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Vienna University of Technology

DIPLOMARBEIT

BRIDGING MOSTAR - A DIVIDED CITY
PLANNING STRATEGIES AND DIGITAL TOOLS FOR A STUDENT CITY

ausgeführt zum Zwecke der Erlangung des akademischen Grades einer Diplom-Ingenieurin unter der Leitung von

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Digitale Architektur und Raumplanung

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von

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Wien, am ....

From everything that man erects and builds in his urge for living nothing is in my eyes better and more valuable than bridges.
[Andric, Ivo, 2014]

for my family

ABSTRACT

Spatial and sociological division is at the same time main feature and problem in the city of Mostar, Bosnia and Herzegovina. Two ethnic groups shape the city's population. Bosnian Muslims - Bosniaks live on the east side of the city, and on the west side Bosnian Catholics - Croats. During the last 20 years, division has resulted in parallel systems which are manifested through architectural infrastructure. Mostar is being compared with other divided cities (Jerusalem, Beirut, Belfast and Nicosia) in order to find similarities and strategies that have already been applied successfully.

The proposed solution is forming of a university campus in the city of Mostar by applying a custom designed digital urban tool. A new student city image should be gradually created through a new university environment that would bridge spatial and sociological barriers. Mostar should, as an academic center, shape future generations which would not be influenced by the past.

This thesis introduces innovative digital solutions for damaged urban structure of divided cities. The proposed tool is a response to problems in segregated spaces. It helps to develop strategies that can adapt to dynamic requirements of a city. It is designed by using a procedural approach, implemented within *CityEngine* and exemplified in the environment of Mostar. The software enables transformation of planning intentions into a three dimensional city model. The city model offers possibilities to change specific parameters in order to create scenarios for reorganizing and linking the two universities.

The developed tools and strategies could be adjusted and reused in other divided environments.

Keywords: Divided city, student city, procedural city model

KURZFASSUNG

Sowohl Hauptmerkmal als auch Problem der Stadt Mostar, Bosnien und Herzegowina, sind die Raumaufteilung und soziale Fragmentierung. Es manifestiert sich durch das Leben der zwei ethnischen Gruppen auf den gegenüberliegenden Seiten der Stadt. Zwei ethnische Gruppen bilden die Bevölkerung der Stadt Mostar. Bosnische Muslime - Bosniaken leben auf der Ostseite und bosnische Katholiken - Kroaten auf der Westseite. Seit 20 Jahren sind die Folgen der geteilten Stadt, zwei parallele Systeme, die durch Architektur verfestigt wurden. Die Stadt Mostar wurde mit anderen geteilten Städten (Jerusalem, Beirut, Belfast und Nicosia) verglichen, um Ähnlichkeiten und Strategien zu finden, die schon erfolgreich angewendet wurden.

Die vorgeschlagene Lösung ist die Schaffung eines gemeinsamen Universitätscampus in der Stadt Mostar unter Anwendung des selbst-entwickelten digitalen Werkzeuges. Ein neues Stadtbild der Studentenstadt sollte allmählich durch die neuen universitären Einrichtungen erzeugt werden, um die Raumaufteilung und sozialen Hindernisse zu überwinden. Die kommenden Generationen, die von der Vergangenheit geprägt sind, sollten durch Mostar, als akademisches Zentrum, beeinflusst werden.

Diese Masterarbeit stellt innovative digitale Lösungen für die zerfallene urbane Struktur geteilter Städte vor. Das vorgeschlagene Werkzeug ist eine Reaktion auf die Probleme in abgesonderten Städten. Es wurde durch Verwendung eines prozedurallen Ansatzes in der Software *CityEngine* entworfen und für Mostar veranschaulicht. Es ermöglicht, Strategien zu entwickeln, die den dynamischen Bedürfnissen einer Stadt, angepasst werden können. Die Ergebnisse des Werkzeuges sind Szenarios, die die Reorganisation und neue Verbindungen der zwei Universitäten zeigen.

Das entwickelte Werkzeug und die Strategien können für andere geteilte Gebieten wiederverwendet werden.

Stichworte: Geteilte Stadt, Studentenstadt, Prozeduralles Stadtmodell

introduction

1.1 Problems in the city of Mostar

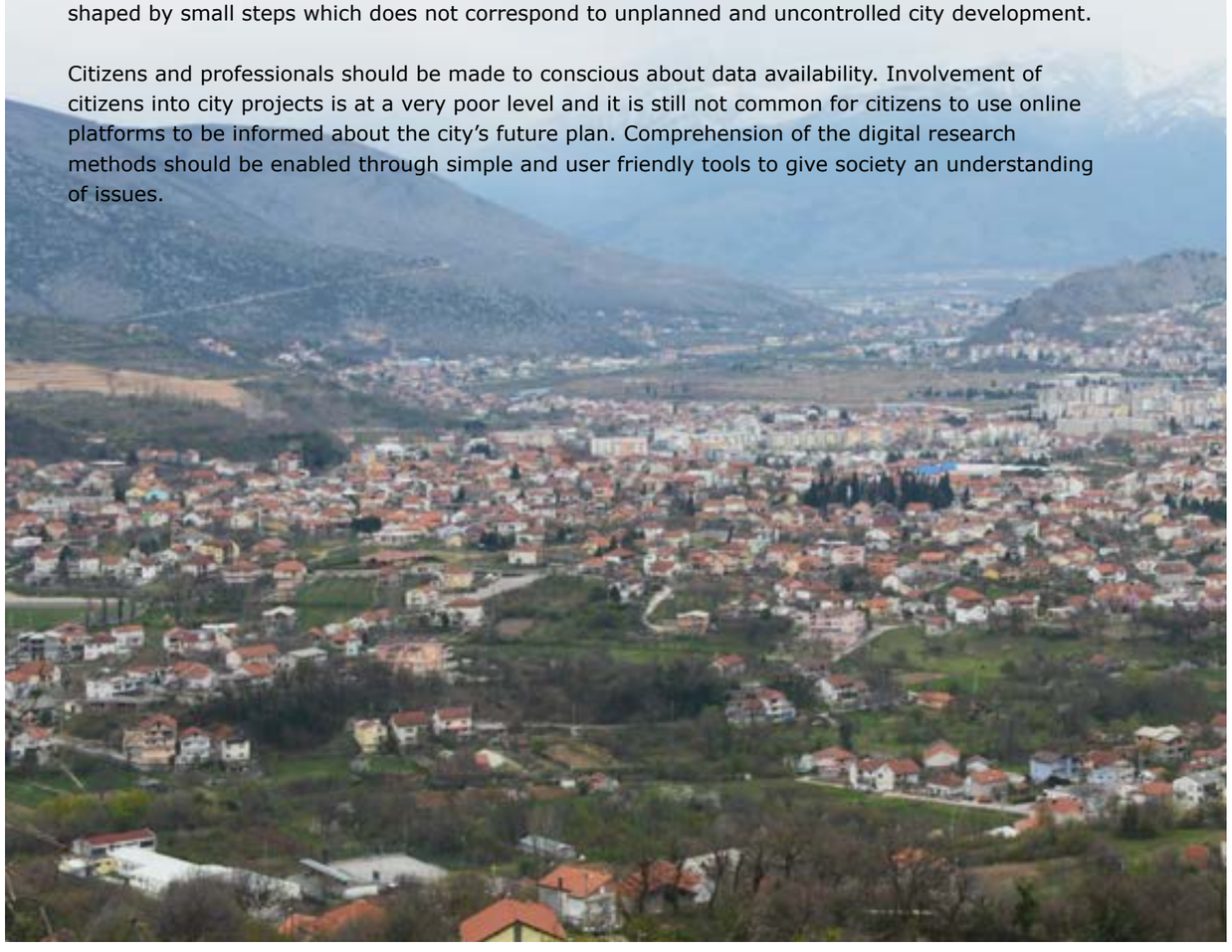
The city of Mostar, the fifth largest city in Bosnia and Herzegovina, throughout its history was one of the richest and most cosmopolitan cities in Bosnia and Herzegovina. However, nowadays it is described as a problem city and a *divided city [Calame, Jon, 2009]*. The phenomenon of city division can be described at various levels. But the Mostarian case is both spatial and sociological, and it also has a religious background. This division has lasted for the last 20 years and it influences all spheres of life.

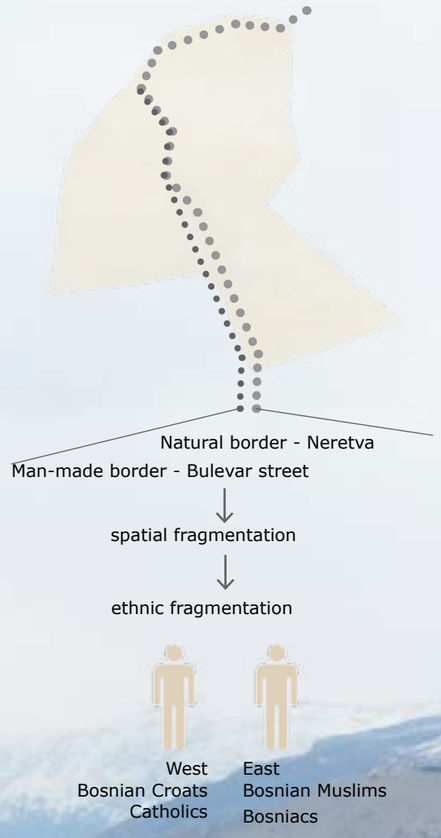
When talking about both sociological and ethnic fragmentation, it is manifested in the separated lives of the two ethnic groups at different sides of the city. Bosnian Muslims - Bosniacs *[Oxford dictionary]* live on the east side of the city, and Bosnian Croats Catholics live on the west side. The division results in parallel city systems and no crossing of interaction takes place. Parallel cultural institutions, education systems and ideologies have been shaped during the last 20 years and are manifested in architecture. Amongst all of the parallel institutions two universities have been selected as the main focus of this master thesis. They are autonomous entities and they presently do not cooperate, nor they have any plans to function as one entity in the future.

Digitally based research methods have a big potential in the field of urban planning, but they are not widely applied in praxis. There are a lot of projects which attempt to solve the spatial divisions which would then contribute to solving social fragmentation in *Divided cities [Calame, Jon, 2009]*

However, the impacts of digital methods in revitalization of the divided cities, is still largely undetermined. Databases are still in analog form and outdated. Online environments are being shaped by small steps which does not correspond to unplanned and uncontrolled city development.

Citizens and professionals should be made to conscious about data availability. Involvement of citizens into city projects is at a very poor level and it is still not common for citizens to use online platforms to be informed about the city's future plan. Comprehension of the digital research methods should be enabled through simple and user friendly tools to give society an understanding of issues.





1.1 Schema of the division

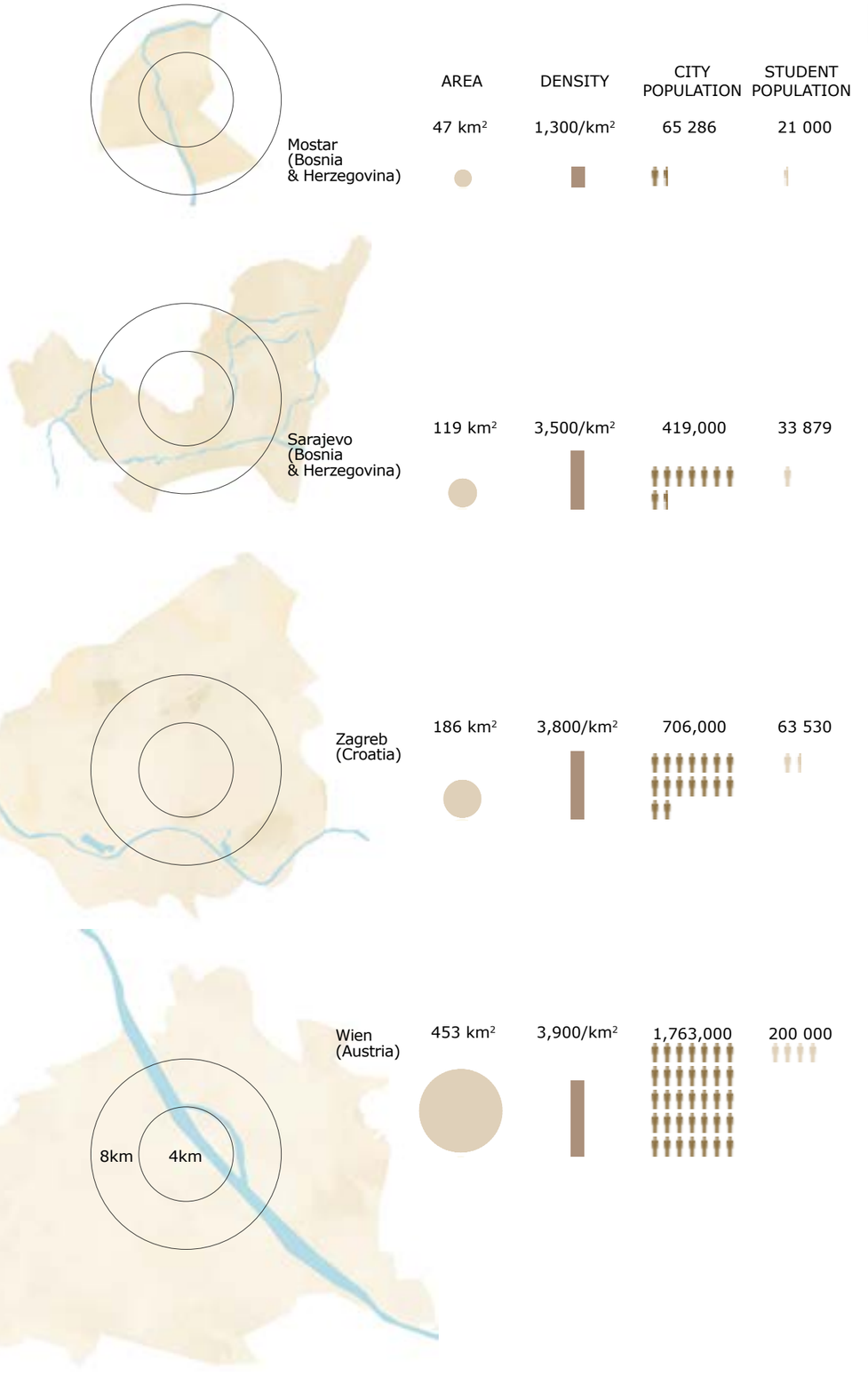
1.1.1 Urban aspect - project location - spatial fragmentation

The City of Mostar is located in the south east of Europe between high mountains and the deep river basin of the Neretva. The part of the river Neretva in the area of Mostar can be described as a contact line for the three main cultural-religious groups in Europe - Catholics, Orthodox and Muslims. Due to that, the river has been an important strategic position throughout the history.

Besides the river Neretva as a natural border, there is also a border shaped by sociological and political factors. It is mostly marked by a street called Bulevar that used to be the border between the old and the new part of the city. The street is about two kilometers long and parallel to the river Neretva. It is avoided by the citizens and there is no interaction or crossings neither from east to west, nor from west to east. There have been many attempts of reconstructing and revitalizing the street, but it still has a reputation of a *dead area*.

One of the consequences of the street Bulevar as a divison line are the parallel systems in the city. Among them are the two univerisites, which are positioned on the opposite sides of the city and do not work coopearate at all. However, they have a big number of students from the region and have gained on popularity since last several years. The student population has been increased and the condition and number of facilities has not changed. Mostar is after Sarajevo and Zagreb, the first choice for students from the region and has the biggest precentage of students in relation to the city population.

1.3 Position in Europe



1.4 Comparison of Mostar's land area with two biggest Austrian cities *[Demographia, 2015]*

1.1.2 Sociological aspect - ethnic fragmentation

A society is like a human organism capable of reproducing itself beyond the life-span of its cells. For that it needs an environmental and human-made material base, a structure–an interaction pattern–and a culture carrying the code of that structure.[russelltribunalonpalestine]

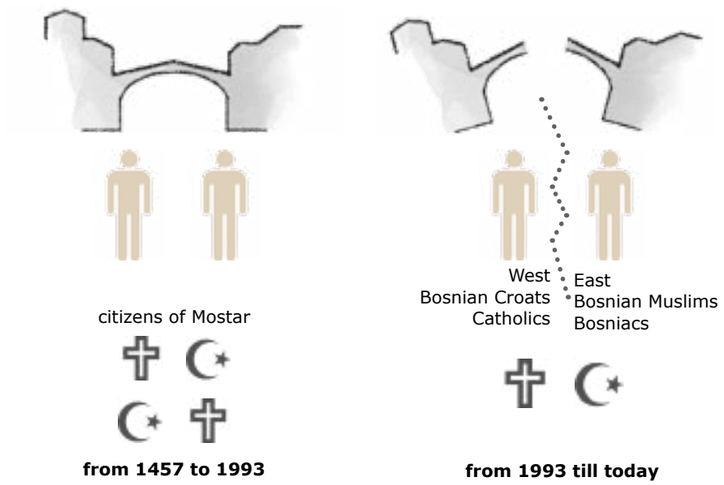
Historically, Mostar has been under the constant influence of numerous cultures and was well known as a multicultural city. However, in the last two decades that cultural diversity has not been treasured and got lost due to ethnic polarization. The two ethnic groups, Bosniaks and Croats cannot find a mutual language to overcome the past and share the space. There is no more interaction pattern, furthermore the culture that used to carry the code of Mostar is blurred.

Sociocide as a category stands for killing a society–or at least wounding it badly–by harming its material-structural-cultural base.[russelltribunalonpalestine]

Result of the wounded society are parallel ideologies that shape new generations and fragmented environment. The urban space is not any more shared by the both communities. Sport and cultural events which both groups attend are rare and they mostly end up with a conflict. The ethnic border is so hard embossed that it is projected onto all domains of life.

People of Mostar forget the fact that they live in the same city and are putting more effort in separating themselves rather than investing in common good.

1.5 Current social situation and desirable situation



from 1457 to 1993

from 1993 till today

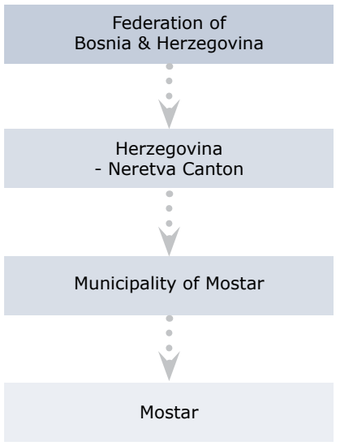
1.1.3 Political aspect

Bosnia and Herzegovina is an independent state consisting of the Federation of Bosnia and Herzegovina, the Republic of Srpska and a small entity; the Brcko District, which does not belong to either of them. The state declared its independence after dissolution of Yugoslavia in 1992 and became the member of the United Nations. The *Dayton Peace Accords [state.gov]* was signed in 1995 in order to end conflicts in the region of former Yugoslavia. Since then, the governmental system of Bosnia and Herzegovina has a reputation of one of the most complicated ones. There is a tripartite presidency whose members are one Bosniak, one Croat and one Serb. Therefore the political affiliation is based on ethnicity and due to that fact the divisions are getting more embossed in the society. *[Yarwood, J. (1999)]*

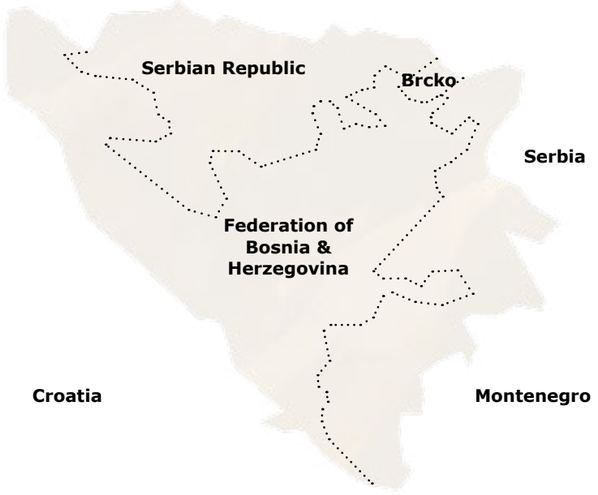
Through the Dayton Peace Accords *[state.gov]* the city of Mostar was also divided into six municipalities and one District. Three of them had Bosniak majority and other three Croat majority. The intention of forming the seventh municipality - District was to start the spatial and sociological reunification in that area. However, the master plan for the District has never been accepted due to constant conflicts between other six municipalities. Instead of focusing on re-linking, they were developing their own system of authorities which resulted in forming of parallel governmental frameworks with two mayors.

After ten years of electing the two mayors the system of six municipalities was abolished by foreign forces. Furthermore, the new political structure was presented in order to form a more democratic system. The first step was the change of the status of Mostar into a city in 2004. This forced the polarized parties to cooperate again after 15 years and, unfortunately, has brought up new conflicts. The first task of the new shared political system was the election for the unique city mayor. They failed for 16 times and the international forces had to intervene again in order to prevent new conflicts.

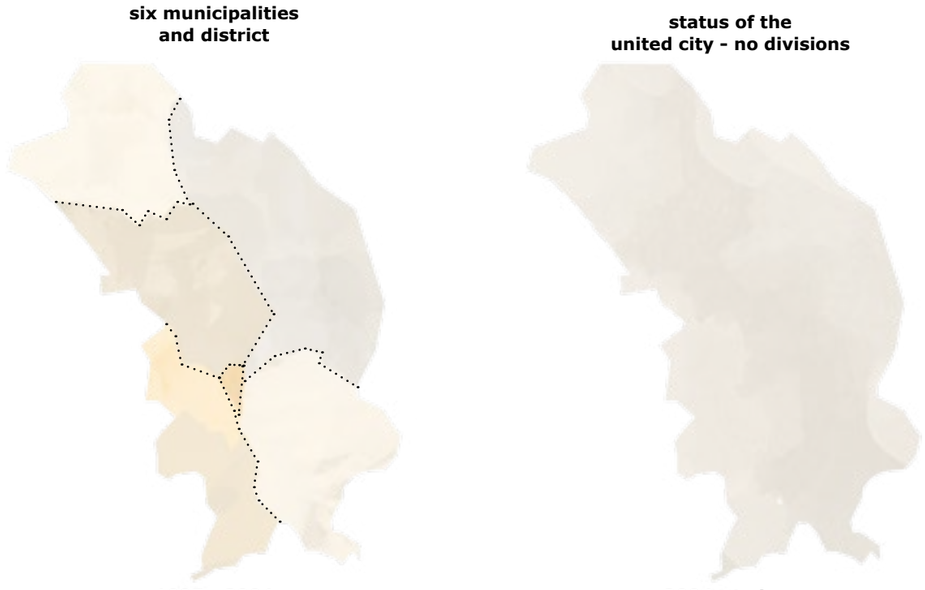
Nowadays Mostar still has its first unique mayor and the city has been unified on paper, however, the parallelism is still present. The urban planning has been facing difficulties for 20 years already, firstly because of divided systems, secondly because of complex and corrupted administration. The monoethnicity and corruption in political parties have to be overcome in order to start new frameworks which could work for common good without prioritizing the interests of particular individuals.



1.6 The political regulation of Mostar within the country



1.7 State of Bosnia and Herzegovina



1.8 Former and current city structure of Mostar

1.1.4 Technological aspect - lack of digital resources

The problems of division are mostly being tried to solve by using separated approaches to form a base for a new start, rather than using an interdisciplinary approach. Furthermore, sociological, geographical and economical perspective of the cities can be quickly put in relations by using digital methods and presented through new strategies of communication. However, the lack of digital resources and citizens' trust prevents and discourages professionals and citizens to cooperate and to have a better overview of city's development plans.

Urban planning in problem cities is much more complex and involves interaction of a lot of disciplines. In order to explain that process in a way which is more comprehensive to the population should various methods of communication be used. Visualization and simplification of data offers numerous ways of interaction between the citizens and city council. The methods of communicating that all already part of everyday life in developed systems are videos, interactive plans, physical 3D city models and procedural city models. Those communication strategies make the urban ideas and strategies more approachable for laymen and it makes them consider their possibility of participa-tion in bringing decisions.

It is hard to expect that only few professionals can bring changes to problem environments because main part of the environment are the people who live there. Therefore, should their interests and need for participation be invoked. The process of problem recognition, focusing on solutions and citizens' involvement can through new technologies and methods be simplified and accelerated.

Accessibility of information has enlarged over the last few decades through the improvement of technology. It has changed the way of studying, working and planning. Good examples of new useful instruments for citizens would be online platforms with city's plans and events. Citizens could be more engaged in city's development and contribute to it with new ideas.

In areas such as Mostar online platforms that gather students and scholars are still unfamiliar and social networks are often misused. The advantages of the Web in less developed countries are still not used to their full potential. The ways to transform learning to more modern methods are not considered.

1.2 Motivation

The city of Mostar has been confronted with many problems since last 25 years and their extent has become bigger and influences the society. The importance of education and basic need of citizens are not being considered because of constant conflicts. New ways of thinking and solutions should be
applied in order to enable changes in the divided society.

Conventional approach to research methods in urban planning is little by little being replaced with innovative digital methods, which are in cities like Mostar, still not widely spread. Although, it is hard to achieve urban development without industrial and governmental resources, the expansion of new technologies and internet gives opportunity to promote new methods without a need of state funding. Knowledge sharing is free and simple through using the World Wide Web.

The role of universities is fundamental due to the fact that they are shaping new generations and influencing the layer of society which is the most adjustable. The tool that implies forming of a virtual university campus would affect society's attitude and shape a new common identity of a student city.

1.9 View to from the Old Bridge

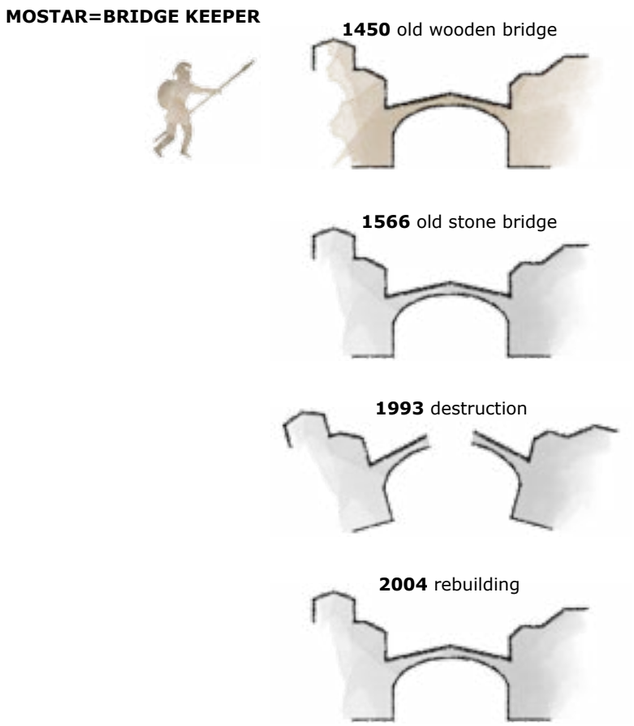
1.2.1 *Mostar* as *bridge-keeper*

The name of the city of Mostar was first mentioned in 1468 during a Turkish population census. In 1474 Mostar was, in documents from the Republic of Dubrovnik, described as a settlement with two fortresses on the river Neretva.

The fortresses were built in around 1450 to protect the wooden bridge on the river Neretva and the people living there were natively called *mostari - bridge-keepers*. The bridge-keepers were protecting the bridge on the river Neretva which was used as a trade road between Adriatic sea and ore-rich provinces of Bosnia. In 1468 Mostar came under Ottoman rule. The rebuilding of the bridge from a wooden into a stone one was a part of the renewal of the town's fortifications and it lasted for nine years, from 1557 to 1566. The town was then organized according to *oriental architecture rules* into crafts and commercial center of the settlement - *čaršija* and the residential area - *mahala*. The city started to spread in the nineteenth and twentieth century by using the old town as a core. It reached the highest point in seventies and eighties, however everything started to fall apart in the beginning of nineties. Almost whole both old and new city was ruined during conflict that lasted for four years and caused division.

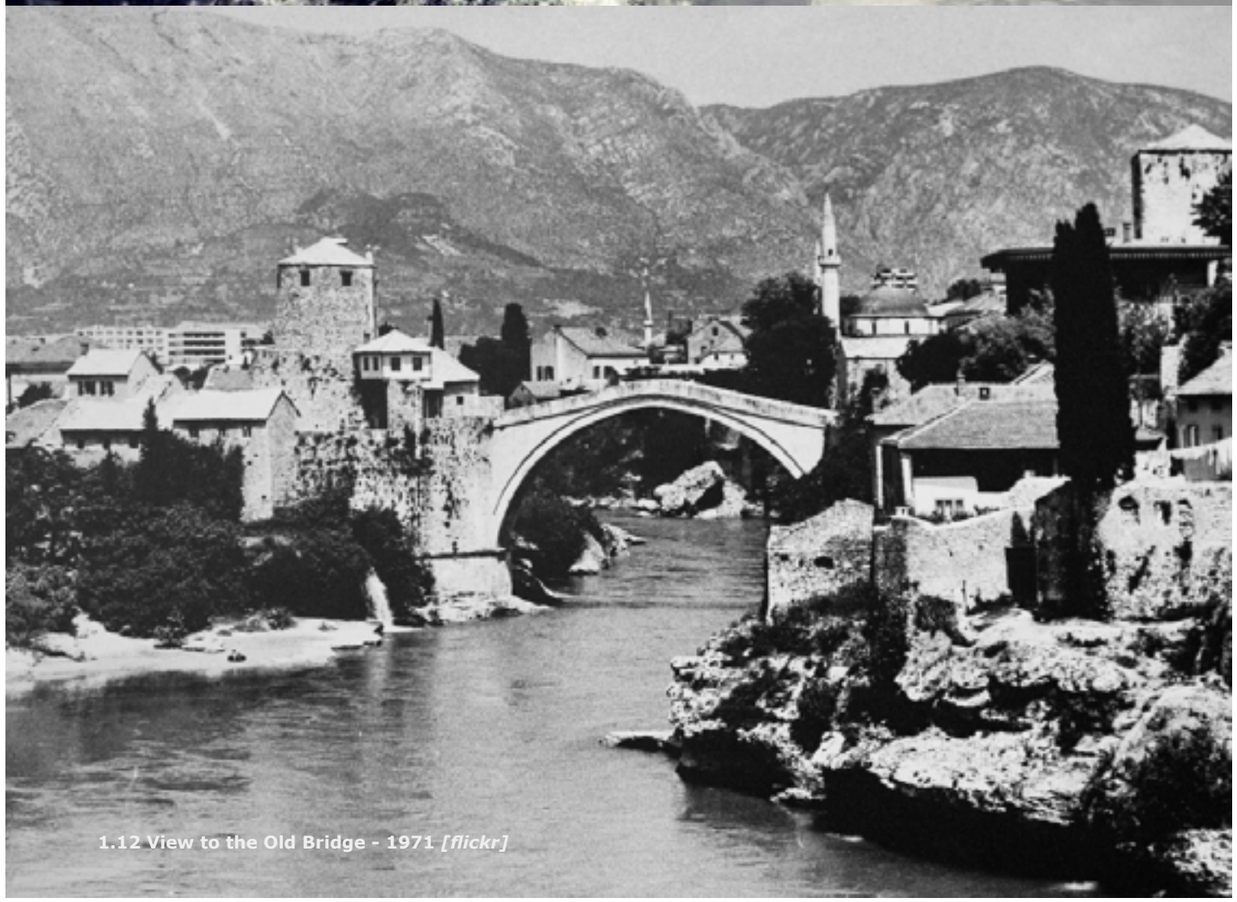
Among all other objects that were ruined is the Old bridge (*Stari Most)* the most well known one. It was standing over the river for 427 years, until it was demolished in 1993. However, it was reconstructed and rebuilt in 2004 and listed as UNESCO World Heritage. It is one of the most famous Islamic architectural structures in the Balkans.

[Mostar in picture and word, 2014]



1.10 History of the *Old Bridge*

1.11 View to the Old Bridge

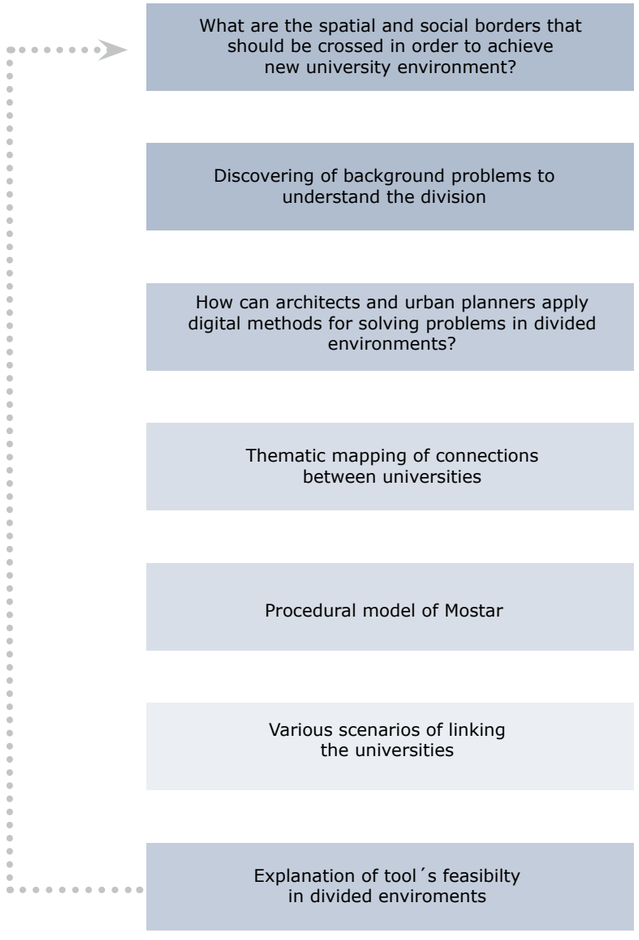


1.12 View to the Old Bridge - 1971 *[flickr]*

1.2.2 Research questions

QUESTION	ASPECT
What are the spatial and social borders that should be crossed in order to achieve new university environment?	CONTEXT-RELATED
How can architects and urban planners apply digital methods for solving problems in divided cities?	TECHNOLOGY-RELATED

1.13 Scheme of master thesis through research questions



1.2.3 Field of objectives

The field of objectives for this project is twofold. On one hand it is about developing a design, focused on the regeneration of divided cities by shaping young generations through new both virtual and physical environment. Secondly, it will contribute at the body of knowledge, focused on the implementation of new digital tools in the urban development. Some of applicable tools and strategies can be used in different projects in divided or problem cities.

The main objective of this thesis is to develop certain tools and strategies than can improve student life, the university facilities and public spaces attached to them. The designed tools and methods should suit to current need of the citizens and students.

In this project the existing qualities of the city will be activated and new qualities designed which will make the city an academic center. Both campuses should cooperate for a benefit of the whole city. Renovation and adding of certain objects and spots will offer new facilities, which can be used by both students and citizens. Their improvement will be reflected on the network of the public spaces. Reactivation of public spaces and forming new ones is fundamental to feel changes. The project aims to enliven both halves of the city and connect them through deeply considered strategy which influences the layer of society which is the most adjustable and that is youth. Young generations should be shaped in new environment which is not divided. Consequently, they would observe cultural and ethnic diversity as a positive feature and be able to appreciate in a real way.

It should be considered that the developed tool would offer input for new concepts and not defined ending solutions. The project would show how could citizens and professionals apply the tool in order to start changes in damaged cities.

A way to increase the participation of citizens would be an annual workshop through the custom designed tool. It would enable them to propose their own solutions and discuss them with the professionals. Through processing the proposals would city authorities get better overview of the society’s state of mind. That could make them consider the changes in the planning management and setting new priorities when adopting master plans.

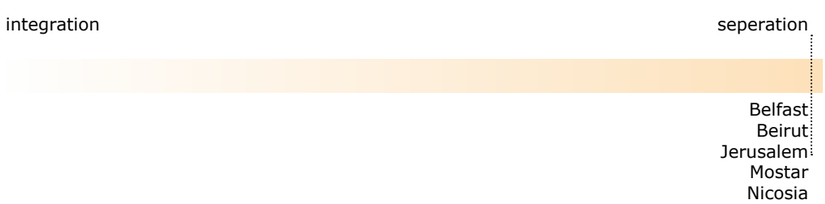
related work

2.1.Divided cities

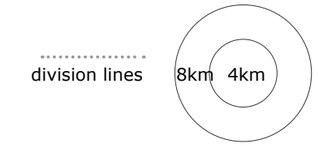
These cities were not destined for partition by their social or political histories. They were partitioned by politicians, citizens, and engineers according to limited information, short-range plans, and often dubious motives. How did it happen? How can it be avoided? [Calame, Jon 2009]

The book *Divided cities* explains the urban partition which in all cases has the same cause and that is ethnicity. The book analyzes circumstances, timing, costs and consequences of segregation. In all five cases, ethnic intolerance is translated into architecture which is in form of either a street or a wall that should not be crossed. Communities on opposite sides do not interact with each other and live in parallel cities.

Besides the detailed illustration of the life in divided cities, it implies that it could come to a division in any other city in the world. There are a lot of unstable environments where triggers for separation could be easily activated and consequently become divided cities. Therefore we should be aware of interethnic disconnectivities and prevent that they turn into spatial division.



2.1 Continuum between perfect spatial integration and complete seperation



	FORM OF DIVISON	LAND AREA	DENSITY	CITY POPULATION
Mostar (Bosnia & Herzegovina)	**street Bulevear** 9km long east - Bosniaks (Muslims) -38% west - Croats (Catholics) - 59% rest - 3%	47 km²	1300/km²	65,286
Nicosia (Cyprus)	**Green / Atila Line** wall 10km long, 4-5m high north - Turkish Cypritos (Muslims) 18% south - Greek Cypritos (Christian) 78% rest - 4%	122 km²	2500/km²	300,000
Belfast (Northern Ireland)	**Peacelines** several walls the longest 1,6 km nonoriented divison Catholics - 49% Protestants - 42% rest - 9%	161 km²	3700/km²	600,000
Jerusalem (Israel/Palestine)	**Green Line/Dayan al-Tal Line** wall 2,4 km , 1-12m high east - Palestians (Muslims) - 64% west - Israeli (Jews) - 33% rest - 3%	233 km²	3600/km²	840,000
Beirut (Lebanon)	**Green Line / Damascus** 9km long east - Christian Lebanese - 40% west - Muslim Lebanese -54% rest - 6%	673 km²	3300/km²	2,200,000

2.2 Comparison of Divided cities and their features *[Demographia, 2015]*

2.1.1 Origins of Division

Belfast
The division lines called *Peacelines [Calame, Jon, 2009]* were firstly created to prevent local violence between Catholics and Protestants. At the beginning they were unplanned and most of them were built up spontaneously to hinder pedestrian movement. However, nowadays they are demolished and rebuilt according to building regulations as all other objects. They have become a common part of Belfast architecture. Officially, there are still 14 major peacelines listed.

Beirut
The *Green line* is the name of the division line between Christians and Muslims in the city of Beirut. The boundary was built by paramilitary forces during the civil war that lasted for 16 years. During that period the crossing from one area to the other was only possible at certain checkpoints. Although the barricades were torn down in 1990, the fragmentation is still present. Both sides agree upon the fact that they would like to be in contact with the ones on the opposite side, but they fear that new conflict might erupt.

Jerusalem
The *Green line* in Jerusalem was built as an outcome of the civil war by military forces in two steps; in the period from 1948 to 1949. Who can pass through and visit the opposite side was also strongly controlled. The civil war between the Israelis and the Palestinians lasted for 19 years and ended in 1976, in the same year the wall was dismantled. Since then the status of the Green line is unresolved. The international authorities have never recognized neither Palestinian nor Israeli demands to list Jerusalem as capital or part of one of the states. Even though the movement back and forth is common, the division line marks not only national and religious border, but also an economic one. That is a more important reason for everyday conflicts and unsuccessful common economic development.

Mostar
The partition line in the city of Mostar was created along the street *Bulevar* which used to be and still is one of most important traffic corridors in the city. It used to be a physical boundary in form of barricades for one year from 1993 until 1994. In that period the citizens were distributed by military forces to the east and west side according to their religious affiliation. The Muslims were mostly deported to the east side of the city, while the Christians stayed on the west. The major difference between this division and the other ones, is that the new ethnic distribution in the city of Mostar was forced. The wall has been demolished and the city has been reunited for almost 20 years now. However, the citizens do not cross that street if they do not have to. There is no interaction between the polarized parts of the city.

Nicosia
In the case of Nicosia the *Green line* is at the same time border between two parts of the island; two states and two parts of the city. The Greek Cypriots live on the southern part of the island and have an officially recognized state. Opposite to that Turkish Cypriots live in the northern part in an unrecognized republic. The division line has had several extensions till today and it is still a physical division with a functional division of the city as a consequence. The reconnecting of the city has been implemented since 2004. The checkpoints where crossing to opposite sides takes place are more common and the buffer zone which has been monitored by United Nations forces for a long time is being reconstructed. Even though the interaction between citizens is not on a high level, certain improvements can be seen over last ten years.

[Calame, Jon, 2012]

2.1.2 Proper solutions

There are a few strategies that have given long-term success of blurring the divisions in the problem cities. However, it is hard to measure the improvement because of the lack of superordinate independent authority.

One of them is *engagement through centralized planning [Calame, Jon, 2009]*, in which the authorities control the professionals who are then obliged to be in favor of one of the opposite sides. In that kind of systems the city planning is biased and does not contribute to improvement of common good. This strategy was applied in the city of Jerusalem and led to *manipulation of jurisdiction*.

Engagement through collaborative or parity planning [Calame, Jon, 2009] is the second strategy. It is applied in Nicosia and it had better effects than the previous mentioned one. The involvement of local professionals was essential for activating the citizens, who felt that they belong to the reunited city. Furthermore, it was the initiative of politicians to gather all relevant, exclusively local practitioners in order to design a new master plan for both the old city area and for the surroundings of the division line. Besides the involvement of locals as a major positive feature; the focus on revitalization of the city districts, rather than only on specific landmarks, was also considered as crucial for favorable outcomes. The whole process included the renovation of infrastructure which initiates economic development. Until now this has been the most successful strategy.

The substitute for the first two strategies is the *engagement through privatization [Calame, Jon, 2009]*. The main driving forces of those kinds of processes are private companies. The City of Beirut illustrates a bad example of overwhelming private interests and its consequences to the city. It ended up with creation of economic boundaries and new social classes instead of removing the ethnic-social segregation.

The city of Mostar is an example of the fourth strategy; *Engagement through private investment in cultural heritage [Calame, Jon, 2009]*. The community and authorities of Mostar based their recovery on foreign donation. However, the money was only invested in the old-city landmarks, which led to deepening of the crisis in society. There was no effort to enhance and revitalize the economy. That has not improved the quality of life of the citizens. Consequently, the economic crisis and massive exodus have become the problems that external efforts cannot solve.

Generally speaking, the division lines are far stronger mentally, present in the minds of citizens, than they are physical in form of spatial barriers. They are very strongly embedded in the society's consciousness; therefore, it is hard to expect that a spatial solution can affect a damaged society. A dialogue between professionals and occupants should be established in order to achieve the atmosphere of a healthy city.

Effort and investment alone are unlikely to revitalize a divided city because healthy citizes thrive on "a general uniting atmosphere in which you feel like a citizen wherever you are" (Marwan T., 2000) - the product of social instititution rather than physical ones. An urban planner from Mostar, active in the city's postwar rehabilitation, offered identical observations. [Calame, Jon, 2009]

2.2 Digital urban planning

Urban practitioners are not able to cope with the problems of divided environments on their own. The way it works nowadays is that a team that should be working on improvement of the master plans and expanding data banks, is occupied with corrupted politicians and individuals which results in mistrust of the citizens and lack of interest in finding the common solution for the problems.

In order to modify and accelerate the process of creating and adopting new urban strategies, implementation of digital tools would be very important. The urban practitioners have an opportunity to overcome the barrier of huge political influence when presenting ideas if using new communication strategies. Digital methods offer more transparency in the process of creating new urban strategies. Furthermore, that means less possibility of manipulation by the politicians, because more people have an overview of the whole procedure

It is necessary to open a constructive dialogue between the architects, urban planners and local population. One way of overcoming obstacles and accomplishing cooperation of architects with the local population is the organization of forums in which architects directly present their proposals in a new way. Through virtual city models and interactive projects local people can become more familiar with city projects. Once a dialogue is established the layman is able to understand the planning intentions and can become a part of them.

This thesis presents new digitally aided planning and communication strategies in order to solve problems in underdeveloped divided areas.

2.2.1 GIS (*WebGIS*)

GIS is a system of hardware, software, and procedures that capture, store, edit, manipulate, manage, analyze, share, and display georeferenced data. [Fu, Pinde, 2011]

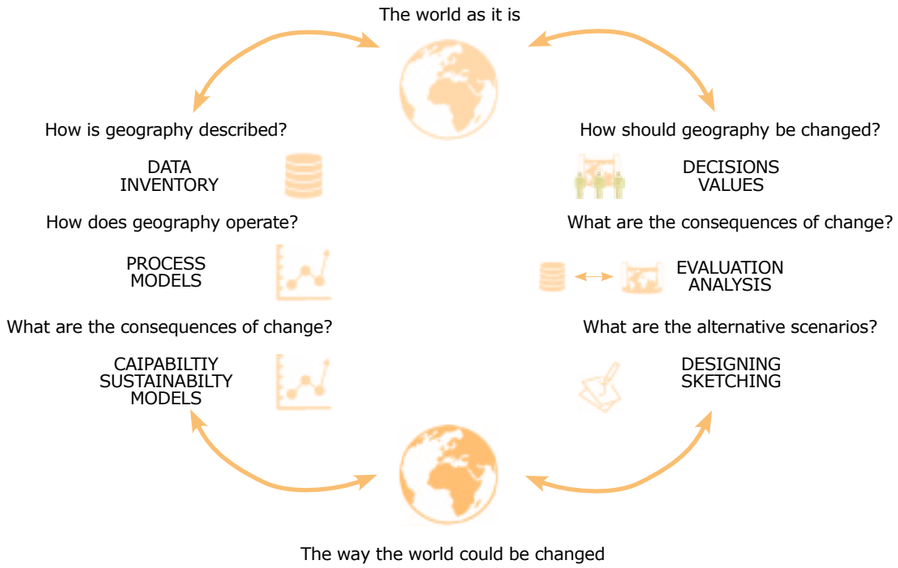
The first GIS technology was developed in 1962, before the Internet and Web; in Canada and was used for Canadian land database and planning. Next to conventional map production of different scales and themes, it has the geoinformatical information system function of advanced data analysis whose results are afterwards being transformed into applicable information. It can combine scattered data according to its mutual geographical characteristics in order to shape unapparent common patterns. The linking of those revealed patterns create new information and ways of communicating which can contribute to advanced decision making.

Since its founding the system has developed a set of data management, visualization and analysis which is being used for various disciplines *[Fu, Pinde, 2011]*. GIS translates the real-world data into specific models which are made out of various layers. The layers are distinguished through different themes of real-world data. They are either presenting 2D or 3D maps and being used for processing of solutions for real-world problems. Their application is common for master planning, traffic analysis, natural disaster analysis, ecosystems modeling and many others fields. Parallel to GIS the geographical design has been developed in order to simplify visualization of information. It made people understand the world's problems and lead to proposals of various solutions.

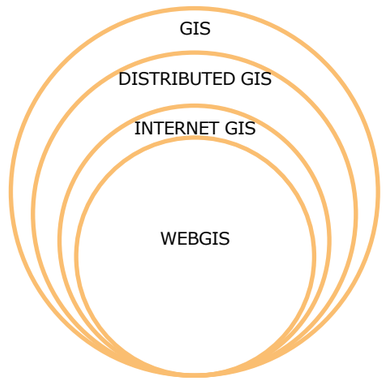
For most of the time GIS has been used only by professionals, however that has changed since development and adoption of Web GIS. The Web GIS system enables exchange of geographic and spatial information between a server and a client by using a web browser. It is a distributed information system which has numerous users in contrast to conventional desktop versions of GIS software. Besides that, the Web GIS is created for wider number of users and prior knowledge is not a condition to use it. Public participation is at a very high level and makes the significance and development of Web GIS possible.

Nowadays GIS software packages in *Divided Cities* are used just partially. Analog data is still being translated into digital, but the advantage of data's multidimensionality has not yet been fully utilized. The large domain of geographical information system broadens the concept of urbanization in post-conflict cities. Among the *Divided Cities,* Mostar and Jerusalem are the cities with official GIS sites with both orthophoto and master plans, which can be downloaded and used for both private and public purpose.

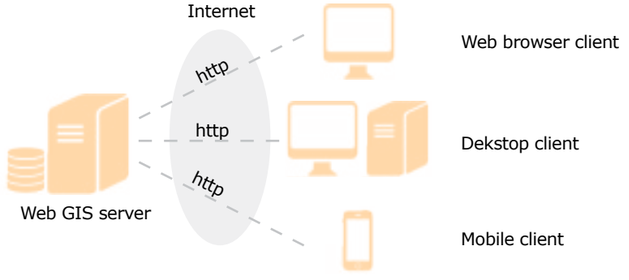
The GIS site of Mostar contains the old scanned master plans and new digitalized master plans of most of the city zones. Mostar is the first city in the state of Bosnia and Herzegovina that has such an urban planning inventory which is published online. However, most of the people do not even know that this kind of site exists and barely know how to use it. Those plans are still not seen as a potential for new ideas and interaction between both city authorities and professionals and between professionals and citizens.



2.3 Systematic methodology of geographic planning and decision making *[Fu, Pinde, 2011]*



2.4 Web GIS in relation to other GIS systems *[Fu, Pinde, 2011]*



2.5 Architecture of Web Gis *[Fu, Pinde, 2011]*

2.2.2 Open Data

Open Data is the idea of making public and administrative data freely available to the citizens. The authorities came to an agreement to make it accessible through an official machine-readable form. The functioning of open data systems is enabled through open software and interfaces, which give more possibilities for participation and collaboration. The official internet portals provide geographic data, urban planning data, statistical data and other diverse data types, however private personal data is never published. There are several ways to use the open data. Citizens use the open data to service themselves, companies are able to create new applications and science benefits from simplified data exchange.

The three main principles of open data are data transparency, participation of population and collaboration. In this kind of system it is possible to query planning scheme and be informed about each planning intention of the city. The availability and transparency of the city documentation improves and develops new strategies of communication. The rise of the open data idea has implied the need of new ways of communication. It is essential to shape, visualize and present the data in a form that citizens comprehend and use in appropriate way.

A well developed example of open data is city portal of Vienna. It contains information about culture, history, education, master plans, working, living and several other that are relevant to the citizens. The portal has a simple user-interface which enables both professionals and citizens to use it. The most advanced part of it is the browser based online map of Vienna which contains diverse data catalogs and basic maps with detailed descriptions. Their content is being updated and expanded constantly in order to provide exact information to the citizens. Besides that, those maps are linked with other portals and applications in order to simplify and improve the everyday life of citizens. The population's participation has been increased since the establishment of *Open Government Vienna [open.wien.gv.at]* in 2010. The principles of this kind of a system have shown importance of population's participation in making administrative decisions.

In the case of *Divided Cities* the involvement of citizens still has not reached the desired level in order to change the social segregation. Among five of them, Mostar and Jerusalem are on the way to make the city portals more accessible and increase population's ability to participate. Next to the official portals, both cities have also expanded their GIS sites and are working on their improvement. However, the idea of participation is still not sufficiently spread and common for the city population. They are not prone to deal with that kind of data and involve in city council's decision. On the one hand, it is very hard to have an open data base in a city where each planning method starts and ends with corruption. Therefore, the citizens are skeptical when it comes to taking part in urban planning. Their participation is either misused or not even taken into account. On the other hand, the data bases have still not been fully created and are not going to be if the city authorities continue to work in the same way.

The open data has the power of transparency and does not underlie the corruption. The citizens have to understand what does it mean to have data catalogs which can be used for free. Once the data base is made, it would be easier to create new applications and visualizations that would help in everyday life.

2.6 Example of Open data *[open.wien.gv.at]*

2.7 Example of using Open data - application that helps control tree registry *[open.wien.gv.at]*

2.2.3 Procedural modeling of cities

There are two arts of 3D modeling, the interactive modeling, which is shaped by a human using a program for 3D modeling manually and the procedural modeling.

The main concept of the procedural modeling is that computer is using a code; procedure which represents a series of commands. In the case of interactive modeling the user manually interacts with the 3d software and creates geometry. The series of commands is actually set of rules is which through its execution gives geometry as an output. In the process of shaping geometry are the basic shapes becoming dynamic objects which can be constantly changed and updated through rules. The set of rules can be either part of the software and controllable through interface or written in separate software and attached to the 3D program.

The advantage of procedural modeling is that it can quickly generate complex models using diverse methods to accomplish variety of the objects. The program operations can use randomness as parameter and enrich the diversity of 3D model. It would take too long for a human to design so many various objects manually, while the procedural modeling accelerates that process.

The distinguishing feature of the approaches in procedural urban planning nowadays is the usage of different software packages, both commercial and custom designed. The principles of three most common one; *Modelur, CityCAD and CityEngine* are going to be explained, starting from the simplest one. *[Steinø, Nicolai, 2010]*

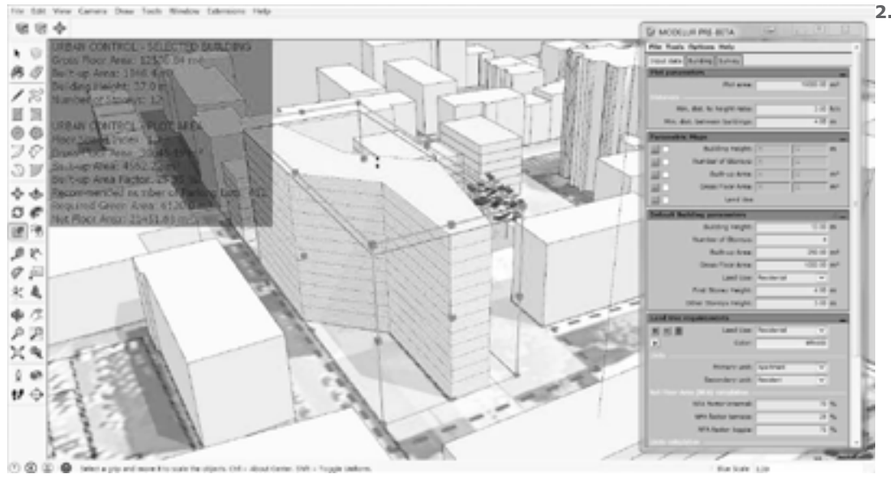
The most simple software in the group of urban design software currently is *Modelur*, a plug-in for SketchUp. The software is used for studying small areas in order to convert 2D drawing into 3D models in quickest possible time. The program is more focused on objects and their features, rather than the whole city infrastructure and other elements of a city.

The second software is *CityCAD* with a focus on both urban design of smaller scale as well as on city planning. The software enables manipulation with spatial and numerical information, rather than control of a realistic visualization of the city. It is based more on the evaluation of data, in respect to urban codes and regulations. The design is more conceptual so it is not possible to build real cities with detailed infrastructure.

The third and most complex program is *CityEngine*. It is a procedural modeling software based on shape grammars. Plans and 3D models can be generated in various ways. They are designed either parametrically or based on input data. When we compare it to other two programs, not only are buildings created parametrically but street infrastructure also. The beginners can shape a city through controlling the parameters in the software's interface, while the professionals script the rules which are then used for creating a model of a city.

There are two main concepts for generating city models that are used in the CityEngine; set of rules and shape grammars. The shape grammar is a production system which iterates basic shapes in order to create complex objects that form a city. More complex set of rules are created based on shape grammars. They enable the translation of the urban regulations into the digitalized rule system which is easily changeable and digitalized. The simple way of applying the shape grammar and a set of rules is explained in the next section.

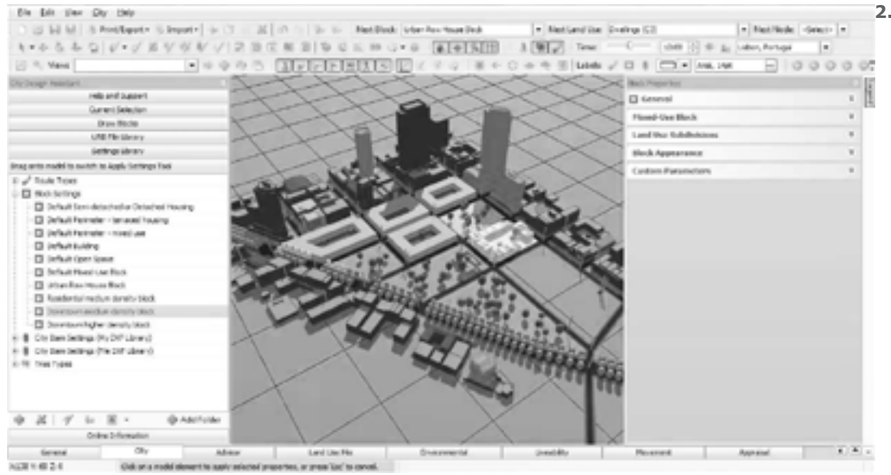
Comparison of procedural modelling softwares



2.8 ***Modelur [modelur]***

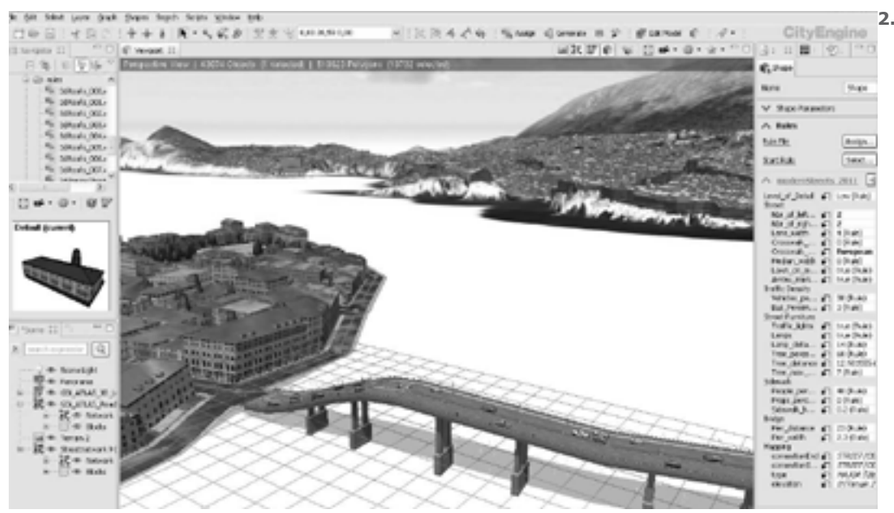
MAIN FOCUS
OF SOFTWARE

3d
objects



2.9 ***Citycad [holisticcity]***

urban
regulations



2.10 ***Cityengine [gdi.net]***

objects,
infrastructure,
urban
regulations

Shape grammar

Shape grammars were invented by Stiny and Gips in 1976. Through two exercises they showed how to apply it in practice and education. However, the usage of shape grammars had not expanded in the first 20 years of their existence until the first specific approach was presented. Nowadays, there are a lot of types of shape grammars, which encompass specific fields of computation design. The CGA (Computer Generated Architecture) shape grammar is being used in procedural city models because it enables rule-based modeling.

The shape grammars are derived from context-free grammars which are using symbols as the initial signs. They are more abstract than shape grammars because the basic idea is forming of strings, languages respectively. Both of them use same principles in order to produce new strings and shapes.

The idea of shape grammar is based on a production system which uses a basic, primitive shape as a starting point. Each production system has an alphabet which consists of initial shapes and production rules. Through the application of production rules on the initial shapes the new shapes are created. The production rules consist of two parts, the left one and the right one. There are always two important steps when the rule is being applied to the initial shape. In the first step the geometry element is on the left side being identified and in the second one all shapes on the left side are replaced with the shapes on the right side of the production rule.

The special feature of grammar-based modeling is that rules are written in a way that they can be easily transformed. The basic idea of applying the rule is to design a CGA shape which can be replaced by new CGA shapes. The two main characteristics of the shape are the bounding box and the shape-symbol or the rule name. Each geometry designed in the software is positioned inside of a bounding box, oriented through its scope and has a specific name.

The fundamental operations in the rules of CGA are scaling, translating, rotation and spiting (or splitting?). Through continuous application of those rules on initial basic shapes very complex objects are generated. Next to that, it is also possible to improve the level of details and complexity through further iterations. The parameters which are used as a framework for the rules are either taken from the attribute charts of object itself or from the relation with the other object, like for example the distance between buildings.

S = start symbol
-> = production rule
a, b = variables
Creation of context free grammar for **$a^n b^n$, n>1**

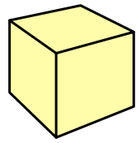
solution :	S -> aSb / ab
possible combinations:	**option 1**
	S -> aSb
	S -> aabb -> a^2b^2
	option 2
	S -> aSb
	S -> aaSbb
	S -> aaabbb -> a^3b^3

2.11 Example for context-free grammar

1st step - 1st generation

rule: A --> initial Box

shape tree: A — Box



a start **symbol A** is defines the rule
it is being replaced through an initial shape - **Box**
the generation process ends here

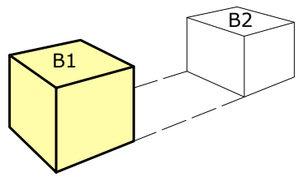
the shape tree consists out of **root symbol A**
and a **leaf shape B**

leaves are representing the generated model

2nd step - 2nd generation

rule: A --> initial Box
translated Box

shape tree: A — B1, B2



a start **symbol A** defines the rule
it is being replaced through an initial shape - **Box** and than copied and trasnlated in x-direction - **translated Box**
the generation process ends here

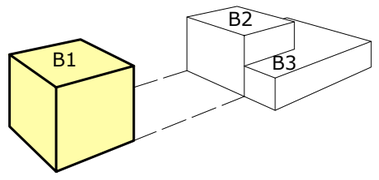
the shape tree consists out of **root symbol A**
and a **leaf shapes B1 & B2**

leaves are representing the generated model

3rd step - 3rd generation

rule: A --> initial Box
translated Box
scaled Box

shape tree: A — B1, B2 — B3



a start **symbol A** defines the rule
it is being replaced through an initial shape - **Box** and than copied and trasnlated in x-direction **translated Box** is in the third step copied and scaled - **scaled Box**
the generation process ends here

the shape tree consists out of **root symbol A**
and a **leaf shapes B1, B2 & B3**

leaves are representing the generated model

2.12 Example of shape grammar

Set of rules

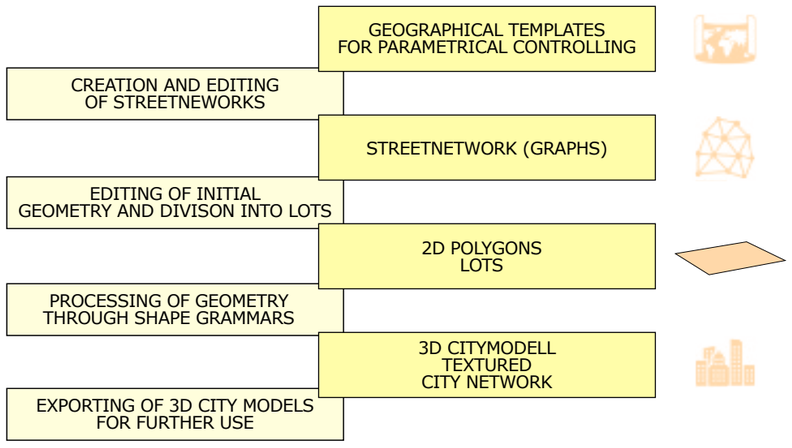
The main idea of a procedural city model is to create, change and control the digital city through a set of rules in order to design scenarios which can improve a real city. The system of rules that defines urban strategy for a city is complex and involves a lot of disciplines. A city consists of visible and invisible entities. The visible entities are buildings, parks, waterways and all kinds of infrastructure, like streets, railways or water system. Opposite to the visible ones are the invisible features, more complicated and harder to define. They are mostly geographical features, that have to be taken in account, like possibility of floods or earthquakes, and probably the most important feature - the people's needs.

This project will show how the visible characteristics of the city can be put in relation and translated into 3D objects through using a set of rules and shape grammars. The city plans consist of objects, infrastructure, green surfaces and waterways which are marked through certain colors, hatches and forms. Each of them is recognizable through specific way of labeling and can be easily queried. Parallel with the city plans are urban rules being created in order to present possibilities and restrictions considering future development of a city.

Each of the labeled entities can be described through one or more parameters in order to simplify its function and application inside of the rule. If an object which is colored red, has a restricted building height of twelve meters, than one of its parameters is the building's height, while the other ones are the lot area, distance to the street, percentage of the green surface, maximum floor height and many others. The procedural approach makes possible to combine and interpret the rules in automatable 3D form.

The main distinction between static 3D model of a city and the procedural model is the automatable set of rules which allows numerous variations. The model can be constantly upgraded, new rules can be created and the old ones extended. In this case it is also possible to adopt the invisible entities of a city and write a rule out of them which is going to be interpreted in a certain way. A possible example would be changing the typology of the buildings according to the wind streaming. The process of testing urban strategies in a procedural city model is much faster and offers more scenarios.

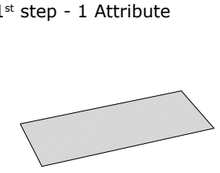
The concepts that allow creation of the rule sets are the shape grammars which are going to be explained in the next part.

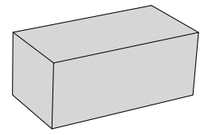


2.13 Cityengine Modules

In each step of creating rule is one attribute/parameter added in order to combine more parameters

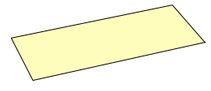
1st step - 1 Attribute

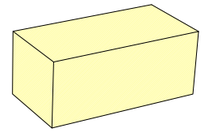




Defining of **Lot** position and **Height**
1st Attribute - Height

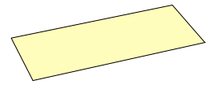
2nd step - 2 Attributes

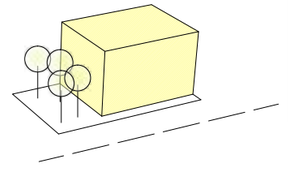




Defining of **Lot** position, **Height** and **Land use**
1st Attribute - Height
2nd Attribute - Land use

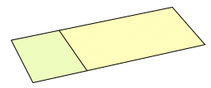
3rd step - 4 Attributes

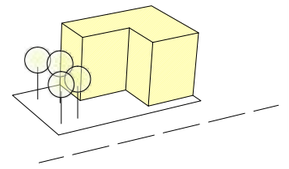




Defining of **Lot** position, **Height, Land use, Greenery, StreetDistance**
1st Attribute - Height
2nd Attribute - Land use
3rd Attribute - Minimal green surface
4th Attribute - Distance from the street

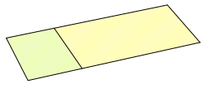
4th step - 5 Attributes

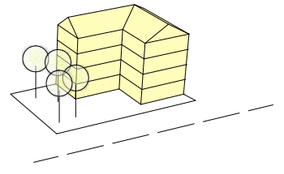




Defining of **Lot** position, **Height, Land use, Greenery, StreetDistance, Typology**
1st Attribute - Height
2nd Attribute - Land use
3rd Attribute - Minimal green surface
4th Attribute - Distance from the street
5th Attribute - Typology

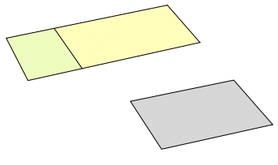
5th step - 6 Attributes

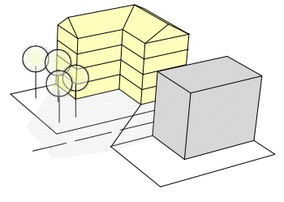




Defining of **Lot** position, **Height, Land use, Greenery, StreetDistance, Typology, Floorh**
1st Attribute - Height
2nd Attribute - Land use
3rd Attribute - Minimal green surface
4th Attribute - Distance from the street
5th Attribute - Typology
6th Attribute - Floor height

6th step - 7 Attributes

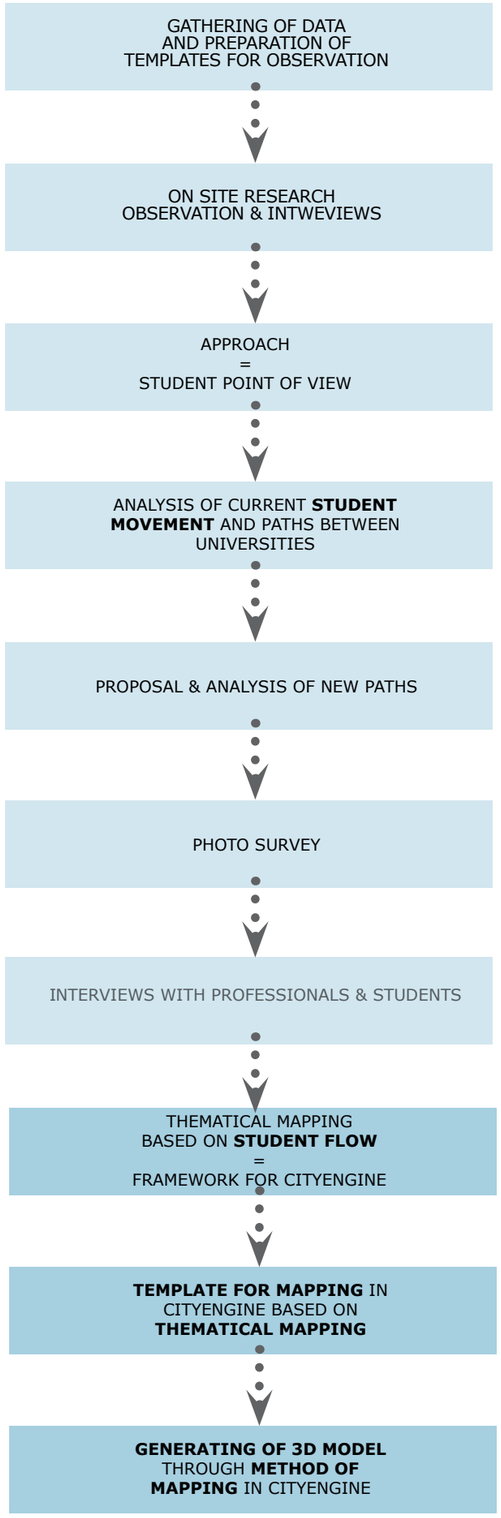




Defining of **Lot** position, **Height, Land use, Greenery, StreetDistance, Typology, Floorh**
1st Attribute - Height
2nd Attribute - Land use
3rd Attribute - Minimal green surface
4th Attribute - Distance from the street
5th Attribute - Typology
6th Attribute - Floor height
7th Attribute - Shading degree

2.14 Structuring of rule

methodology



3.1 Scheme of the methodology

3.1 On site research - observations and interviews

Several researches were undertaken in the city of Mostar in order to get impression of the consequences of the division in the city.

3.1.1 Observations

The size of observed area is defined through positions of university. They define scope of about 3,6 km². Parallel to on-site research the city is structured into housing, traffic and greenery layer in order to specify their area size and relations to each other.

The approach to the research is from the student point of view and focuses on their daily behaviour and movement flow. The students are mostly pedestrians and use bike and public transport in very small amount.

In the first observations stage were the common student paths and spots which are mostly used and visited by students mapped. The universities are positioned at the opposite sides of the city, therefore is the first part of research done separately. The second stage of the observations was walk along new proposed paths, which could link the universities. Next to existing path that connects universities, there are also four new ways which could shape framework for new university campus. All five paths overlap each other and enable creation of more interlinks. After analysis of the stage development of traffic infrastructure, the next step would be to research objects and their land use. Ruins and objects that could be reused are mapped in order to propose it as a part of campus facilities.

3.1.2 Interviews

An introduction interview was held with the urban planning advisor in the city of Mostar PhD candidate M. Arch Senada Demirović Habibija. She gave an overview about both theoretical and practical city planning. There is an online platform, which offers insight into small amount of urban plans for the city Mostar. The main problem is that almost every attempt of city renewal is ruined because of corruption. For that reason are the citizens not even able to be introduced to the planning ideas and participate in bringing decisions.

Afterwards, interviews were performed on the streets, universities and at the workshop in order to get to know student needs and opinions about the division. They were questioned about the facilities they think the city lacks and appropriate positioning of them. Most of them agreed about the problem of *soft infrastructure* in the city. There are no bike paths and side walks are in very poor condition. Besides that , there is not enough student dormitories, sport and culture facilities where they could spend their learning and free time.

All gained information through the interviews is going the be applied in the design proposal.

3.2. Data sources

Most of the data for the project was gained from city planning authorities and their consultants. The two-dimensional data was mostly outdated and not well organized. However, it was possible to get most of the planning documentation, which was partially redrawn and purged in CAD programs according to updated orthophotos.

The statistical data of the city of Mostar is at a very poor level. There are no acquired resources to develop a registry like in other cities with higher standards. Few documents were obtained in order to comprehend the city's ethnic and social background. However, Mostar has GIS data resources that are at very high standards. Topography of Mostar and its surroundings is designed and available for public usage within the GIS system. Terrain model of the size of the research area's scope was also made available for this master thesis. It was a big contribution to this project and helped a lot in further processing of the tool design.

Generally speaking, most of the textual data about Mostar in the past 25 years has been written in English. While the local professionals were dealing with conflicts in the city, the international professionals were trying to analyze and record. Only recently have the local professionals managed to restart the institutions and establish certain databases.

3.3 Planning concepts

3.3.1 Approach to the problem of the divided Mostar

After the first encounter with the problems of the city of Mostar, the leading ideas were how to reconnect the polarized society through a new metaphorical bridge. The current physical bridges that connect the west and the east bank are not fulfilling their purpose. The citizens try to avoid crossing the bridges and going to the opposite side if it is not necessary to do it. The bridges are seen as a division, rather than connection. Furthermore, they are creating parallel cities and institutions to embrace it. That is the reason why a metaphorical bridge in a sense of connecting the institutions, two universities, is going to be used as a starting approach to the master thesis.

The social division of population is a result of an external forced process and not a normal and natural process of settlement. It is hard to set up an initiative for bridging the problems when citizens mostly see it as a potential for a conflict. Avoiding taking sides is crucial in the process of creating new connections. The way to avoid it is activation of both sides at the same time. Culture and education have always been applicable instruments of dialog and overcoming of conflicts. This is how the idea of connecting educational institutions became the main concept of the master thesis.

Next to creating a connection between institutions in Mostar and solving its problems, *Divided Cities* have become the second focus of the thesis. Some of the applicable tools and strategies can be used in different projects in divided or problem cities. The expansion of new technologies has been considered as an opportunity to promote new methods and develop a tool which could be adjusted for use in other problem cities.

3.3.2 Thematic mapping

Thematic mapping is a proposed method of analyzing the pedestrian and bike movement of the students in this master thesis. The first step, before visiting Mostar, was defining the paths between the universities which would be analyzed and spots that have certain significance.

The drafts were made in GIS, CAD and several online platforms to get the impressions of distances and the scope of the research. The main products of thematic mapping are panorama photos and proposed paths between universities. There are about 60 panorama photos that contain information about the potential of the environment, lack of infrastructure and possible locations that could be reused. Each path is then marked by panoramas and defined by vehicular possibilities.

The obtained results should show the current state of pedestrian and bike infrastructure, soft infrastructure near the roads which is mostly illegal and could be reused, residential, public, educational and industrial land use. The mapping was done parallel with photo survey.

3.3.3 Photo survey

Photo survey was made along current and new possible paths between universities in order to mark qualities and potentials of the scope area.

3.3.4 Procedural model of Mostar

CityEngine is a procedural modeling software based on shape grammars. Urban plans and 3D models can be generated in various ways. This system manages to combine geographical and statistical input and enables a user to control it. Besides its application in urban planning, it is also widely spread in the game and film industries for imaginative environments.

In the first stage of the data preparation GIS and CAD were used. *Qgis* is an open source program that enables analysis, edition and visualization of geospatial information, it could be said it is a geospatial *Photoshop*. Insight in any part of the world is possible through its plug-ins which use open information licensed maps of the world, eg *OpenStreetMap, Google Maps, Bing* etc . It is possible to have a very detailed illustration of a space without even visiting it physically. It supports numerous 2D and 3D formats that can be easily transformed and georeferenced.

In the second stage the 2D data was transformed into procedural 3D model in the software *CityEngine*. The model was a starting point for development of the tool and processing and testing the planning intentions.

bridging the universities in mostar

4.1 University environment - research area

4.2 University system in the city of Mostar

The scope of the research area is defined through positions of universities.

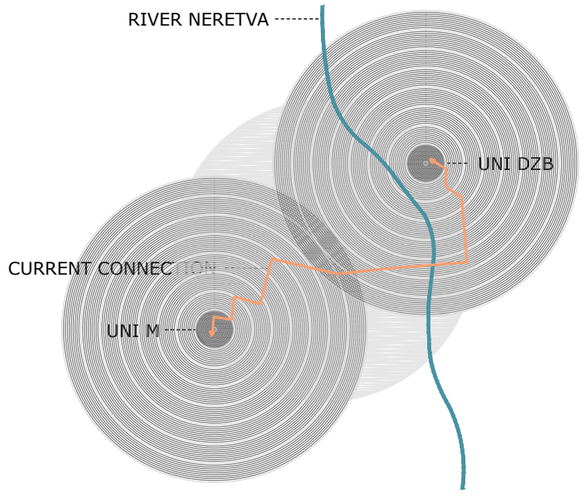
The city of Mostar has two universities with 21 000 students. The particular feature of the universities is that although they mostly have the same study programs, that does not imply diversity of faculties, but rather the rivalry between the universities.

The main criteria when choosing which university to enroll is mostly based on ethnicity. Bosniaks enroll at the University of Dzemal Bijedic, while the Croats enroll at the University of Mostar. Since the last few years, a percentage of student who chose university by other criteria has increased.

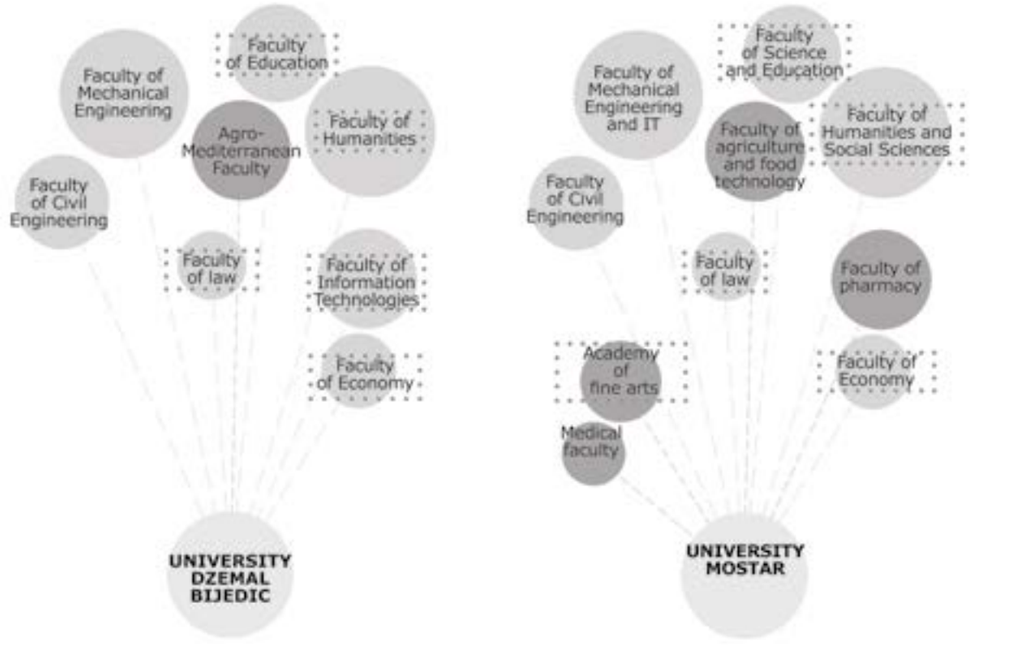
The first university was established in 1977 and it carried the name Dzemal Bijedic University. In 1992, the University was renamed into University of Mostar and it stayed situated in western Mostar. Rest of the professors left the University and established a new one with the old name - the University Dzemal Bijedic of Mostar. The new University moved to a location in the northern part of the city and used old military facilities as a starting point for development. During the first fifteen years they differed a lot in study programs, but eventually by adopting international standards they became competitive at an international basis.

The universities are positioned on the opposite sides of the city. The Dzemal Bijedic University of Mostar on the east side and the University Mostar on the west side. The current traffic connection between the two universities is possible mostly by car because infrastructure is not suitable enough to walk or to use a bike.

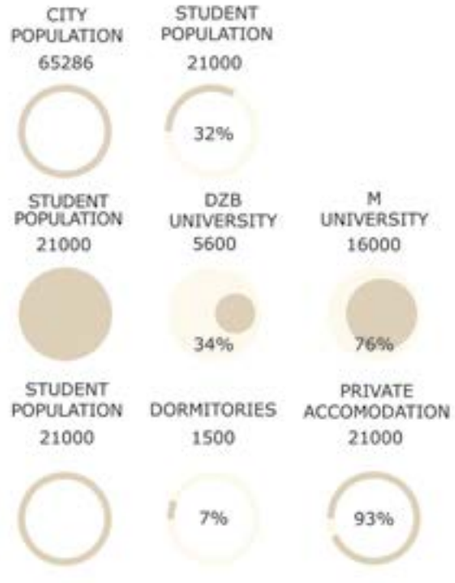
There are three student dormitories which accommodate 1250 students. It is only 5% of the student population. The others live in private accommodation. The city of Mostar still does not have exact statistical data about the number of guest and home students and the way they are distributed among faculties.



4.1 Radius of universities - 750 m



4.2 Current faculty distribution - study courses



4.3 Student distribution

RESIDENTIAL

FUN

dormitory

RESIDENTIAL

daily movement of students of
University of Mostar
taking place only on the **west side**

RESIDENTIAL

WORKING

RESIDENTIAL

shopp
on of t
from b

dormitory

SPORT

SPORT

FUN

university mostar

EDUCATION

EDUCATION

0 20 100 200

4.2.3 Daily movement of students

SPORT

FUN

EDUCATION

SPORT

EDUCATION

daily movement of students of
Dzemal Bijedic University
taking place only on **east side**

RESIDENTIAL

university dzemal bijedic

FUN

RESIDENTIAL

dormitory

RESIDENTIAL

FUN

FUN

ping center / cinema
the rare places where citizens
both sides come to spend time

N

4.3 Urban patterns between universities

There is only one current connection between the two universities and is not frequently used because no interaction between two sides is taking place. In order to change the daily movement of the students and encourage crossing sides were several possible connections analysed. There were four new proposed connections next to the one existing.
Among those five connections are in the end three selected as basis for creating scenarios of university environment.

air distance - 1400m
distance by traffic - 2600m

9 min | 13 min not available | 30 min | 12 min not available

1 2 3 4 5 6 7 8 9 10 33 34 35 37 38 52 53 55 56 57

dormitory

stadion
stadion
dormitory
university mostar
stadion
mostar university clinic center
cultural center
rondo
interr

0 20 100 200

4.3.1 Analysis of the current connection between universities

university dzemal bijedic

dormitory

railway & bus station

shopping center

This is the shortest way between the two universities. There are few bus lines to commute from one place to the other one. It is also possible to go by foot or bike, although the infrastructure is not totally appropriate for that kind of transport. Most of the citizens use cars out of two reasons. One of them is because the public transport undeveloped is and the second one is that it is not so common to go by foot anywhere. There are rare pedestrians to meet in the streets.

musala

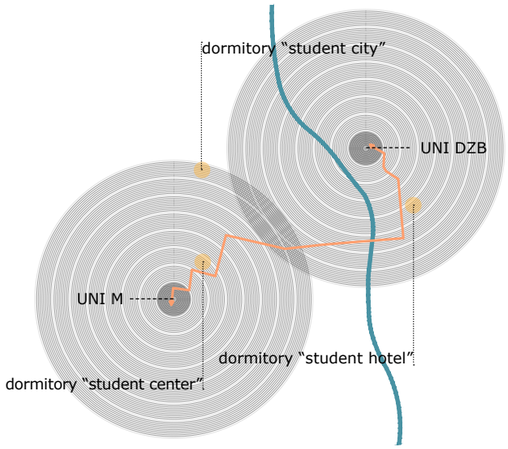
spanish square

national gymnasium

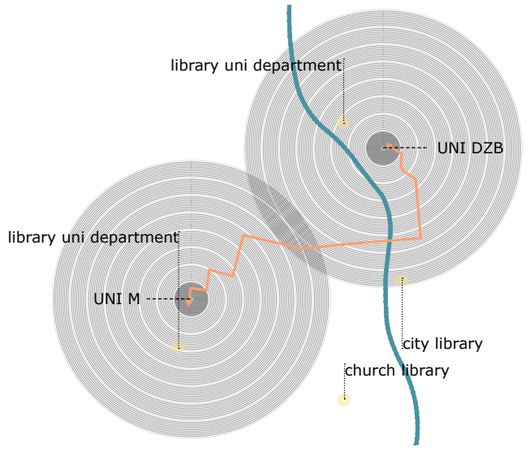
N

4.3.2 Evaluating of the current connection between universities and facilities

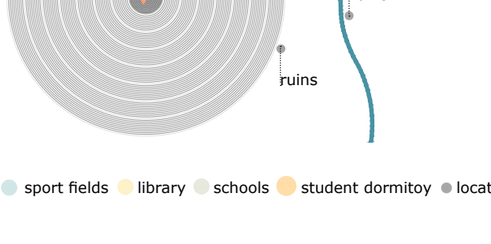
LAYER 1 position of dormitories



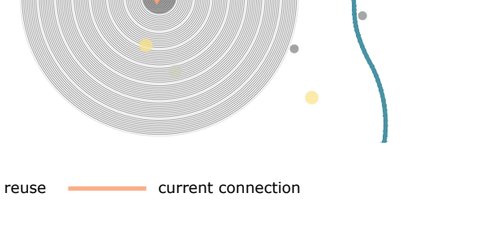
LAYER 2 position of libraries



LAYER 3 position of schools



LAYER 4 position of sport fields



LAYER 5 position of sites suitable to reuse

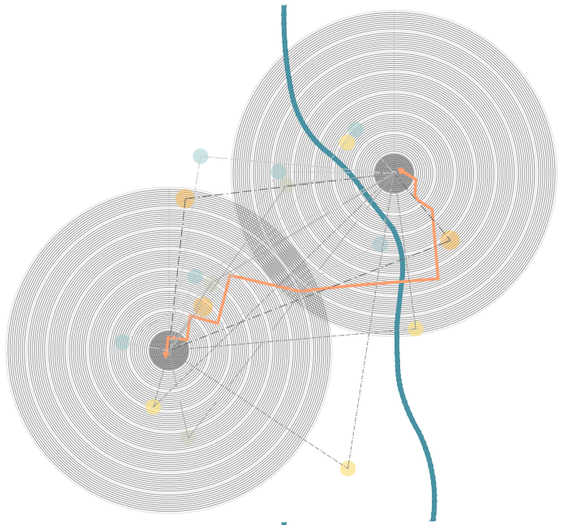
LAYER 6 overlayering

sport fields · library · schools · student dormitoy · locations to reuse · current connection

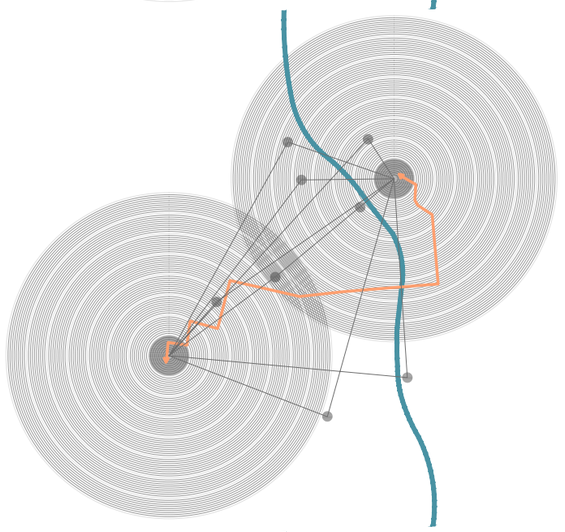
LAYER 1
evaluating current connections
of both universities

CONNECTIONS from
weakst to strongest

dormitories
libraries
sports
schools
ruins

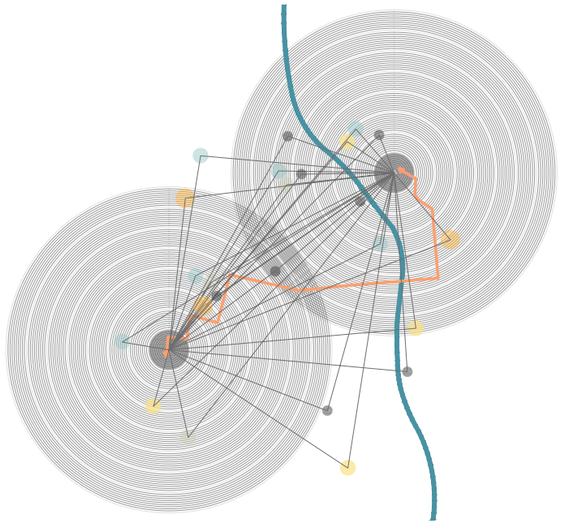


LAYER 2
proposal of new connections to
diverse sites that could be reused
in order to be university facilities



LAYER 3
proposal of future networking
with new university facilities

dormitories
libraries
sports
schools
ruins



1st path air distance - 1400m
distance by traffic - 2600m

9 min | 13 min not available | 30 min | 12 min not available

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

2nd path air distance - 1250m
distance by traffic - 1500m

6 min | 19 min | 7 min not available

1 2 3 4 5 6 7 8 9 10 33 34 32 25 23 20 47

3rd path air distance - 1100m
distance by traffic - 1500m

6 min | 19 min | 7 min not available

1 2 3 4 5 6 7 8 9 10 33 34 35 30 31 29 28 27 26 24 41

4th path air distance - 1000m
distance by traffic -1400m

5 min | 18 min | 6 min not available

1 2 3 4 5 6 7 8 9 10 33 34 35 37 38 39 40 41 42 43 44 22 47 48 49 50 51

dormitory

university mostar

stadion

mostar university clinic center

cultural center

rondo

0 20 100 200

4.3.3 Analysis of new possible connections between universities

university dzemal bijedic

dormitory

railway & bus station

shopping center

musala

spanish square

international gymnasium

N

1 public furniture - renovation

2 boost existing green spaces

3

4 stadion - renovation

5

6 student dormitory

7 small pavillons - cafes, bakeries, copy shops

4.3.4 Photo survey - panoramas on paths between universities

UNI DZEMAL BIJEDIC

UNI MOSTAR

1 2 3 4 5 6 7

uni sport fields

N position of north in the photos

1 location

8

N

9

green street profiles

10

partly renovated ground floors

N

greenery

11

12

N

13

new housing

14

4.3.4 Photo survey - panoramas on paths between universities

N

UNI DZEMAL BIJEDIC

12 13 14 11 9 10 8

UNI MOSTAR

N

N

N

N position of north in the photos

1 location

15 N old silos

16 N new bridge under construction

17 old silos N

18 N old silos

19 N

20

21

N

16
15
17
18
19
20
21

UNI DZEMAL BIJEDIC

UNI MOSTAR

unused supermarkt hall N

elementary school N

N position of north in the photos 1 location


31


green street profiles
32

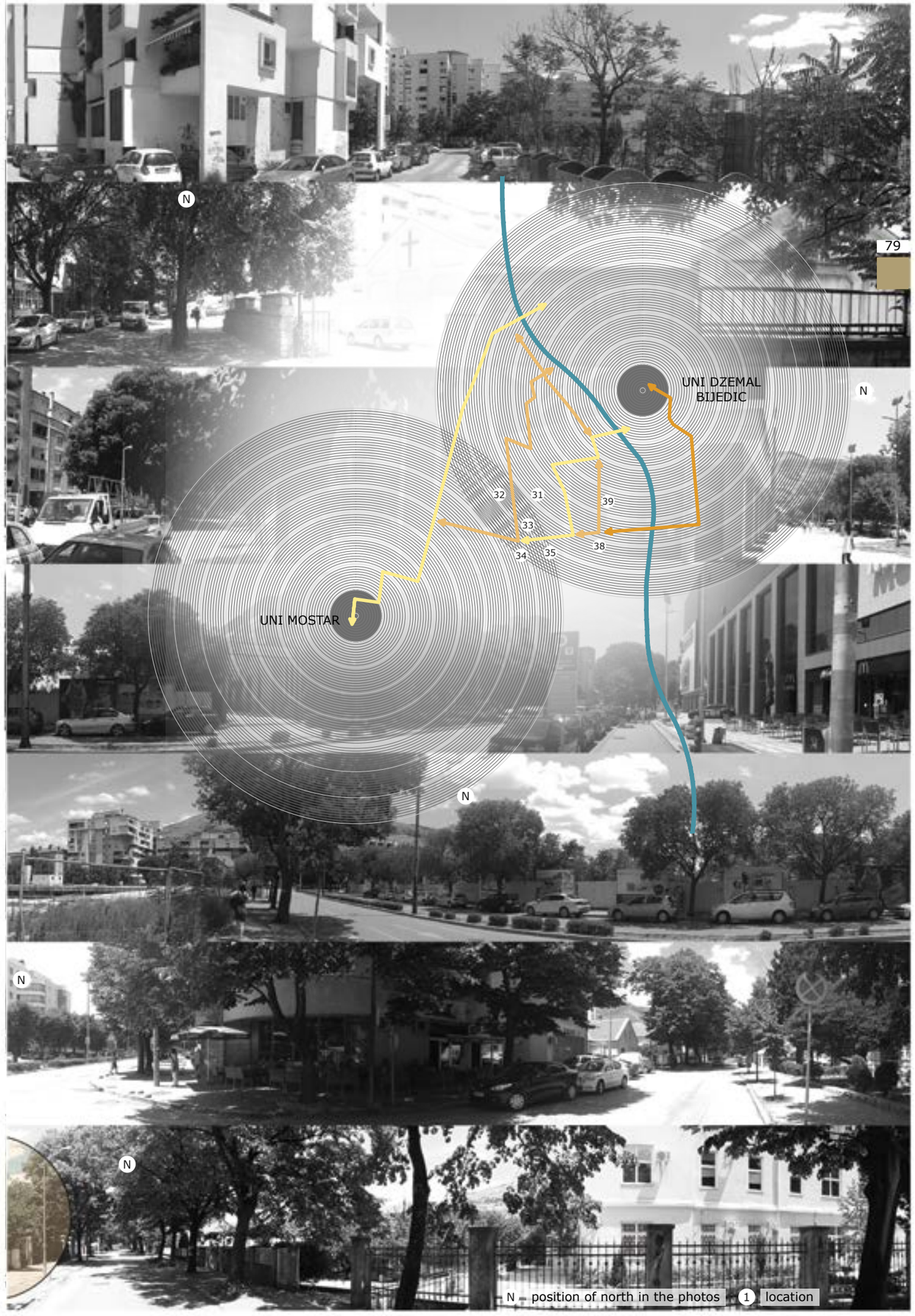

33


34
N


35


38


39
family houses


N
UNI DZEMAL BIJEDIC
UNI MOSTAR
32
31
39
33
34
35
38
N
N
N
N – position of north in the photos
1 location

40 biggest shopping mall

41 family houses

80

43 N

44 abonded family houses N

45

46 N

47

abonded family houses

N

N

81

UNI DZEMAL BIJEDIC

UNI MOSTAR

47 46 45 43 41 44 40

N

N

N position of north in the photos 1 location

51

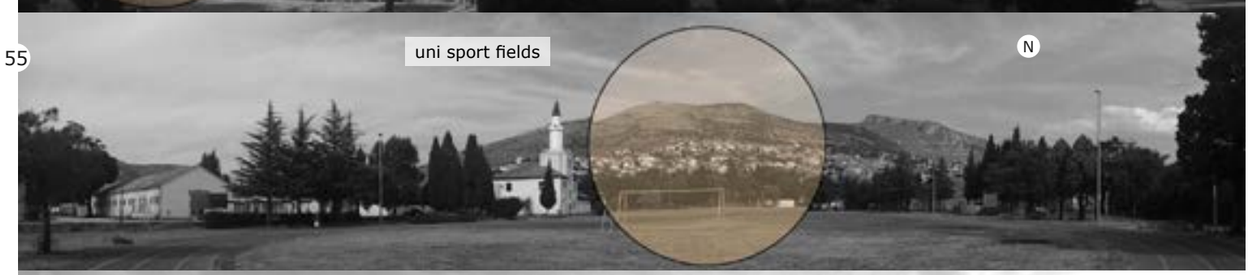
52

82

53

54

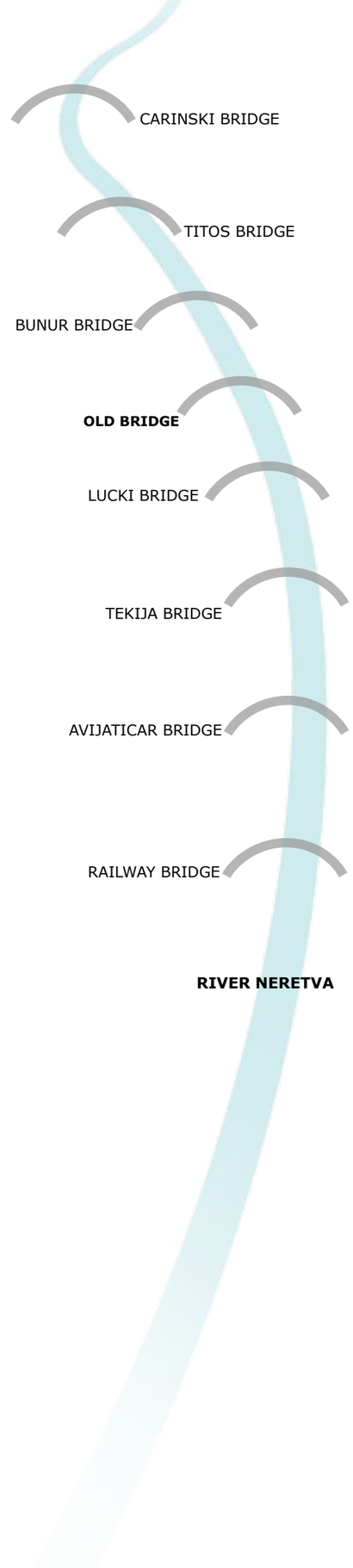
55



56

57

Exsisting bridges in Mostar

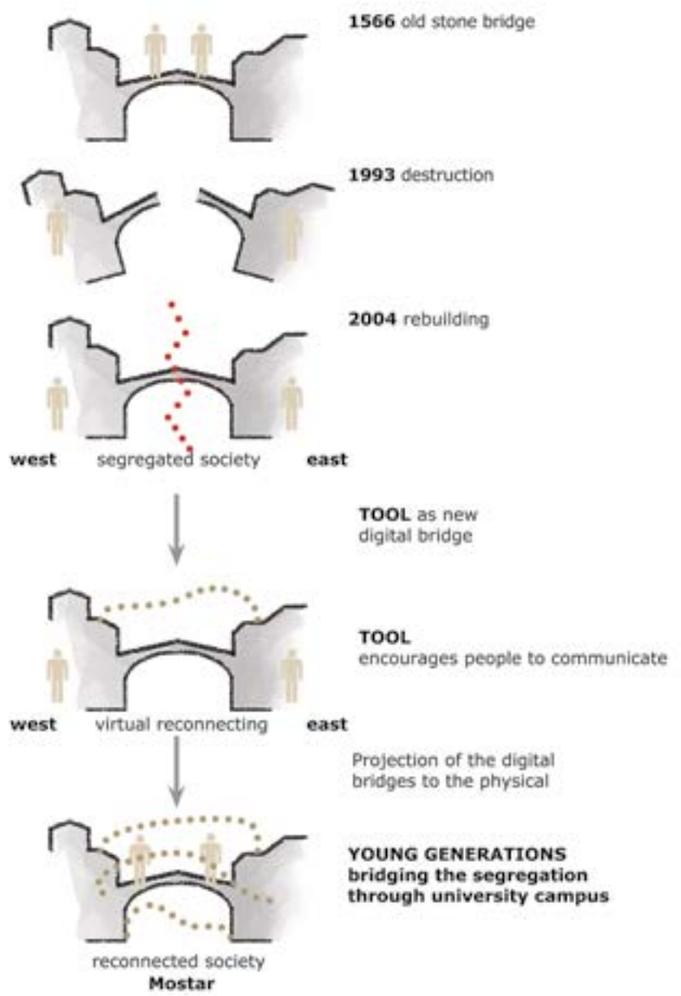


4.4 Concept of new *bridges* in the city of Mostar

Before a bridge is built, you have just an environment; some land, trees, a river. But once a bridge is in a place, all of these things come into definition around this bridge: "The bridge gathers the earth as landscape out of land. It makes natural beauty out of nature. The bridge is a place that holds this gathering." [Willems, Brien 2009]

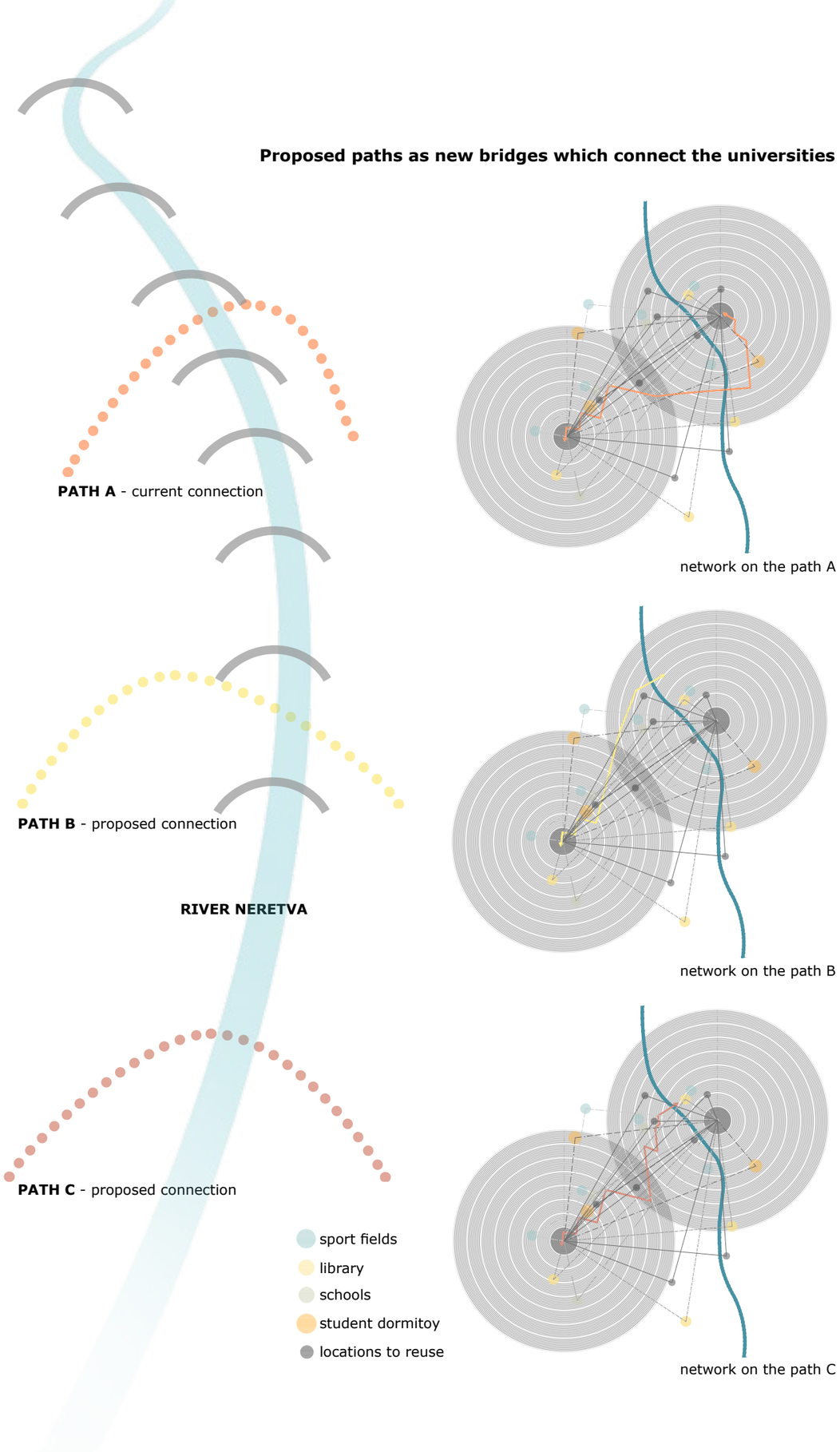
Mostar has nowadays six vehicular bridges and two pedestrian bridges, including the Old Bridge. All of them were ruined and rebuilt in the period from 1992 to 2000.
However, those bridges are not playing their role of connecting. They are not gathering the citizens of Mostar, rather separating them and remembering each day of the dysfunctionalities in the city. The city of Mostar is not one place, connected via bridges, it is turning into two places divided by the bridges.

This projects aims to create digital bridges which would initiate the communication between professionals and citizens from both sides of the city. The digital bridges would be the output of the tool. They would offer new solutions that would become both physical and metaphoric bridges and reconnect the city.



4.5 Concept of bridges

Proposed paths as new bridges which connect the universities



network on the path A

network on the path B

network on the path C

procedural city of mostar

5.1 Procedural modeling workflow

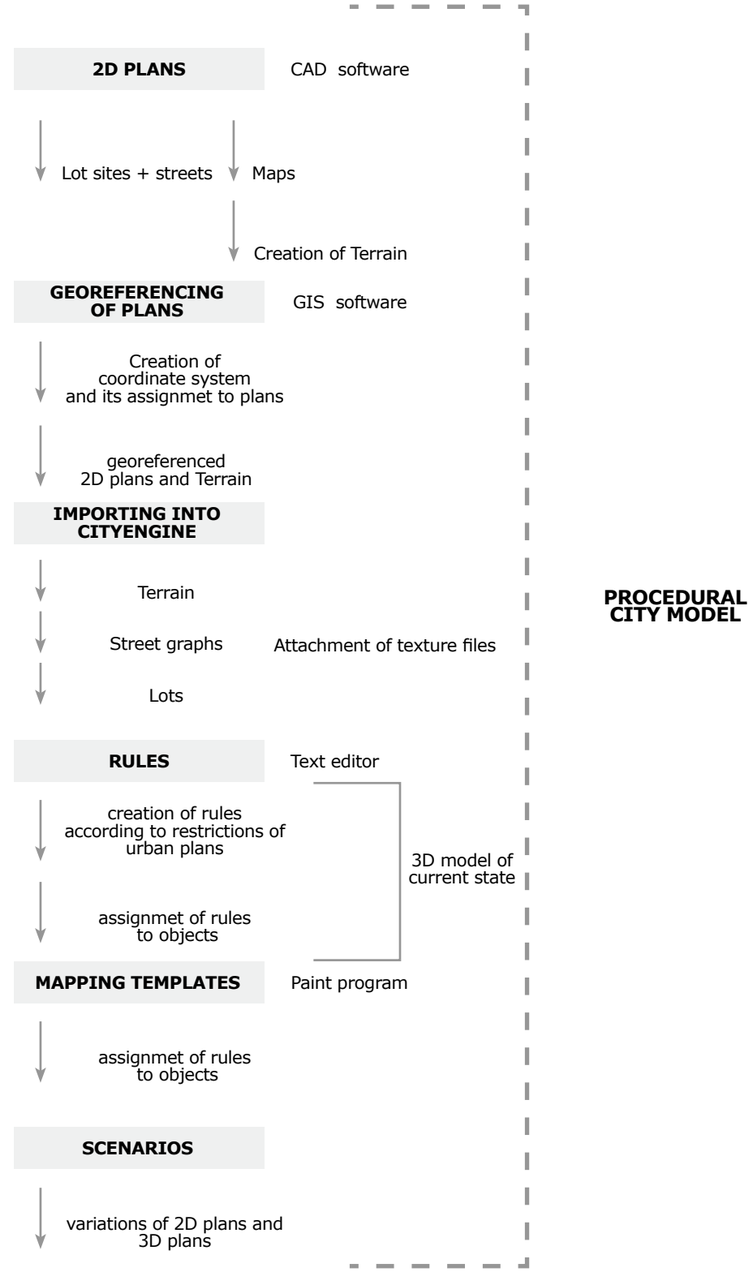
This part of the project explains the workflow before and inside of the *CityEngine*. It is going to be shown how to prepare and transform sketches and plans from conventional software in order use them in the *CityEngine*.

CityEngine is procedural modeling software based on shape grammars. Urban plans and 3D models can be generated on various ways. This system manages to combine geographical and statistical input and enables that a user controls it. Next to its application in the urban planning, it is also widely spread in the game and movie industry for imaginative environments.

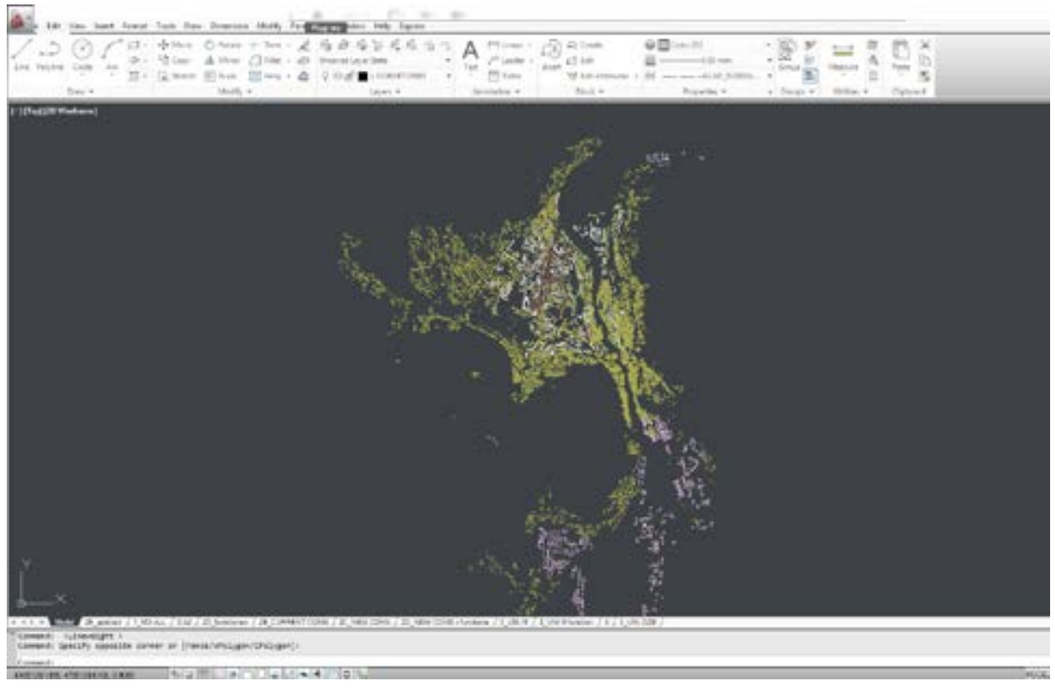
The main reason that *CityEngine* was chosen as the tool in this project is because it allows the automatized transformation of planning intentions into a three dimensional procedural city model. Once procedural model of the city is made it can be endlessness adapted and improved in order to be everyday tool for making decisions and encouraging participation of citizens in the city planning.

In this case is the procedural model of the city be used for reorganizing and linking the two universities through three proposed path by using the method of mapping.

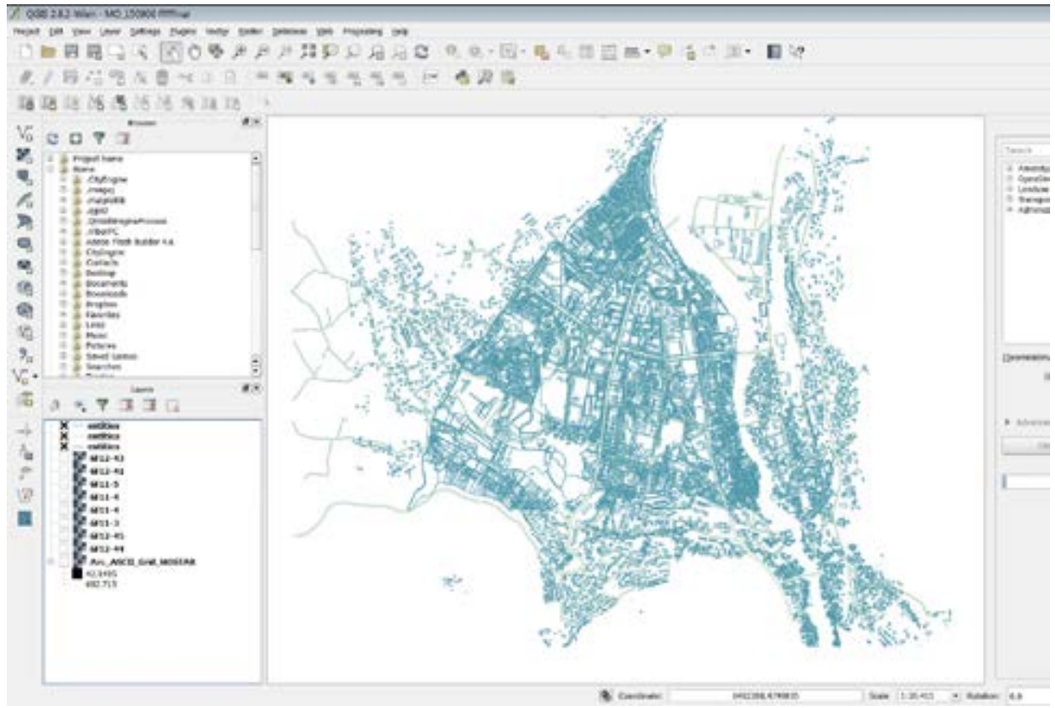
The special method of controlling the parameters through image maps, called mapping, is intuitive and the best method that could present potentials of the software to a beginner. The method of mapping is used as the main technique to show numerous scenarios of bridging the universities on the simplest way.



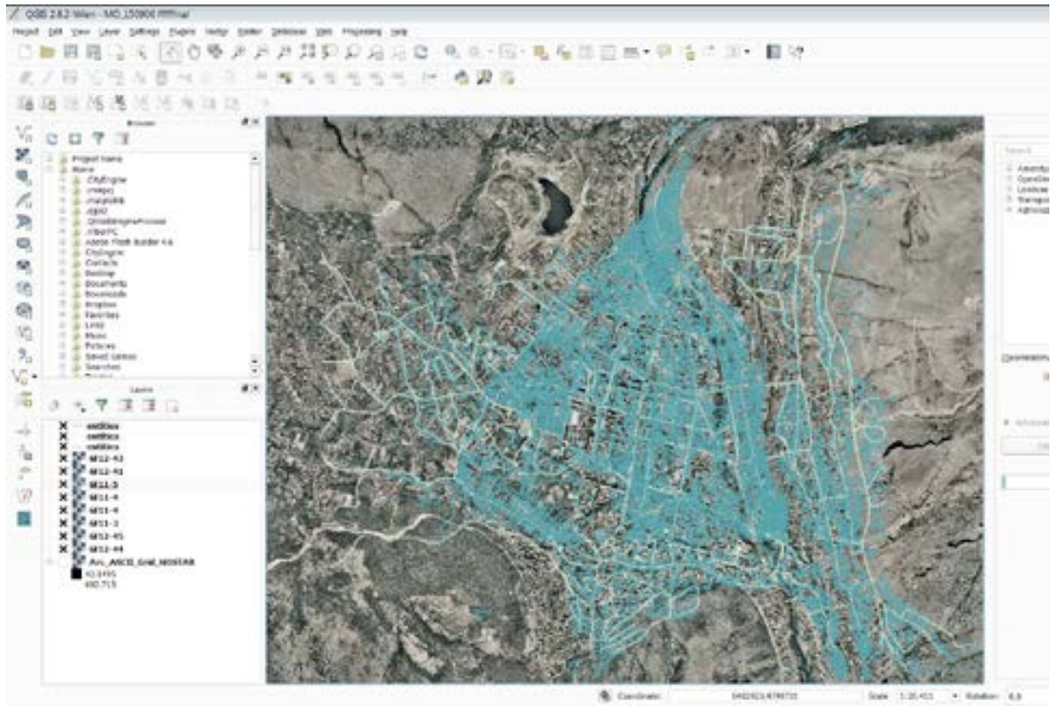
Screen shots of plan preparation and georeferencing



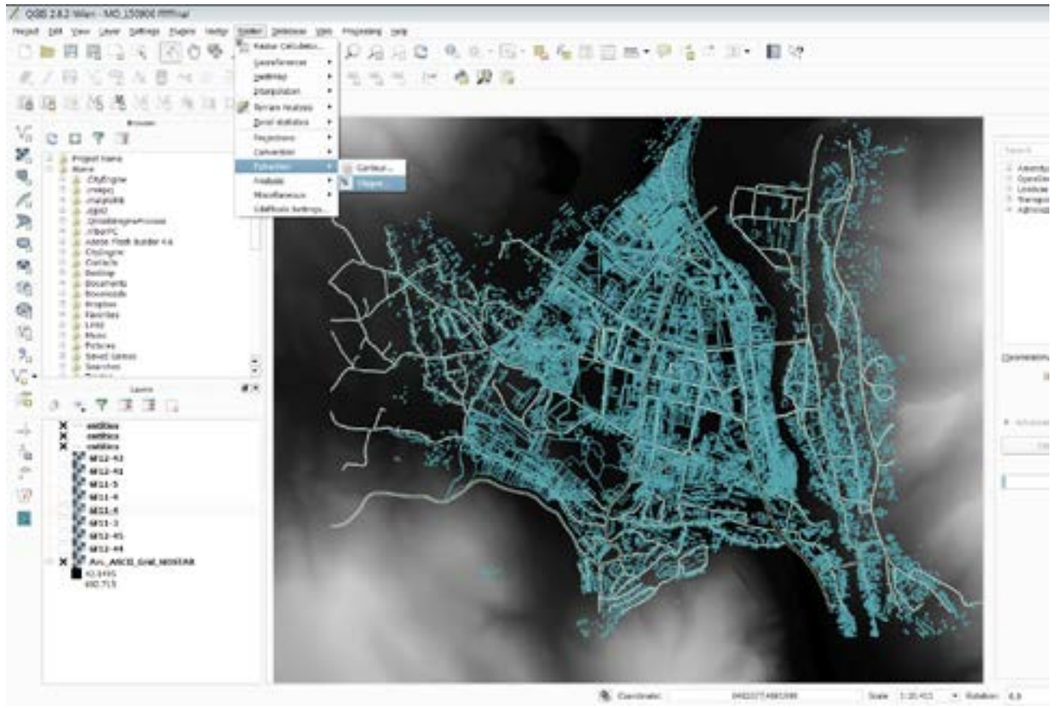
5.2 Lot sites preparation in CAD software



5.3 Georeferencing of plans in GIS software



5.4 Assigment of orthophoto in order to create texture for terrain (GIS software)

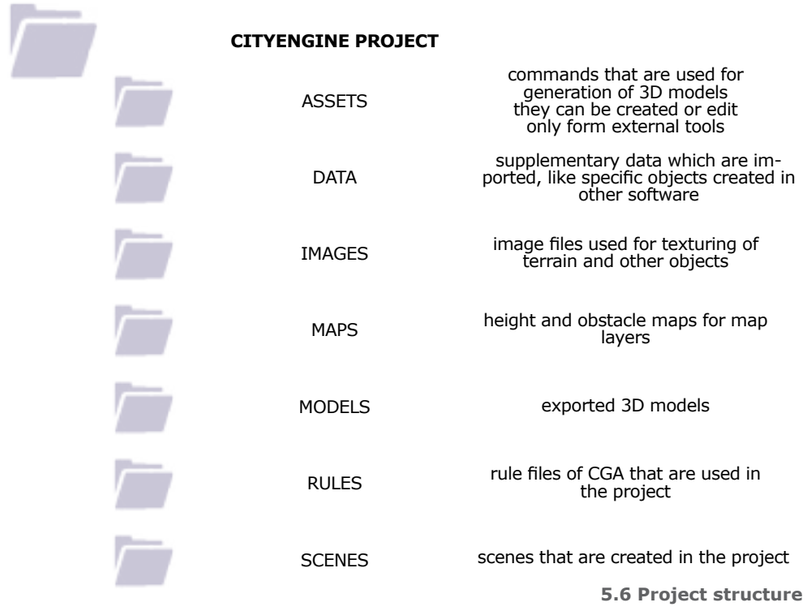


5.5 Clipping of terrain into cutout in order to use it in the *CityEngine*

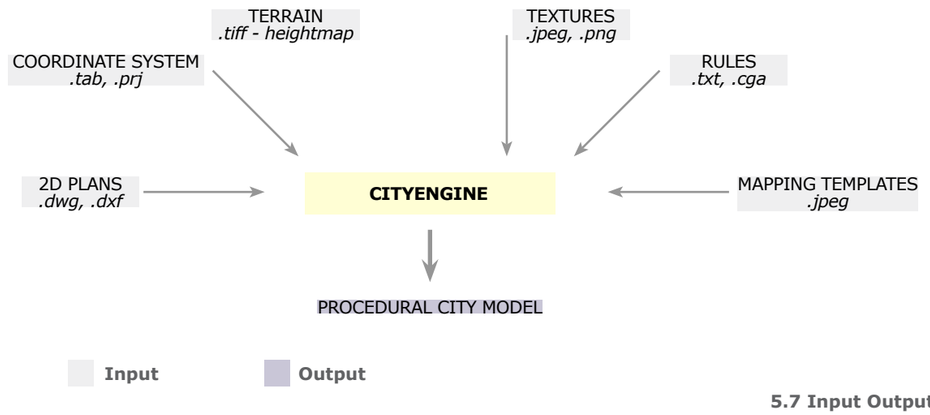
5.1.1 Data classifying

The *CityEngine* project consists of more folders that are structured to store similar file formats. The standard folders are *assets, data, images, maps, models, rules* and *scenes*. All files that are imported into the folders must have the same path in order to be opened.

CityEngine supports numerous input and output formats. The four main file formats that are imported in the projects are 2D plans in form of *.dxf,* the 3D of terrain as *.tiff* format with proper *.jpeg* texture and *.cga* rule files.



5.6 Project structure in *CityEngine*



5.7 Input Output data

5.1.2 Data preparation

Geo-referencing

Georeferencing is a process of assigning a plan to a specific geographic location. In other words, it is scaling and particular positioning of data inside of the world space. The georeferenced data in a digital world coordinate system have the same coordinates as they have in physical space.

There are two possibilities of allocating the data, either in CAD software or in GIS software. Both of them have already predefined coordinate systems referring to specific locations in the world. By choosing a coordinate system, an additional file is produced and saved in the same folder as data. It is important that *.dxf* files are in the same folder as *.pjr* file or other format that specifies coordinate system of the data.

In some cases the data cannot be specified through offered systems and a new system has to be created, like in the case of Mostar. A specific coordinate system with description *mgi/Balkans zone6* has been created in the GIS software. The data about the world geographic and projected bounds was taken from *Spatialreference* organization. *[spatialreference]*

Terrain preparation

The first file that should be imported in *CityEngine* is the terrain file. For appropriate process there are two steps to be done before it. Firstly, GIS software enables the conversion of *.asc* 3D model into the .tiff file with preserving its features. The heightmap file is *.tiff* format, which stores data about the terrain based on the photo brightness. The size of the photo should not exceed 4000x4000 pixels per image. Additional format is .jpeg of the terrain texture, which has to have the same size as *.tiff*. Secondly, the *.asc* file has to be analyzed in suitable software to read out the exact minimum and maximum elevation of the terrain and the size of a pixel in a metric unit. In this case is the software for equalization and evaluation of terrain file used to get the data.

Only now can the import be done adequately. After defining the coordinate system in the settings, the georeferenced terrain is positioned in the *CityEngine* and stored as a layer in the folder maps.

Plan preparation

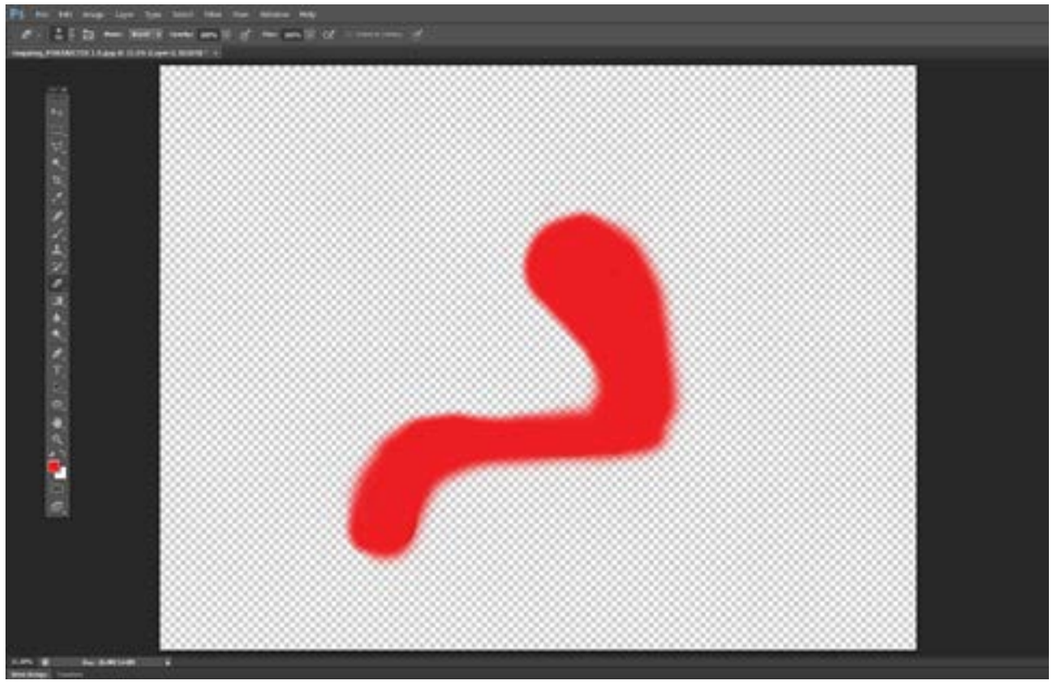
The first step of plan preparation is in one of the CAD software and it focuses on two dimensional drawings. The drawings, in this case, consist of buildings with diverse land use types, road infrastructure and open spaces. Buildings and open spaces are lots and should be drawn as closed polylines, which can be checked afterwards in properties window and changed if needed. Only as closed polylines they can be used as a start polygon for extrusion in *CityEngine*. There should not be any three dimensional lines, which can be quickly checked through flattening commands in the used software.

Road infrastructure is drawn in axis and grouped by traffic frequency into layers. They should also be drawn as polylines so they could form the exact street network. There is also possibility to import them from *OpenStreetMap* directly to the *CityEngine* and purge them to use them as a layer.

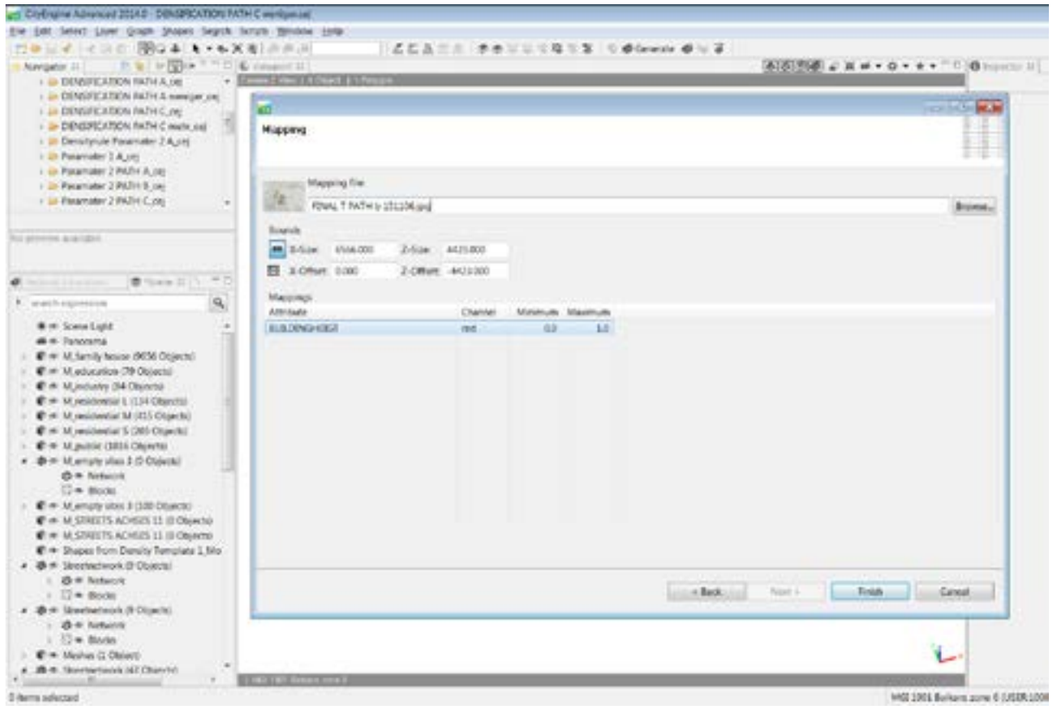
The road infrastructure and land lots are imported as *.dxf* files separately.

Control of their settings is better, and attachment of the rule files easier, if they are already structured in the CAD software into layers. Import windows offer a possibility to clean up the graph and position it to the same coordinates as the terrain. The lots and streets should than be aligned to the terrain in order to start their further generating.

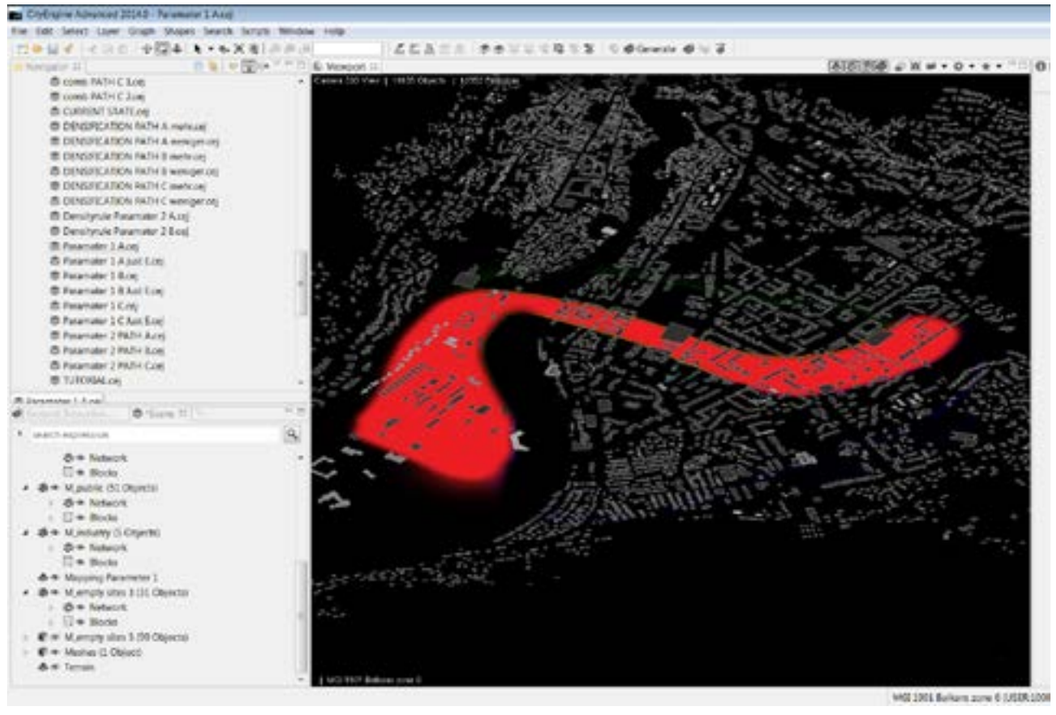
Screen shots of preparation of mapping templates and mapping in CityEngine



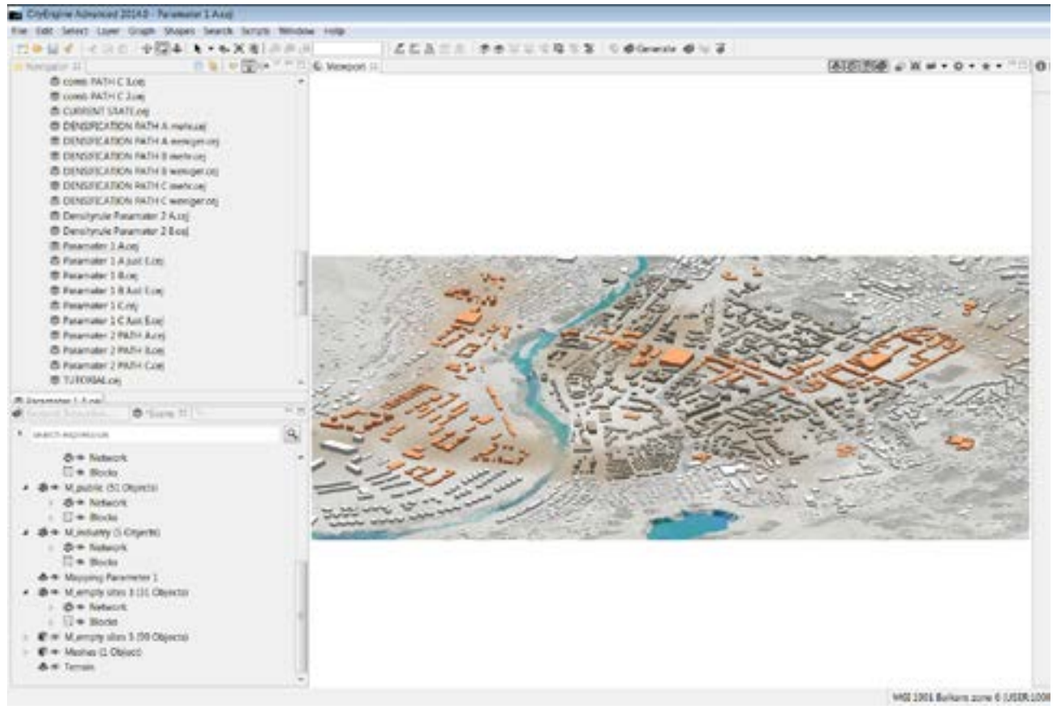
5.8 Preparation of mapping template in any *paint* software



5.9 Importing of mapping template into CityEngine and adding attributes



5.10 Assigment of mapping template to the rule files in CityEngine



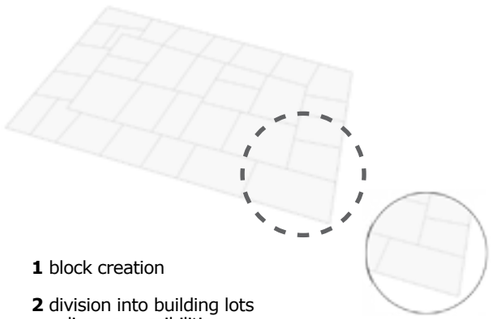
5.11 Variation of 3D model as a result of mapping concept

Rule files preparation

After importing all of necessary data, the scripting of rule files can start. The rule files can be either written in any code editor, or written directly in the *CityEngine's* user interface. The connecting of the rule files and 2D drawing is the main part of the procedural workflow. After the attaching of the rule file to certain drawing the output are 3D objects with their attributes. The attributes are the diverse characteristics of the objects which can be easily controled through user interface.

In this short tutorial is going to be explained how simple it is to change planning parameters and intentions to test different variations of urban design.

5.12 Overview of the rules creation

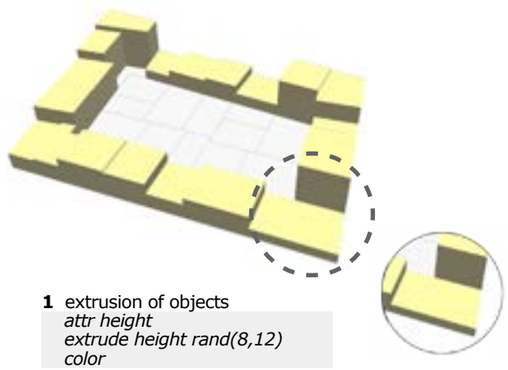


1 block creation

2 division into building lots
- diverse possibilities
- defintion of minimum and maximum area of the lot

first 2 steps through user interface

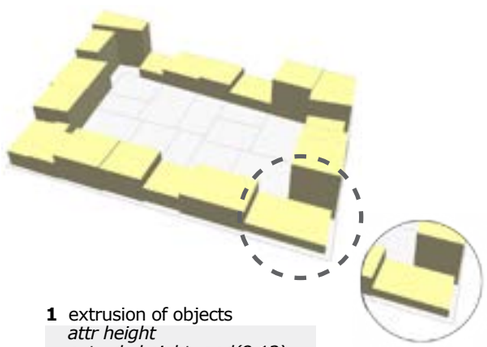
3 scripting of the own *.cga* rules
creation of own rules in text editor



1 extrusion of objects
attr height
extrude height rand(8,12)
color

2 defining of the distance to the street
attr streetdistance 0

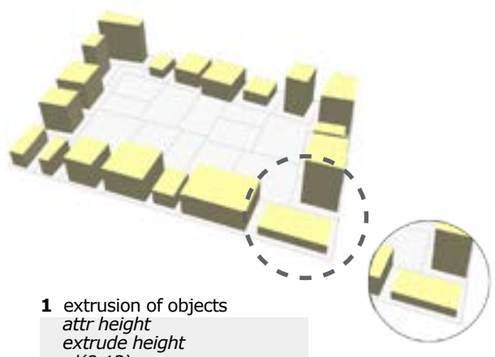
3 defining of the distance between objects
attr streetdistance 0



1 extrusion of objects
attr height
extrude height rand(8,12)
color

2 defining of the distance to the street
attr streetdistance rand (2,4)

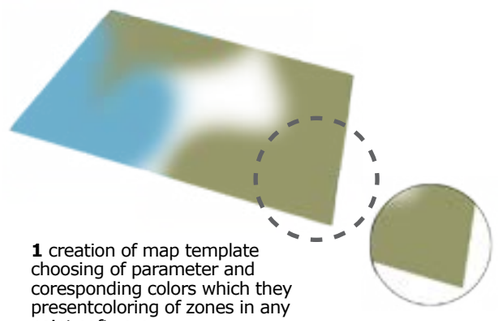
3 defining of the distance between objects
attr streetdistance 0



1 extrusion of objects
attr height
extrude height rand(8,12)
color

2 defining of the distance to the street
attr streetdistance rand (2,4)

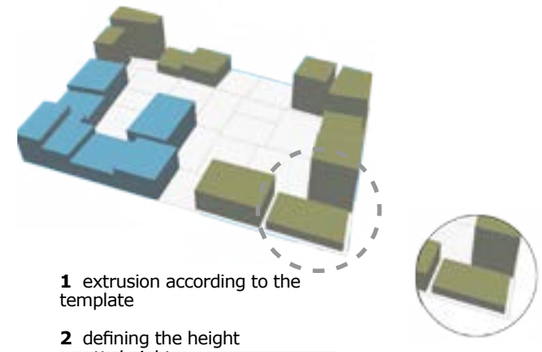
3 defining of the distance between objects
attr streetdistance rand (4,8)



1 creation of map template
choosing of parameter and coresponding colors which they presentcoloring of zones in any paint software

2 creation of map layer
importing of .jpeg with same size as the scope area

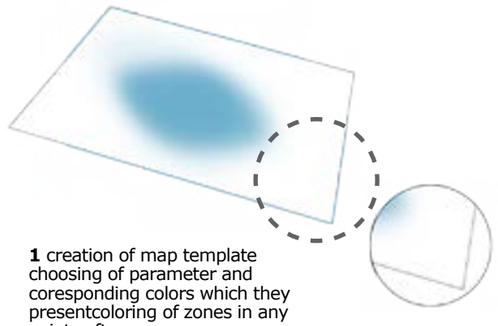
3 adding of 2 attributes which are mapped through colors, defining their min and max



1 extrusion according to the template

2 defining the height
attr height
Footrprint ->
extrude height rand(12,15)

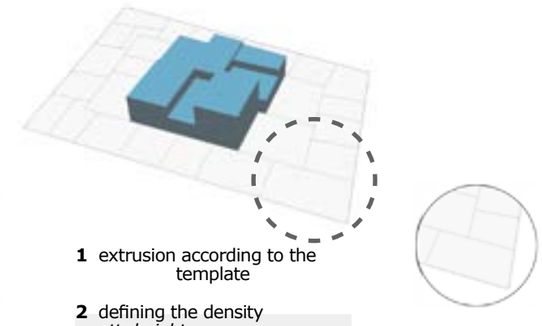
3 defining the land use
lot 1 -> land use 1()
color (#6cafcc)
lot 2 -> land use 2()
color (#96986a)



1 creation of map template
choosing of parameter and coresponding colors which they presentcoloring of zones in any paint software

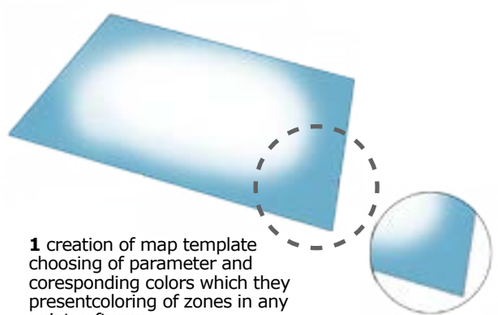
2 creation of map layer
importing of .jpeg with same size as the scope area

3 adding of 1 attribute which are mapped through color, defining its min and max



1 extrusion according to the template

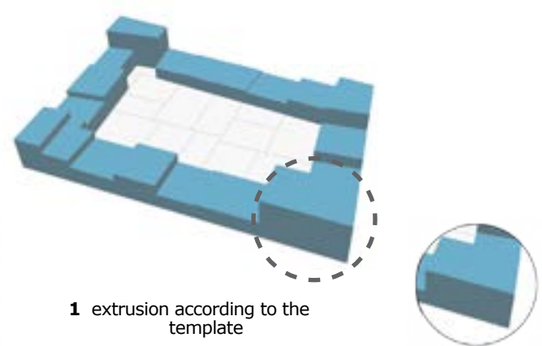
2 defining the density
attr height
Footrprint ->
extrude height rand(10,12)
color (#6cafcc)



1 creation of map template
choosing of parameter and coresponding colors which they presentcoloring of zones in any paint software

2 creation of map layer
importing of .jpeg with same size as the scope area

3 adding of 1 attribute which are mapped through color, defining its min and max



1 extrusion according to the template

2 defining the density
attr height
Footrprint ->
extrude height rand(10,12)
color (#6cafcc)

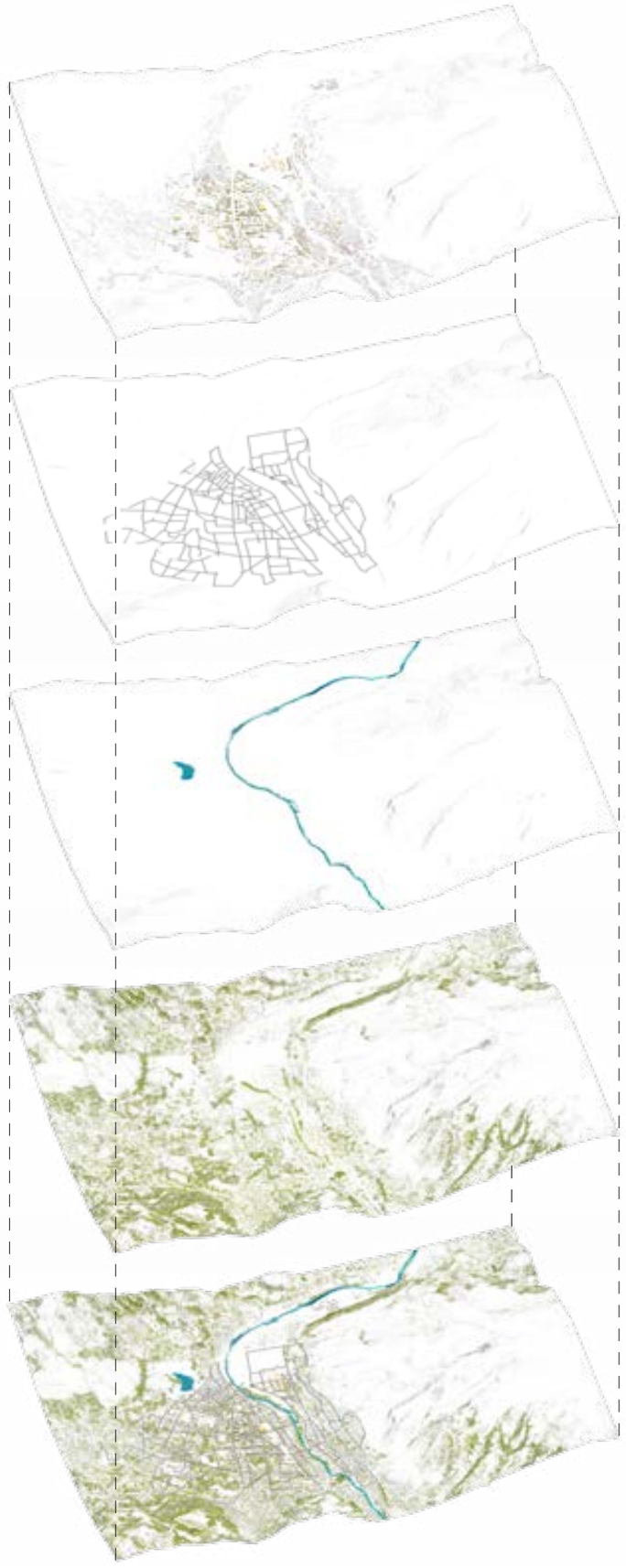
5.1.3 3D Model of Mostar

The procedural city model enables creating of diverse 2D and 3D visualizations. Once 3D model of existing buildings and infrastructure is made, it can be changed through numerous approaches and concepts. In the first steps was model of Mostar used to present the structures of the city and set relations of them. While in the second one were the divers scenarios tested in order to get proposals for university environment.

5.13 Aerial view from the north

5.14 Aerial view from the south

5.1.4 Axonometry of Mostar



housing

10%

street infrastructure

2%

water space

8%

green space

37%

research area

13,5km²

5.2 Concept of mapping

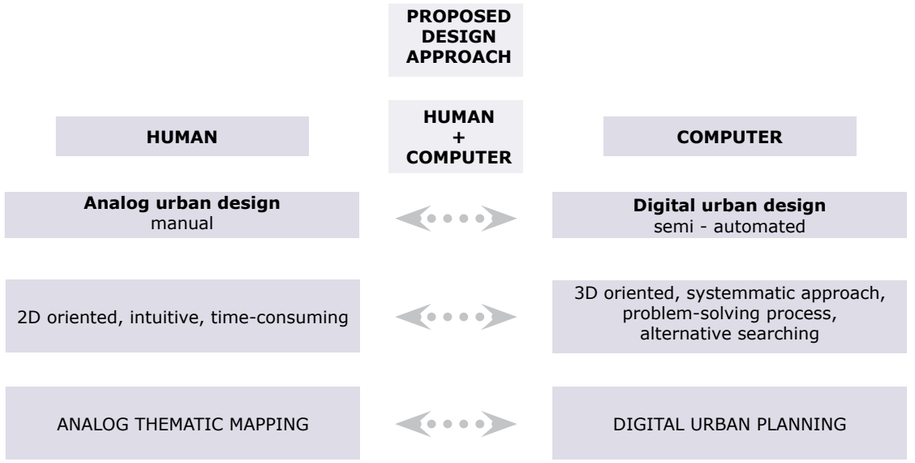
Thematic maps were made in the first part of the project in order to collect data and map the movement of students, most used public spaces and places that could be renovated. The main result of the first part are three paths, one current and two proposed ones. They connect the two universities and locations which could become a part of university campus in Mostar.

In the second part was the procedural model of the city made in order to test possibilities of reorganizing the university environment. The selected paths were than used as starting point for getting the mapping templates which can be processed in the *CityEngine.*

City models consist of a large number of objects and to control them manually by assigning attributes to them would take too long. That is the reason why mapping method is selected to generate 2D thematic maps into the 3D model.

The method of mapping uses different channels in order to map certain values and transform them into objects. This function analyses the values coming from the maps and returns objects accordingly. In this project are the brightness and RGB channels used for processing data from thematic maps into procedural city model.

The chosen parameters for the simulation of the university environment were land use, density and building height. In the last part were parameters combined in order to get more complex model.
[arcgis]

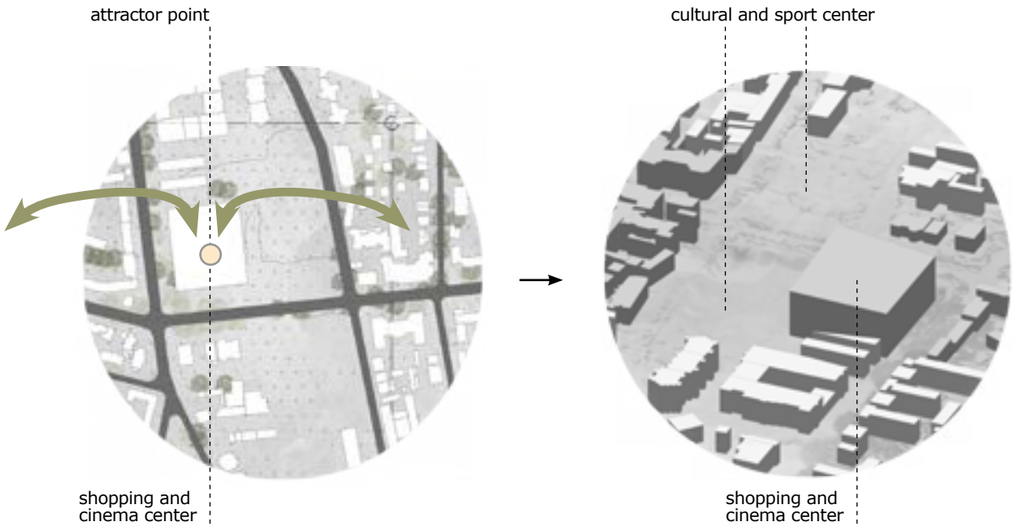


5.15 Schema of approach to problem of *Divided Cities* through digital methods

variations of planning scenarios

The results of simulation in the *CityEngine* are the proposed scenarios of relinking the two universities in Mostar. Furthermore, the shaping of university environment was made through using three parameters; land use, building height, density and their combinations based on three selected paths from thematic mapping.

The point of comparison of all scenarios is the shopping and cinema center because it is one of the rare attraction points for the citizens from both sides. In the surrounding are two empty lots where are cultural and sport center being planned. This point could be one of main squares in the *new age Mostar.*



Existing land use

The existing land use in the city of Mostar is mostly residential, especially in the city center. There are just few buildings which belong to commercial and office land use. The forth land use that is frequent in the researched area is educational. However, certain number of building lots is either empty or objects on them are in a bad condition. The testing of this parameter aims to show scenarios how could the city adapt its land use in order to adopt the idea of a unified university campus.

6.1 Parameter - land use

The first simulation was made with the land use and the way it could affect the areas in the surrounding of the paths. The idea was to assign the objects, which are next to the paths, either partially or totally to the university campus. They would change their land use into educational through the assigment of the mapping rule. The red channel was used in the first stage as the main value for attribute of land use and in the next stage were both red and green for two different land uses.

The first step was to color the templates according to the thematic map. Afterwards was each color of the paths transformed into red and in the second stage was grey transformed into green.
Through importing of the *jpeg* with red channel is the red color becoming attribute in the form of land use - education. The attribute of educational land use is being attachted to the objects which are in the red zone and the attribute of commercial land use are attachted to the objects in the grey area.

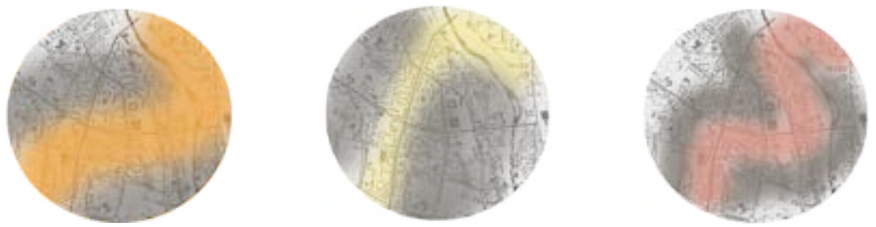
colors that were used for paths in the thematic mapping step 1

coloring of the area affected by the path step 2

land use > mostly educational + residential & office

land use > commercial - mostly office + residential

land use > residential



colors that have to be **input** for *Cityengine - tool* step 3

transformation of colors

6.2 Example of mapping

6.1 Parameter - land use - path A

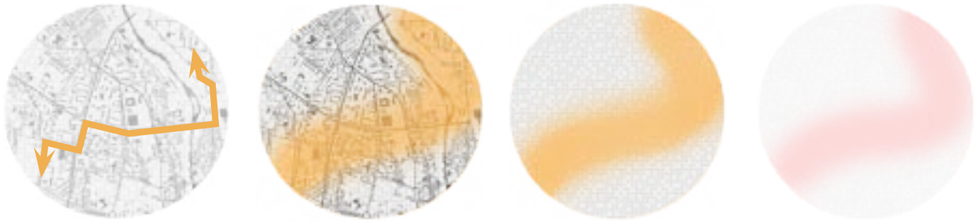
Land use showed through one attribute - educational land use

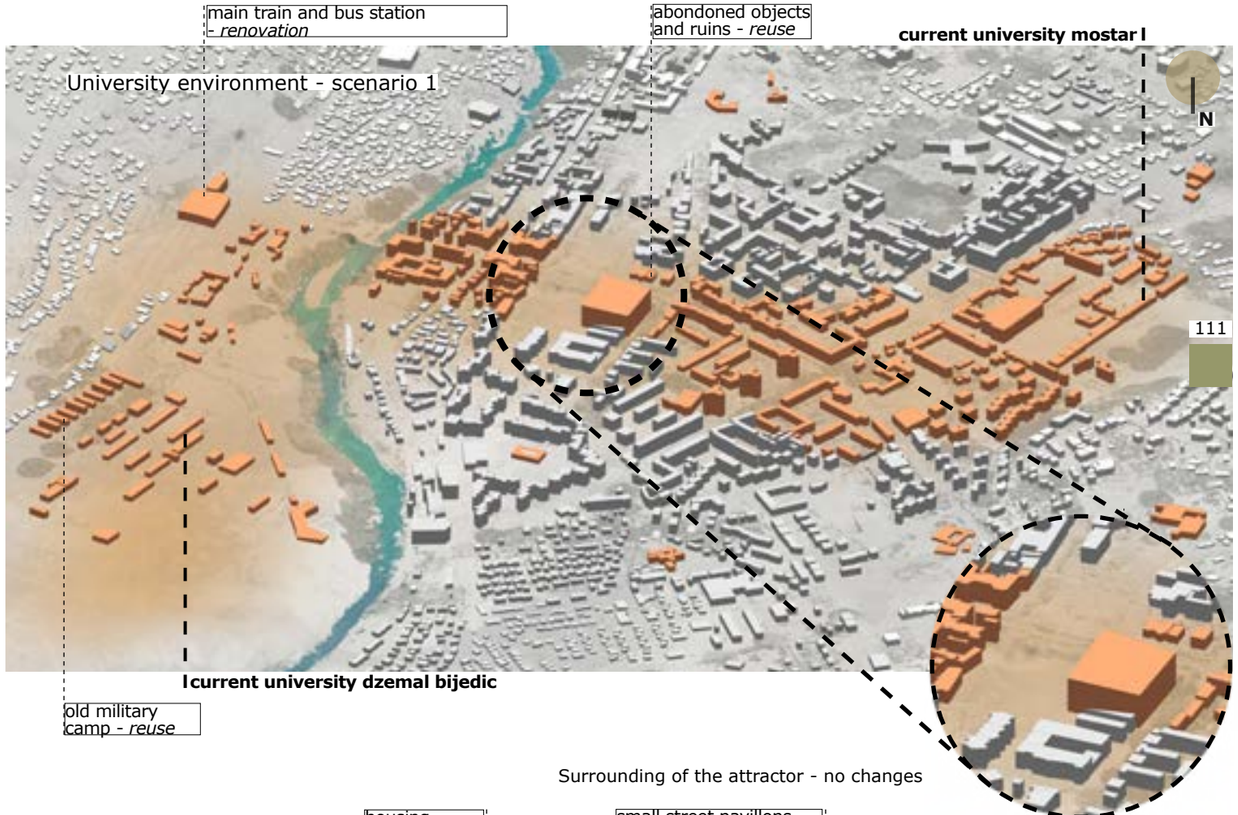
zone 1
based on the current **connection** between universities colored zone consits of univercities and objects that could either totally or partially be used as university facilities

zone 2
existing land uses

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template





Land use showed through two attributes - educational and commercial land use

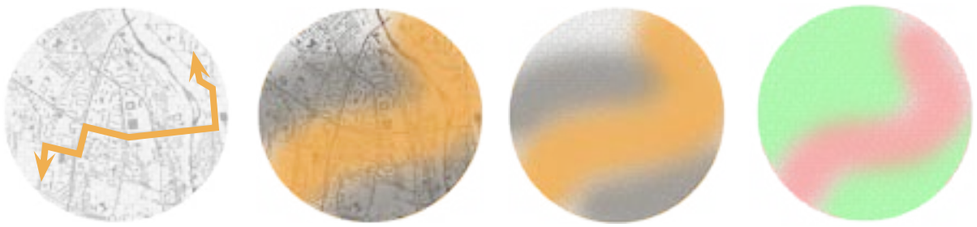
zone 1
based on the current **connection** between universities colored zone consits of univercities and objects that could either totally or partially be used as university facilities

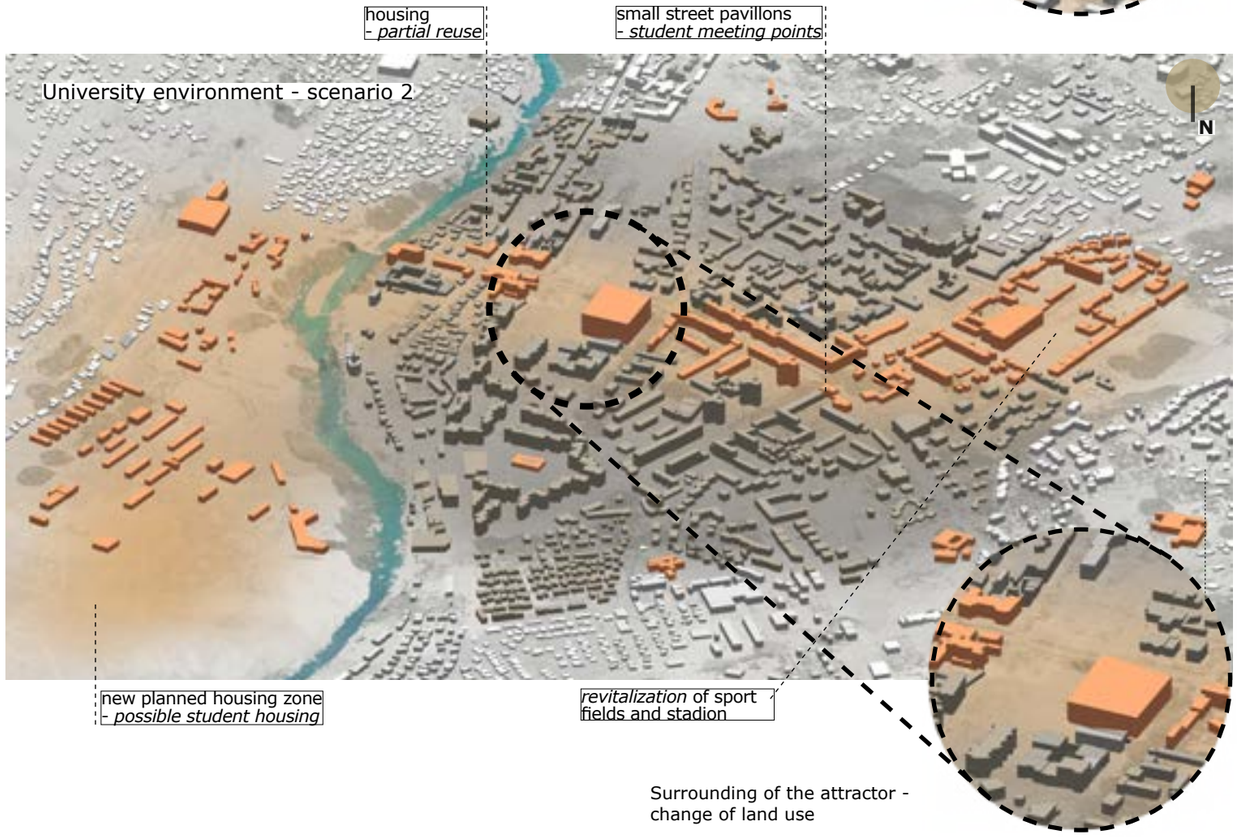
zone 2
existing land uses

zone 3
could either totally or partially be used as commercial zone, offices + residential areas in some parts

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template





6.1 Parametr - land use - path B

Land use showed through one attribute - educational land use

zone 1
based on the proposed **connection** between universities
colored zone consits of univercities and objects that could either
totally or partially be used as university facilities

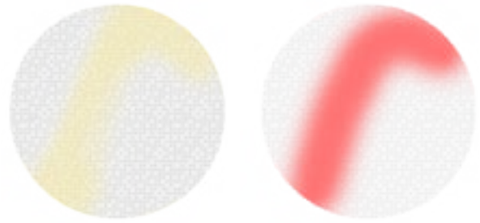
zone 2
existing land uses

Steps between thematic map and procedural city model

1 - thematic map

2 - coloring of the area affected by the path

3 - transformation into template



Surrounding of the attractor - no changes

Land use showed through two attributes - educational and commercial land use

zone 1
based on the proposed **connection** between universities
colored zone consits of univercities and objects that could either
totally or partially be used as university facilities

zone 2
existing land uses

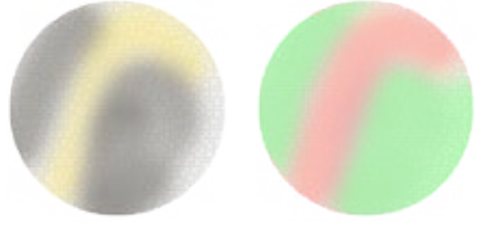
zone 3
could either totally or partially be used as commercial zone,
offices + residential areas in some parts

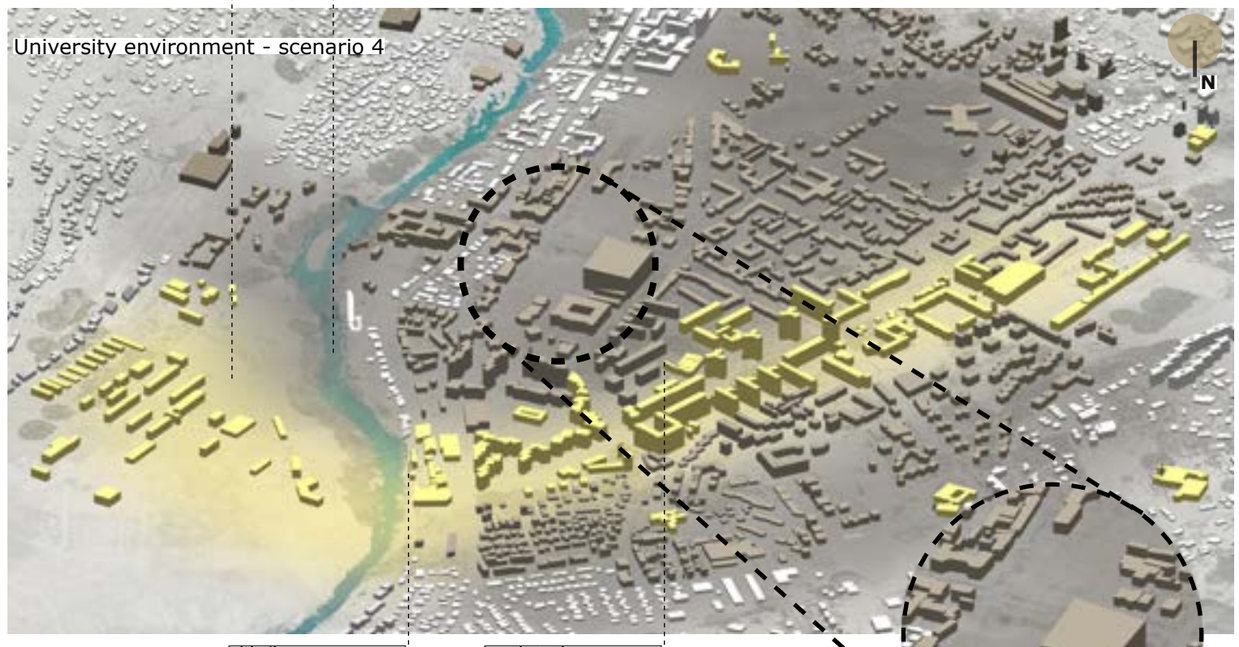
Steps between thematic map and procedural city model

1 - thematic map

2 - coloring of the area affected by the path

3 - transformation into template





Surrounding of the attractor -
change of land use

6.1 Parametr - land use - path C

Land use showed through one attribute - educational land use

zone 1
based on the proposed **connection** between universities
colored zone consits of univercities and objects that could either
totally or partially be used as university facilities

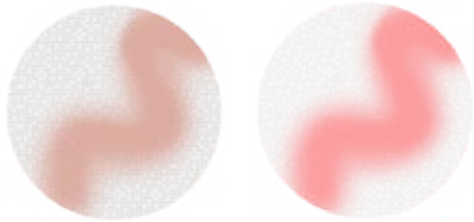
zone 2
existing land uses

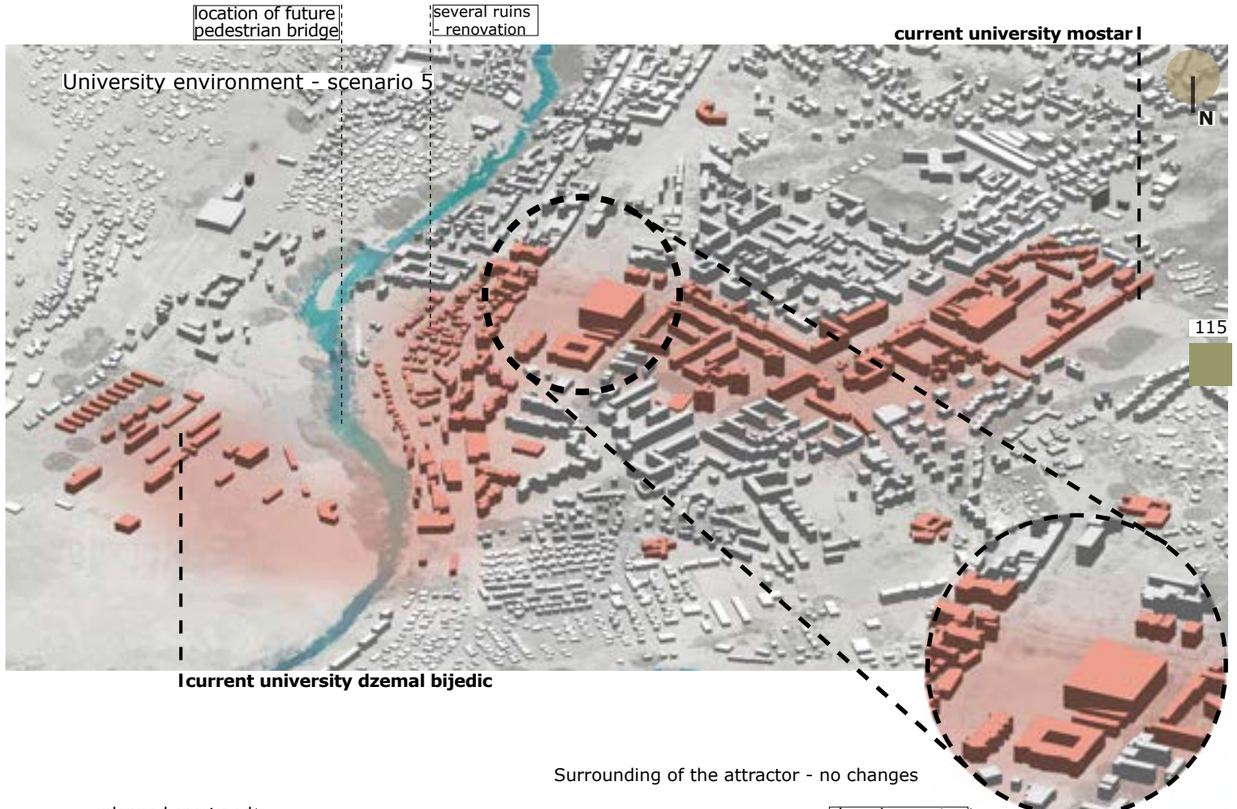
Steps between thematic map and procedural city model

1 - thematic map

2 - coloring of the area affected by the path

3 - transformation into template





Land use showed through two attributes - educational and commercial land use

zone 1
based on the proposed **connection** between universities
colored zone consits of univercities and objects that could either
totally or partially be used as university facilities

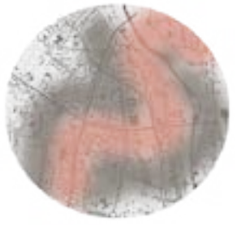
zone 2
existing land uses

zone 3
could either totally or partially be used as commercial zone,
offices + residential areas in some parts

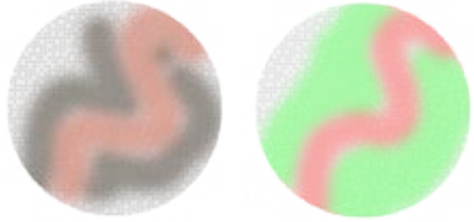
Steps between thematic map and procedural city model

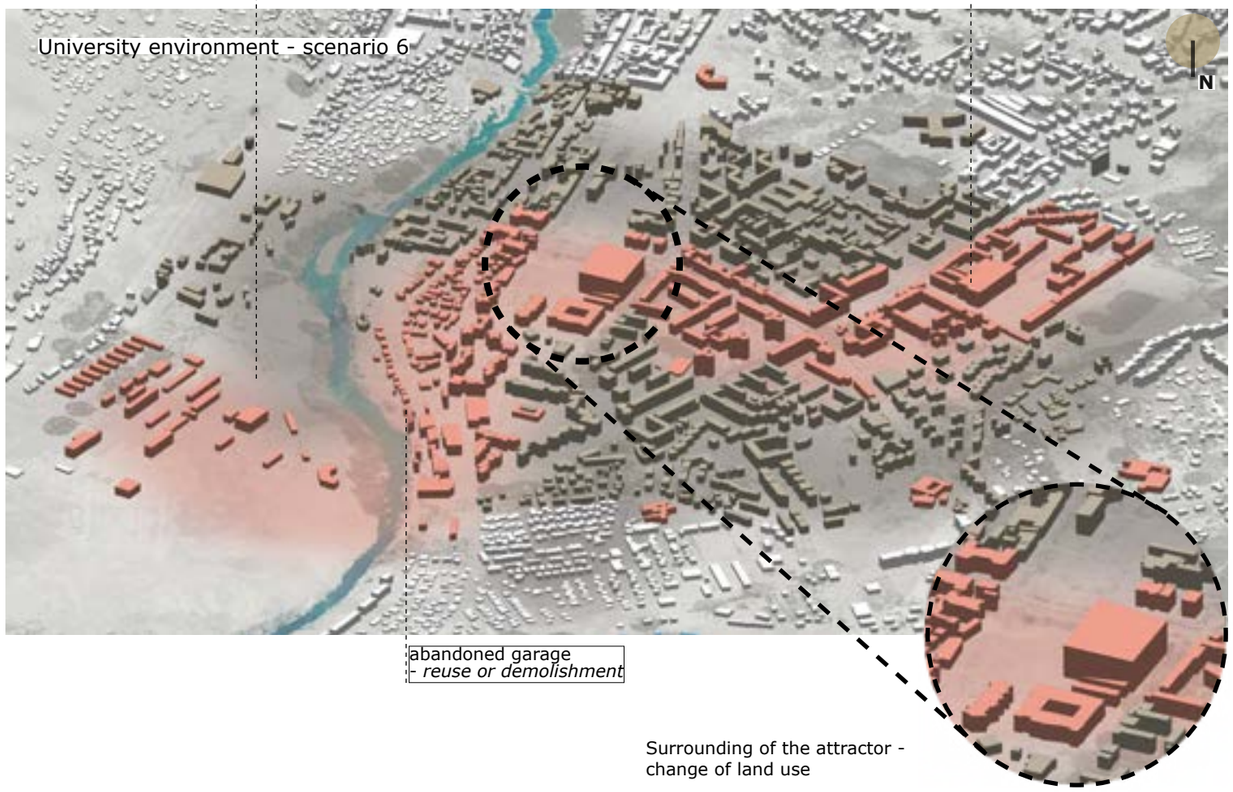
1 - thematic map

2 - coloring of the area affected by the path



3 - transformation into template





Existing density

The existing density in the city of Mostar is very low. Mostar has the lowest density among both other divided cities and student cities. There are few master plans for densification of the city through residential projects in undeveloped areas. However, the surrounding of developed area also allows densification through other land uses. The testing of this parameter aims to show scenarios how could the city be densified through adding university facilities.

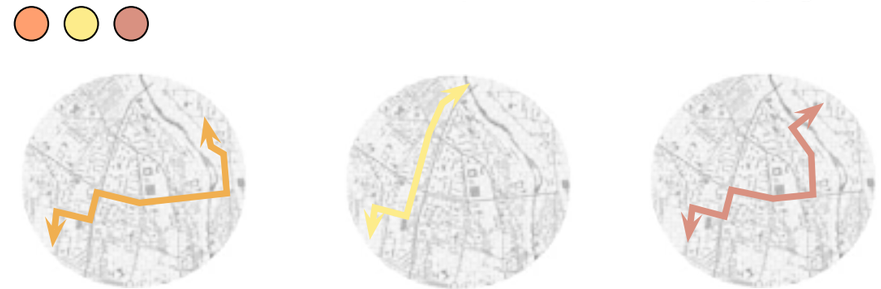
6.2 Parameter - density

The second simulation was made with the building density in the surrounding of the paths. There are a lot of empty lot sites and ruins which could be reused and assigned either to the university campus or used for other purpose. The idea was to test how could city structure in these area look like if the density changes.

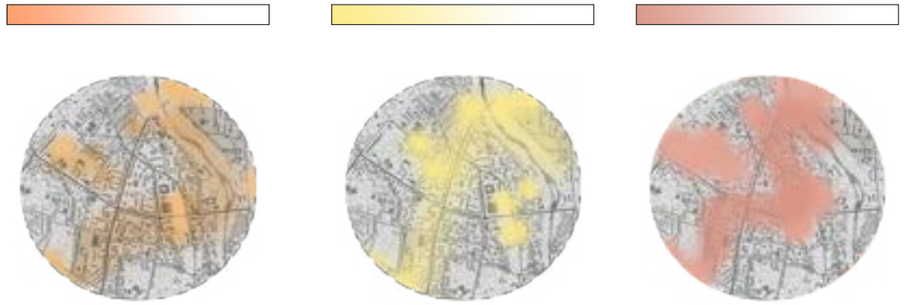
The first step was to color the templates according to the thematic map through using one color and its brightness. The most darkest zones were suppoused to be most dense and the brightest less dense. Afterwards were templates switched to grayscale modus in order to import them into the software.

Through importing of the *jpeg* with certain density pattern are the values of brightness being remapped to the attributes of density.

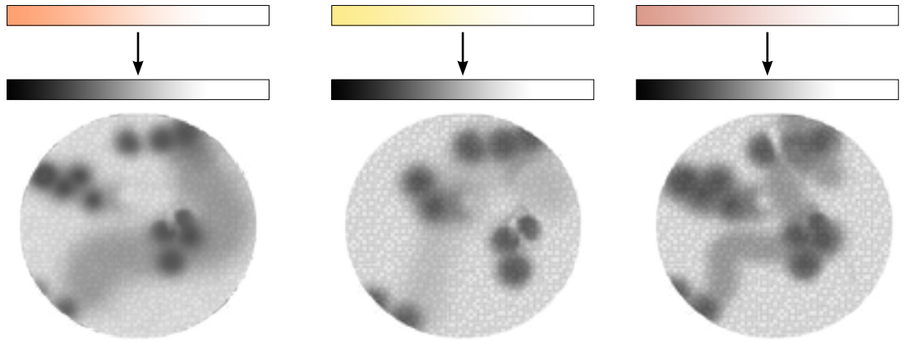
colors that were used for paths in the thematic mapping



coloring of the area affected by the path



brightness map that has to be **input** for *Cityengine - tool*



6.2 Parameter - density - path A

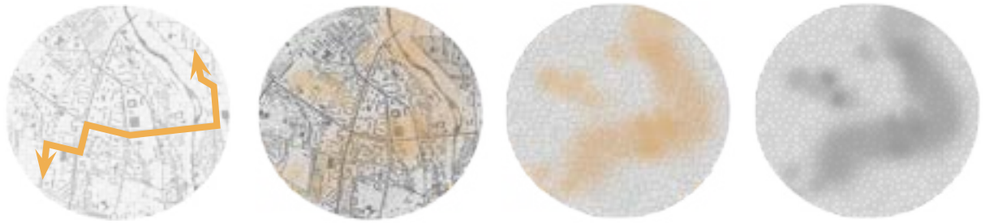
low density showed through mapping the brightness into attribute

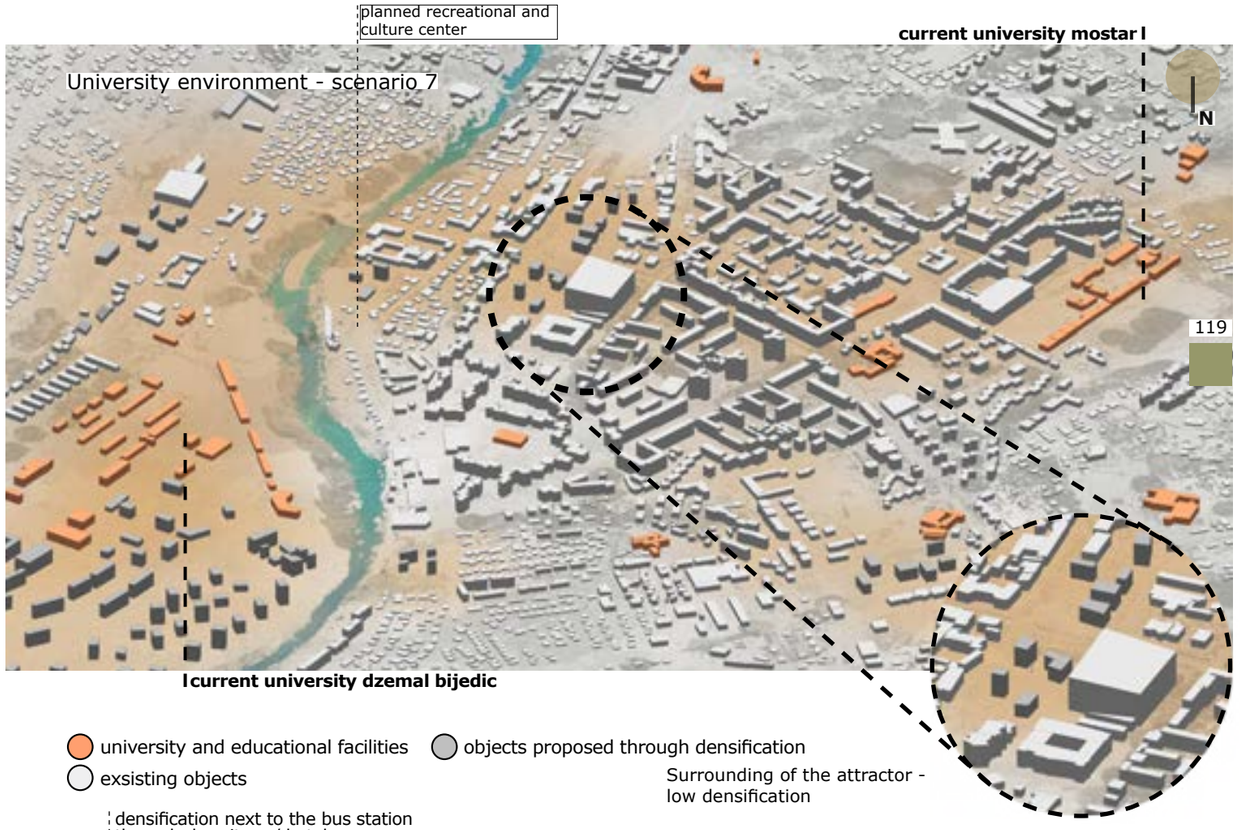
zone 1
proposal of low densification for undeveloped land in the surrounding of the path A

zone 2
existing density

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template





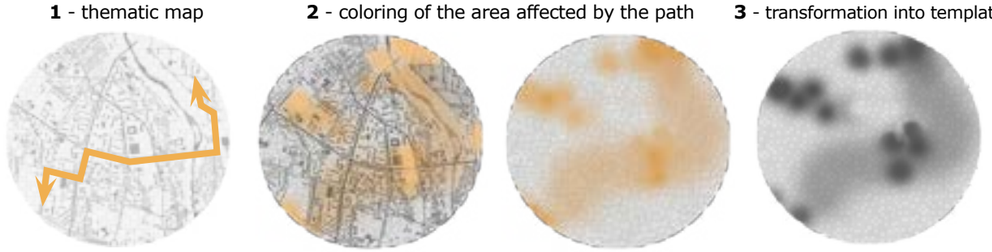
high density showed through mapping the brightness into attribute

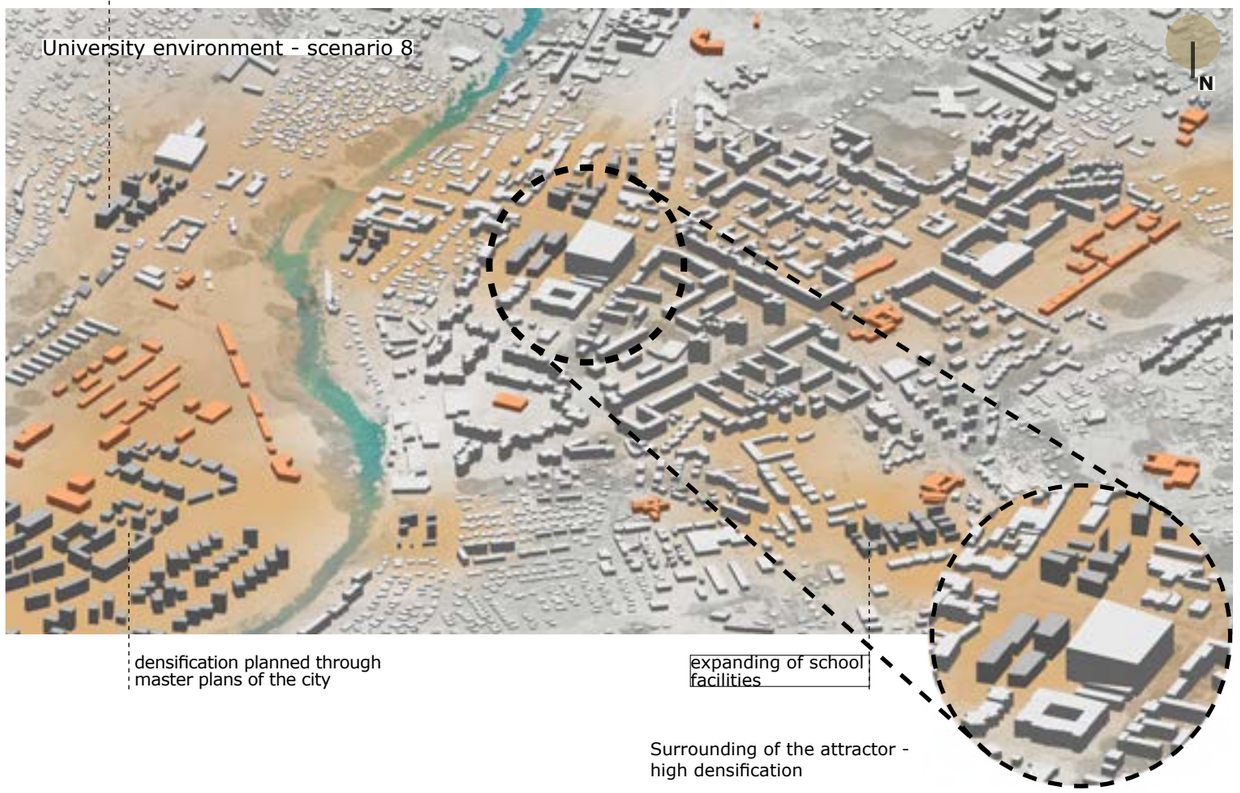
zone 1
proposal of high densification for undeveloped land in the surrounding of the path A

zone 2
existing density

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template





6.2 Parameter - density - path B

low density showed through mapping the brightness into attribute

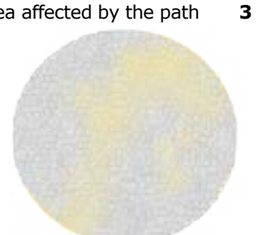
zone 1
proposal of low densification for undeveloped land in the surrounding of the path B

zone 2
existing density

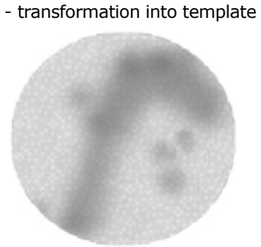
Steps between thematic map and procedural city model

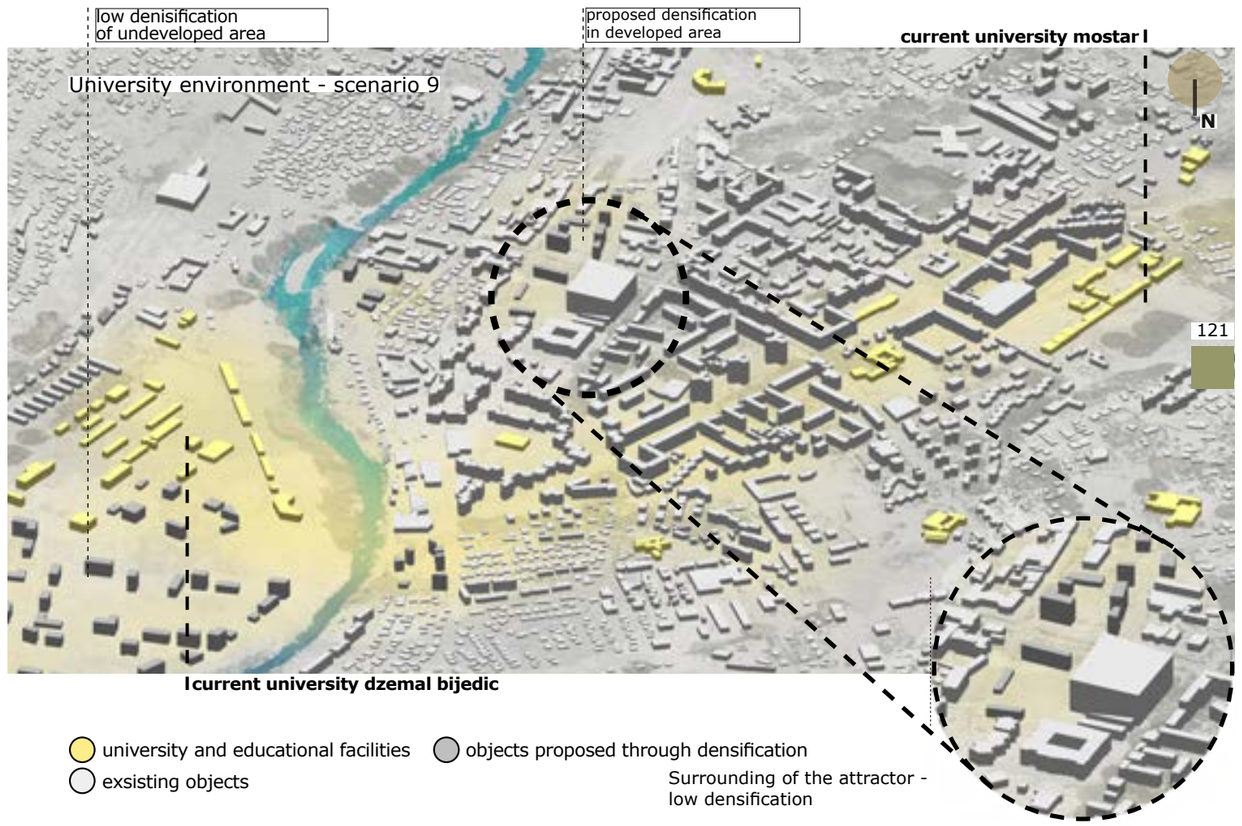
1 - thematic map

2 - coloring of the area affected by the path



3 - transformation into template





high density showed through mapping the brightness into attribute

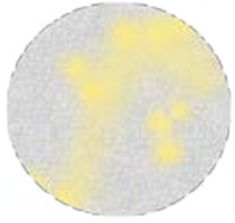
zone 1
proposal of high densification for undeveloped land in the surrounding of the path B

zone 2
existing density

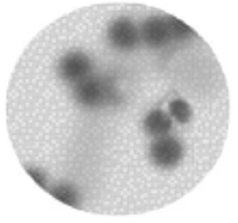
Steps between thematic map and procedural city model

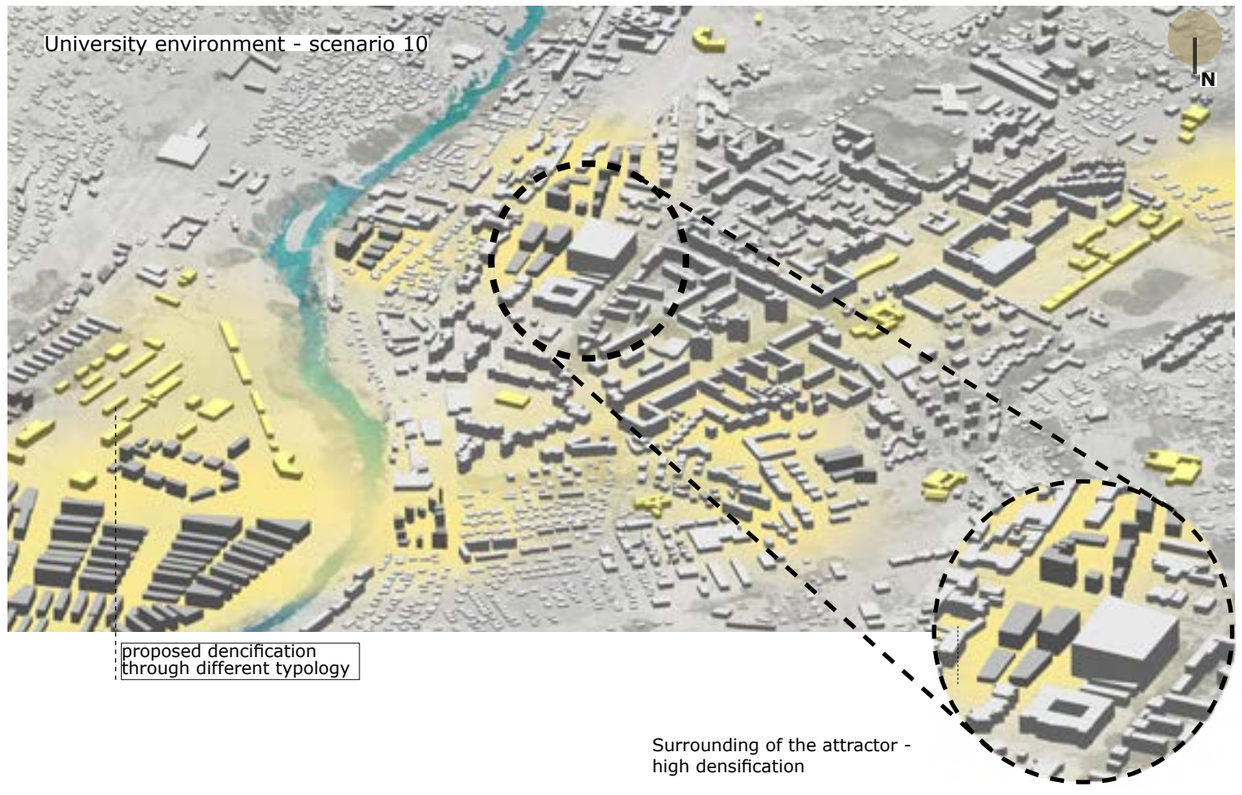
1 - thematic map

2 - coloring of the area affected by the path



3 - transformation into template





6.2 Parameter - density - path C

low density showed through mapping the brightness into attribute

zone 1
proposal of low densification for undeveloped land in the surrounding of the path C

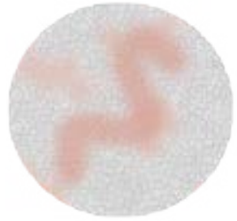
zone 2
existing density

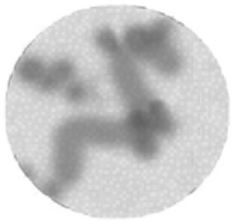
Steps between thematic map and procedural city model

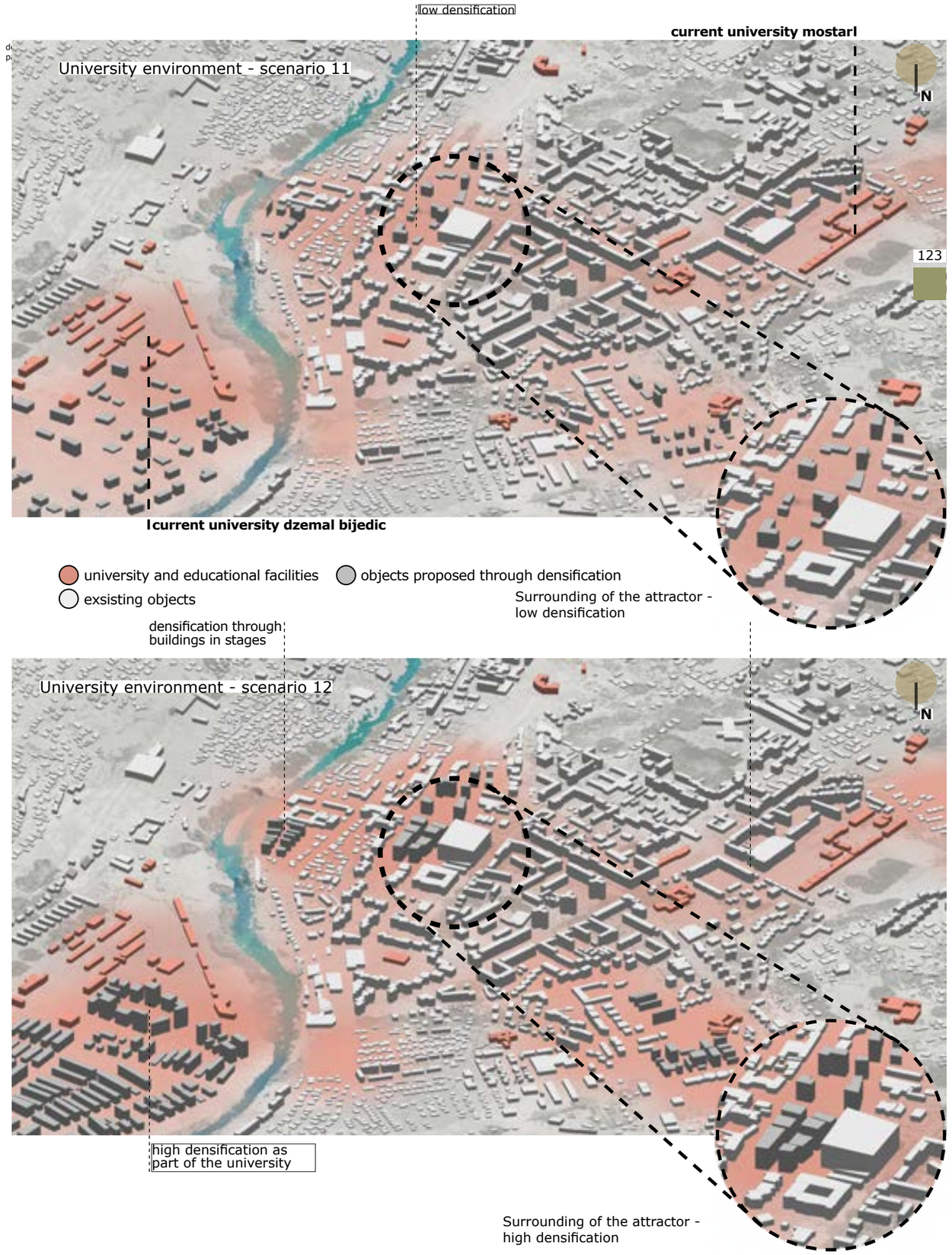
1 - thematic map

2 - coloring of the area affected by the path

3 - transformation into template







high density showed through mapping the brightness into attribute

zone 1
proposal of high densification for undeveloped land in the surrounding of the path C

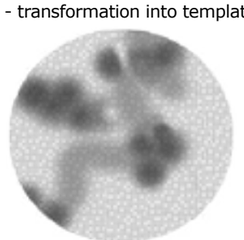
zone 2
existing density

Steps between thematic map and procedural city model

1 - thematic map

2 - coloring of the area affected by the path

3 - transformation into template



Existing building height

The existing building height in the city of Mostar is very low. The average building height in the city is approximately around 25 meters. The testing of this parameter aims to show scenarios of changing the building height in order to get different building topography and change the city skyline.

6.3 Parameter - building height

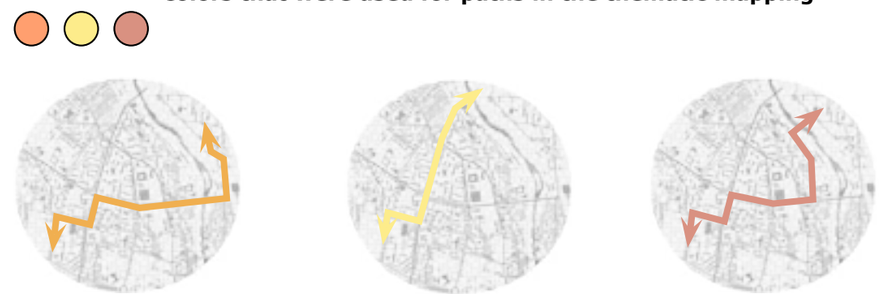
The third simulation was made with the building height in the surrounding of the paths. The empty lot sites and ruins in the surrounding of the paths were again used to test how could city structure in these area look like if the building height changes.

The first step was, like in the previous simulation; to color the templates according to the thematic map through using one color and its brightness. The most darkest zones were supposed to be the Highest and the brightest the lowest.

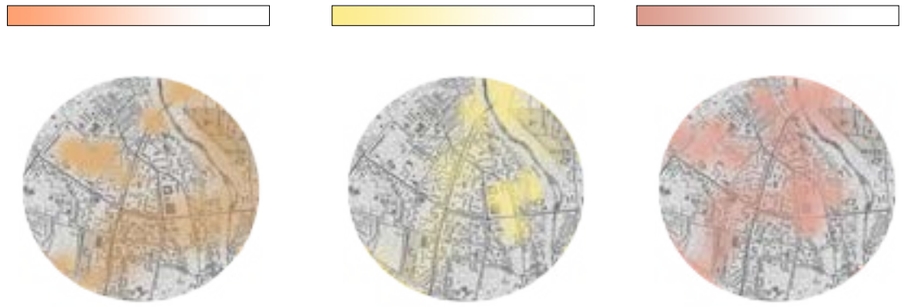
Afterwards were templates switched to grayscale modus in order to import them into the software.

Through importing of the *jpeg* with certain height pattern are the values of brightness being remapped to the attributes of building height.

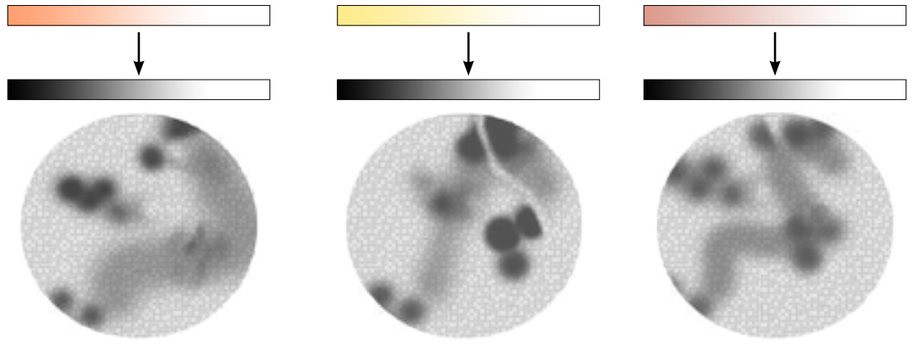
colors that were used for paths in the thematic mapping



coloring of the area affected by the path



brightness map that has to be **input** for *Cityengine - tool*



6.3 Parameter - building height - path A

mostly **lower** buildings - showed through mapping the brightness into attribute

zone 1
proposal of lower building height for undeveloped land in the surrounding of the path A

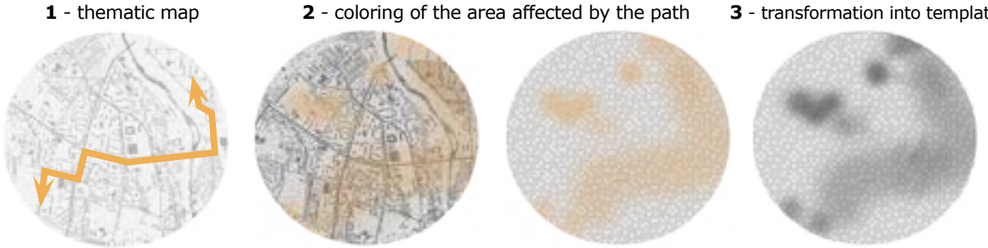
zone 2
existing density

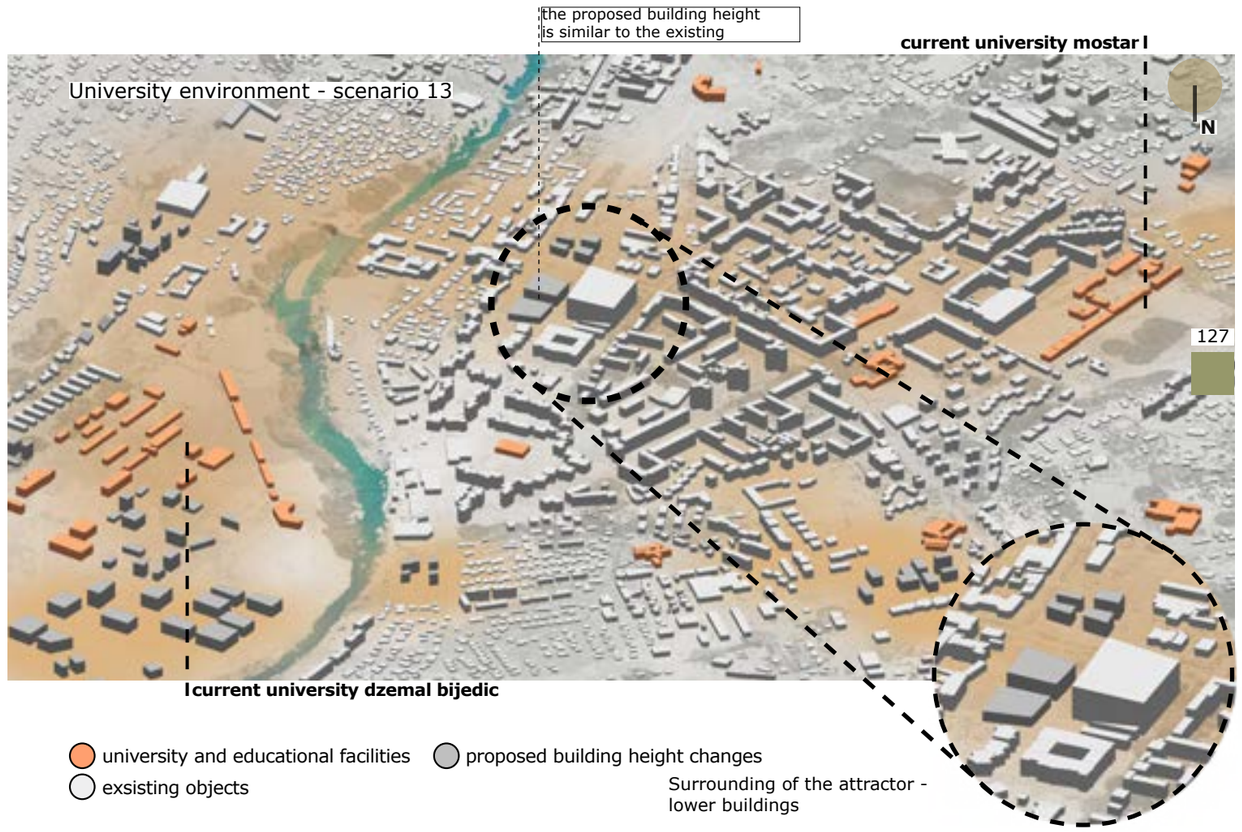
Steps between thematic map and procedural city model

1 - thematic map

2 - coloring of the area affected by the path

3 - transformation into template





mostly **higher** buildings - showed through mapping the brightness into attribute

zone 1
proposal of higher building height for undeveloped land in the surrounding of the path A

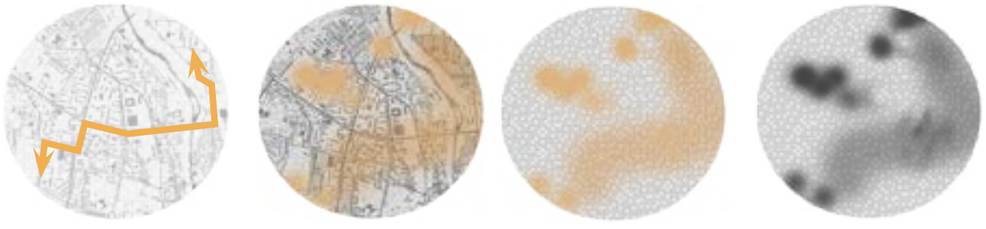
zone 2
existing density

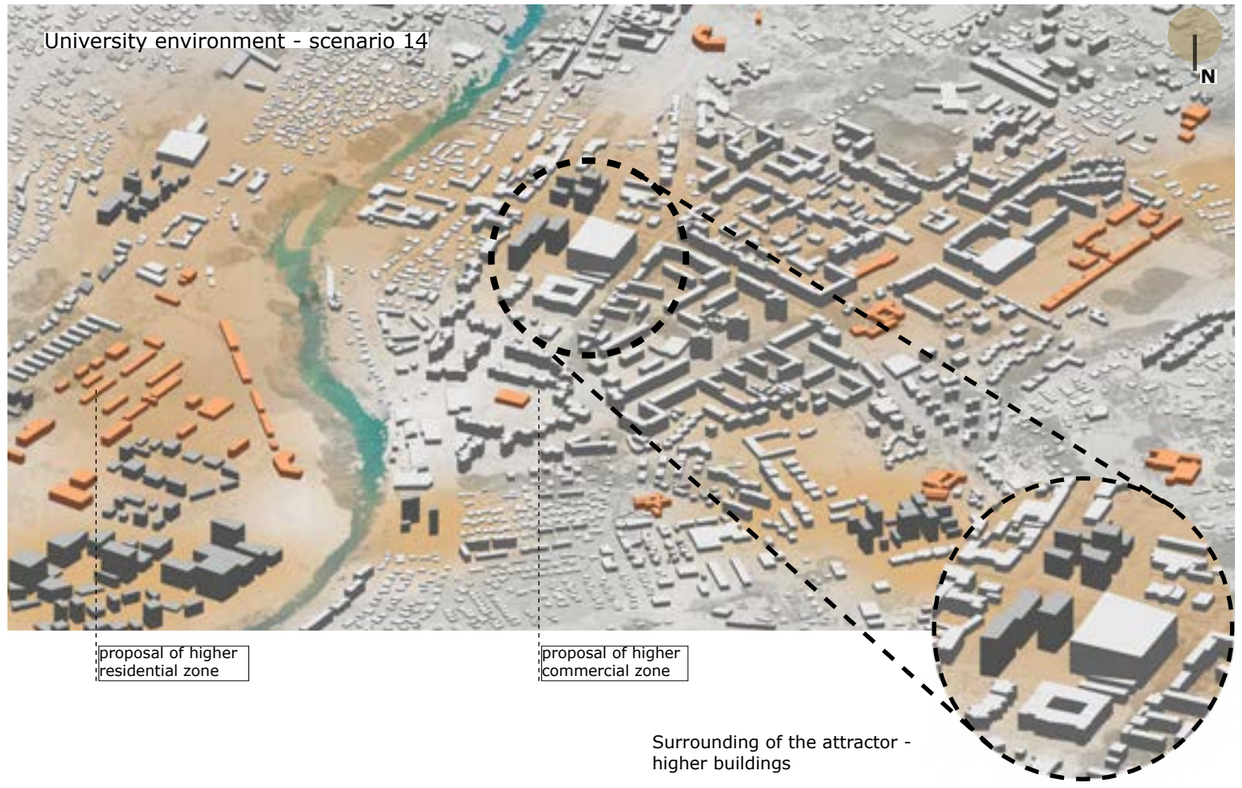
Steps between thematic map and procedural city model

1 - thematic map

2 - coloring of the area affected by the path

3 - transformation into template





6.3 Parameter - building height - path B

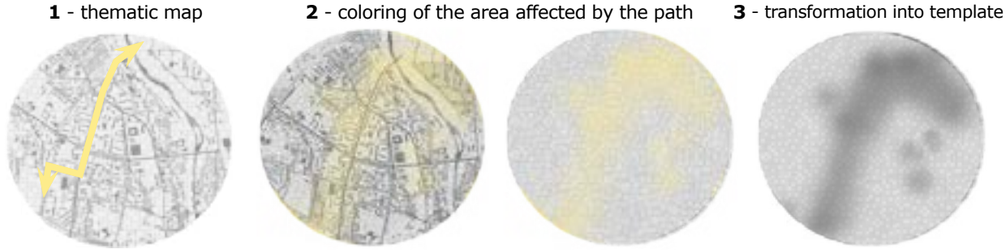
mostly **lower** buildings - showed through mapping the brightness into attribute

zone 1
proposal of lower building height for undeveloped land in the surrounding of the path B

zone 2
existing density

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template



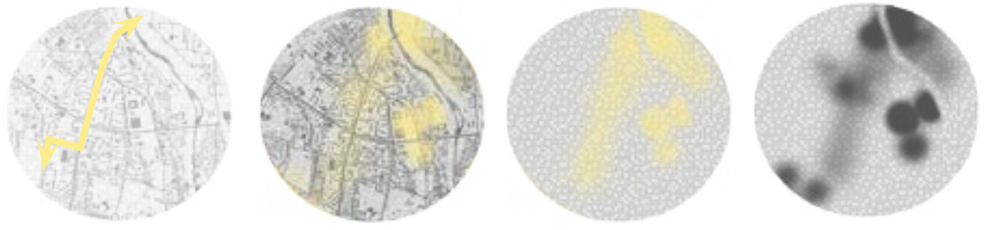
mostly **higher** buildings - showed through mapping the brightness into attribute

zone 1
proposal of higher building height for undeveloped land in the surrounding of the path B

zone 2
existing density

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template



6.3 Parameter - building height - path C

mostly **lower** buildings - showed through mapping the brightness into attribute

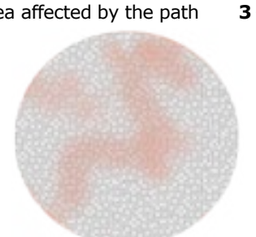
zone 1
proposal of lower building height for undeveloped land in the surrounding of the path C

zone 2
existing density

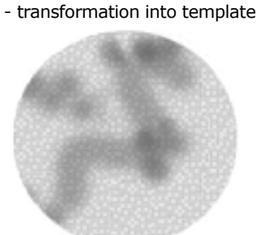
Steps between thematic map and procedural city model

1 - thematic map

2 - coloring of the area affected by the path



3 - transformation into template



mostly **higher** buildings - showed through mapping the brightness into attribute

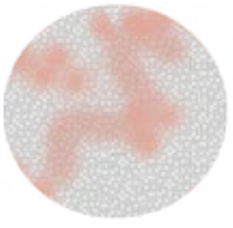
zone 1
proposal of higher building height for undeveloped land in the surrounding of the path C

zone 2
existing density

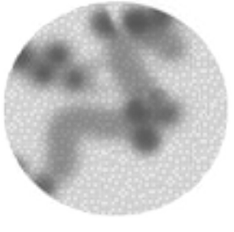
Steps between thematic map and procedural city model

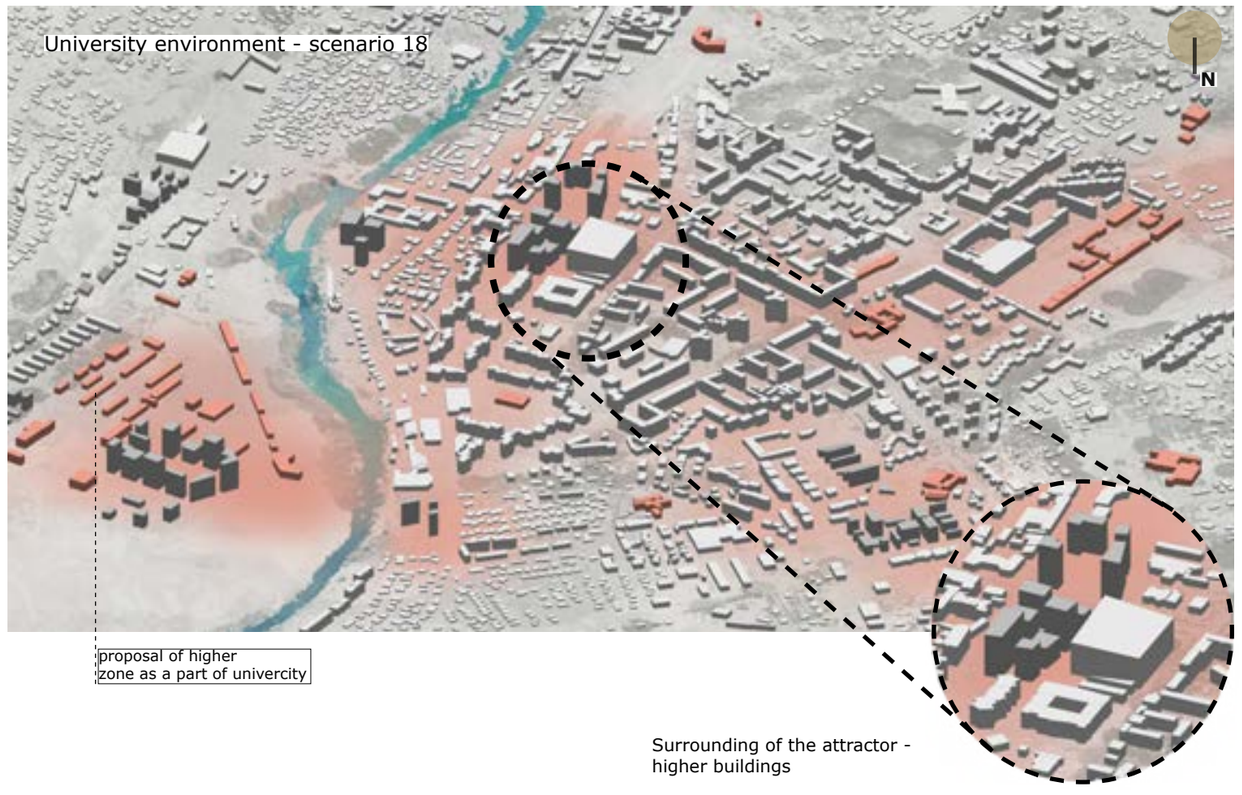
1 - thematic map

2 - coloring of the area affected by the path



3 - transformation into template



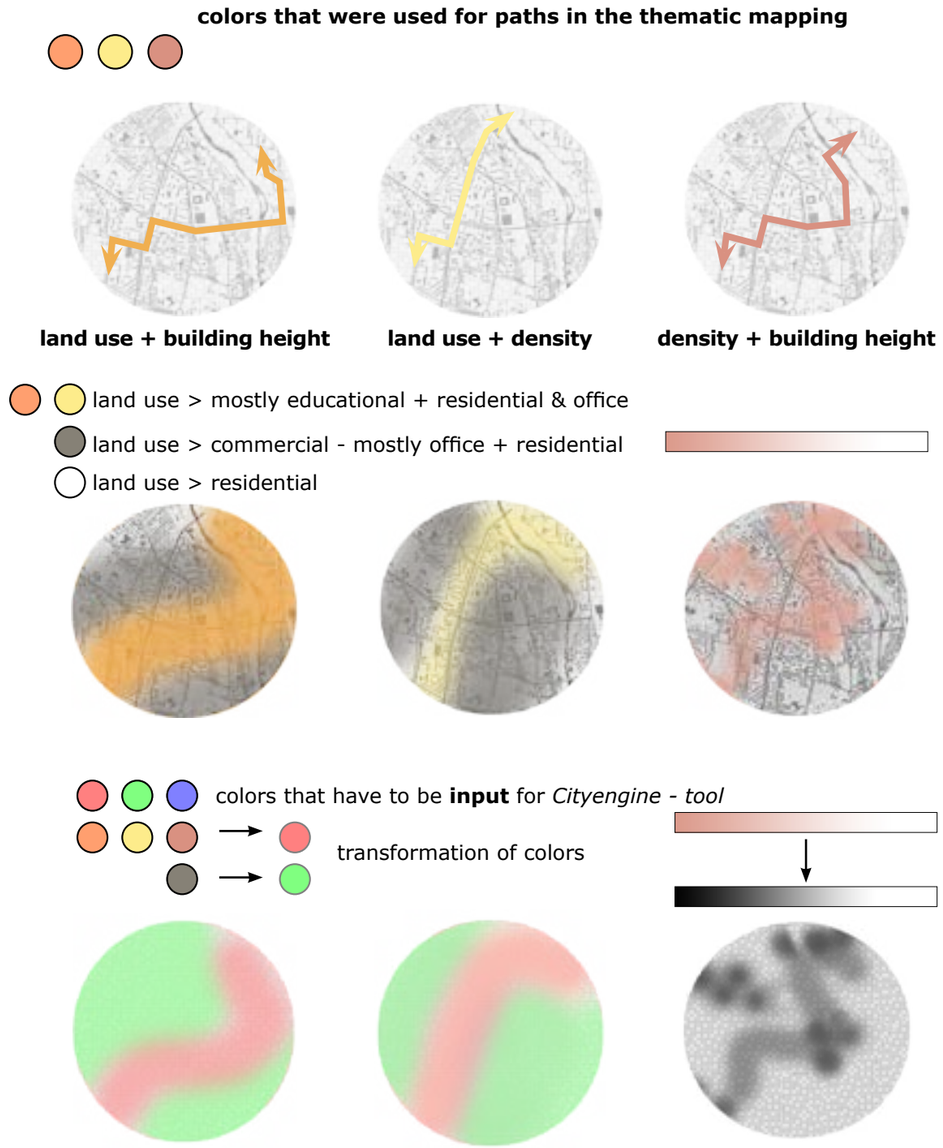


6.4 Combination of parameters

The fourth simulation was made with the combinations of three parameters. In the first case was the land use and building height combined in the surrounding of the path A. The existing building height was controled through mapping in order to see how could city skyline in these area look like if the building height changes. In the second case was again land use combined with the density in the surrounding of the path B. Several empty lot sites were chosen along the path B and processed through two brightness templates. In the third case were building height and density combined in order to get scenarios along path C. Again were the empty lot sites chosen and controlled through mapping templates.

The first step was, like in the previous simulations; to color the templates according to the thematic maps through using one color and its brightness.

Afterwards were templates switched to grayscale modus in order to import them into the software.



6.4 Combined parameters - land use + building height - path A

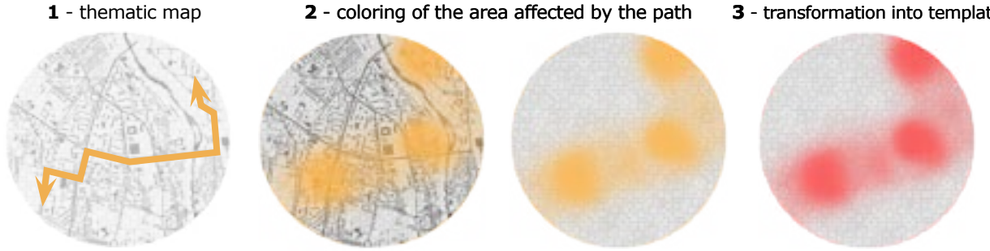
building height and land use - showed through one attribute - 3 zones that are higher

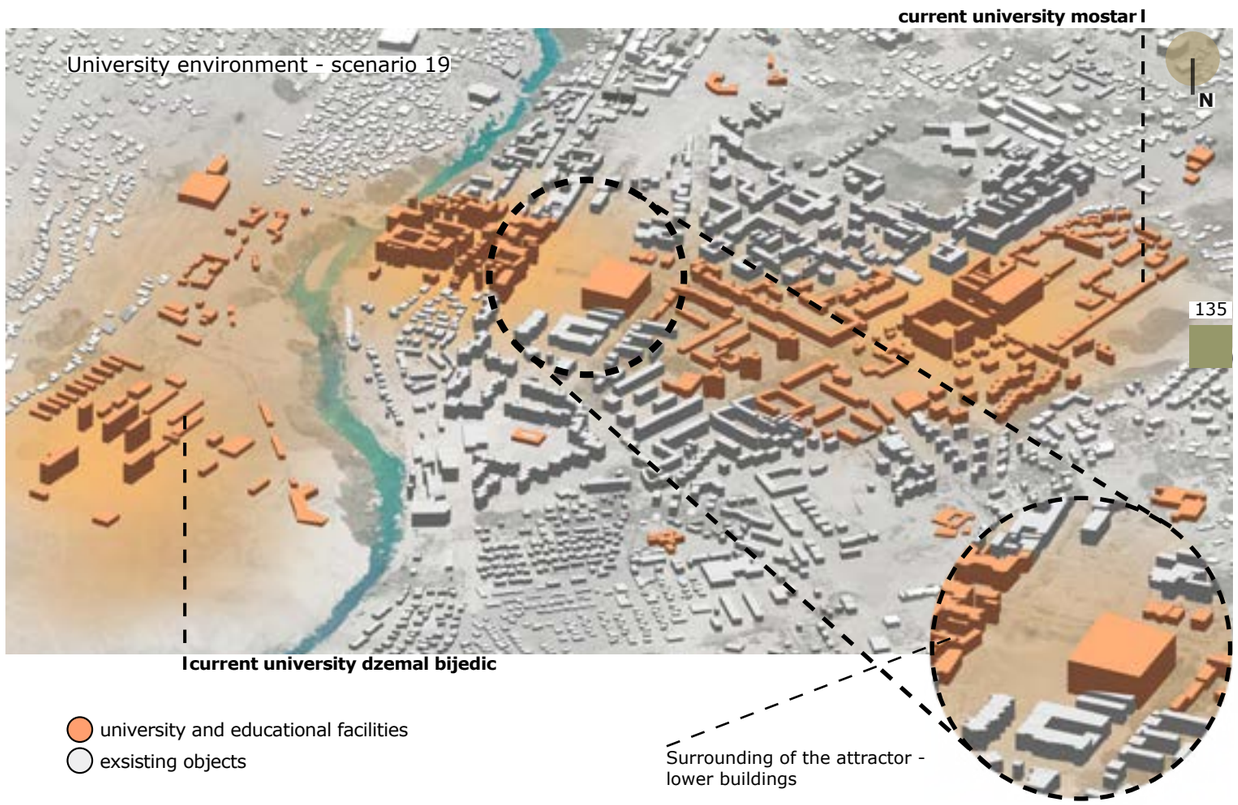
zone 1
based on the current **connection** between universities
colored zone consits of objects that could become belong to the univercities and their height is controlled through land use

zone 2
existing land uses, existing building height

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template





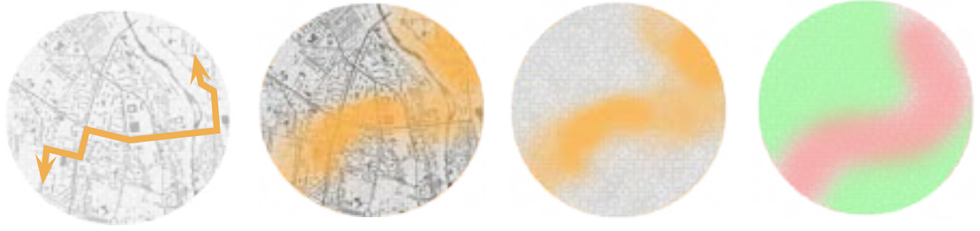
building height and land use - showed through one attribute - 2 zones that are higher

zone 1
based on the current **connection** between universities
colored zone consits of objects that could become belong to the univercities and their height is controlled through land use

zone 2
existing land uses, existing building height

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template



6.4 Combined parameters - land use + density - path B

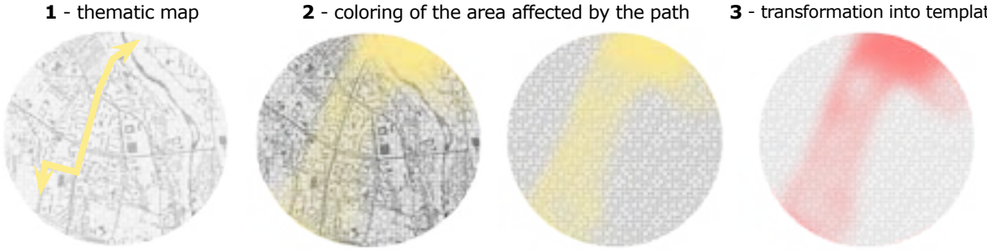
land use and density - showed through one attribute - 1 zone with densification

zone 1
based on the proposed **connection** between universities
colored zone consits of univercities facilities and objects that
would be added through densification

zone 2
existing land use and density

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template



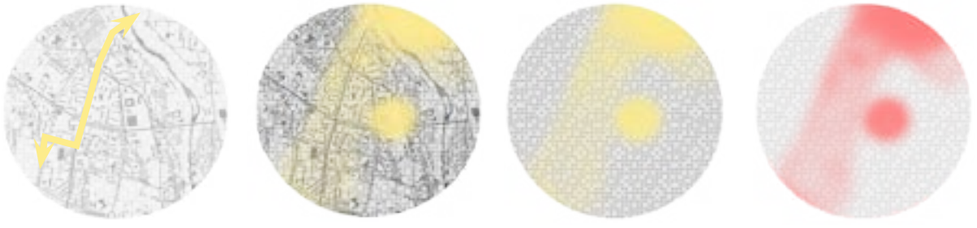
building height and land use - showed through one attribute - 2 zones with densification

zone 1
based on the proposed **connection** between universities
colored zone consits of univercities facilities and objects that
would be added through densification

zone 2
existing land use and density

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template



6.4 Combined parameters - building height + density - path c

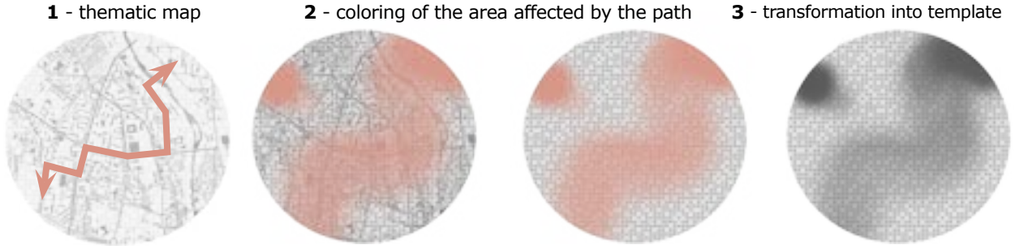
higher density and building height in 2 zones
- showed through mapping the brightness into attribute

zone 1
proposal of densification through higher buildings for undeveloped land in the surrounding of the path C

zone 2
existing density

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template



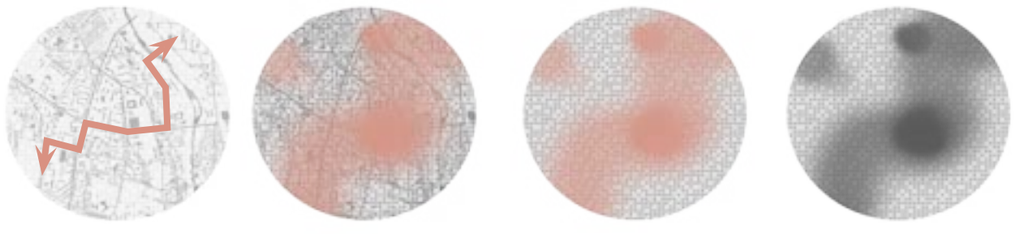
higher density and building height in 2 zones
- showed through mapping the brightness into attribute

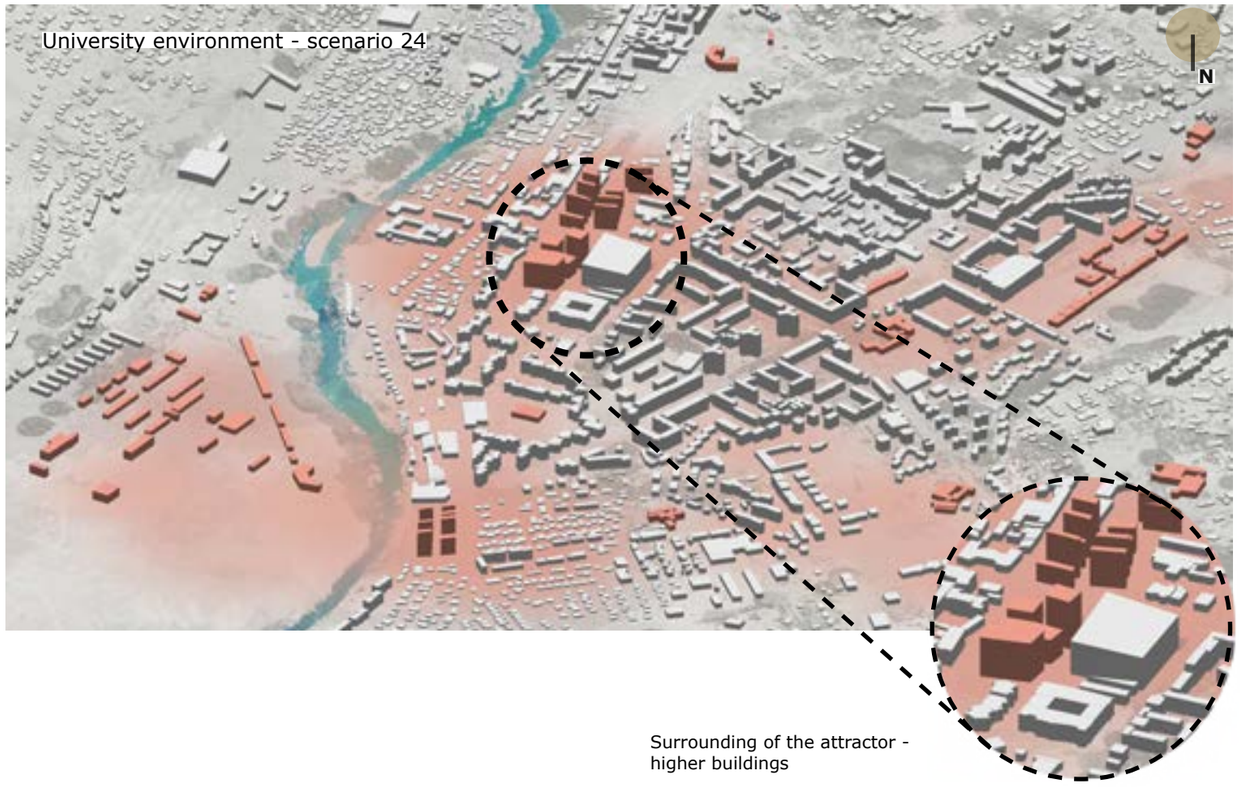
zone 1
proposal of densification through higher buildings for undeveloped land in the surrounding of the path C

zone 2
existing density

Steps between thematic map and procedural city model

1 - thematic map **2** - coloring of the area affected by the path **3** - transformation into template





6.5 Overview of parameters

The procedural modeling in the *CityEngine* allows infinite number of parameters for each object in the model. Parameters can refer to buildings, streets or any other city infrastructure. In this thesis were only used parameters related to the buildings. They are mostly scripted by the user in form of *.cga* rules, rather than assigned through user interface like by the streets. In that case are the parameters already programmed and on simple way controlled through user interface. However, it is also possible to write own rules for traffic infrastructure also.

The main parameters that are used for buildings are land use, building height, typology, gross floor area and density. The other parameters that could be added are the ones that define facades and roof design.

6.6 Discussion of concepts

Participation on several conferences was also part of this master thesis. They contributed to the further work and research because of the feedback gained at them. The participants were professionals with diverse backgrounds which furthermore enriched the events. The most relevant and interesting attendants for this project were the urban planners and architects from other *Divided Cities.* Therefore, it was possible to share concepts and solutions which have already been applied in that environments.

The first conference was taking place in Rome, Conference MaPS - Mastering public spaces; and the main topic was the way of mapping public spaces. The approach of mapping the environment of Mostar through connections between universities was considered to be appropriate for beginning. Those paths are most relevant for thematic maps which could offer proposals for reconnecting the universities. The work presented in Rome were basic thematic maps that were showing daily movement of the students. The given proposals were to map each important facility and question the students about their expectations and suggestions. *[Davisi, 2015]*

The architects from Nicosia and Jerusalem were also presenting their projects at the conference in Rome. The project from Nicosia was an artistic project that has been performed in the streets of Nicosia and they wanted to share their experience and insights. Their idea was to create and place small art installation on specific locations in order to initiate the interaction of citizens. The citizens' feedback was positive because they felt like they belong to the city were invited to participate. The second project was from Jerusalem, about a tram which supposed to reconnect the city because it hat an unconventional route. The idea was that the tram drives through all parts of the city which are in the surrounding of the division line. However, the project was not well accepted from the citizens.

The conclusion of the conference in Rome was that participation of citizens in the urban planning plays important role. Therefore, certain tribunes and workshops should be organized regularly to gain their feedback in order to improve their everyday life with thought through ideas.

The second conference, including summer school, was within the scholarship *KUWI* and took place in Mostar. Research for this master's thesis corresponds to the concepts of the revitalization of the city Mostar. *[Demirović Habibija,2015]* The main aim of the workshop was to specify location for the center for art, dialogue and architecture. The thematic maps and their application helped in the process of searching for the location of the center. The center is an independent platform where citizens, public institutions, associations and representatives of economic and social areas can meet and experience the city as a cultural expression through art and architecture beyond just theory. It would be possible to organize workshops in order to present the tool and involve citizens in finding the solutions for their environment. *[Demirović Habibija,2015]*

The third conference was RE-DO in Aarhus, Denmark and brought together professionals and practitioners for a discussion about the role of cultural sustainability and its relation to environment, economy and society. The work presented there were already scenarios of reconnecting the city and the way how digitalization could help to overcome the problems. The new generations and approaches should be starting points for creating a reunited Mostar. It is not possible to recall history and only new ideas with involvement of students and citizens will revitalize Mostar. *[Radovic,2015]*

conclusion & outlook

Conclusion

The problems of spatial and sociological division in Mostar were compared with other divided cities in order to find common approaches for the regeneration of divided environments. The participation of citizens and collaboration with local professionals is crucial for bridging the social borders and starting the process of spatial revitalization. The architects and urban planners should use digital methods and provide open data to the citizens and make them aware of the fact how important their involvement in the planning process is.

The students' daily behaviour and movement was the main observation point in the first part of the project. The results of those observations were thematic maps that were used to develop the concept of new bridges. The new metaphorical bridges should connect the two universities and form the new city image. The students were selected as a main target group because they are more likely to quickly accept changes and adapt to new surroundings. Therefore, they are capable of shaping future generations and changing the segregated society structure.

In the second part of the project an urban digital tool has been designed in order to provide solutions for problematic environments. The tool enables creating of three dimensional environments and simulations of planning intentions. It can be easily applied on diverse problem areas. This master thesis presents its performance in the city of Mostar. The procedural model of the city and the tool have been created in the software CityEngine.

The main focus in the procedural city model was the university environment. The method of mapping was used to process data from thematic maps into 3D objects and scenarios for reorganising and relinking the two universities. It is an intuitive method which analyses values from templates and returns them to city model accordingly. The advantage is that the template can be made in a very easy and simple way through using colorized digital maps.

The offered concepts intent to be an initiative to derive proposals for mental bridges and encourage citizens to be part of both the city planning and of a future unified city.

Outlook

The implementation of digital solutions to overcome the problems and bridge spatial and sociological barriers in the dysfunctional area is yet to become applicable. However, the main problem of wounded society is the fact that the citizens neither have a feeling of affiliation to the city nor interests for the benefit to the community. Therefore, new principles have to be a applied in order to invoke social engagement in their surrounding.

The division lines are both, embossed in the society's conscious as experienced as a physical barrier in the city space. Therefore, it is hard to expect that only spatial design can invoke changes in the damaged society. There has to be a step between mental and practical process in order to broaden the citizens' comprehension of how important their participation in the city planning is. The designed tool will be an essential element for the adjustment of citizens to the proposed urban solutions and establishment of a reunited city environment.

The process of collecting data for this project was very complex because of incomplete digital resources and outdated documentation. The statistical data about the city is at a very poor level, therefore it was very hard to compare the level of city's development with other cities. It would be easier if there was an online portal with updated facts and plans.

The procedural model of the city and the results of this research are going to be accessible for the citizens of Mostar. That could be a part of an online platform which would be used for opening new discussions, workshops and sharing data. The platform should be a basis for forming a virtual university campus that would lead into a physical one over time.

The people of Mostar should rethink the meaning of the word bridge and start to cross it in order to overcome the differences.

Bridges are more important than
houses, more sacred than shrines. Belonging to everyone and being equal to
everyone, useful, always built with a sense, on the spot where most human needs are crossing,
they are more durable than other buildings and they do not serve for anything secret or bad.
[Andric, Ivo, 2014]

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for analysis of Mostar

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