definition for the isovist view area



Grasshopper definition for the urban microclimate

Conclusion

To conclude one can say that these tools can be a very usefool instrument not only to test but also to illustrate design choices. I found the tools to be very interesting as a method to measure, verify and visualize qualities that we as architects often find difficult to describe. The word "density" for example can mean so many things, and often during discussions it is not clear what one means exactly. The isovist field tool provides a number of ways to examine the density of a place using traceable measurments. On the other hand I am not sure wether I can use these tools for the design process. The time that is needed by my (moderatly fast) computer to calculate these models (especially the isovist fields) is hard to integrate in a smooth work flow. But I'm sure that these tools will become more efficient in the future.

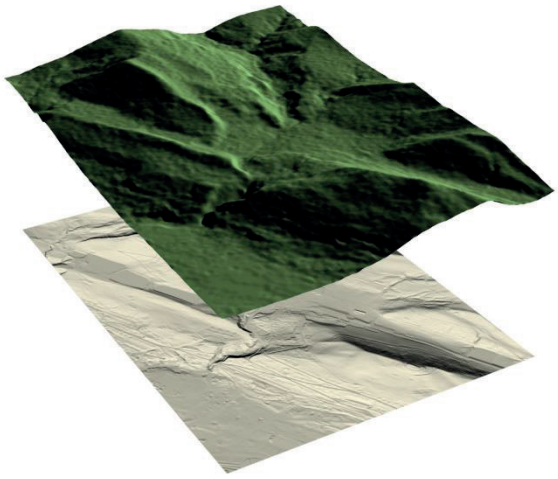
Settlement Growth Analysis

Student: Michael Fehr

Summary & Motivation

To get as much insight into not just the Rhinoceros/ Grasshopper combination itself, but also the different plugins and their offer of tools and analyses, the rest being the translation of a GeoTIFF image file into elevated topography. Then, different exclusion criteria for building positions were set up. After the creation of (cylindrical) buildings of varying height and diameter, an analyses of annual solar gains was conducted to evaluate the design.

Even if there is probably not a lot of scientic value in this project, it can show how many factors infuence the growth of settlements and present some of the possiblities of the software environment used.

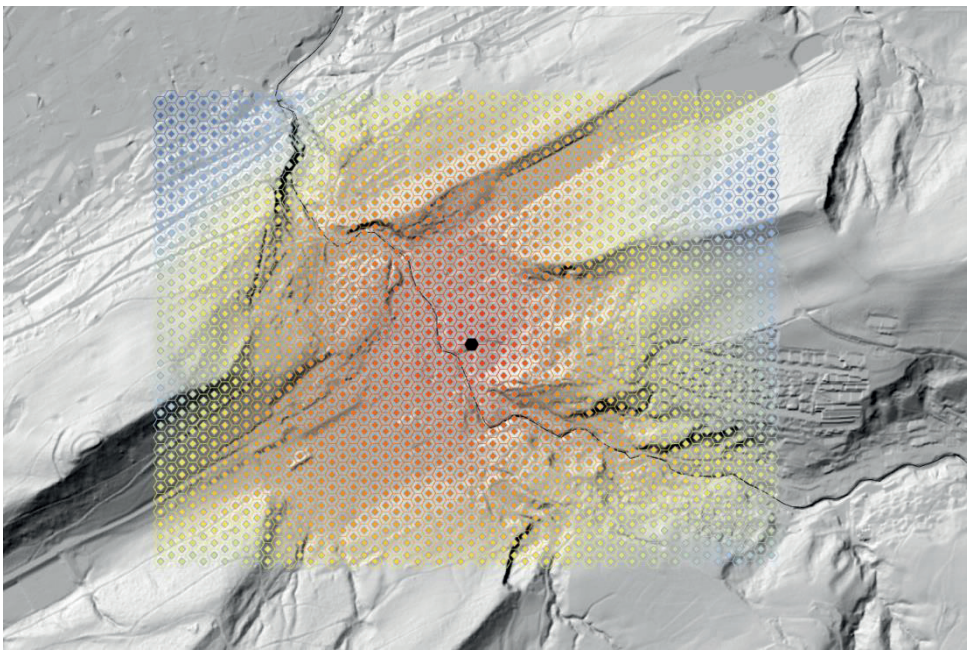


Topography

After downloading relief and elevation pictures from the net (1), these were transformed into grayscale JPEG to be used by Grasshopper image sample. The real extensions and height extremes were then used by a grid to get the real profile. It shows an area of St. Gallen:

Tessellation & Street Network Analysis

Because of a better use of space and manageable computation effort, the tessellation for the building plot creating and network analysis was done with a hexagonal grid. Feeding this grid and the topography to the streetNetwork tool (Configururbanist plugin) result in a coloured grid showing the distances to a set point. The chosen point (black spot) in this case is located around the historical centre of the village, close to school and church.



Exclusion Factors

For the development of a settlement with centre, not all places are suitable. The behavoiur of the settlers in this project was set to “ecological” - in different ways:

River

The settlers want to leave the river its original path and bed. This is beneficial for plants and animals living in and around the river. It also helps reducing the risk and damage of floods. No building should be closer to the river (black line) than 20 meters.

Slopes

Buildings should not be standing in very steep terrain, which decreases the potential damage from landslides and the building costs. The threshold values were set from knowledge of the site and applied on a (slightly blurred) gradient image which holds the information of steepness.

Distance to Centre

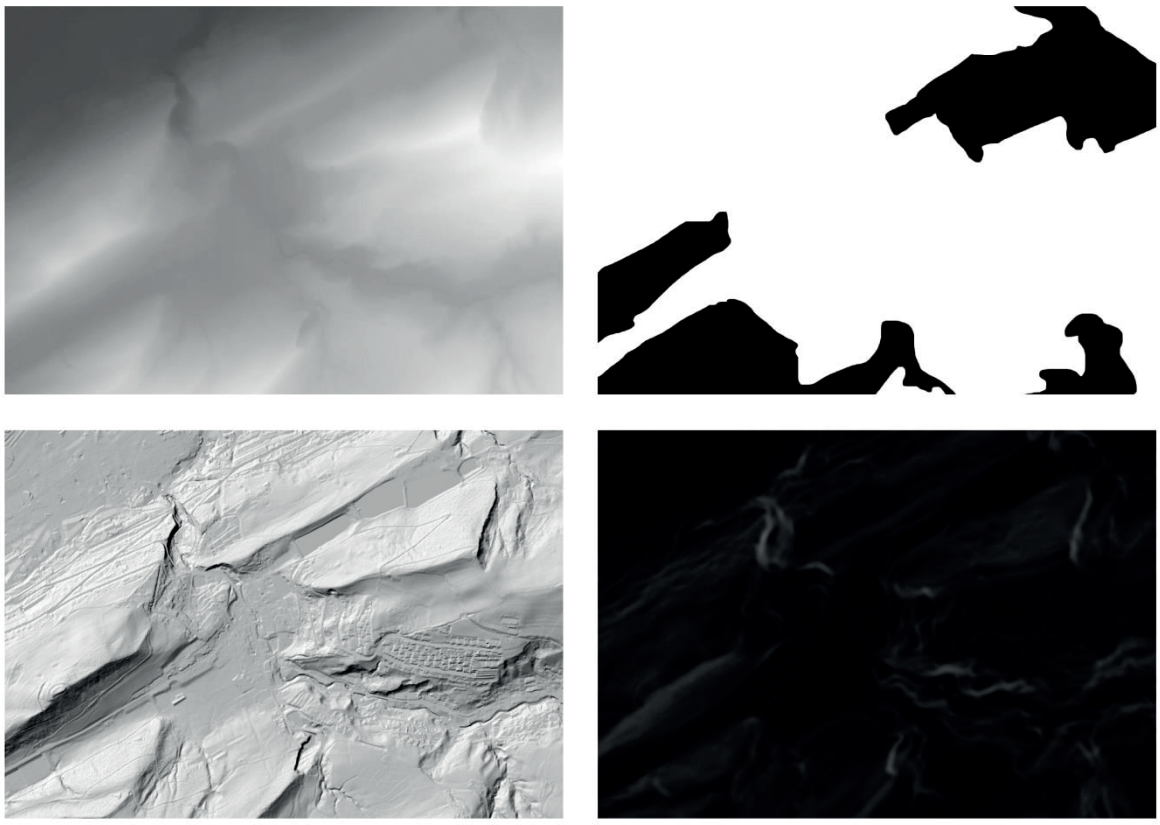
The maximum distance to the point set as centre should not exceed a certain distance (800m in this case). The distance also determines the building heights so as to have more people close to the centre.

Sun

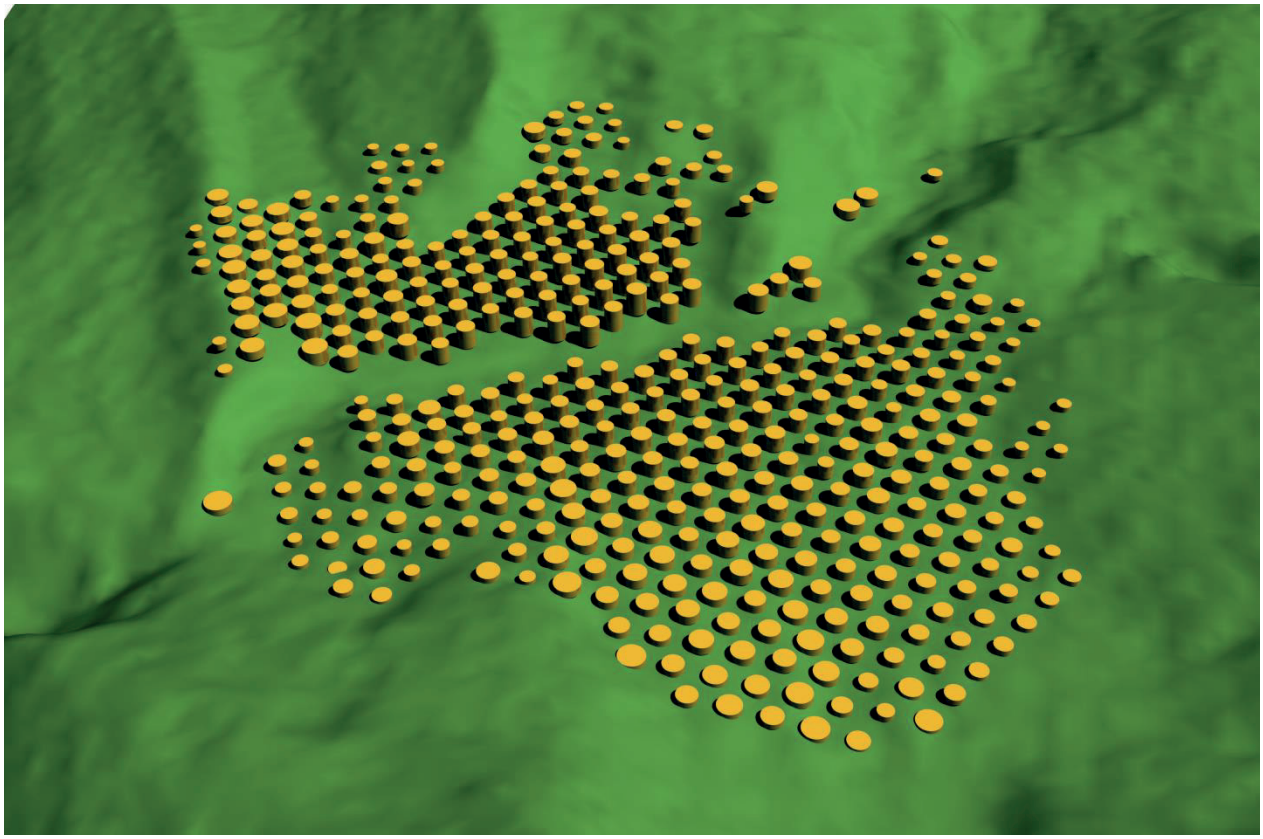
To reduce heating loads in winter, buildings should not be built on north facing hillsides. Instead of a large solar potential analysis, a vector based (and much faster) approach was chosen: at each plot, the vector normal to the topography (without east-west component) was compared to the sun ray vector of equinox (spring). Plots with an angle of more than 90° between these vectors are dismissed.

Forest

Areas covered by forest and ponds are not taking into consideration for building sites. An aerial view of the site was used to find the outlines of these.



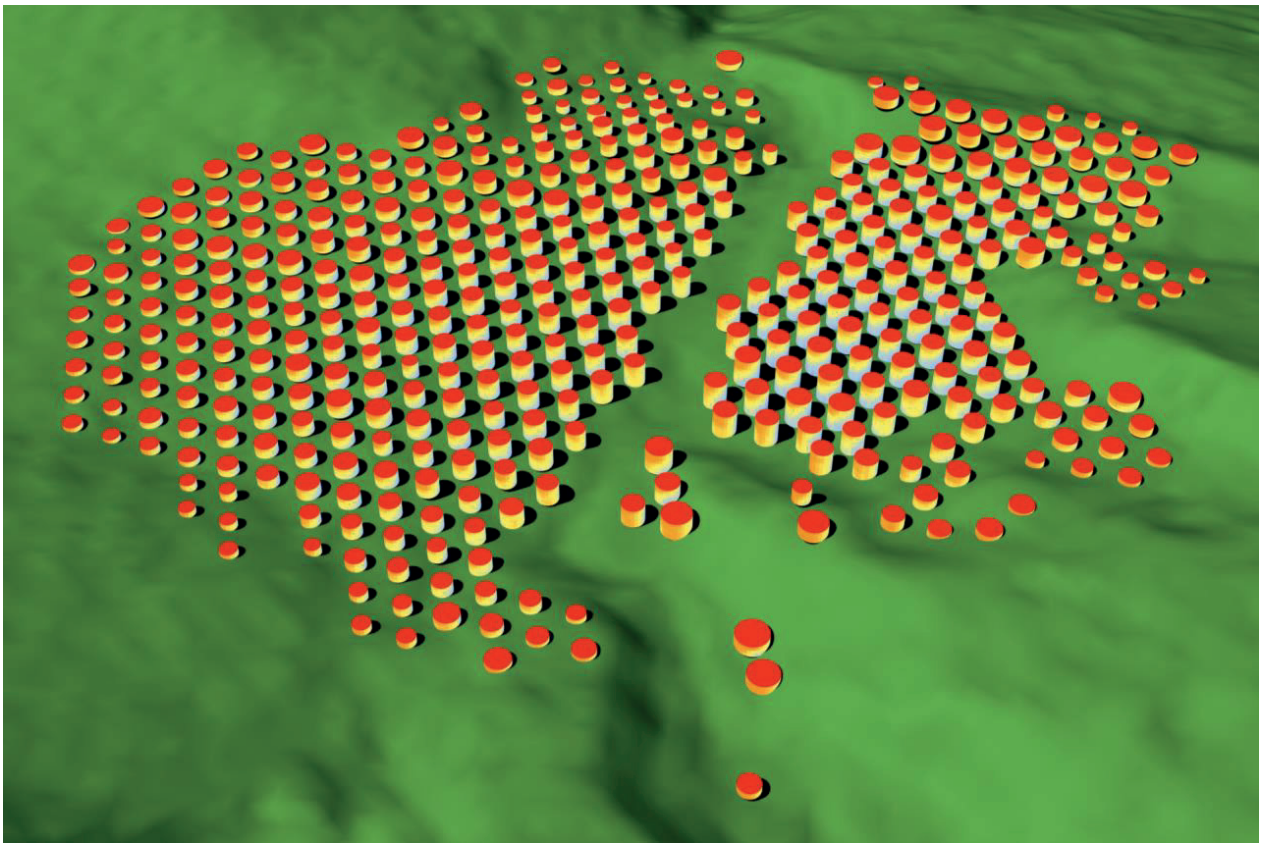
Top left: Elevation image where brighter pixels are higher. Top right: Areas covered by forests etc. Bottom left: Relief image. Bottom right: Gradient image showing sloped as brighter pixels



Circle Offset & Extrusion

All plots that were not eliminated by one of the exclusion criteria have their seed circle offset. Plots with smaller angles in the sun criterion get enlarged circles, buildings with ^high angles get a size reduction. This measure should reduce the shading effect on other buildings.

The extrusion is the last step. Buildings are given heights between 3.5 m (one story) and 21 m (6 stories)

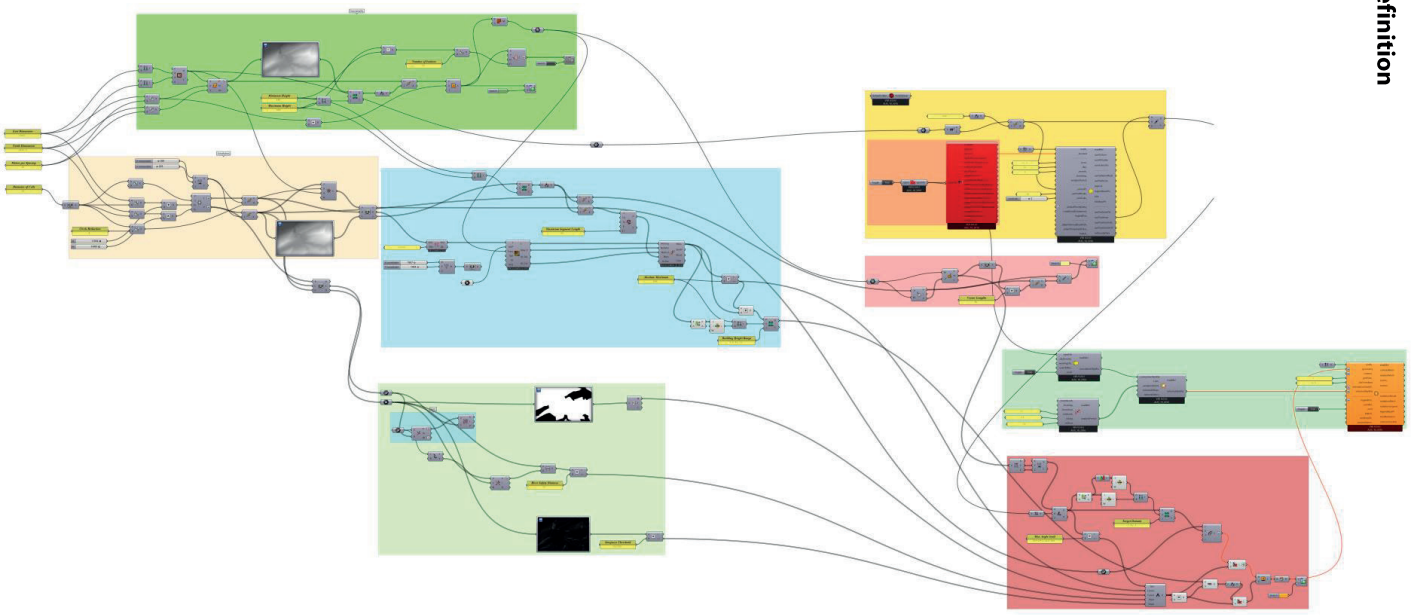


Solar Analysis

To see whether the energy measures make sense, a solar analysis was conducted using Ladybug features. The extruded buildings were analysed using the weather file of Zurich.

Not surprisingly is that the roofs of all have the same intensive red. The facades are more interesting. Lower parts in dense areas get significantly lower solar gains than higher floors. This problem could be solved by reducing building heights or diameters in dense areas or change the shape. Different shapes could also help to distribute solar gains away from the roof. But this again would be wanted when using photovoltaics.

Grasshopper Definition



Conclusion

After spending some time fixing mistakes, finding errors and struggling with computer crashes, the result is comprehensible and seems to make sense. The combination of geological data and images with Grasshopper programming (and also Matlab and Photoshop) offers many possibilities!

Analysis of a New Sub-Centre in Shanghai

Student: Tian Zhou

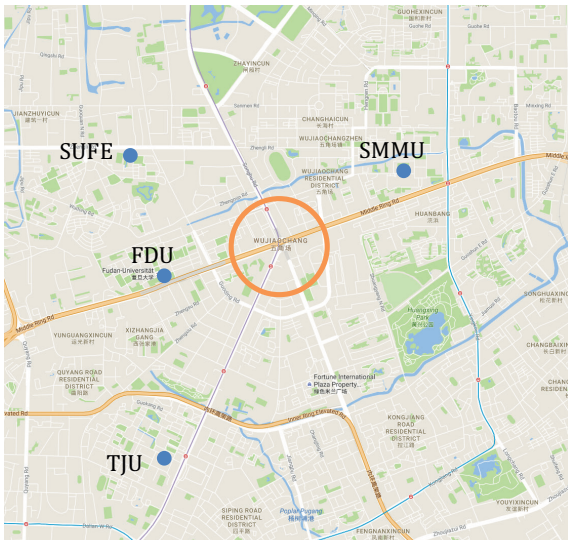
Summary:

As the new city sub-center of northeast Shanghai, Wujiaochang is not merely a shopping center but also an active hub of high-tech innovative companies and an essential connection of the four universities (TJU, FDU, SMMU, SUFE) near it.
Source: ctps.cn Source: landscape.cn

In order to analysis the rationality of the new city sub-center and to give some reasonable suggestions on the development of this sub-center, the following analysis are carried out and interpreted in this report: Choice analysis, Integration analysis, Accessibility analysis, Path detection, Isovist analysis, Isovist field analysis, and Solar irradiation analysis.

Source: ctps.cn

Source: landscape.cn



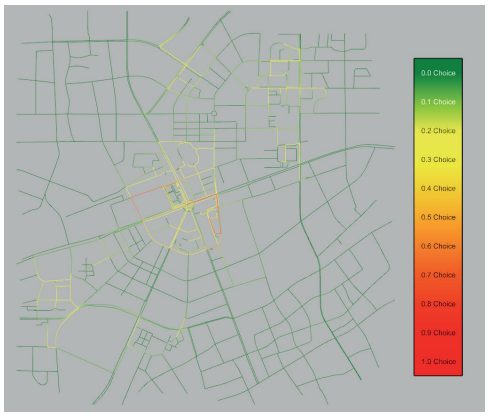
2. Motivation:

I had lived in this area for 4 years before I came to Zurich. It was interesting seeing the fast development of this integrated new city sub-center, so I believe it is also valuable to check the mechanism behind the prosperity and derive some possible strategies for this urban area. Therefore, choice analysis and integration analysis are implemented to assess the rationality of the spatial location; accessibility analysis and path detection are implemented to check the convenience of the spatial location; isovist analysis is carried out to assess the visual results; and solar irradiation analysis is applied to look for an environmental-friendly energy-saving solution.

3. Analyses and Interpretation:

Choice analysis (Segment analysis):

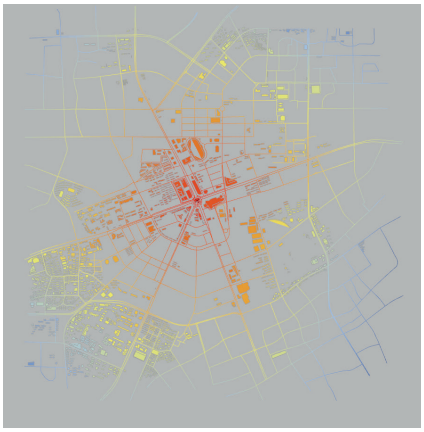
As shown in the right figure, for this urban area, the roads around Wujiaochang are mostly chosen by people, which means it is reasonable to consider Wujiaochang as the local center.

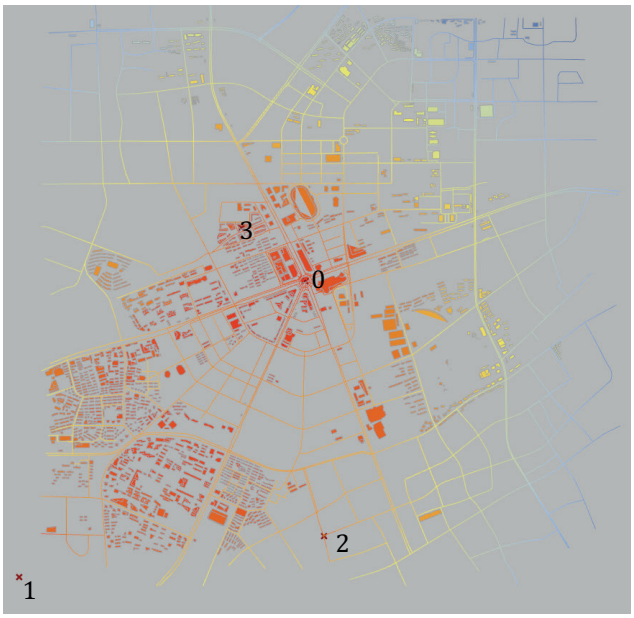


Integration analysis:

Single point situation (right) shows the distance network to Wujiaochang. Multiple points situation (right) shows the integration using various positions of point of interest with various weigh values. Points 0 (Wujiaochang) and 1 (Hongkou Football Stadium) are two big shopping centers, which share a weigh value of 10/10; while points 2 (Jiangpu Road) and 3 (Daxue Road) are two relatively small shopping centers, which have a weigh value of 5/10.

The result shows that the urban area is well covered by the services from the four shopping centers, which indicates a convenient life within this urban area.

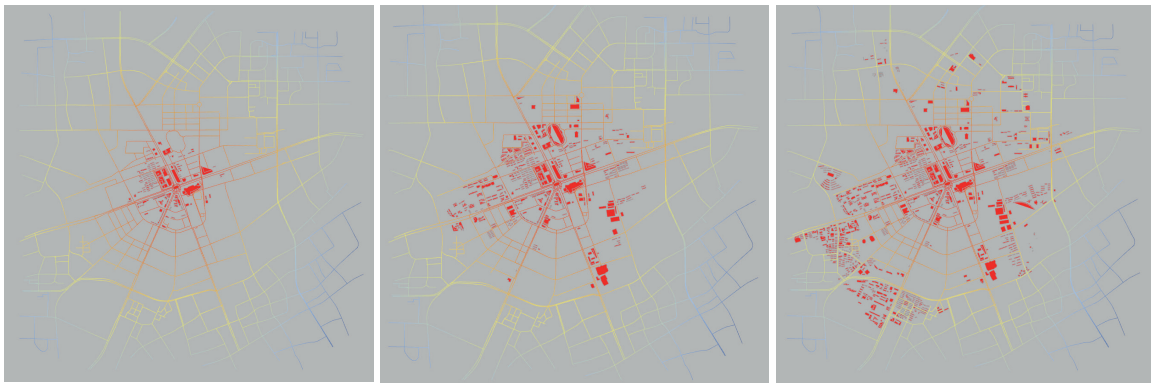




Accessibility analysis:

- Spatial accessibility of 500 meters, 1 kilometer and 2 kilometers.

- Temporal walking accessibility of 10 minutes, 20 minutes and 30 minutes.

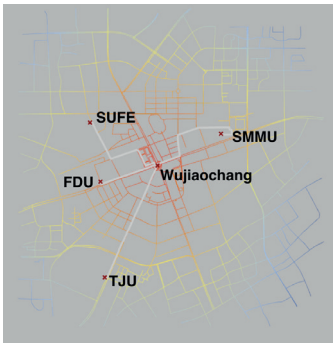


- Temporal cycling accessibility of 5 minutes, 10 minutes and 15 minutes.

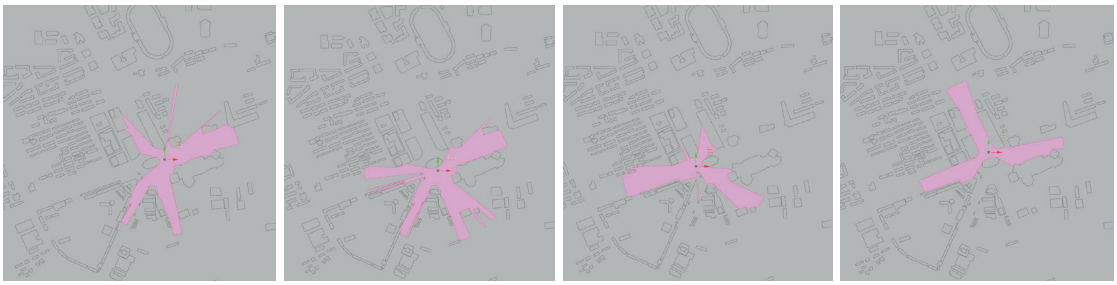
From the results, we could see that this urban area, with a diameter of more than 2 km, is quite big and Wujiaochang could be considered as the center of this area. With 30-minute walking or 15-minute cycling from Wujiaochang, most buildings could be approached.

4. Path detection:

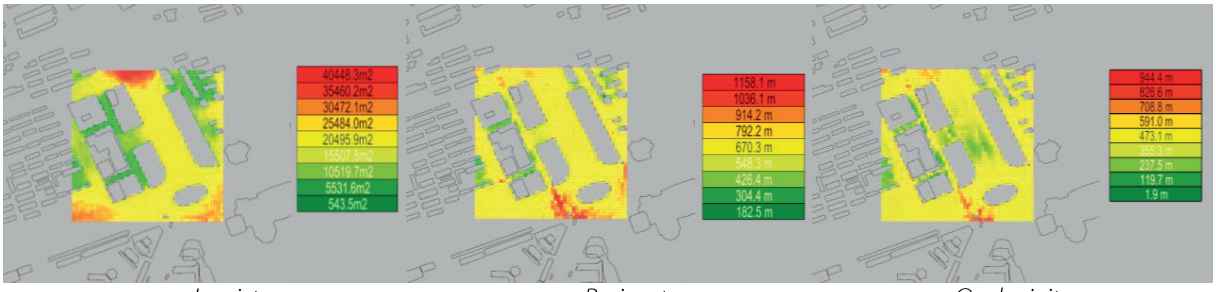
The paths from Wujiaochang to the 4 nearby universities are detected. As a result, we could see that Wujiaochang is well connected with the universities and could be considered as the bond or the bridge between the different universities.



5. Isovist point analysis: Isovist areas at different positions (east, south, west, north to the elliptical plaza of Wujiaochang) are visualized below.

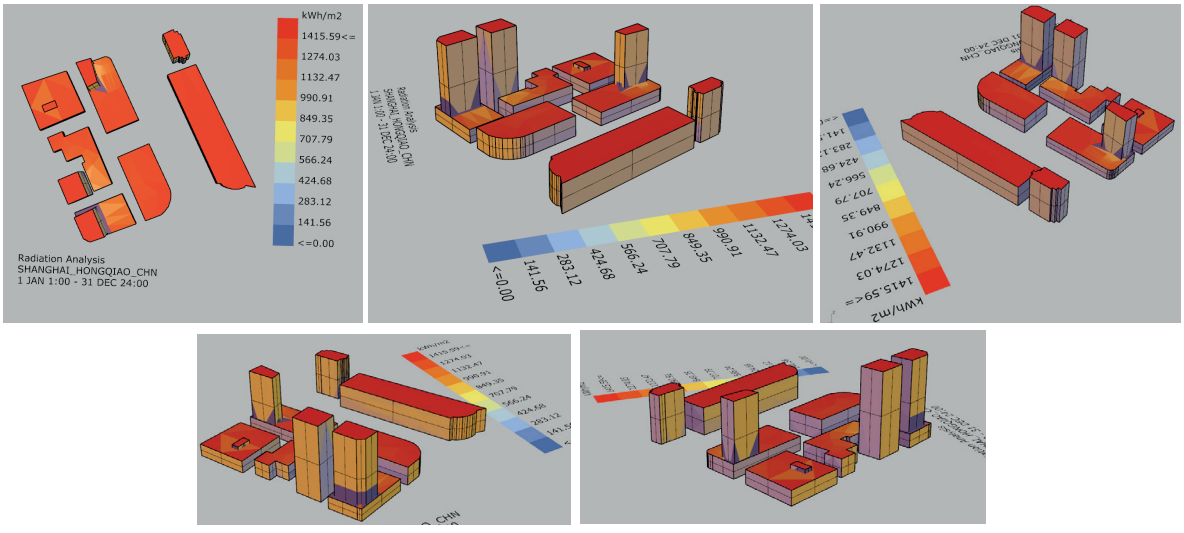


6. Isovist field analysis: This analysis is implemented for the shopping center zone of Wujiaochang. From the results shown below, we can easily notice that isovist area of some parts are small due to the visual block effect by the high-rise buildings.



Isovist area *Perimeter* *Occlusivity*

7. Solar irradiation analysis: This analysis is also implemented for the shopping center zone of Wujiaochang, and the results are shown below. As a result, we can see that most part of the roofs has high solar potentials (>1000kWh/m2). Therefore, I would suggest that PV or PVT panels could be integrated on the high solar potential part of the roofs of the relatively low buildings, since it's easier to implement.



Conclusion:

As a new city sub-center of Shanghai, Wujiaochang has a perfect location and works well as a bond of different elements nearby. Together with other local centers, a convenient urban life could be provided to the citizens. However, the high solar potential of this area should be taken advantage of, in order to involve the city in a more ecological and energy-saving way.

Huangguang East Town Planning

Student: Difei Yang

Summary:

With the growth of economy, Huanggang is planning a new town near Baitan Lake to meet the increasing demand for office and residential buildings.

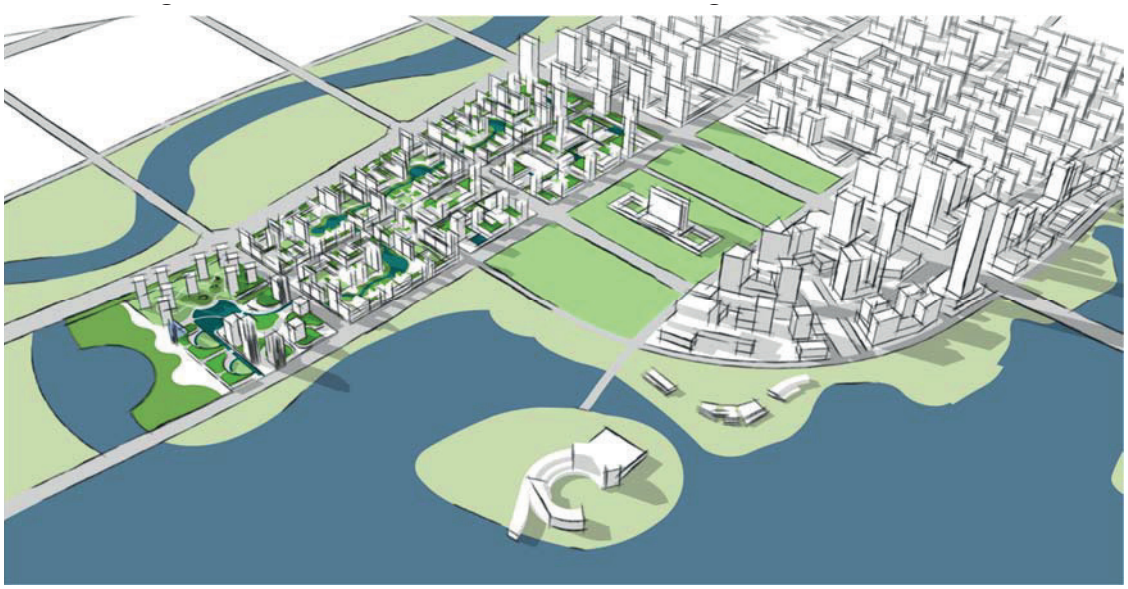


Figure 1. Masterplan of Huanggang East Town

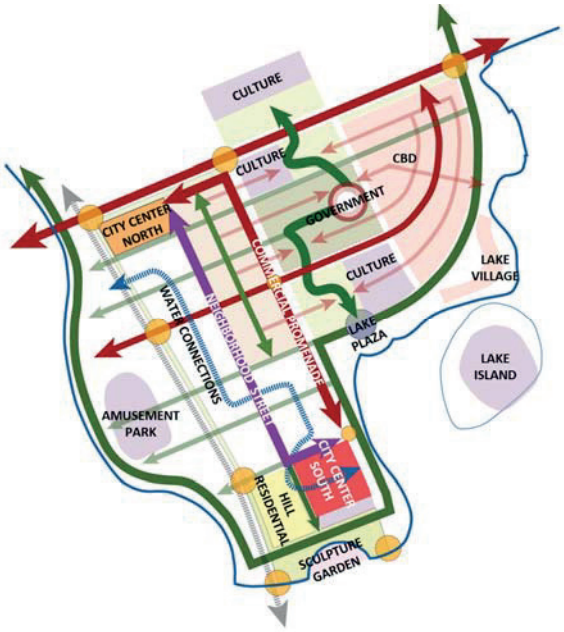


Figure 2. Functional Design

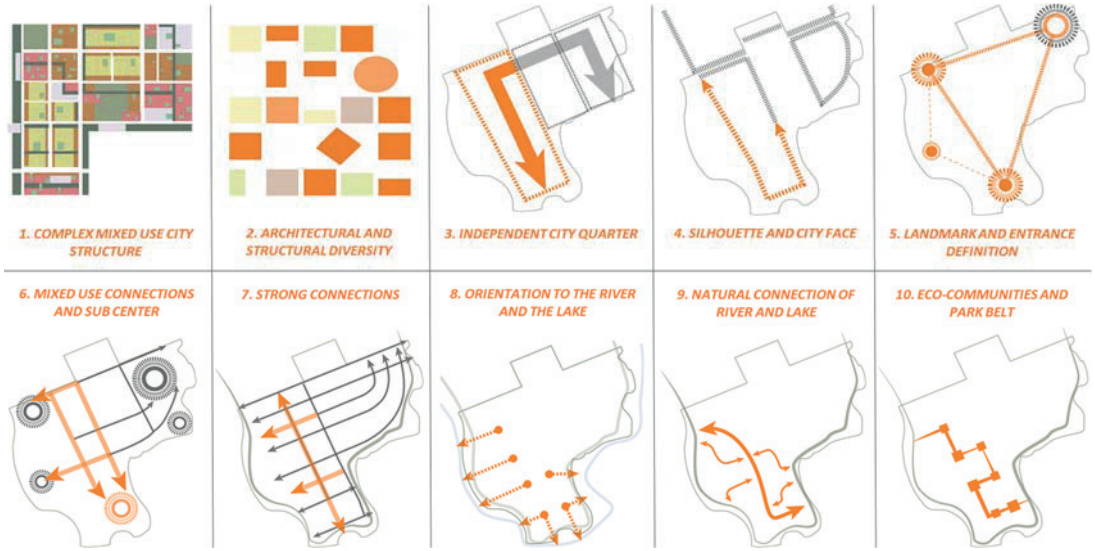


Figure 3. Development Guide

This project aims to analyze connectivity, accessibility, visibility of the master plan, also the solar potential that could be used in buildings' operation.

2. Motivation:

I was working on this project three years ago, as a sustainability consultant and cooperated with planners. It was anguishing for us that we could hardly find a way to show the connectivity of the road network, also to find locations for services and bus stops to build a friendly neighborhood of everything within walking distance. Such issues could be analyzed and also clear images could be developed with Grasshopper.

3. Analyses and Interpretation:

3.1 Connectivity

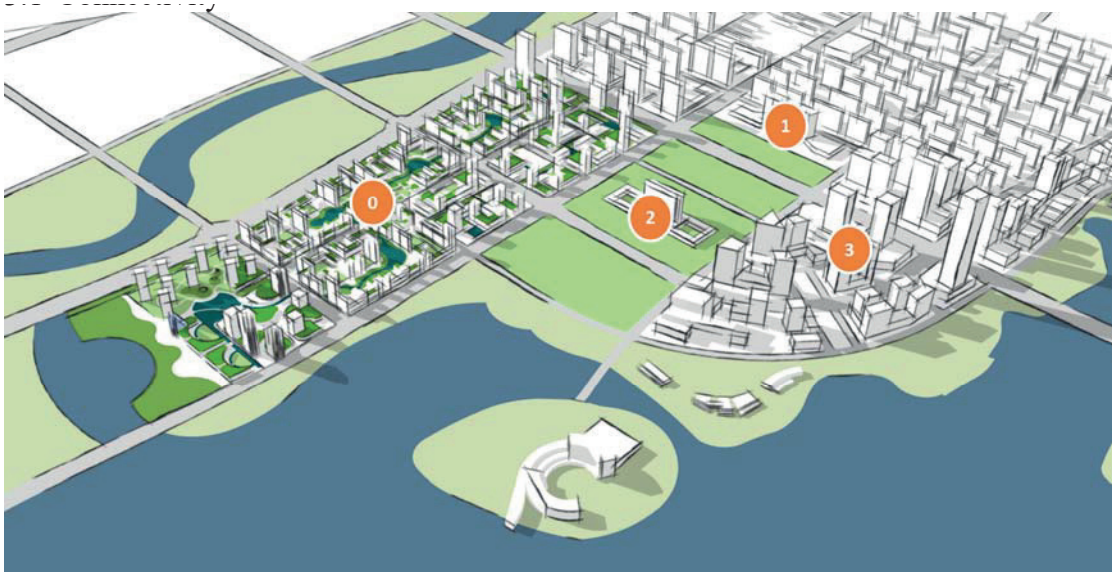


Figure 4. Locations that to be analyzed

Figure 5. Connectivity

Connectivity is analyzed based on four major functional area of the project: residential buildings, main government building, cultural plot, and CBD. The result shows they are well connected with each other.

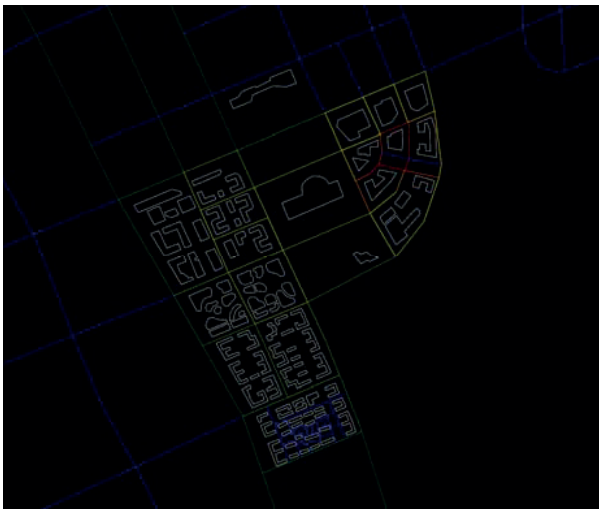


Figure 6. Segment

The roads around the middle area of CBD performs a higher choice level, which indicates that it's better not manage to run bus lines get in or across this area.

3.3 Accessibility As to accessibility, the first analysis would be conducted that how far people could get to from the selected locations, within 15 minutes of walking or cycling.

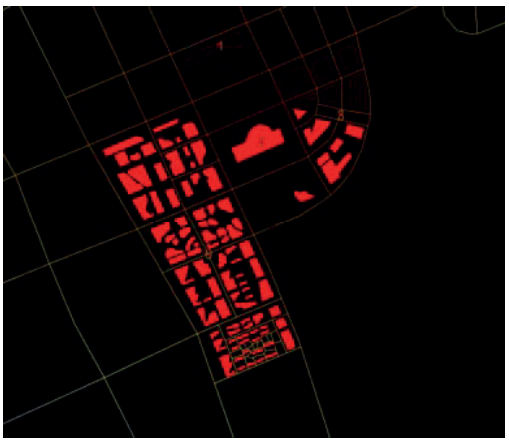


Figure 7. Walking 15 min from Residential Area (Point 0)

For the residential area, occupants could get to the center part within walking of 15 mins. Thus, basic services like supermarket, day-care, post-office, etc. could be places near the center.

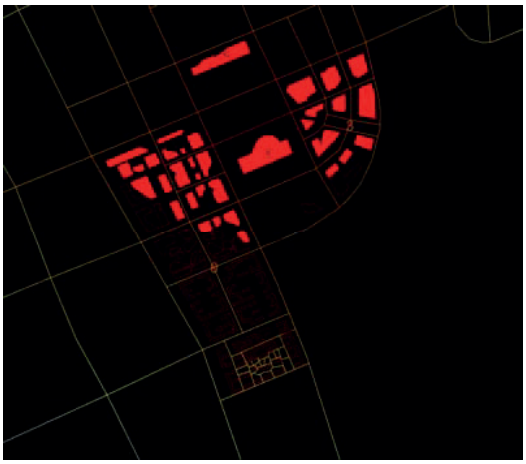


Figure 8. Walking 15 min from Cultural Plot (Point 1)

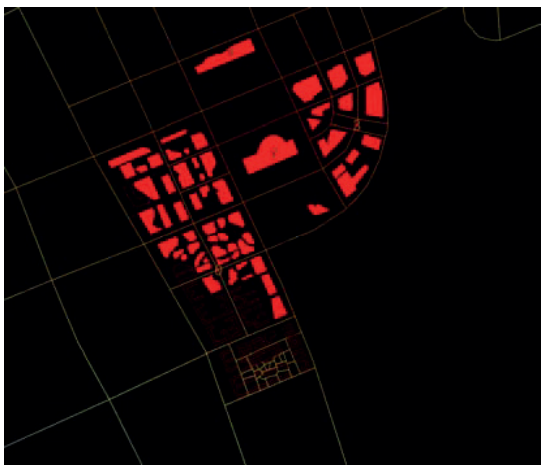


Figure 9. Walking 15 min from Government Building (Point 2)

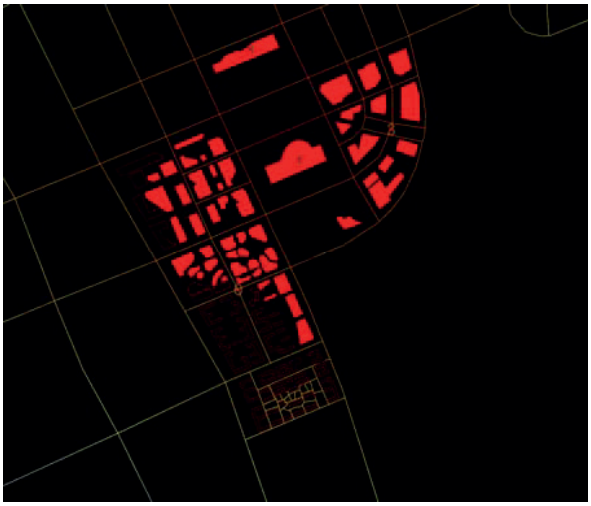


Figure 10. Walking 15 min from CBD (Point 3)

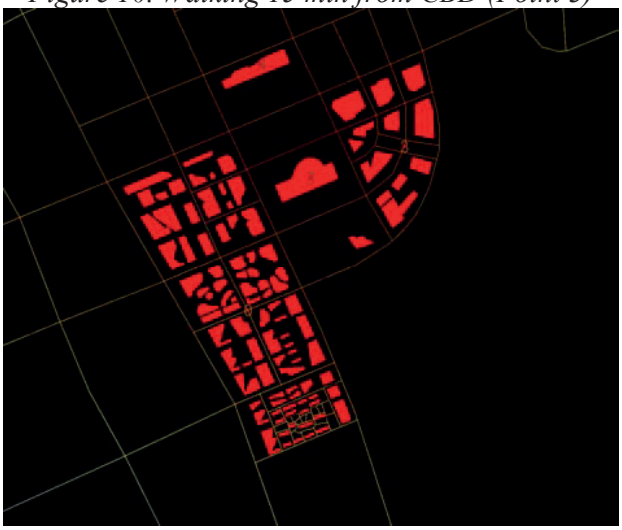
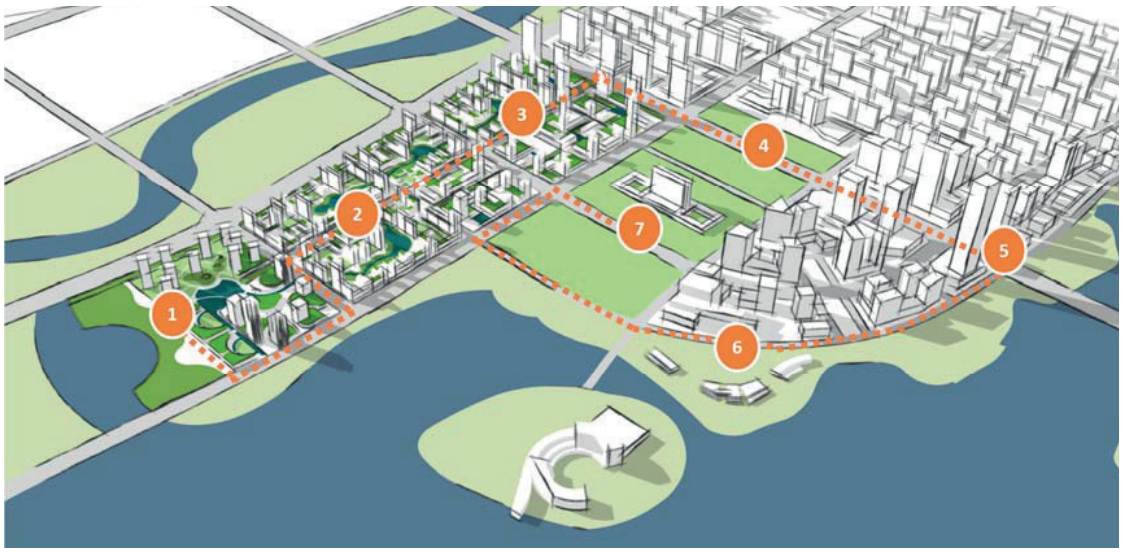


Figure 11. Cycling 10 min from Each Location

None of each location could cover the whole area with 15 mins' walking, while cycling with around 10 mins could reach every building. So it's a must to provide a shuttle bus for the people who prefer public transportation than cycling to get round this area.



On account of analysis above, the route and stops of the shuttle bus are shown as the image.

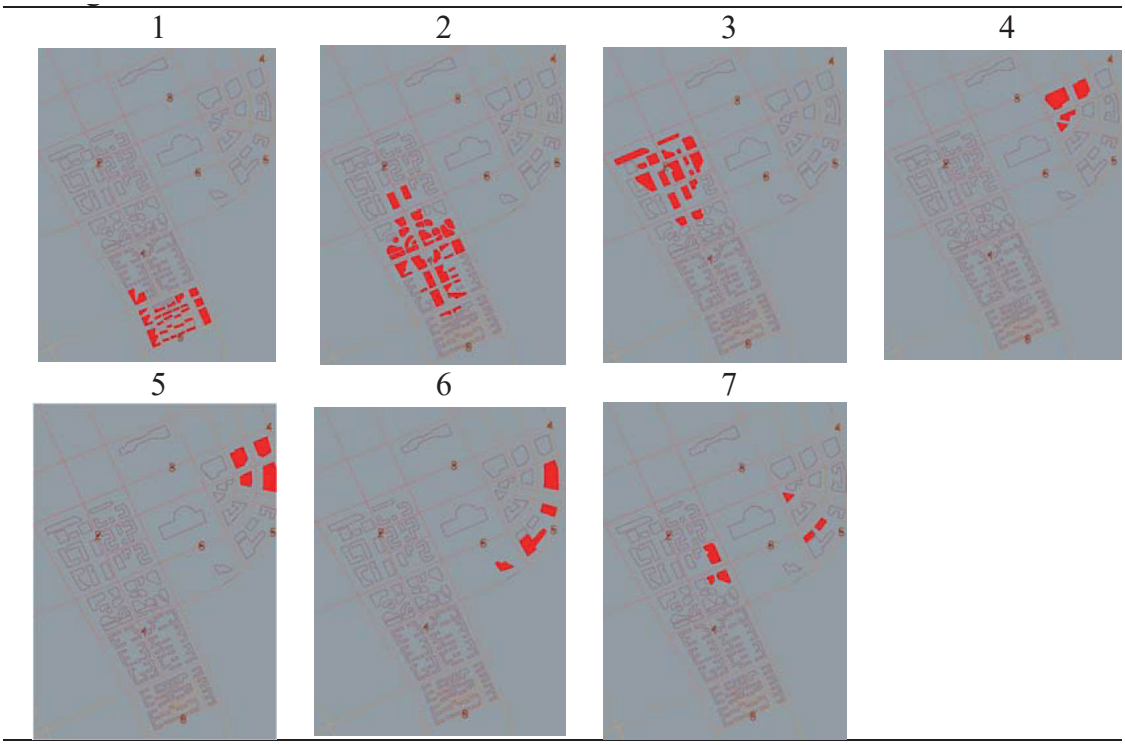
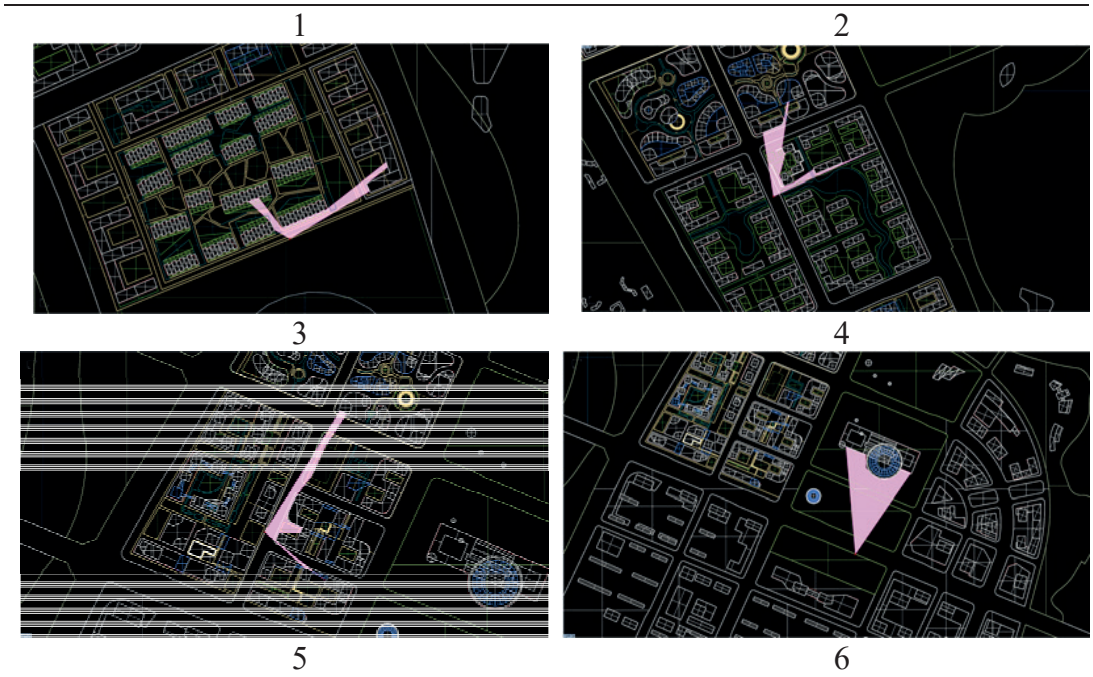


Table 1. Walking 5 mins from Each Stop

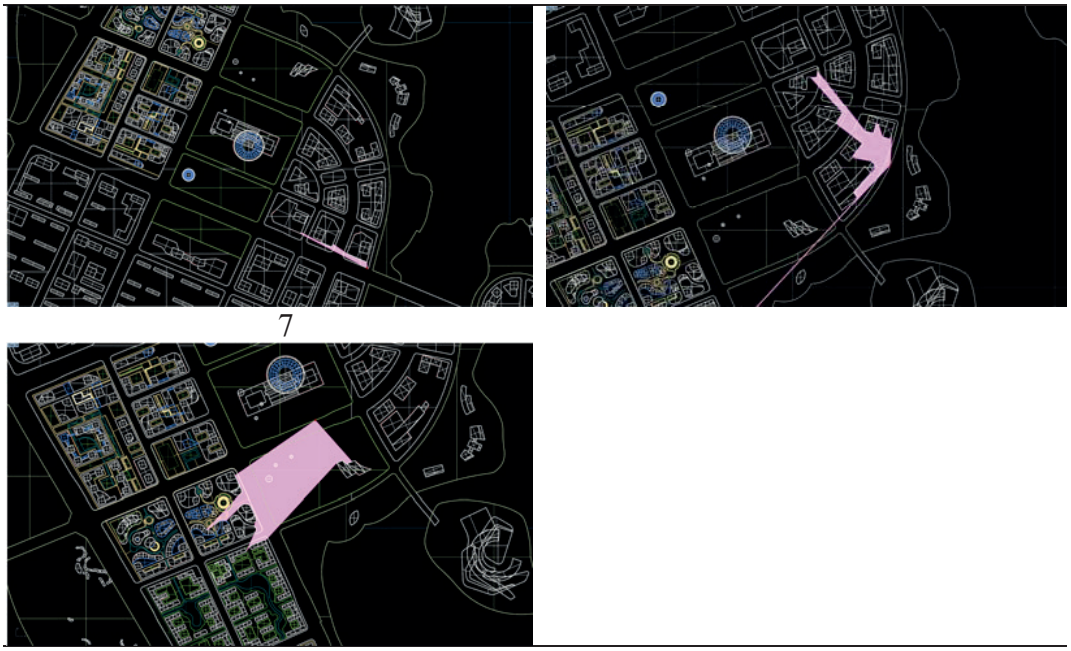
Though several buildings cannot be reached on above analysis, considering that Grasshopper has a limit on dealing with road network with high density, pavements within each plot are not cover in this report. Hence, considering the distance between buildings and bus stops, all bus stops could be reached within 5 mins walk.

3.4 Isovist of Bus Stops



3.5 Isovist Field of CBD

As the CBD has a significant amount of transients every day which comes for business meetings, isovist plays a major role in this area, and it is analyzed with minimal and maximal radial. Though areas around buildings have relatively lower isovist, the intersections perform better.



7

Table 2. Isovist of Each Stop

3.6 Solar Potential

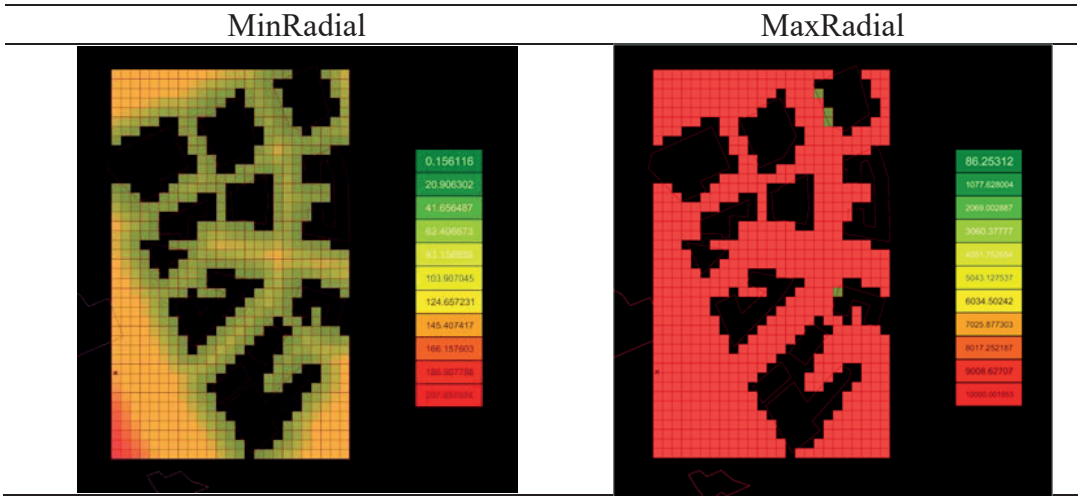


Table 3. Isovist Field of CBD

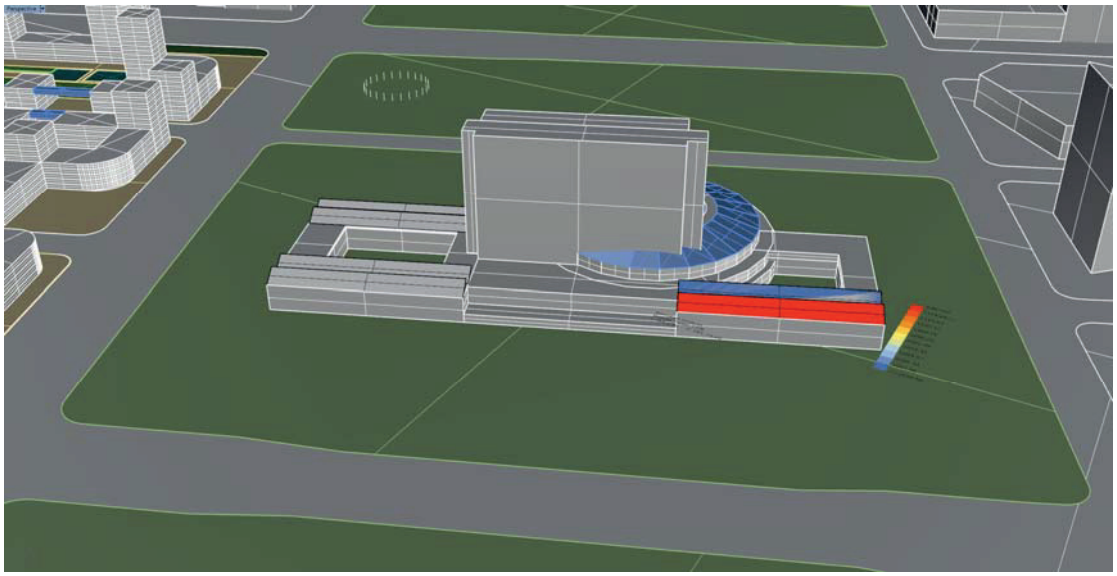


Figure 13. Solar Potential of the Government Building. Due to the limits of Grasshopper, only two solar panel could be analyzed, otherwise the software would get stuck. Total solar potential is 259.32MWh/yr.

Conclusion:

Nowadays, urban planning would not only care about connectivity, but also renewable potential it could provide to deliver a sustainable and livable life. Grasshopper could help in analyzing and presenting such kind of design work. However, the capacity limits the application of this method. As in segment analysis, pavements would lead to the overburden. In the case of solar analysis, a model of large scale (even only part of it are chosen to analyze) will cause 'No Response' of the software. As a result, to implement grasshopper in urban planning, it's better to set clear limitations to get rid of time wasted in dealing with such beyond capacity issues.

Comparison of Grid Patterns

Student: Laura Cowie

1. Summary:

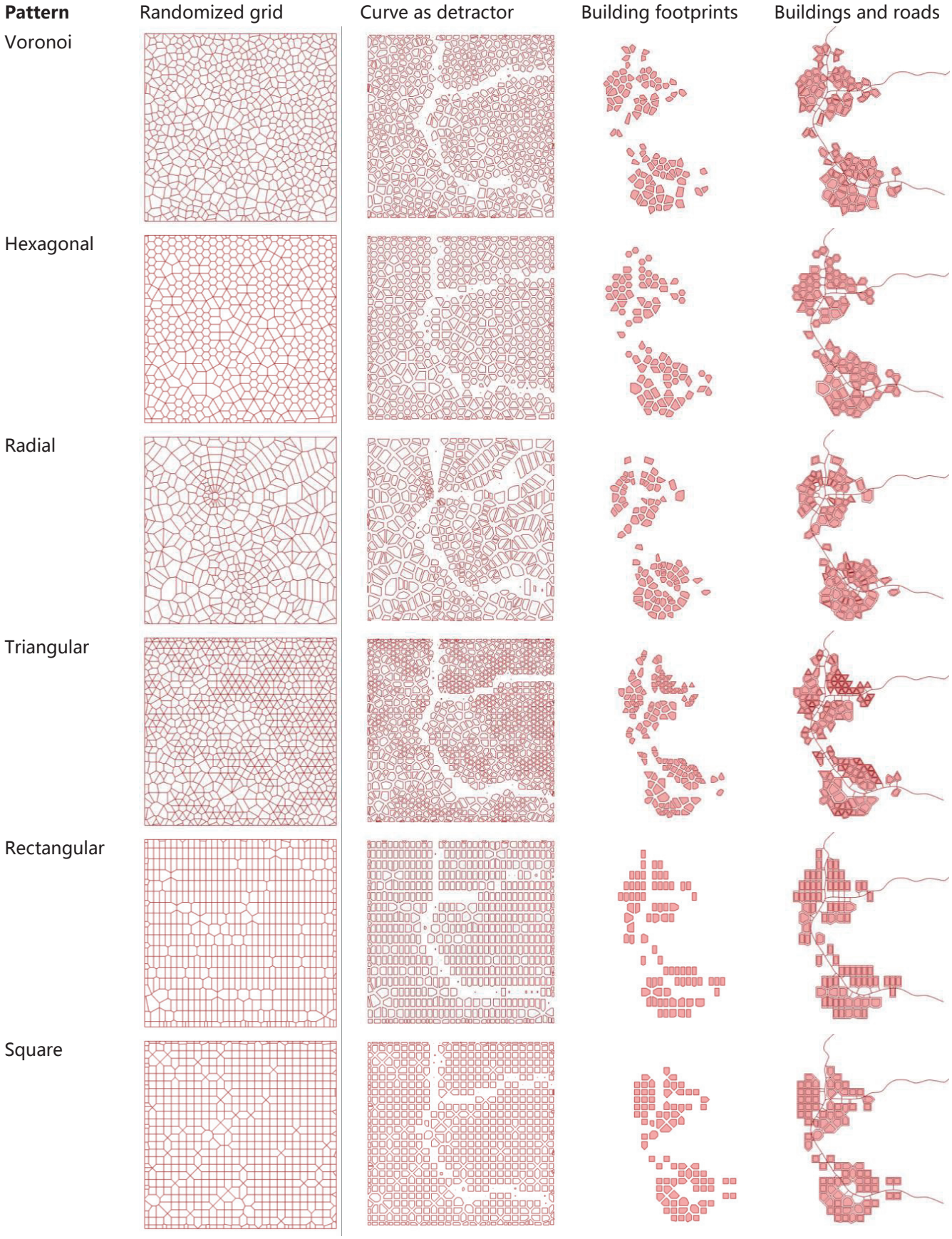
The goal of this project was to develop two clusters of buildings, one at an intersection, the other along a road, using various different grid patterns for buildings and roads, and then compare these clusters using segment analysis and isovist tools to determine which pattern would produce the most desired cluster in terms of choice, visibility and compactness.

2. Motivation:

The results of this project will be useful for future projects that require building layouts to be designed with visibility, as well as choice and compactness, in mind. One such project would be the Empower Shack development project which, in its pilot phase, is focused on developing a cluster of 68 houses located within an informal settlement in South Africa. The results of this project could be used for the basis of the initial design concept for building positioning. In this instance visibility and choice would be very important for developing a safe, resilient living environment.

3. Pattern Grid Development:

Growth of the different grid patterns used to generate buildings and roads, using the same curve as a detractor and the same central points to generate building clusters around. One cluster was centred at a Y-junction and the other at a bend in the main road.


Pattern
Randomized grid
Curve as detractor
Building footprints
Buildings and roads
Voronoi
Hexagonal
Radial
Triangular
Rectangular
Square

4. Analyses and Interpretation:

The chosen analysis tools are listed below:

- Choice - measures movement flows through spaces
  - higher = better

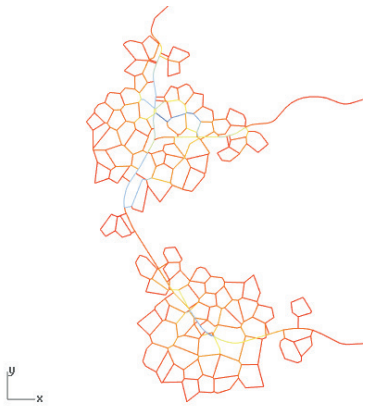
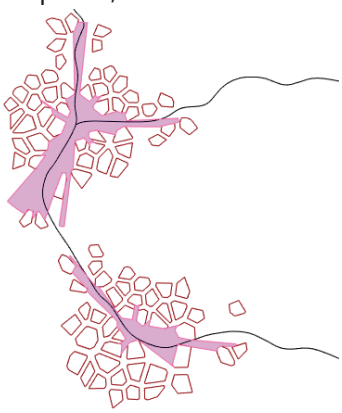
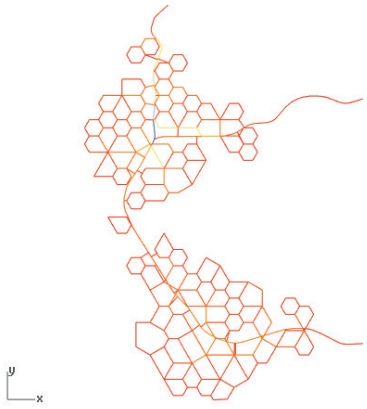
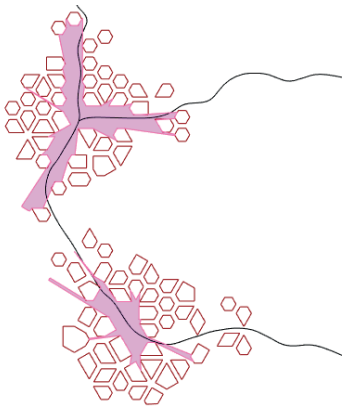
- Visibility – all points that can be seen from a location in space
  - higher = better

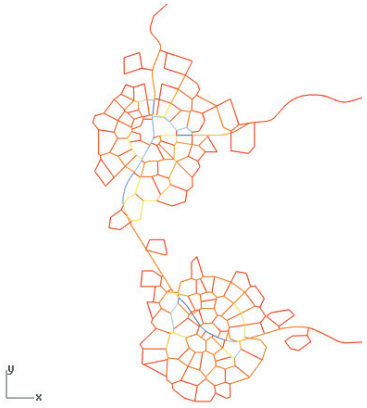
- Isovist Area - area of a view field
  - lower number means less visible area from center point
  - lower = worse

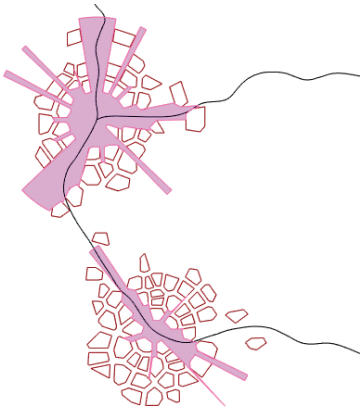
- Compactness - ratio of area to perimeter in relation to an ideal circle
  - lower number means less compact

- Min radial - shortest view ray
  - larger number means larger distance between buildings

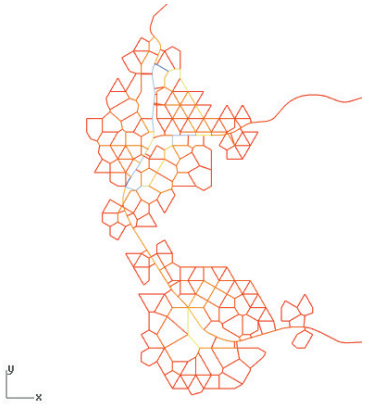
The visual results and average values from different the analysis tools are shown below.

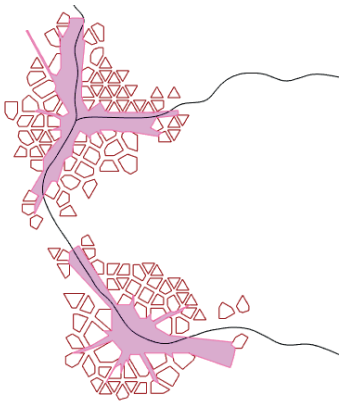
Segment Analysis – **Choice** radius of 150m	**Average**	Isovist Area – **Visibility** 500 count points, radius of 180m	**Area at Y**	**Area at I**
	0.20023		17,398	7,741
	0.12488		17,337	7,202



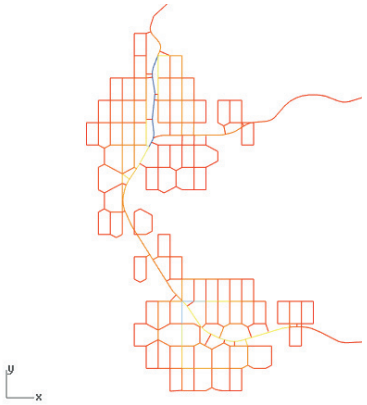


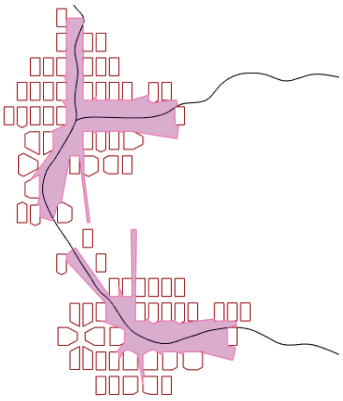
0.194856 28,987 8,766



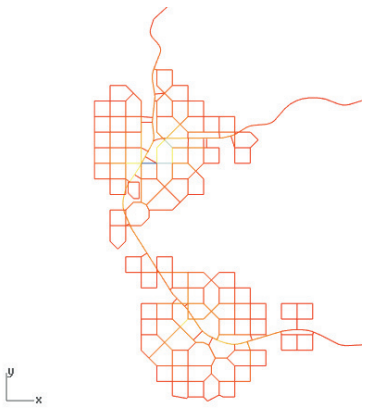


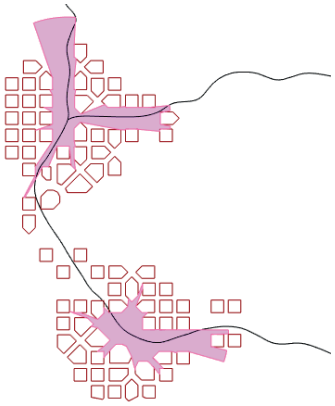
0.13279 17,303 14,804



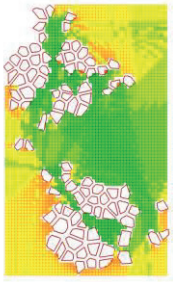
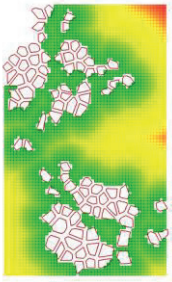
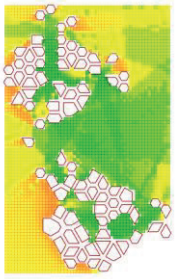
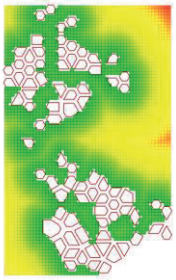
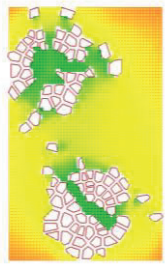
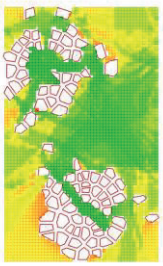
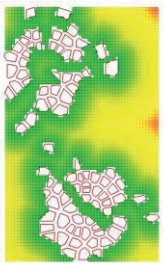
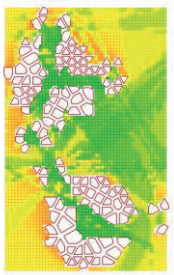
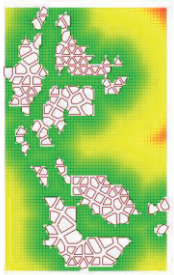
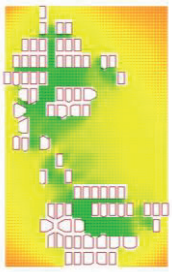
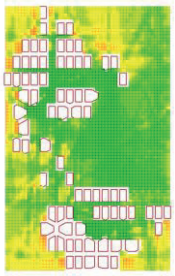
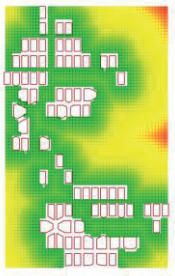
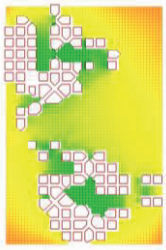
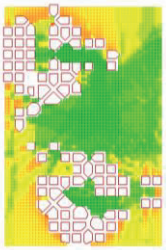
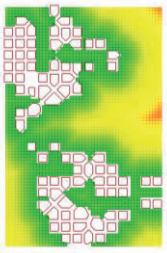


0.153923 22,939 16,467





0.116686 17,398 12,101

Isovist area	max 3e+8	**Compactness**	0 - 1	**Min radial**	max 200
	1.398e+8		0.33		47.29
	1.394e+8		0.33		47.7
	1.435e+8		0.28		46.19
	1.379e+8		0.34		45.64
	1.377e+8		0.22		48.11
	1.398e+8		0.33		47.29

5. Results and Conclusions:

Using the interpretation indicated previously, the following patterns were indicated as best using the different analysis tools from above.

- Choice = voronoi
- Visibility – Y-intersection = radial, I-intersection = rectangular
- Isovist Area = radial
- Compactness = rectangular is least compact
- Min radial = rectangular largest distance between buildings

The conclusion of this analysis was be to focus on using a radial or rectangular grid as the base pattern for building placement in future projects, especially where visibility and compactness are important. For projects where choice is the most desired outcome then a voronoi pattern may be preferential.

Summer Urban Thermal Comfort Design

Student: Carlos Pacheco

Summary

This exercise intends to design a new urban development in a hot summer area near Málaga ,Spain crossed by a river, with the use of parametric design in growth, attraction points and total direct solar radiation parameters. First, an specific grid shape is chosen with thermal and wind comfort criteria.

Second, plot densification, both height and plot ground floor area, is defined with proximity criteria to different points of interest (POI) in the urban space.

Figure 1. Given topography, Madrid, Spain.

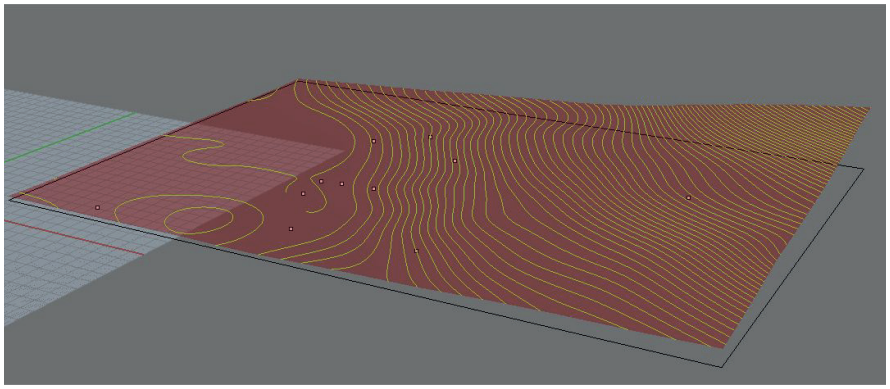


Figure 2. Rhino topography

Motivation

The motivation of the following study is to optimize the design of an urban development considering classical elements of urban design as well as pedestrian thermal comfort in an area where estival tourism will be the main economic activity of the new Master Plan.

Design process

In the design process Rhino and Grasshopper software are implemented as a tool to model and parametrize the different variables of the design. First, a rectangular grid with cells of 13x46 units is chosen facing east-west to maximize cooling effect by convection with the most frequent wind in that area.

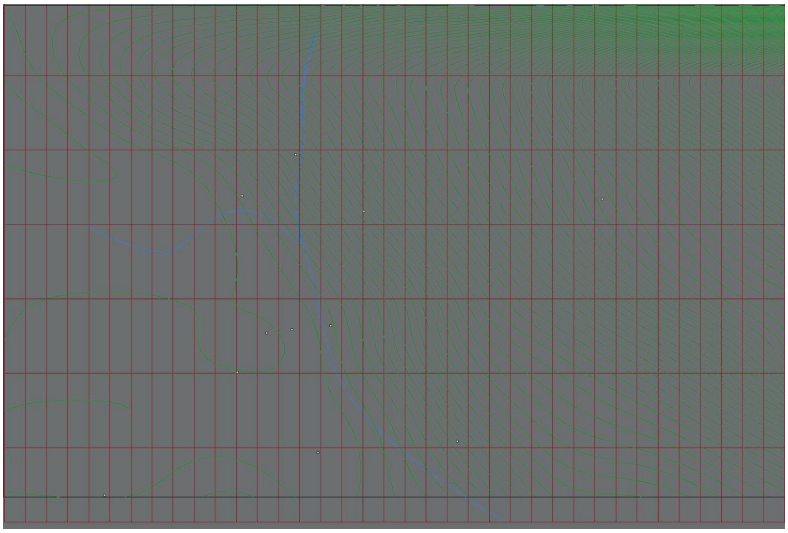


Figure 3. Rectangular grid (46x13)units cells

Second, a double river is modelled as a point of interest and building plot geometry is modified with the use of voronoi patterns around the center of the river to allow for bigger open areas. The densification strategy consists in increasing urban space around the river, limiting large building plot areas close to it.

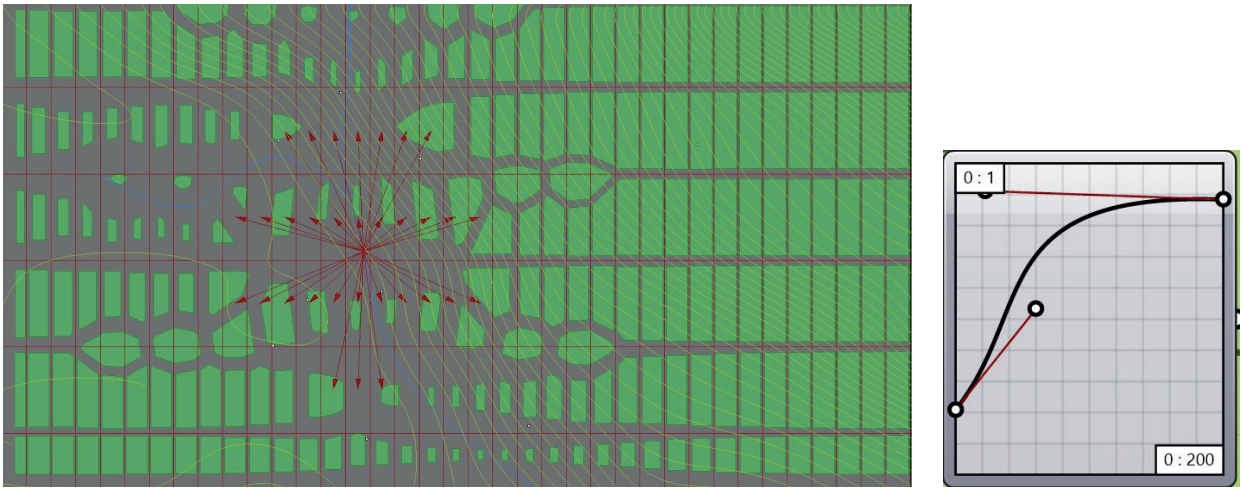


Figure 4, River and grid impact of river attractor (left). Building plot density distribution (right)

Third, 3 points of urban growth are distributed around the city center. A reduction factor is applied to all of them to fulfil urban regulations in terms of open areas per m2 built.

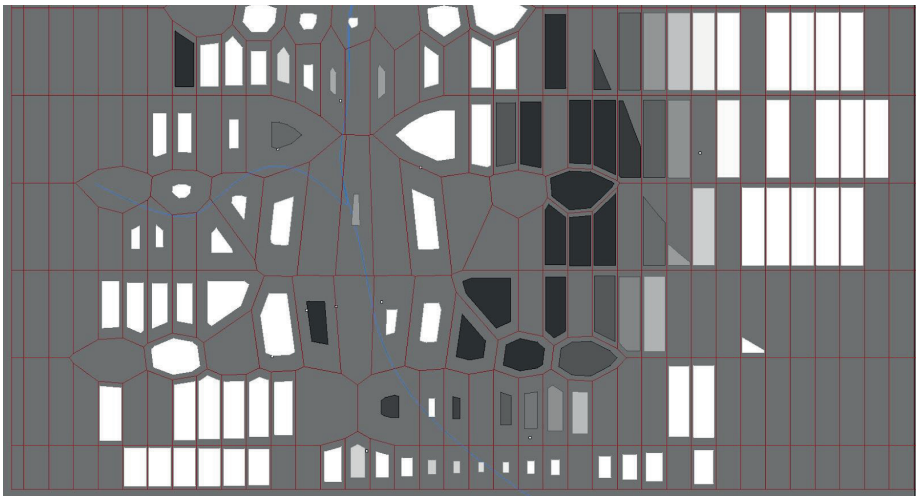


Figure 5, 3 points of urban growth.

Fourth, Height is defined in terms of distance to the river with the following function to reduce height gradient: Height = z / √d where z is a given factor and d , distance to the center of the city.

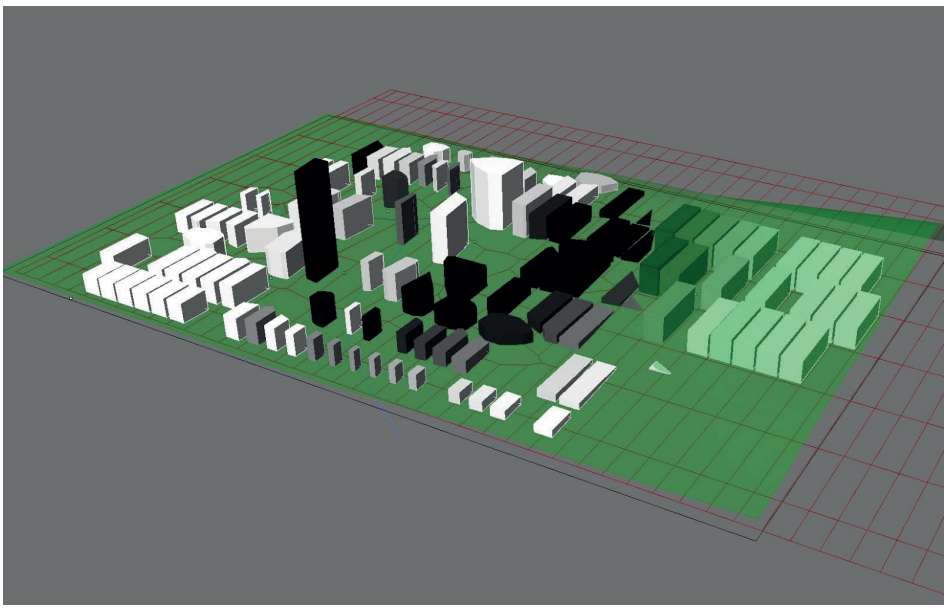


Figure 6, Final envelope of the buildings.

Finally, direct radiation to the residual urban space is calculated. In order to improve surface temperature in the whole area during the hottest period of the year an optimization is implemented to minimize direct radiation. Building direct solar radiation is not taken in account and buildings are used as context and shading. The objective function is total direct radiation across the summer(21 June to 21 September) just for the hottest hours of the day in that latitude from (9:00 to 19:00) in the whole summer.

The dependent variables are the size of the grid cells and the factor z of the height function. Constraints for dependent variables are also set; The X dimension of the cell is restricted to the domain (9,25) units of length. The Y dimension is restricted to (30,50) units of length. The height factor of the buildings is also limited to 500 units.

The original design has (13x45)units2 cells, 200 units of height factor and captures 3449 units of energy/m2 of pavement during the summer period. The optimized solution has (9 x 36) units2 cells, 310 units of height factor and captures 2045 units of energy/m2 of pavement during the summer period.

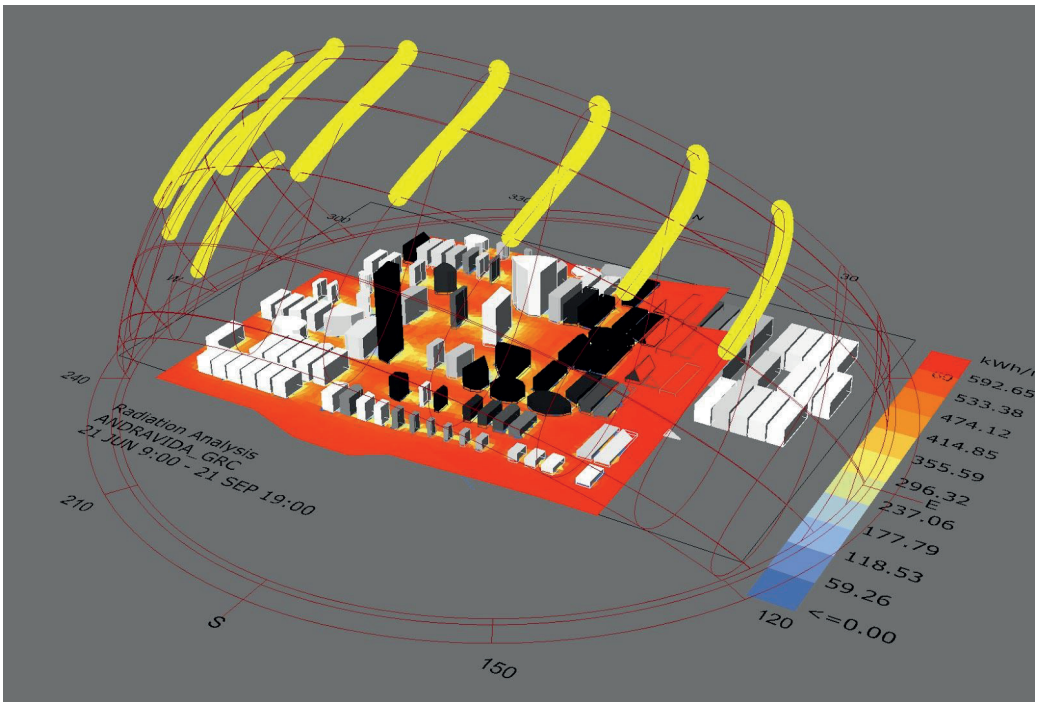


Figure 7, Sun path curves from summer solstice 21 June to autumn equinox 21 September 10 hours/day 9:00 - 19:00

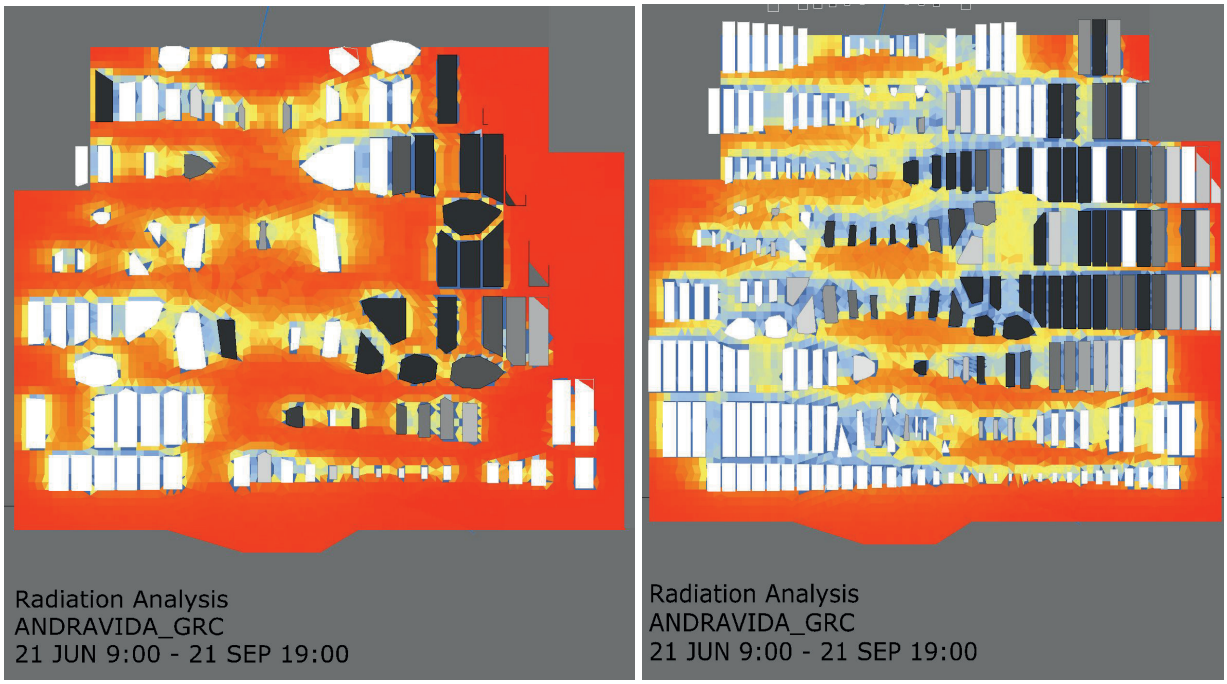


Figure 8, Comparison original solar radiation (left) to optimized solar radiation in urban space (right).

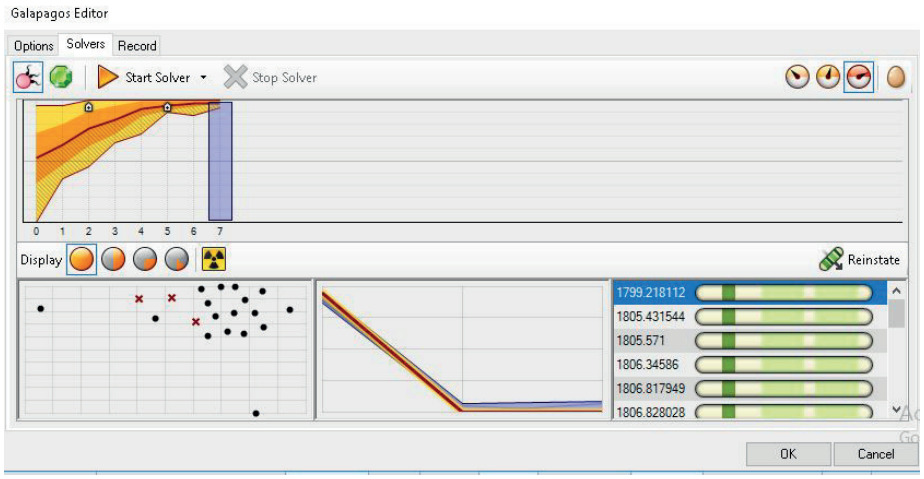


Figure 9, Galapagos optimization panel. (Selected genome in blue)

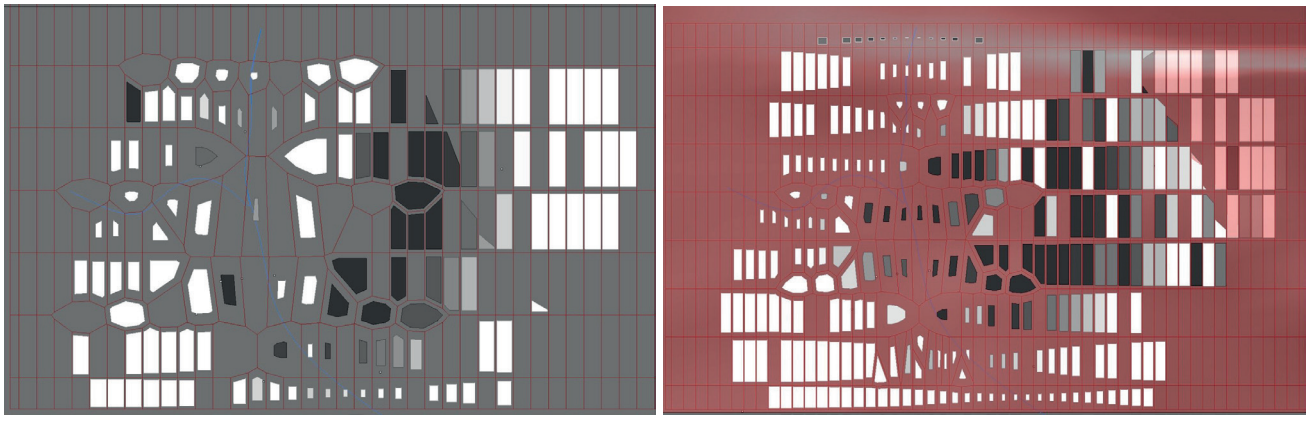


Figure 10, Comparison original design (left) to optimized direct solar radiation design (right).

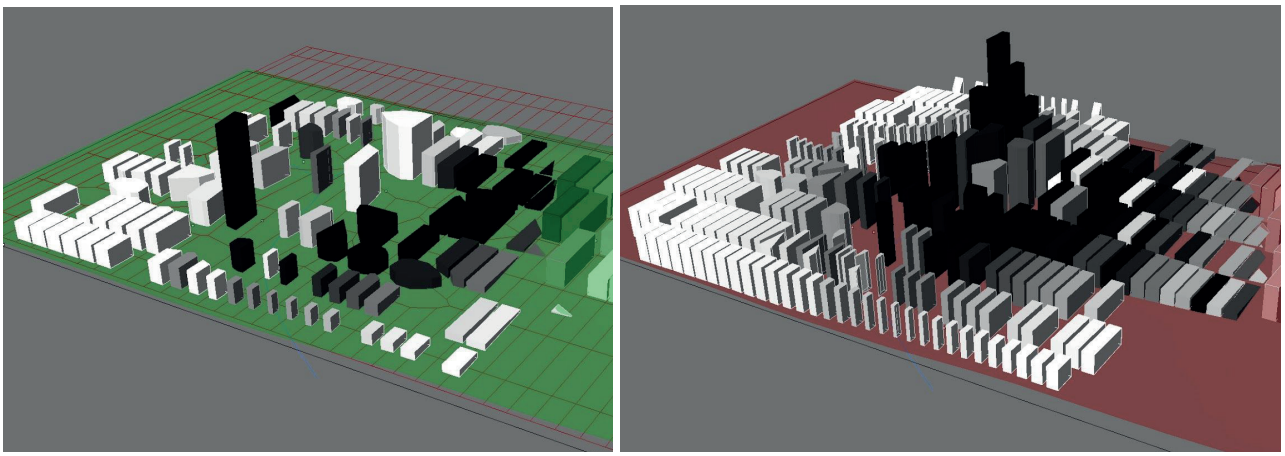


Figure 11, Comparison original design (left) to optimized direct solar radiation design (right).

Final urban quality analysis

After the study some analysis in terms of urban function are carried to validate urban quality of the space. First, a distance analysis is conducted to show level the of integration of each segment of the urban connection grid respect to 3 points of interests depicted in figure 8.

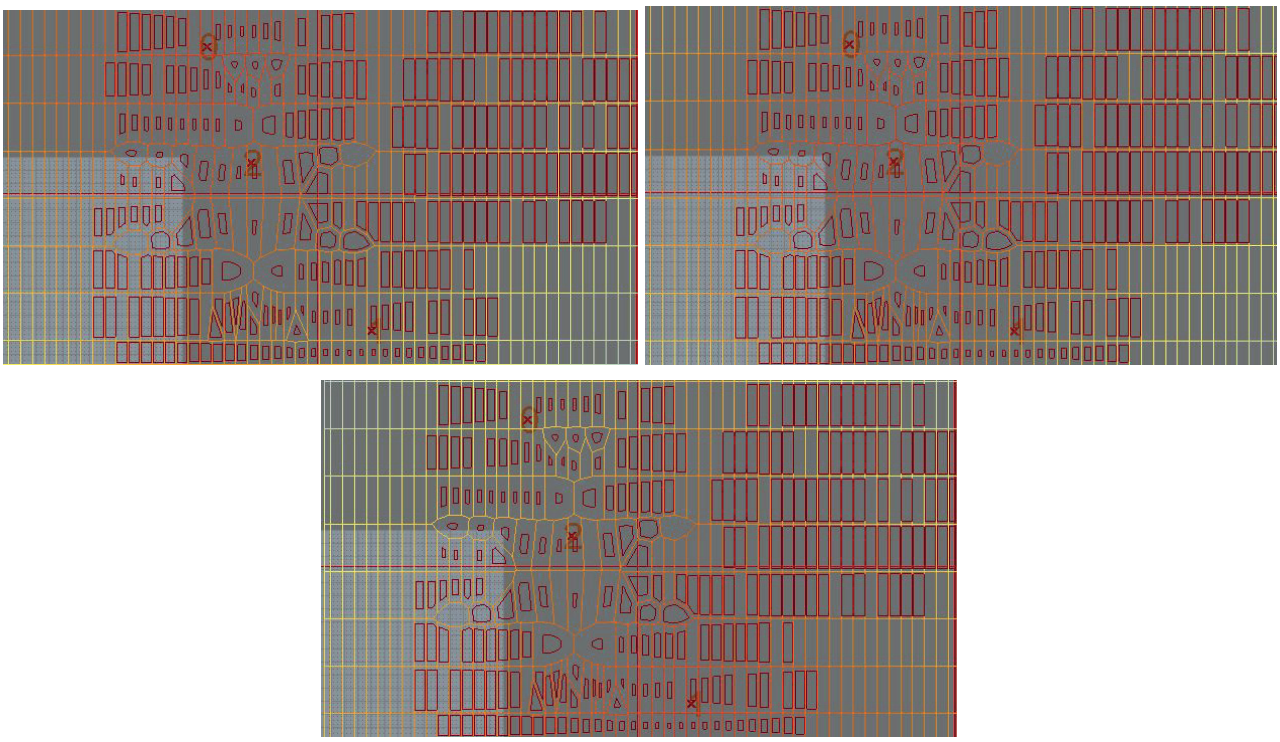


Figure 12, Network segment distance to three points of interest (POI). POI 0 (upper left) POI 1 (upper right) POI 2 lower.

Second, distance of building plots to the three points of interest is analysed represented in a red-yellow color code.

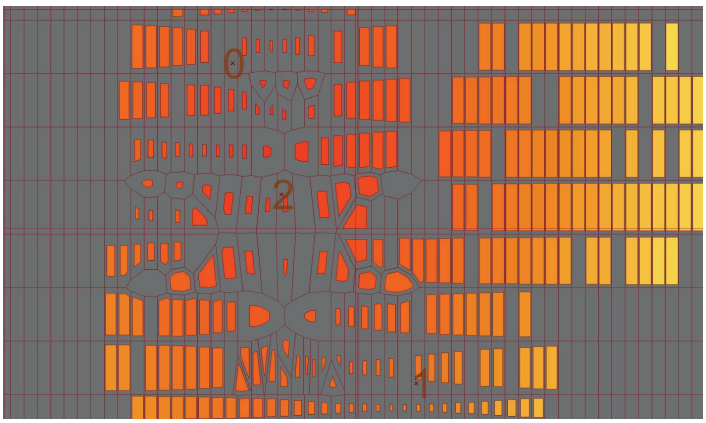


Figure 13, color code of building plots distance to the 3 POI (in red)

In order to assess use dynamics in the new urban development, temporal and spatial catchment ratio are analyzed to confirm the correct operation of the urban space.

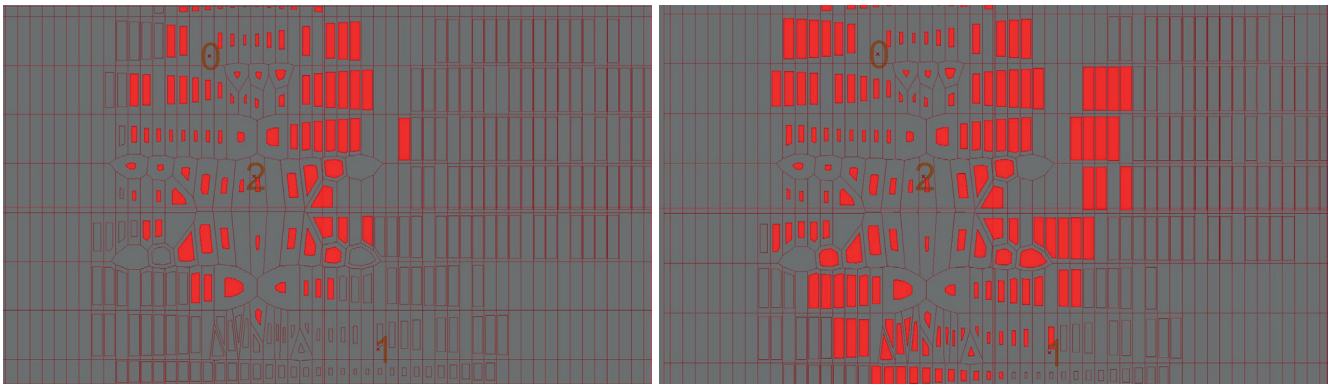


Figure 14, temporal catchment radio = 2 units(10mins) (left) spatial catchment radio = 200 units(1km) (right).

Conclusion

The results of this study shows that parametric and optimization approaches in urban design can be very useful to assess different energy aspects of the cities. In this case, thermal comfort is optimized with the master plan geometry for the hottest time period of the year in a mediterranean area. As a result 40% of the original solar radiation is reduced until 2045 units of energy/m2 pavement.

Kilchberg

Student: Roberta Murad Lima

1. Introduction

Kilchberg is a municipality with over 8'000 inhabitants in the canton of Zürich, and it is the place I currently live in (Figure 1).

***Figure 1**. My currently address in Kilchberg represented as the yellow pin.*

After living there for around four months, I decided it was time for a change - I am about to move to an apartment in the city of Zurich, but I will always carry this lovely place in my heart. Before I leave, I wanted to understand the municipality a bit better and, therefore, I thought about doing this project on it. Some analyses were made, with the help of the tools learned during the extent of the course, to help me with this task.

2. Analysis

2.1 Distance Network Analysis

The first analysis made was to find out the distance of all network segments towards a set of attraction points. The points chosen are consistent throughout the work, and they are the ones which are of biggest interest to me, being them: 1) my house, 2) the train station, 3) the supermarket, and 4) the hospital. As it can be seen in Figure 2, the area close to the train station and the supermarket is the most important one, which is logical, since two of the points used in the analysis are situated there. The house is also in a pretty good position, but the hospital is a bit distant from everything else.

***Figure 2**. Network distance calculator.*

2.2 Proximity and Vicinity

As a second analysis, the proximity and vicinity were considered. Here, the idea was to find out how close the house is to all destinations of interest, which is the whole municipality segment depicted. It can be seen in figure 3 that the hospital is one of the furthest buildings from the house, since it is represented by a colder colour.

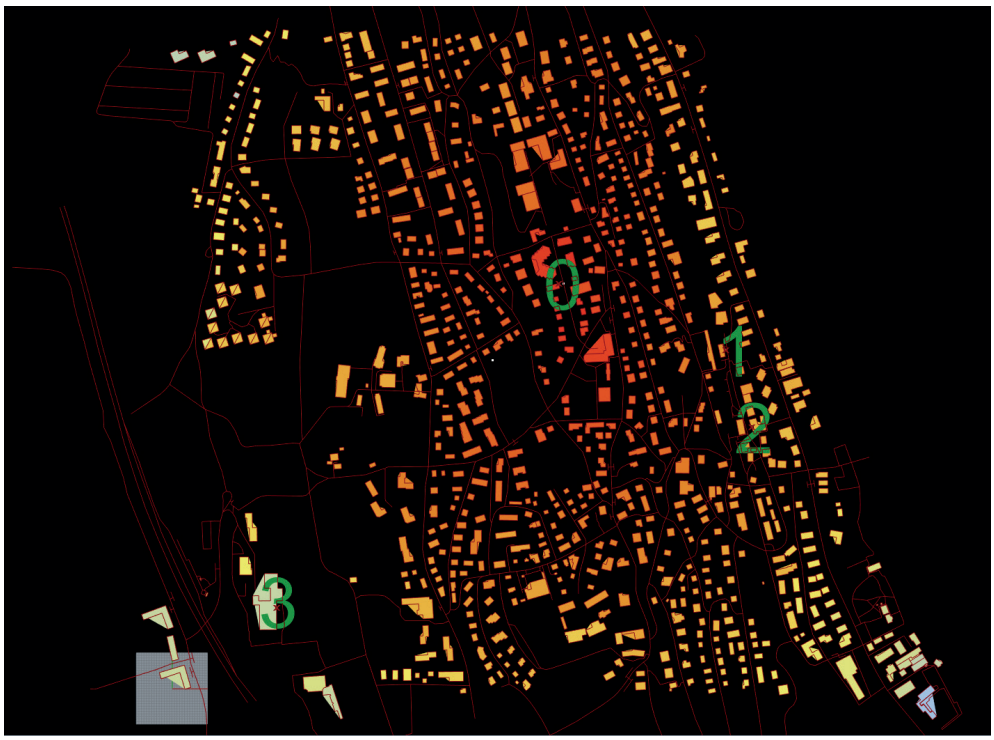


***Figure 3.** Proximity and vicinity.*

2.3 Accessibility

With the goal of finding how long it would take to the places of interest, several analyses were made. Two means of transportation were considered: walking and cycling. Since the train station and the supermarket are located very close to one another, it was considered the time necessary to reach both. In Figure 4, the locations that can be reached by a 10-minute walk are shown – the minimum time where both locations 1 and 2 were reached. To get to the hospital (Figure 5), it would be required 17 minutes walking, which is not so convenient in the case of an emergency. The exact same scenarios were found by biking for 3 minutes (Figure 4) and biking for 6 minutes (Figure 5).

***Figure 4**. Places one can reach by walking for 10 minutes or cycling for 3 minutes..*

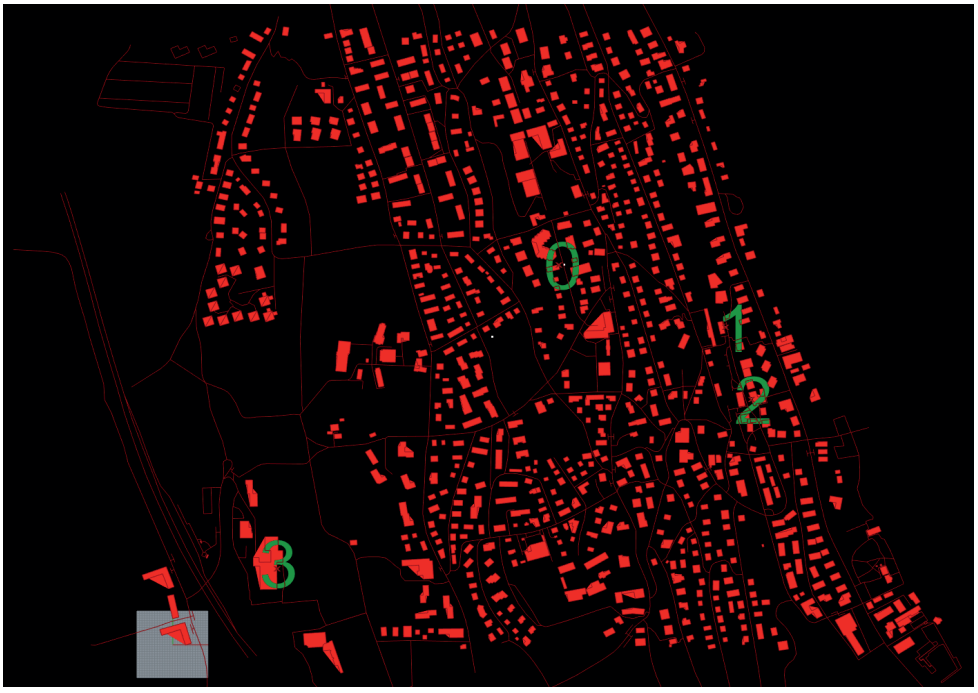


***Figure 5.** Places one can reach by walking for 17 minutes or cycling for 6 minutes.*

It was also found, using the spatial analysis, that the train station/supermarket are in a 796-meterradius from the house, whereas the hospital is on a 1’341-meter-radius. 2.4 Shortest Path Detection It was also of interest to find the shortest path between the house and the other locations aforementioned. The result can be seen in Figure 6.

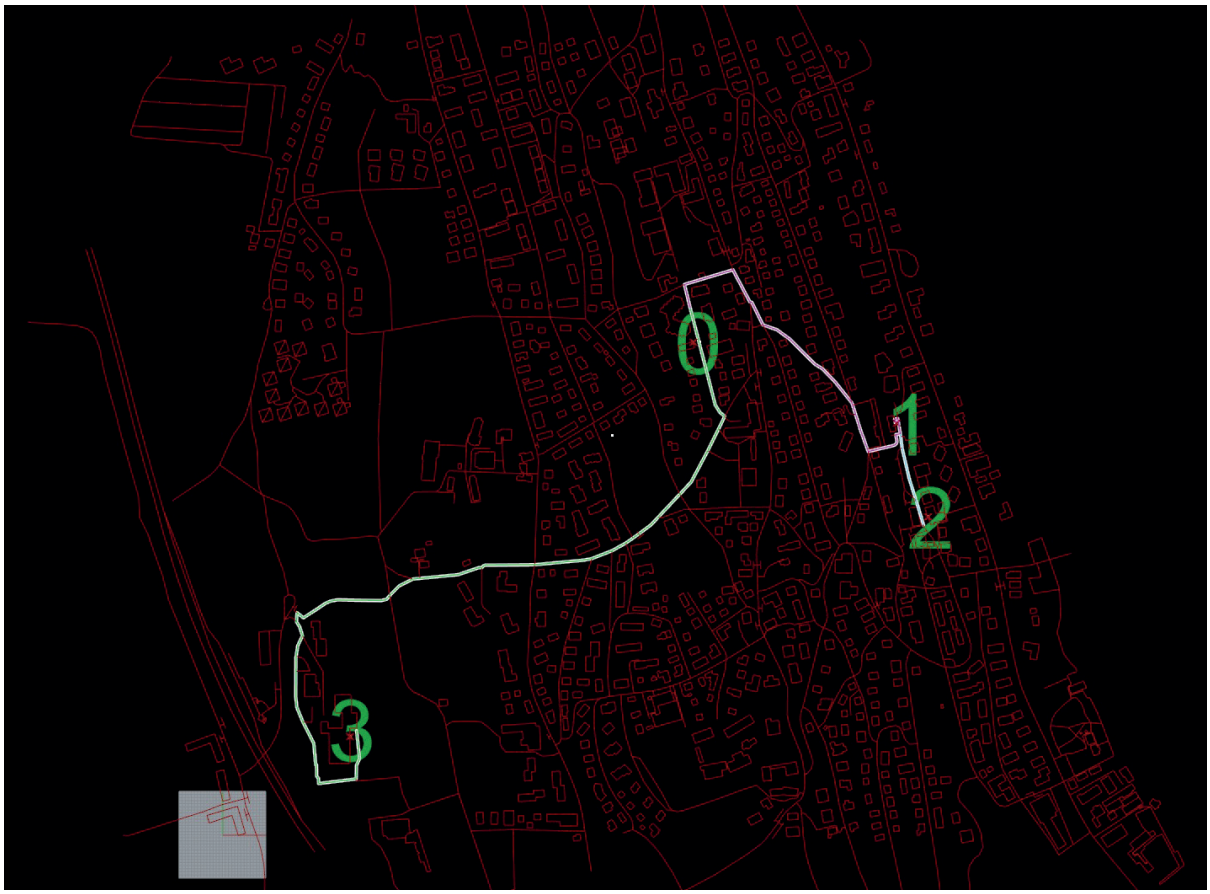


Figure 6. *Shortest path detection.*

The paths were assigned different colors for an easier identification, but since the train station is on the way to the supermarket, the route to the latter is only depicted in a new color from point 1 to 2.

2.5 Isovist

2.5.1 Isovist from Individual Point

The isovist from an individual point analysis was made and then compared to a real scenario, to see how much it represents reality. The point was placed right in front of my house, and the result can be seen in Figure 7. When it comes to the view on the same street level, the outcome is pretty accurate, as it can be seen in Figure 8 (where a picture was taken from approximately the same point). The view to the front of the house is a bit exaggerated, as there are trees and houses standing on the way and hence blocking it.

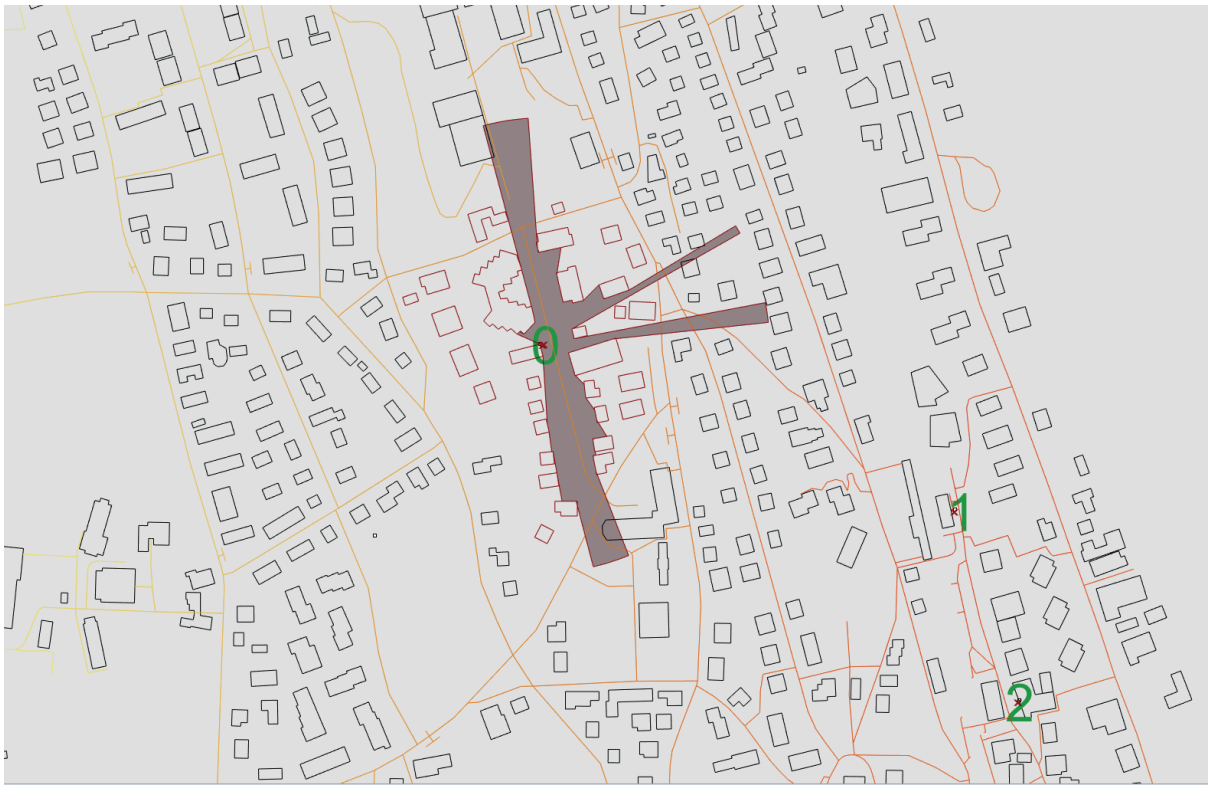


***Figure 7**. Isovist from a point in front of my house.*

***Figure 8**. Reality view from the same point represented in Figure 9.*

2.5.2 Isovist Field

The isovist area measures the area of a view field, where warmer colors indicate the ones more connected within the environment. Thus, the area around the house has a small isovist area and visibility (Figure 9). This is beneficial, since it means that the space is more visually blocked, a good aspect for the safety and privacy in a residential zone.

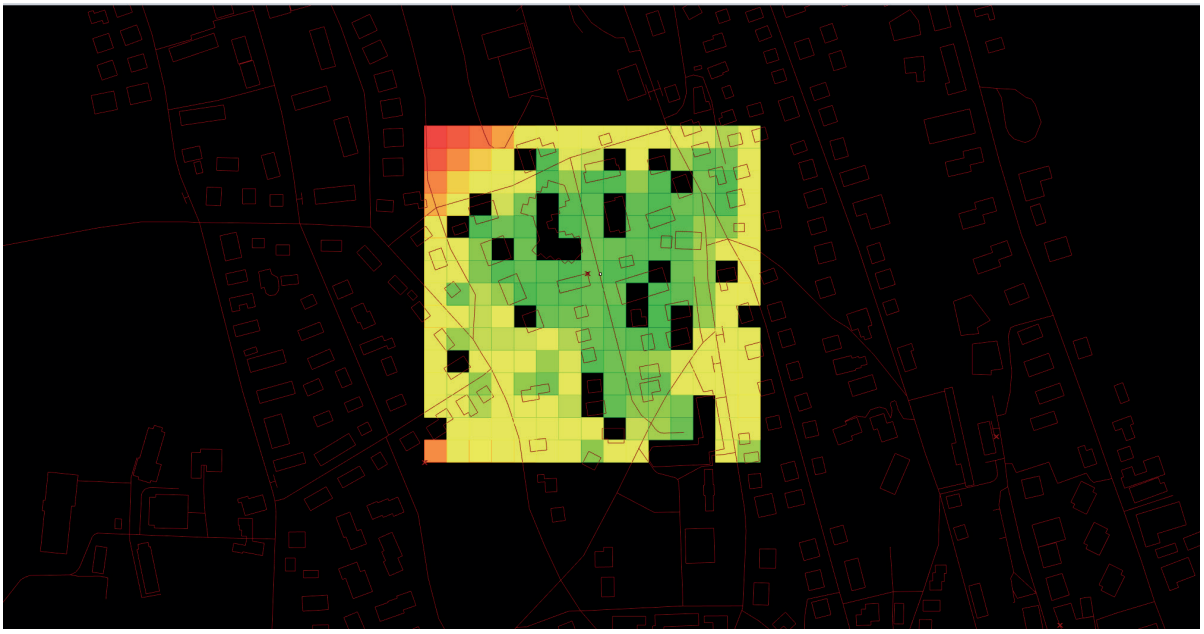


***Figure 9**. Isovist area.*

The isovist perimeter represents the circumference of a view field, and it has also small values around the house (Figure 10).

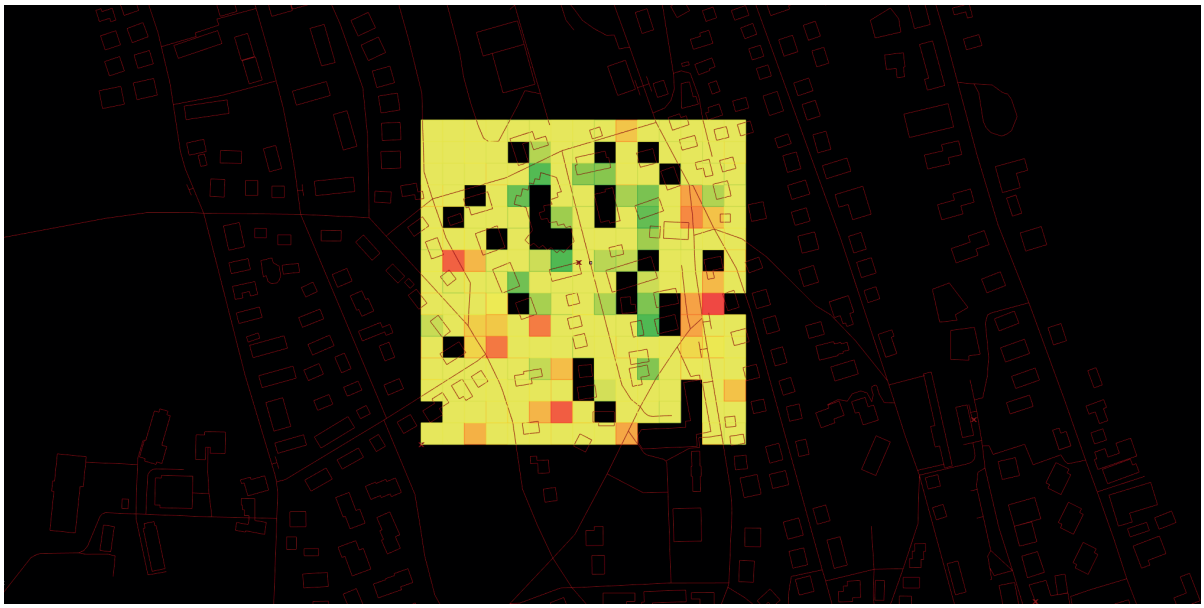


***Figure 10.** Isovist perimeter.*

The occlusivity measures the length of hidden edges. The area in question has medium to low occlusivity values (Figure 11), which is also good for a safety feeling.

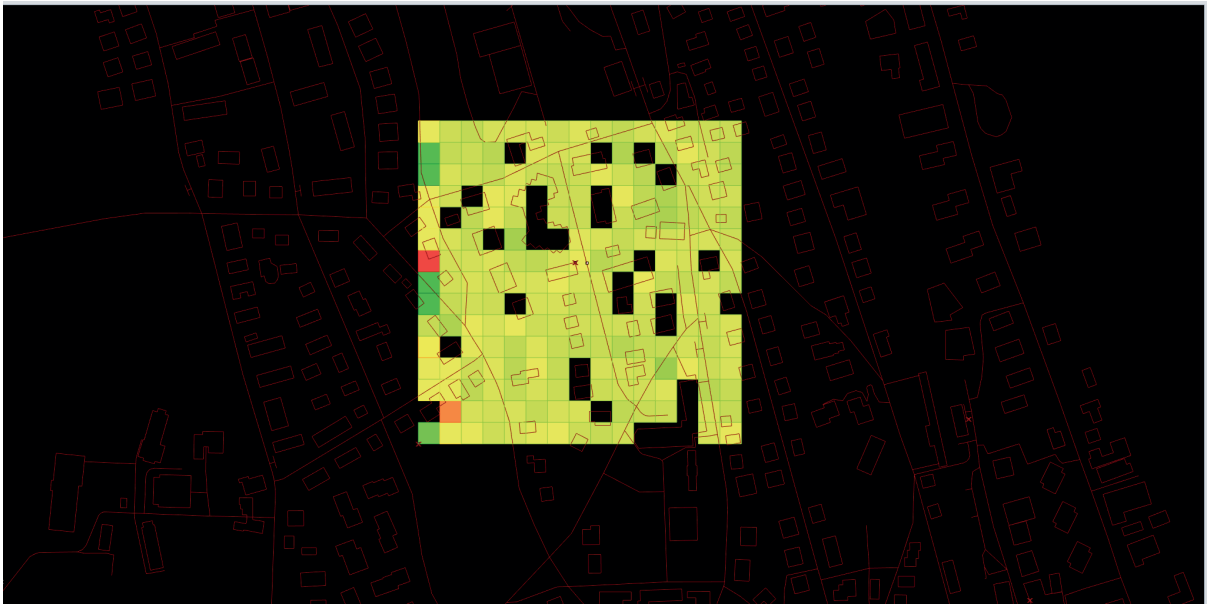


***Figure 11**. Occlusivity.*

3 Conclusion

Grasshopper is a powerful tool, not only to support decisions for new projects, but also to help with the understanding of existing areas. The analyses gave me a pretty good comprehension of Kilchberg and were in general quite accurate. The time found to reach the desired places by foot or with the bicycle are reasonable when compared to reality. The shortest paths were also right, as it was compared with other routing tools.

The isovist from an individual point was the only analysis which was a bit off, but it was still a good estimate. The isovist field gave a decent overview of the area around me, and it was interesting to see the results. All the analyses show that the area is a pretty quiet and private residential zone. Nonetheless, basic services are found nearby, and they can be easily reached by bike or by foot, with a longer time required for the latter.

4 References

Cover Picture: <http://www.blick.ch/news/schweiz/kriminalitaet-drei-verdaechtige-imtoetungsdelikt-von-kilchberg-id2611850.html>

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