Delft University of Technology
Faculty of Architecture and The Built Environment
Master Landscape Architecture
Flowscapes

P5 Report
Horti Danubii

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November 2015

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Figure 1: view on the Danube from the river banks of Rousse (Bulgaria)

PREFACE

The studio “Flowscapes” which is led by Steffen Nijhuis and Daniel Jauslin explores infrastructure as a type of landscape and landscape as a type of infrastructure (cf. Strang, 1996). Still a quite complex definition. During the graduation process, my understandings of what Flowscapes is were improved. In my point of view a flowscape is the fusion of landscapes in order to create a natural transition, a process between natural and human systems.

The studio focuses on the water basin of the Rhine and Danube. Two large rivers that cover different countries. For me it’s the first occasion to design at a different place. Different from the “flat” Netherlands. To design with real height differences is a first defiance, but of course for example language and landscape properties are challenging as well. Limited information and less verbal communication lead to a different design. Although the Rhine is flowing through Holland, therefore a possibly more challenging choice would be a location abroad.

The analysis and design of this flowscape have been an inspiring trip. I would like to thank in the first place my supervisors Daniel Jauslin and Machiel van Dorst for their accurate help and the welcome enthousiasm with which they supported me. I would like to thank my family from Ruse, Erik and Plamena Leone, her mother Yvanka, and Hristo Metev, who helped me with specific information and introduced me to the real Bulgarian culture. Furthermore I’d like to thank the helpful people from Ruse and Bucharest, including Boryana Brezovska, Diana Lois and Gabriela Nishanyan who helped me with translations, showed me the way and braught me to the Island Luliaka. I’d like to thank Astrid Blom and Pepijn van Denderen for their technical support. They helped me with questions about the water system. And of course I would like to thank my fellow students, friends and my family for their support.

After the trips to Bulgaria and Romania I’m inspired by the beauty of the countries and people, and I hope to transfer this enthousiasm by reading this document.

Roel Muselaers, Delft, November 2015.

Figure 2: view on the Danube from the river banks of Silistra (Bulgaria)

SUMMARY

For a large stretch the border of Romania and Bulgaria runs over the Danube. At only two points this river is crossed by transportation infrastructure. One of the two points is the crossing between Ruse (Bulgaria) and Giurgiu (Romania). In these surroundings several places were visited along the Danube. Most of these observations turned out to be different from the expectations: the places were neglected at the backside of the countries. This seems to be caused by a lack of money from authorities and possibly a lack of awareness from the local population.

The next part of the report is a search to a solution for this problem: how to create a connection between the existing ecological and recreational network and the river border area of the Danube? By the use of different methodologies the search is deployed. On the one hand several observations took place, strengthened by desk research. Not only in the studied stretch, but -parallel to this- as well studies of nature parks in Holland were undertaken. On the other hand a more theoretical approach took place, by the use of the patch-corridor-matrix-theory (Forman, 1995) and studies about animal-visitor interactions.

Eventually a solution is found in the concept of connectivity and elaborating on this a green infrastructure: at every scale an interweavement between the recreational and ecological network and the river border area takes place. Neglected places are found and activated to create an interconnected network of protected nature areas. The otter and beaver form in this network the symbol of a healthy nature.

On the **L**(arge)-scale, the stretch between Ruse and Silistra, a regional plan is elaborated with linked recreative routes that show the new green infrastructure. On the **M**(iddle)-scale of Ruse and Giurgiu a masterplan is drawn up with again linked recreative routes and an interconnected network of green areas that provide habitat for wild animals. On the **S**(mall)-scale one of the newly actived places is elaborated: the missing link between several valuable Natura 2000 areas at the island Luliaka. This part contains a detailed design of an otter and beaver nature park including a planting plan and several impressions.

Figure 3: Central square, Ploshtad Svoboda, of Ruse

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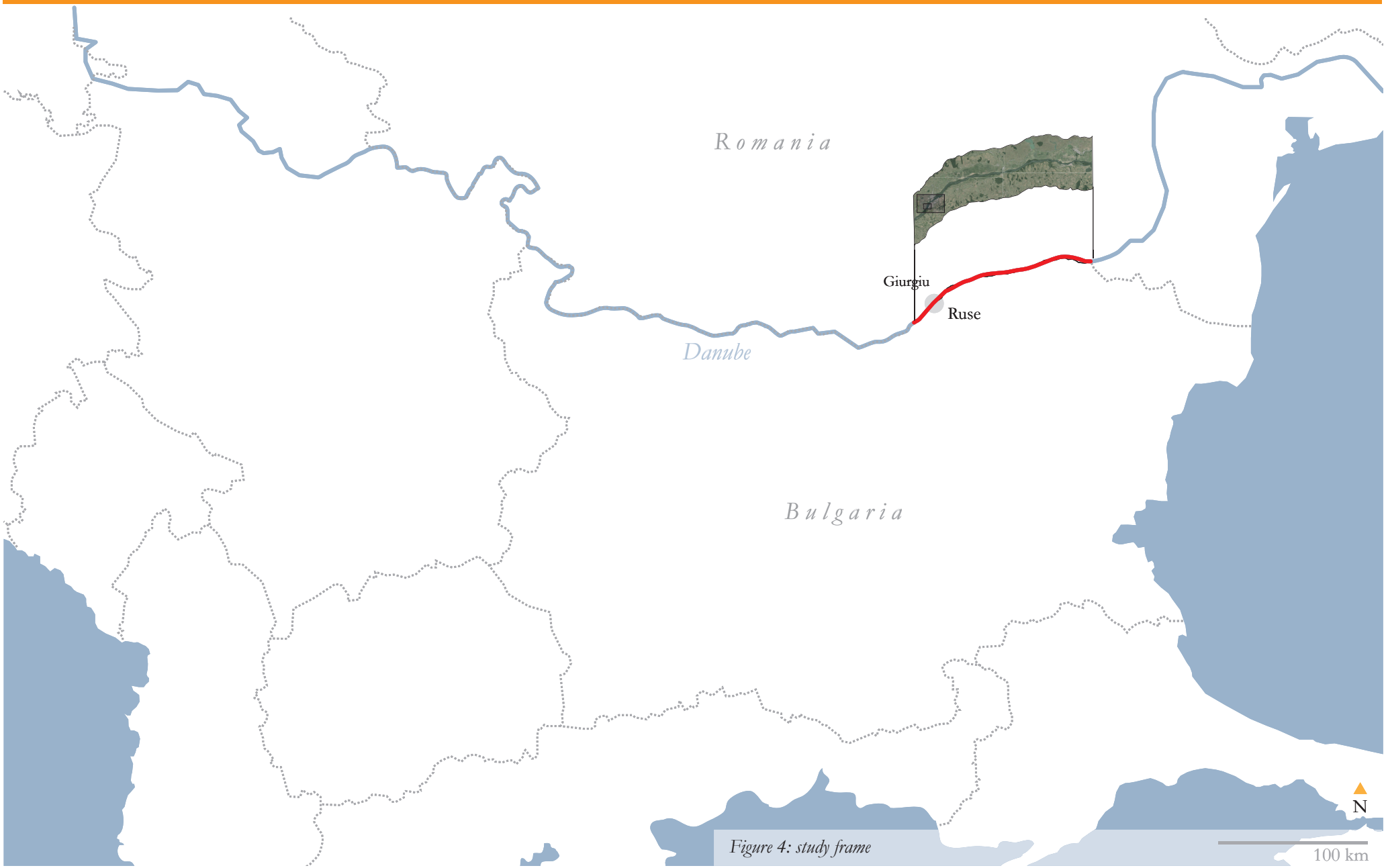


Figure 4: study frame

INTRODUCTION

FRAME OF STUDY

Since there was an opportunity to design in totally different surroundings than in previous projects, the decision was clear to choose a location outside of the Netherlands. In the Flowscapes-studio one could choose from ten proposed example places, or propose another location situated along the Rhine or Danube. During the first period of analysis, in which the basins of the rivers Danube and Rhine were studied in groups by different themes, the geography and soil were investigated as well. This accurate study also touched the interesting point of Ruse and Giurgiu: where the border runs along the Danube and where there used to be the only Danube crossing between Romania and Bulgaria until 2013 (there's one other crossing between the cities Vidin and Calafat now). As my aunt originally comes from Ruse and still has family living there, the definitive decision to choose for this area was made.
For proper imaging, it is recommended to make a trip to the chosen area. This is essential for the investigation. Later, the observation during this trip turns out to be very useful. Because observation is leading in this research, the observation was taken as normative for the boundaries of the case study.

The first visit (of two) to Ruse was used to explore the surroundings with a focus on the Danube and was made during the start of the project (the orientation stage). By car I discovered the stretch from Ruse to Silistra, and this formed the starting point for the area of study: the west of Ruse and Giurgiu forms the outer western limit; Silistra, where the border quits the Danube, forms the outer eastern limit (view figure 7). Moreover, to get a good image from the Danube banks a 20 km stroke on both sides from the Danube is taken to define the outer northern and southern limit.
During the first visit, between Ruse and Silistra smaller villages Marten, Tutrakan (fishermen's village) and nature reservate Srebarna were visited. In this way arises an image from the river banks of the Danube in this stretch. This stretch from Ruse to Silistra will form the **L**(arge)-scale as indicated in figure 4.

The second visit focuses on the city of Ruse and more specific the visit to the Island Luliaka (7 km from Ruse) and a visit to the nature park of the small stream Rusenski Lom. The stream flows into the Danube at the height of Ruse near the Island Luliaka. This visit took place during the end of the project (The P4 stage). The cities Ruse and Giurgiu form the **M**(edium) scale and the island of Luliaka the **S**(mall) scale (figure 4).

APPROACH

The report will be setup as follows. After the introduction it is divided into five parts according to the project's process: orientation, P1, P2, P3 and P4. All stages are represented in five icons (displayed below). The stages will contain the three different scales: **S**(mall), **M**(edium) and **L**(arge) (View the scheme in figure 5).

The report starts with the stadium of orientation. This part shows the findings of the first trip to the site (the observation), the cohesive desk research (theory) and the first design ideas.
It involves the **L**-scale and the **M**-scale, but because in this stage the study area is being explored, the area on the small scale is not defined yet, so a defined **S**-scale is not applicable.

The second part contains the road to the P1 presentation.
Fascinations about the explored site will be presented and the first outlines of the project become clear. This involves the **L**-scale in particular, but it affects the other scales as well.
On the **M**-scale the direction towards the Danube of Ruse and Giurgiu is being described.

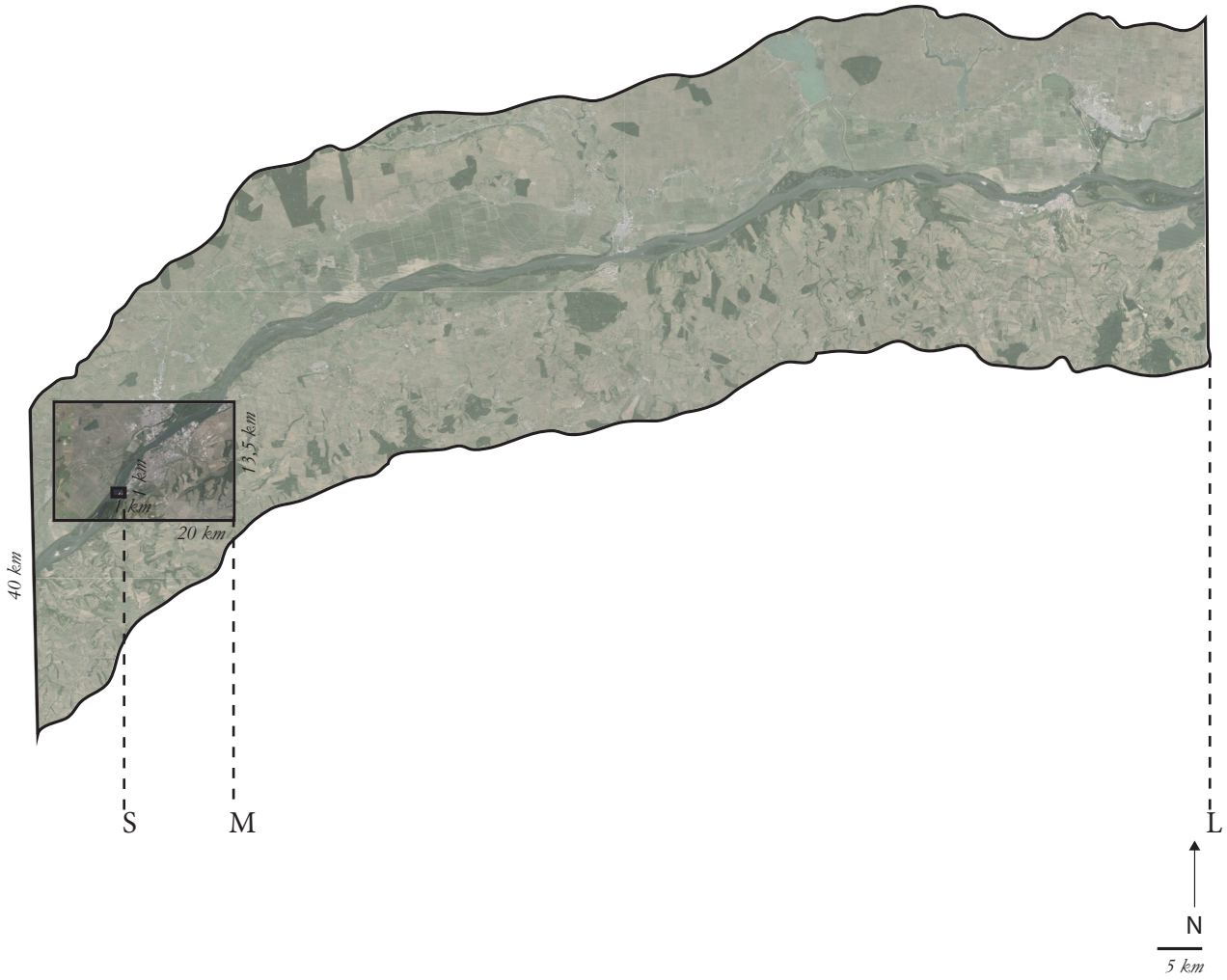


Figure 5: Study frame divided into three scales: S(mall), M(edium), L(arge)

On the **S**-scale the first thoughts will be shown in a collage and a reference.

The P2 stadium shows a more developed image of the project. An analysis will be shown on the three different defined scales and problem statement, opportunities, research question and concept will be presented. All scales will be divided into three main elements: ecological network, recreational network and river border area, denoted by icons.
At the **L**-scale a general introduction will be given to both countries and the ecological and recreational network will be analysed. Furthermore is displayed what happens in the river border area.
On the **M**-scale a general introduction to Ruse and Giurgiu will be given and again the ecological and recreational network will be analysed. What the river border area looks like will be shown as well.
At this moment the island Luliaka comes into view for the first time. Again the scale is divided into ecological network, recreational network and river border area and even a first impression on this **S**-scale is made. The otter is introduced as a symbol and measure for a good ecology (an indicator species).

In the P3 stage a different kind of research is started. A period of practical research (observation) with a theoretical underpinning (theory): models and excursions were made, and several articles were studied. Models were made to get a grip on the scale of the environment of otters and beavers and the surroundings of the island. Excursions were made to get an idea of nature parks and otter and beaver parks. The articles in fields as animal-visitor interaction of zoos, beaver eviction and other subjects were studied to get an insight into the animal's environment. Furthermore the existing analysis and design will be elaborated on the diverse scales and the design becomes more clear.
On the **L**-scale the ecological and recreational network is shown and the river border area will be analysed as well.
At the **M**-scale five variants of possible green connections will be presented. Furthermore the river border landscape of the Danube will be analysed.
On the **S**-scale besides the otter the beaver will be introduced, since it is living close to the area and is a keystone species like the otter. An overview will be given of the differences and similarities between the two indicator species.

The P4 stadium contains a report from a second visit to Ruse and the island Luliaka and the presentation of the elaborated design.
On the **L**-scale a regional concept is presented, including a map of the different phases in which it will take place.
On the **M**-scale the earlier presented variants come together in a masterplan.
From the masterplan will be zoomed in on the **S**-scale, the island Luliaka. A detailed plan of the design will be shown including impressions, a planting plan and technical details.

METHODOLOGY

In the first place a personal method, based on observation is used. During the project at every turn the observation was taken as leading, supported by a theoretical background. The "direct" observational way of research is almost free from influences of others. In most other forms of research, information is framed by the reference frame of the author. The author is trying to show a certain aspect to convince the reader. In order to achieve this, the author hides -from his point of view- needless information and influences the reader in that way. Although an observer has a certain reference frame as well, in situation the environment is better judged according to reality, because it's harder not to balance certain aspects of fascination against background aspects. These background aspects are harder to hide in the real situation.
During the field-trip there were as well moments of "guided-observation". Some local residents (for example a lady from Ruse and a doctor of the hospital of Ruse) showed or focused on

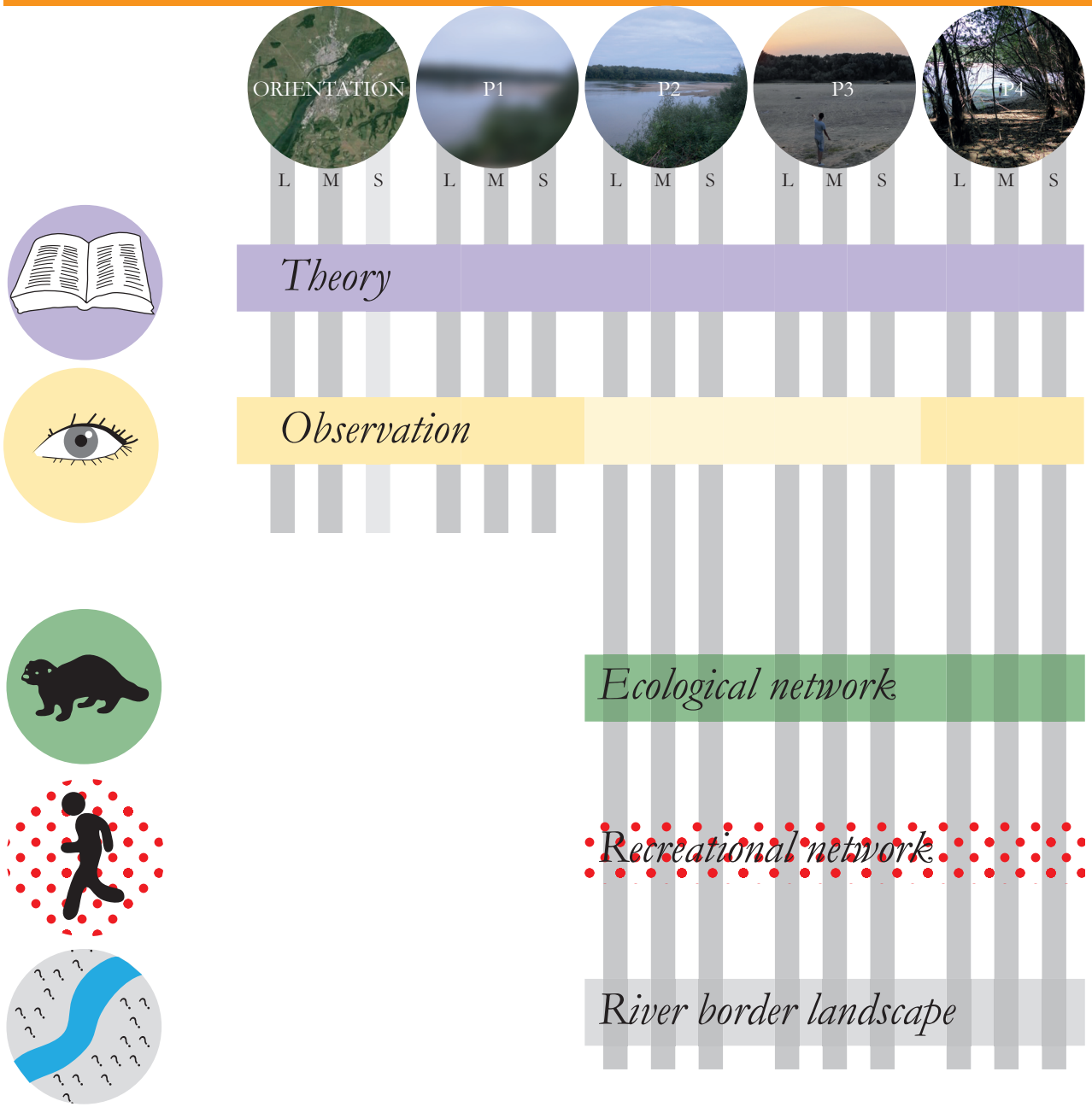


Figure 6: Scheme of setup of report

some specific spots or routes in the frame of study. At the same time these residents shared ideas and doubts about the places and regions. Since the reference frames and ideas of the persons where in general quite different than personal ideas it triggered to compare these ideas.
After the P2 a different type of observation started: excursions to for example otter and beaver stays and parks were made. All observations were strengthened by desk research. The second visit to Ruse in the final stage and surroundings created the opportunity to see the frame of study in two different seasons, which contributed to a thorough observation.

In the second place, to strengthen the personal method, the patch-corridor-matrix-method (Forman, 1995) is introduced. This method can be applied on different scales, starts from an ecological point of view, but involves human activities as well. This means that the method can be applied to urban areas as well, which seems to be an underexposed aspect of the first method.

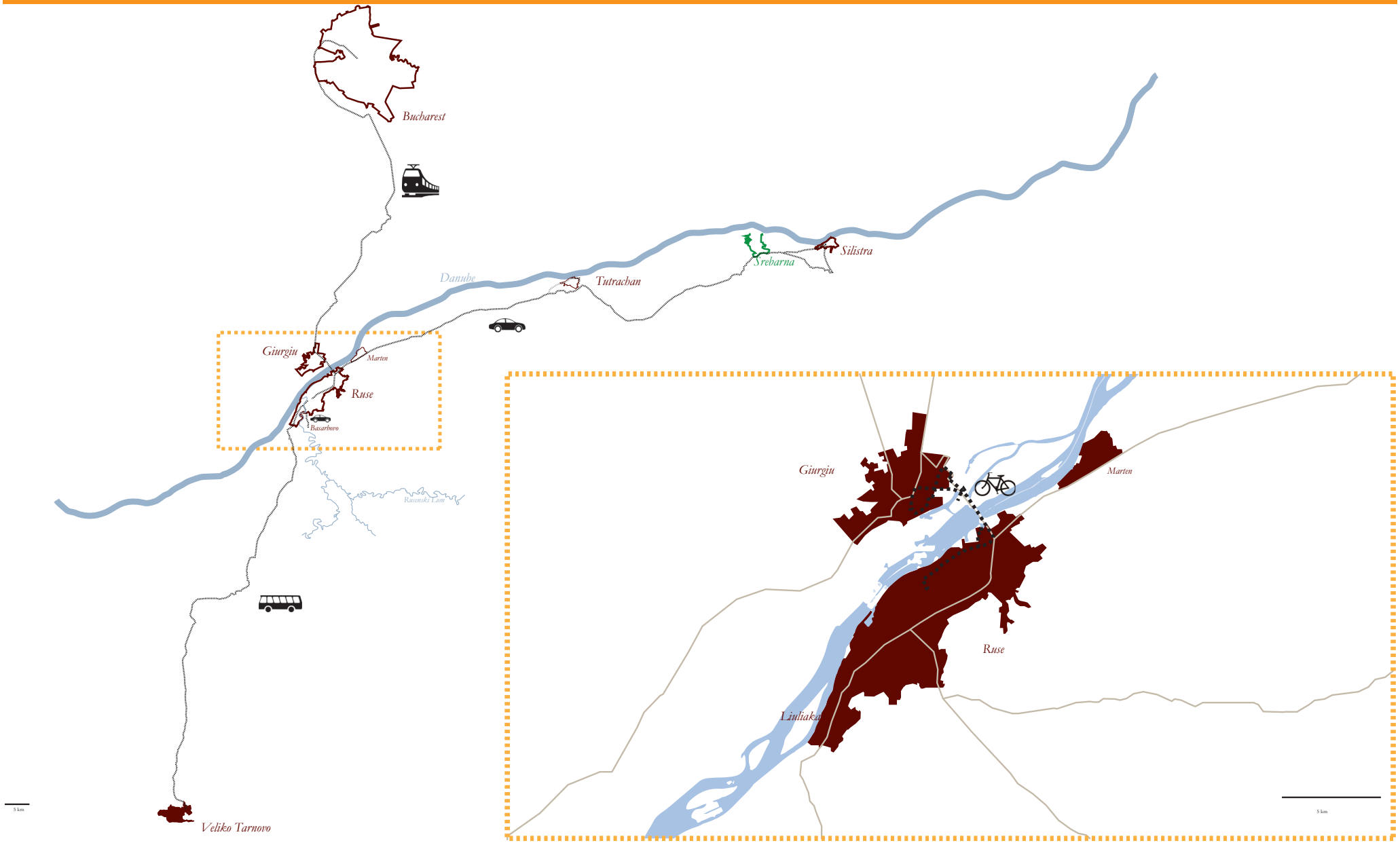
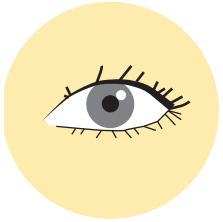


Figure 7: Excursions during first trip to Ruse and surroundings: by train, car, bus and bike.

Figure 8: view on the Friendship Bridge between Ruse (Bulgaria) and Giurgiu (Romania) from the adjacent industrial part of Ruse.

ORIENTATION



Ruse and Giurgiu. Two cities located at a very interesting location: where the border is running on the Danube and where there's one of the only two bridges between Romania and Bulgaria. The latter is the impressive Friendship Bridge which is shown on the left page. Figure 11 shows that many borders come together at this point. First of all the city borders of Giurgiu and Ruse. Then the border of the countries Bulgaria and Romania and finally the physical border of the river Danube. The tension between these cities and countries triggered my attention...

At the first trip to Bulgaria I explored the surroundings in several ways: by train, by car, by bus, by bike and by foot with a focus on the Danube. In this way the outlines of the study frame were explored and therefore this orientation stage will mainly focus on the **L**-scale and the **M**-scale.

After the trip a few things become clear from observation. The river border area at the stretch between Ruse and Silistra contain high ecological values. Desk research confirms the observation: in the defined stretch a large amount of Natura 2000 areas are situated (view figure 9). Wetlands and flood forests are found in and around the Danube, and streams flowing into the Danube, provide a large biodiversity and perfect habitats for extraordinary flora and fauna.

However, not at every spot with high ecological potential the maintenance and arrangement is good. Although the village of Marten is situated next to the Danube, observation shows the area around the Danube is poorly shaped: it is not attractive and has become a "back" of the village (figure 13). Something similar happens to the river banks of the Danube near Giurgiu: the area contains high ecological values, but the places are abandoned.

Most striking example of the visited places is Srebarna: world heritage site and nature reservate with a fantastic view (figure 14a). Although the view is beautiful, something strange is happening to the site. The site is visited in October. While in the adjacent museum more than a hundred species of birds and other animals are exposed, none of them could be observed at the moment of the visit. The sound of loud music could be heared, a car was driving by and paths and viewing points were in poor condition (figure 14b). This shows what happens at several places in the river border area with potentially high ecological values. Many observed places are neglected (view figure 10).

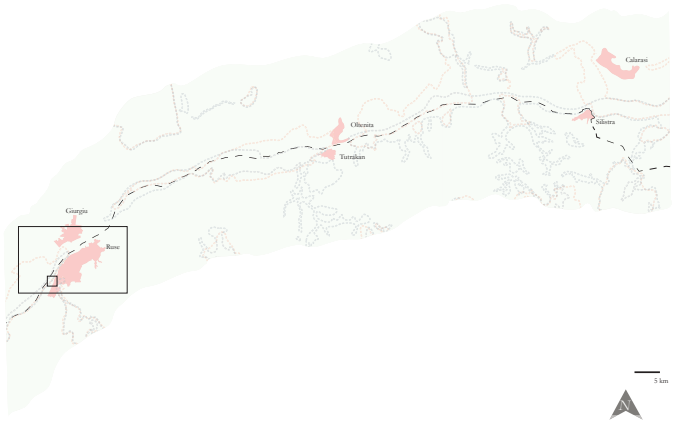


Fig 9 Natura 2000 areas on the L-scale

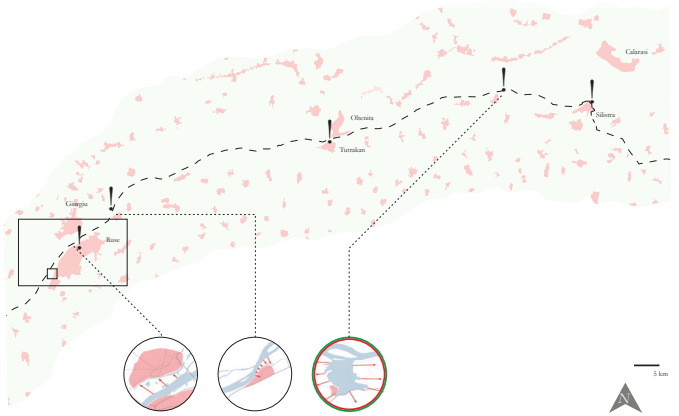


Fig 10 Observed neglected places along the Danube

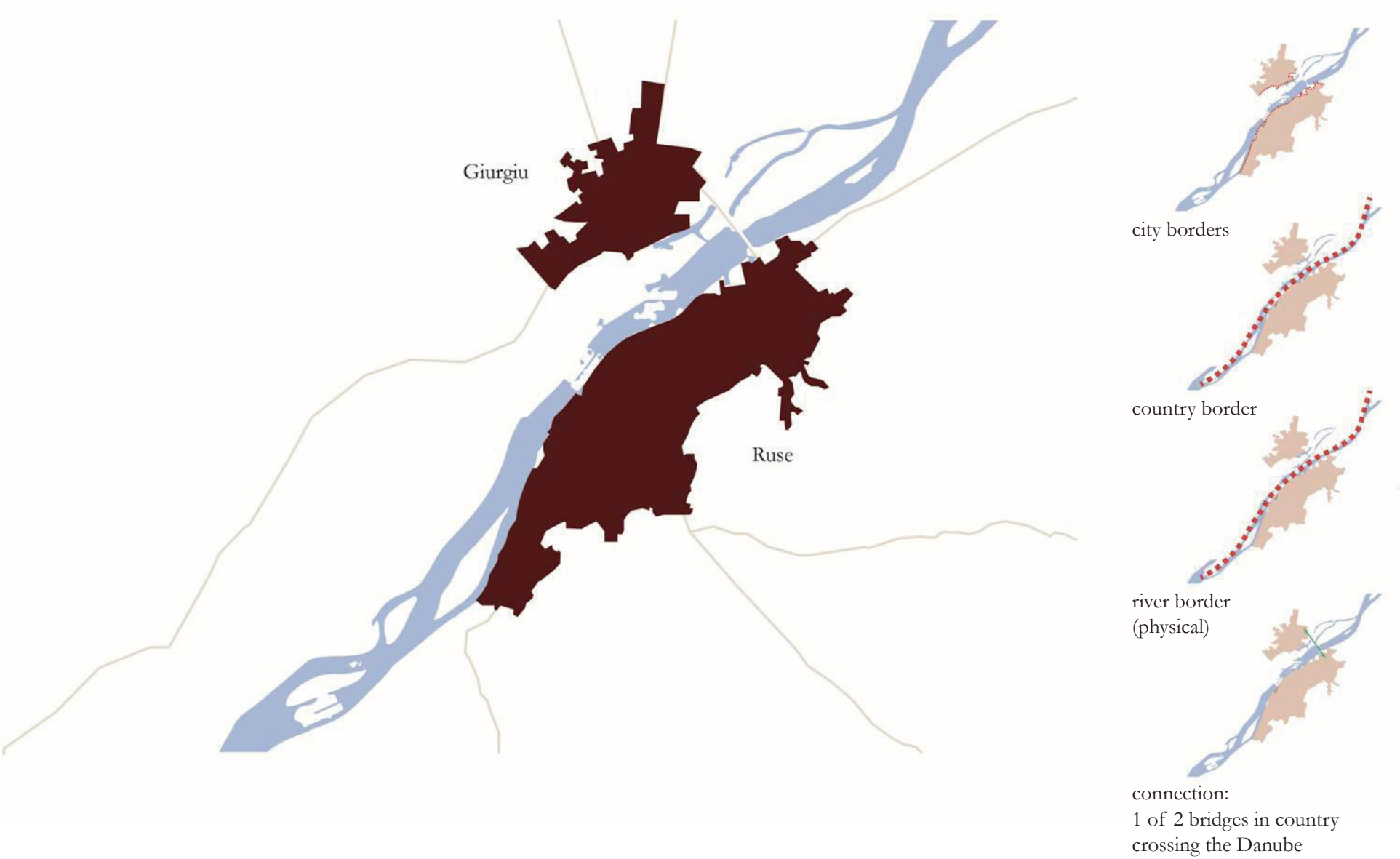


Figure 11: Ruse and Giurgiu: a point where many borders come together

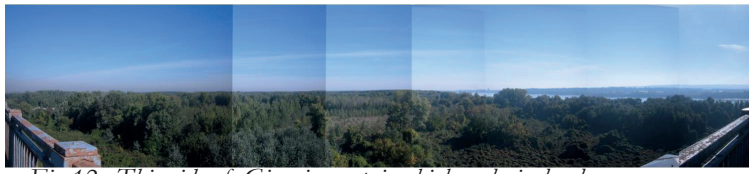


Fig 12a This side of Giurgiu contains high ecological values

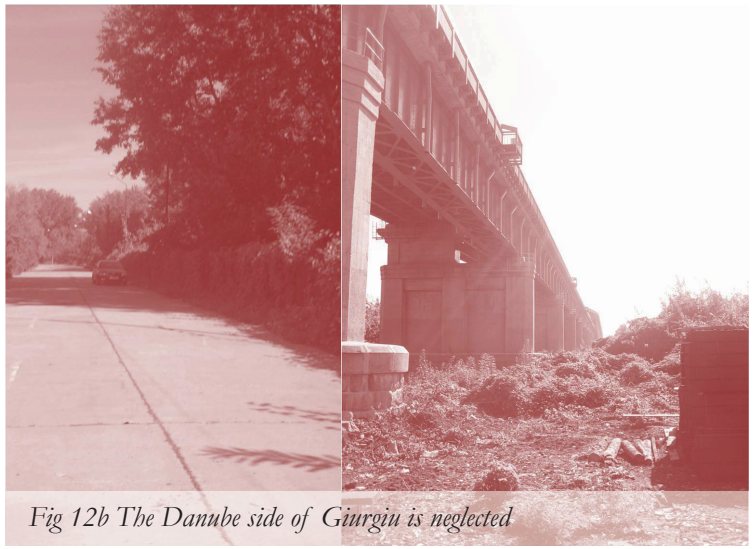


Fig 12b The Danube side of Giurgiu is neglected

Fig 13a The central part of the village of Marten is attractive

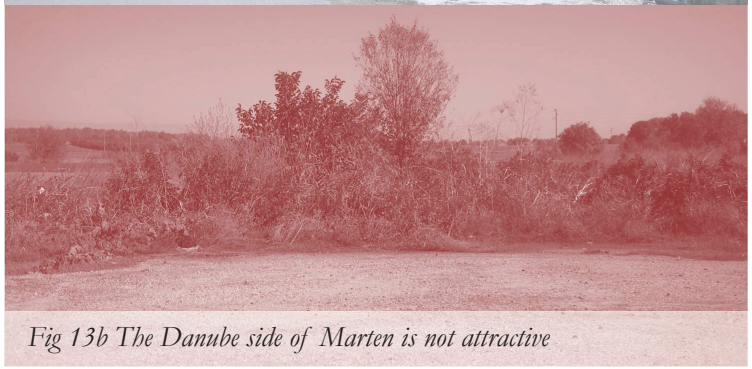


Fig 13b The Danube side of Marten is not attractive

Fig 12c The side of Giurgiu turns its "back" to the Danube

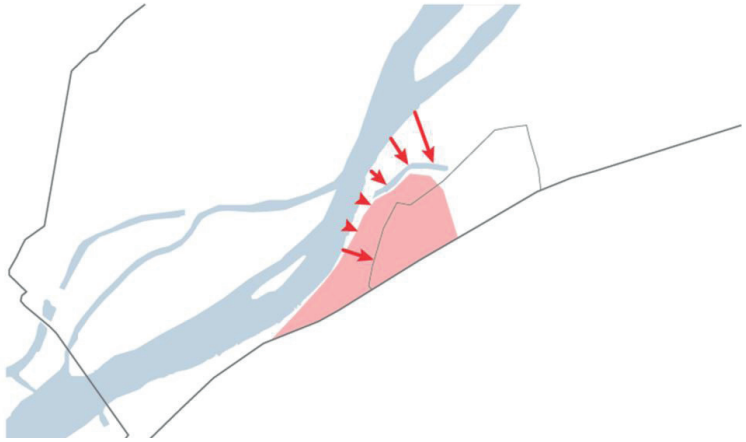


Fig 13c The village of Marten turns its "back" to the Danube

Figure 14a: view on the Srebarna lake, world heritage site and nature reservate

Figure 14b: Neglected paths and view point of Srebarna nature reservate.

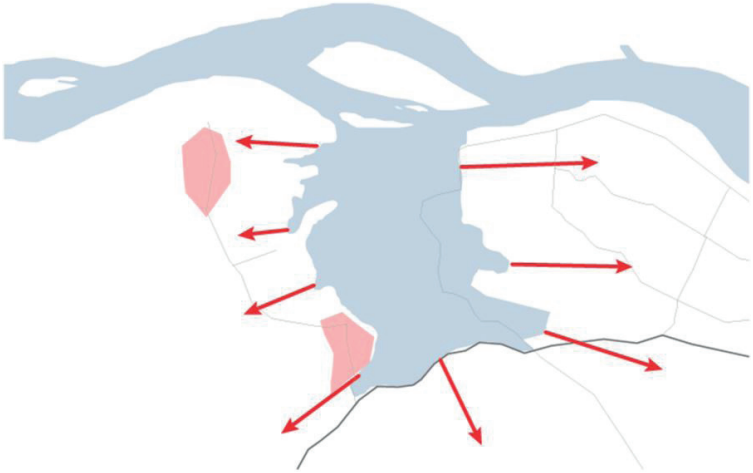
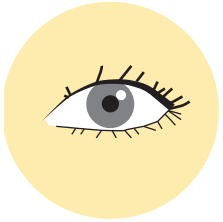


Fig 14c Srebarna has turned its "back" to the Danube

Figure 15: Canoes and rowing boats at the river banks of Silistra



In the P1 stage, the period between orientation and the first official presentation moment, all scales come into sight. On the **L**-scale fascinations from the trip and desk research will be explained. On the **M**-scale Giurgiu will be discussed and on the **S**-scale first impressions and a precedent will be shown.

L-SCALE

FASCINATION

As becomes clear from the orientation stadium the banks on both sides of the Danube river contain high ecological values in the stretch between Ruse and Silistra. Despite of these high values, a lot of the places are neglected as well. The countries seem to turn their back to the Danube at these points.

M-SCALE

What happens on the scale of Ruse and Giurgiu? Ruse is an exception in its relation to the Danube. As this city is directed to the Danube Ruse seems to gain the advantages of the Danube. From the beginning of the 17th century Ruse is an important port. The active river transport had a positive impact on the town. This can be seen by the impressive architecture in the city. The opening of the Friendship Bridge strengthened the position of Rousse. (Alexander Tour Company, 2002). Furthermore it has a paved boulevard along the river banks of the Danube which is frequently visited by many people.

Giurgiu on the other hand is not directed to the Danube. In between the Danube and Giurgiu is a flood plane. On this flood plane industry is settled mostly directed to Giurgiu. In this case the Danube has become a "back" of the city as well.

S-SCALE

At the end of the P1 period an impression captures the actual situation and the "dream" (view fig 16) to create an image of what the design could do: it shows what the river border area seems to be like at some places and what it could become in a design. At most observed places next to the Danube with an urban connection it looked abandoned and neglected. Sometimes the natural values were lost because of the industry, other times only abandoned houses could be found and places "taken over" by gipsies. In short these places could be seen as a drain of the Danube. In "the dream" the potentially high values prosper. The river banks of the Danube turn into attractive places with a rich flora and fauna, where animals can freely move and live. A perfect sign for Danube passers.

Figure 16: Impression of what the river border of the Danube actually seems to be (left) and what it could be like (right) in the studied stretch

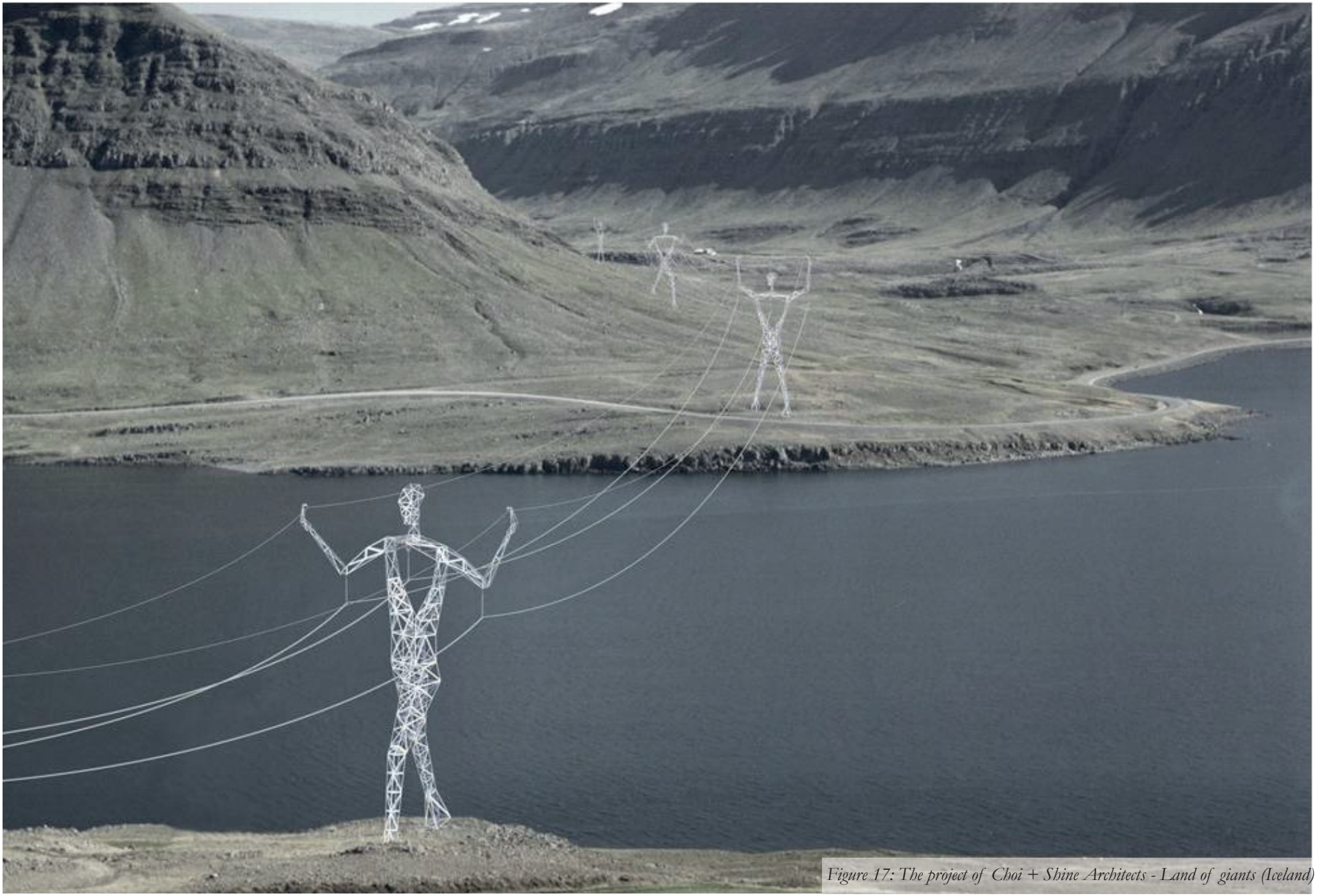
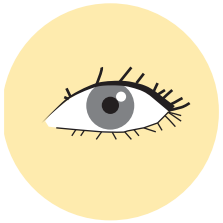
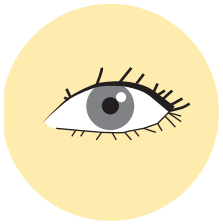


Figure 17: The project of Choi + Shine Architects - Land of giants (Iceland)



Although in this stage the image of the design is not clear, a first precedent is introduced to display the design ambition in figure 17: the design of Land of giants by Choi + Shine Architects in 2008. This project shows how to use a needed infrastructure to connect two sides of a river, by adapting it's atmosphere. Giants fit into this large mountaineous landscape and this is what will be searched for in the design: a language fitting to the landscape.

Figure 18: The port of Ruse as seen from the ruins of Sexaginta Prista



At the stadium between the P1- and the P2- presentation a clear setup is made for the rest of the project on the three scales. In this stage an analysis will be displayed in simplified diagrams and a secure problem statement is made. Furthermore the research question and concept will be defined.

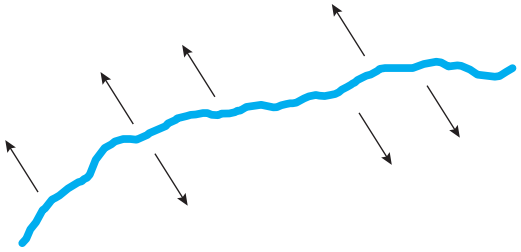


Fig 19a From the observation becomes clear: some places in the river border area have become the "back" of the area.

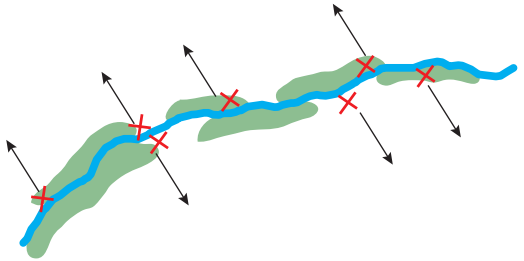


Fig 19c Quite some observed places are neglected

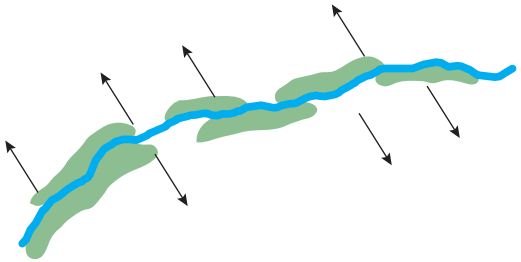


Fig 19b At the same time at these "back" areas contain high ecological values.

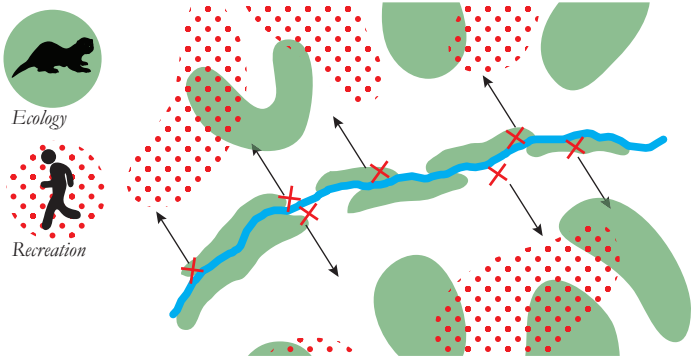


Fig 19d The hinterland contains many places with high ecological and recreational values

Figure 20: One of the advertisements of the campaign of Bulgaria against illegal activities in protected areas

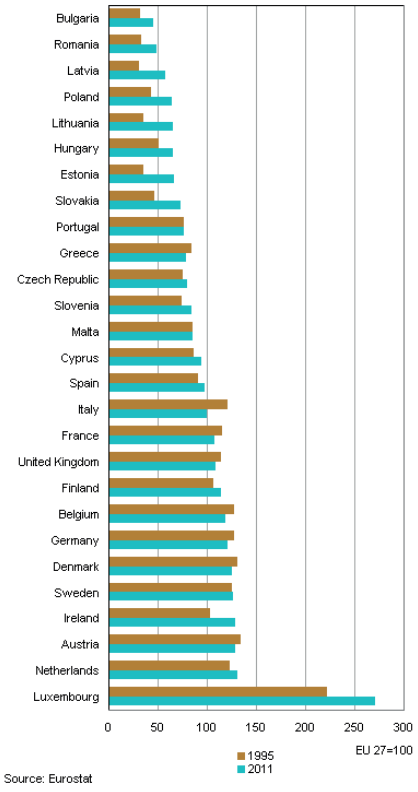


Figure 21: Per capita GDP in the European Union (adjusted for price level differences)

PROBLEM STATEMENT

As derived from the analysis from observation and desk research, the problem statement can be defined.

"Places are neglected in the river border area of the Danube between Bulgaria and Romania, as a result of a lack of money from authorities and possibly a lack of awareness from the local population."

The pressure on places with high ecological values turns out to be very high. This is emphasized by the following facts. In 2006 a campaign was started by the WWF in Romania which displays the pressure on the places with high ecological values. *"The 3-month campaign focuses on the increasing number of illegal activities that are affecting Romania's protected areas and the authorities' lack of reaction, involvement and financial support necessary for the management of these areas."* (WWF Romania, 2006)
Moreover, the same article speaks about the awareness of the local population: "*The focus of the campaign is to raise people's awareness regarding these issues and to put them on the Romanian public agenda."*

The same kind of pressure on sites with high ecological values can be found in sites in Bulgaria:
"*Holiday homes, hotels, villas, ski resorts and ski runs are being built in many of Bulgaria's national and nature parks. They are being built illegally, against existing national laws and regulations."* (Ivanov, 2007)

These quotes show that a solution for the problem in both countries is urgent. The posters of the campaign emphasize this (view figure 20).

The diagram of figure 21 shows the prosperity of both the countries Romania and Bulgaria is the lowest of the countries of the European Union. This underscores the lack of money from authorities.

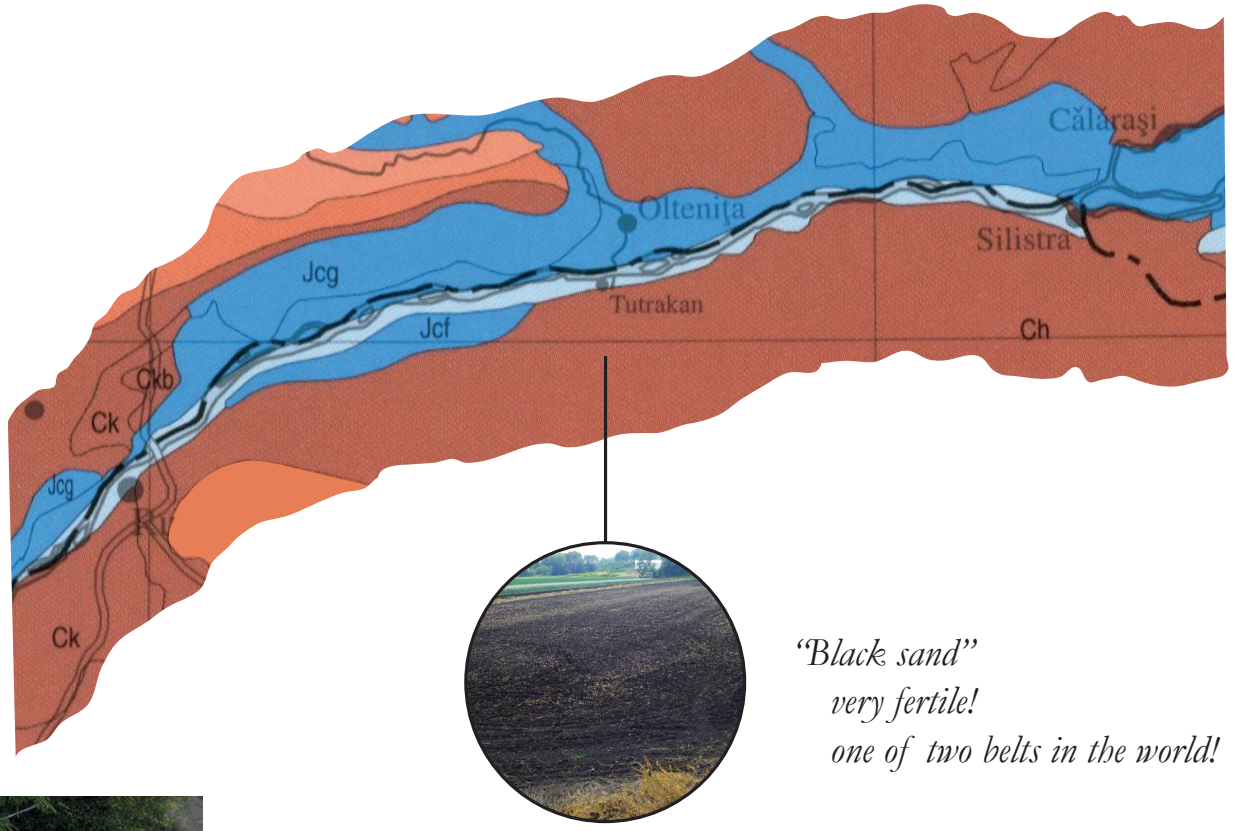
OPPORTUNITIES

To find a decent solution for what is explained in the problem statement, different opportunities come up, in the fields of tourism, subsidies and education.

The lack of money from authorities could be reversed by the increasing tourism in Bulgaria and Romania. From figure 24 the increasing tourism statistics for these countries can be derived. Moreover, the "Sustainable Transport & Tourism along the Danube" report states that the tourism in the area of Ruse is still growing. "*Tourism is one of the most important and promising economy sectors. (...) In recent years the tourist flow to the municipalities in the region has steadily increased."* (CSDCS, 2013)

Another chance lies in the subsidies for the region, as for example the "Danube Region Strategy", which is a Strategy to boost the development of the Danube region by the European Commission. One of the so called priority areas is "*to preserve biodiversity, landscapes and the quality of air and soils*" and another is "*to promote culture and tourism, people to people contacts*" (EUSDR, 2015). This strategy is an opportunity to gain money from authorities.

For the possible lack of awareness in the local population lies a chance in education. Education could make people aware of the neglected places and create a certain feeling of responsibility among them. A good example on how to do this is the Communication, Education and Public Awareness (CEPA) programme of the Convention on Biological Diversity (CBD). In this programme the involvement of major stakeholder groups is encouraged to contribute to a better biodiversity. In this case the stakeholders "Children & Youth" and "the Green Wave for schools" in particular are important (CBD, 2015).



"Black sand"
very fertile!
one of two belts in the world!

Figure 22: The soil in the south of Romania and north of Bulgaria

The soil

Chernozem

Phaeozem

Luvisol

Calcaric Fluvisol

Water body

N

5 km

RESEARCH QUESTION

"How to interweave the river border landscape of the Danube between Bulgaria and Romania with the surrounding ecological and recreational network?"

By river border area is meant the river from the frontier and its direct adjacent landscape. Between this and the ecological and recreational network mutual connections should be created (the interweaving has to take place). By ecological network is meant the coherent system of groups of natural elements (plant & animal life); by recreational network, the coherent system of places to stay for pleasure for tourists and locals.

CONCEPT

The found neglected places should be turned into activated ecological connections to create interweavements. These

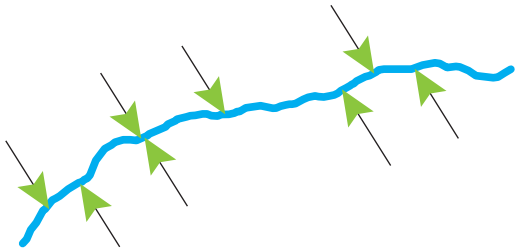


Fig 23a Activate ecological connection by restructuring neglected places

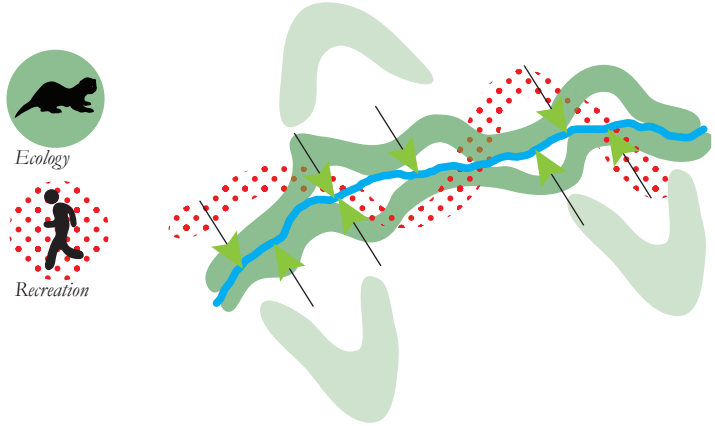


Fig 23b Interweave in this way the river border area with the existing recreational and ecological network

interweavings connect the river border area with the existing recreational and ecological network.

FURTHER ANALYSIS

L-SCALE

Now the need is to find out how to activate ecological connections of the neglected places and how to interweave. This starts with a more general alaysis on the L-scale. Figure 22 shows the soil of Bulgaria and Romania. The soil map shows that almost the whole area is covered with Chernozem, so called "black earth", which is very fertile. This explains partly the high ecological values.
Looking at the weather conditions, the studied area has a distinct continental climate, with hot summers and severe winters. This is

COUNTRY	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BULGARIA																			
Inbound tourism - Arrivals - Thousands	3,466	2,795	2,980	2,667	2,472	2,785	3,186	3,433	4,048	4,630	4,837	5,158	5,151	5,780	5,739	6,047	6,328	6,541	6,898
ROMANIA																			
Inbound toursim - Arrivals - Thousands	5,445	5,205	5,149	4,831	5,224	5,264	4,938	4,794	5,595	6,600	5,839	6,037	7,722	8,862	7,575	7,498	7,611	7,937	8,019

Figure 24: Increasing tourism data in Romania and Bulgaria, UNData

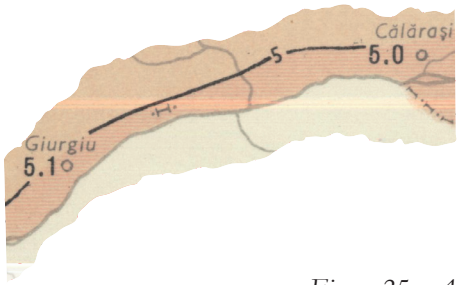


Figure 25a: Average temperature in January 1948

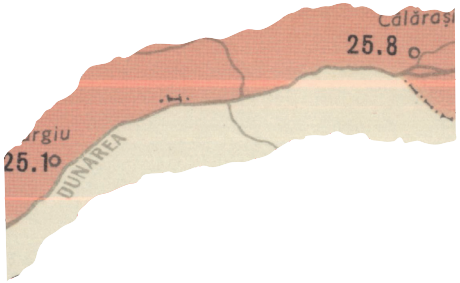


Figure 25b: Average temperature in July 1946

Figure 26: Average height of precipitation 1896-1955

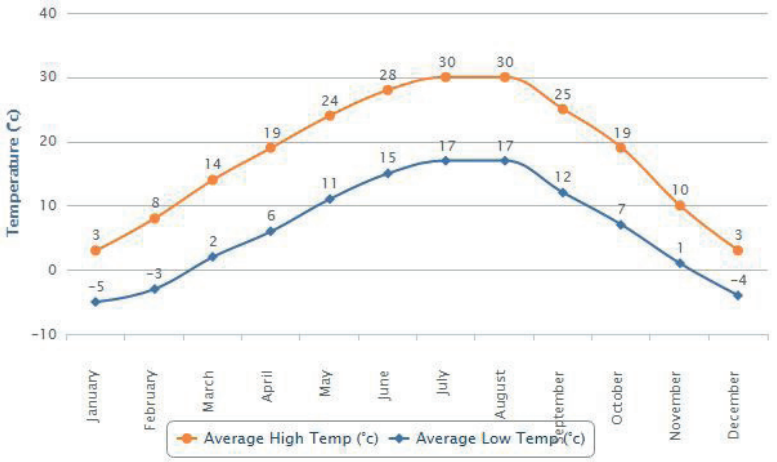
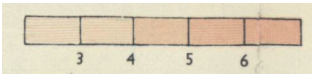
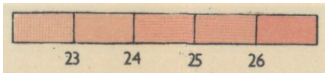


Figure 27: Average temperature (°C) graph of Ruse from 2000 to 2012

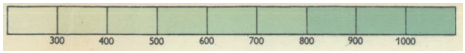
Average temperature in January 1948 (°C)



Average temperature in July 1946 (°C)



Average height of precipitation 1896-1955 (mm)



— *5 km*

what is shown in old maps of the Romanian side in figure 25. In Januari '48 the average temperature was 5 °C and in Juli '46 the average temperature was 25,5 °C. Figure 27 shows in a more recent diagram, nowadays this is still applicable. It's important to notice the continental climate, because in the design the climate should be kept in mind: designing in a different climate means a different design.
The average height of precipitation fluctuates between 500 and 600 mm. It decreases to the east side.

RECREATIONAL NETWORK

Looking at the recreational hotspots (Figure 28) many of them are situated near the river border landscape. Some of them are as well ecological hotspots, such as the Srebarna lake and the Rusenski Lom national park. In the recreational connections (Figure 29) the crossing Ruse/Giurgiu is an important spot. It is situated along two of the ten Pan-European Corridors: Pan-European Corridor VII (Danube), linking Western Europe to the Black Sea and Central Asia, and the Pan-European Corridor IX, connecting Scandinavia and Federation Russian to Southern Europe and Asia Minor. Besides that the recreational network is mostly underdeveloped. There's only one bridge in the stretch that crosses the Danube and there's one ferry between Calarasi and Ostrov. The Danube provides the opportunity to connect.

ECOLOGICAL NETWORK

Looking at the ecological hotspots (figure 30) there's again an overlap in spots that are used for recreational aims (indicated as red). Figure 31 shows the natura 2000 areas along the Danube are quite well connected and the otter is largely present. The natura 2000 areas contain for a large part forests along streambeds of small streams.

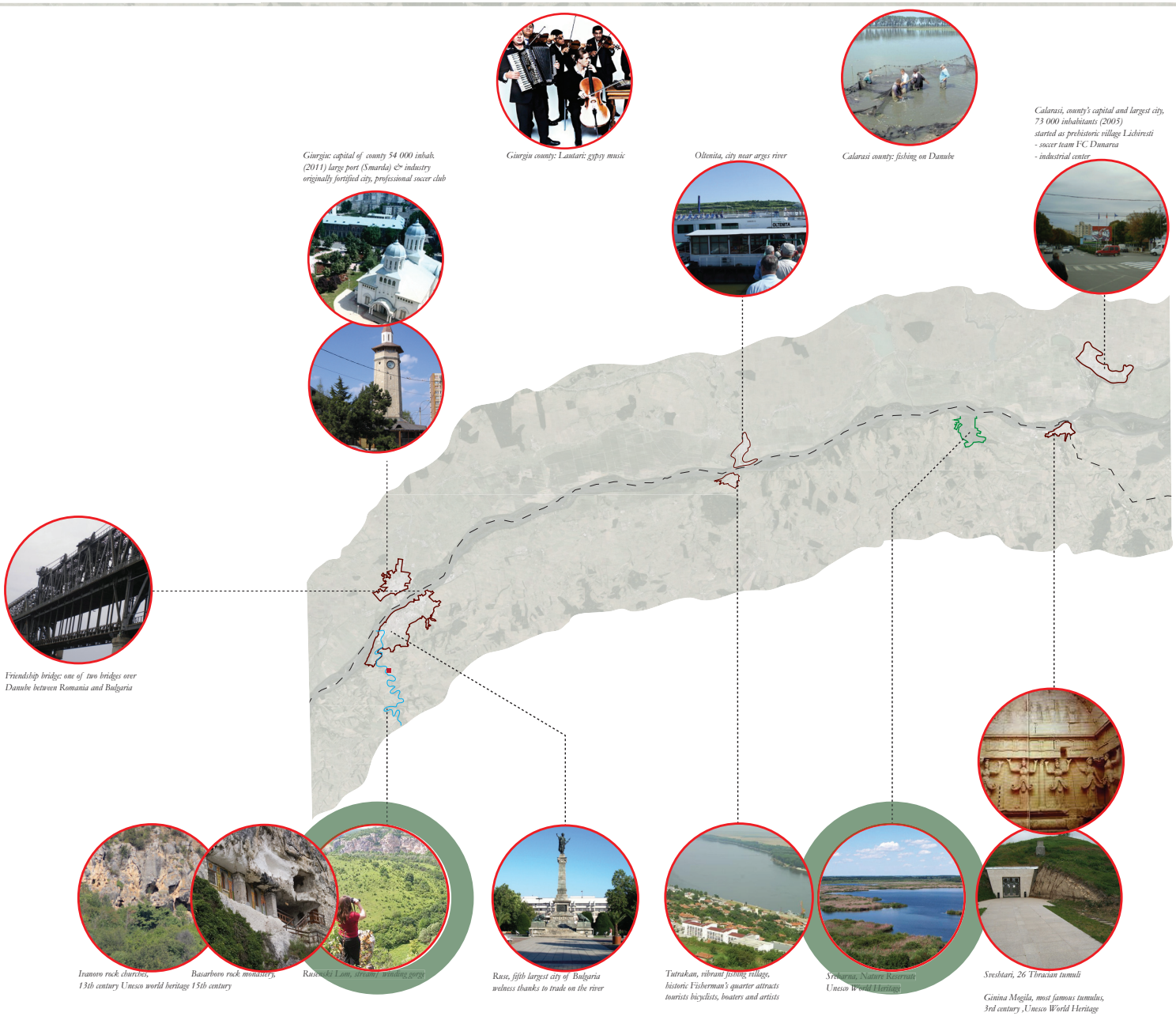


Figure 28: Recreational hotspots

Recreational connections

International train two times per natural day to Bucharest & Istanbul

Highways are in good state, local ways in worse state

Ferry between Calarasa and Ostrov

Cruises on Danube

N

— 5 km

Figure 29: Recreational connections

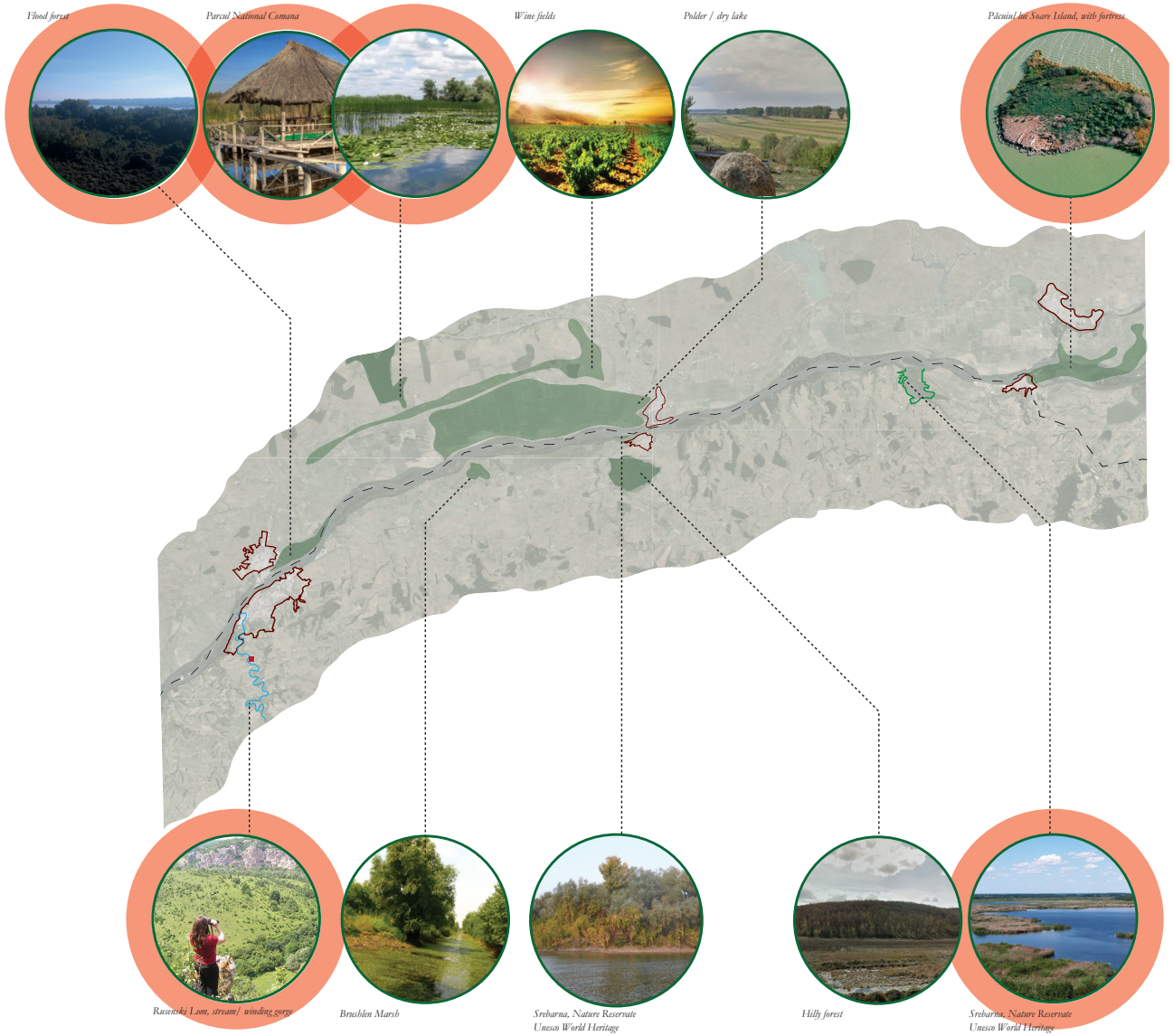


Figure 30: Ecological hotspots

Ecological connections

Natura 2000 habitat directive site

Natura 2000 bird directive site

Lutra lutra present

Lutra lutra poorly present

X *No lutra lutra present*

N

5 km

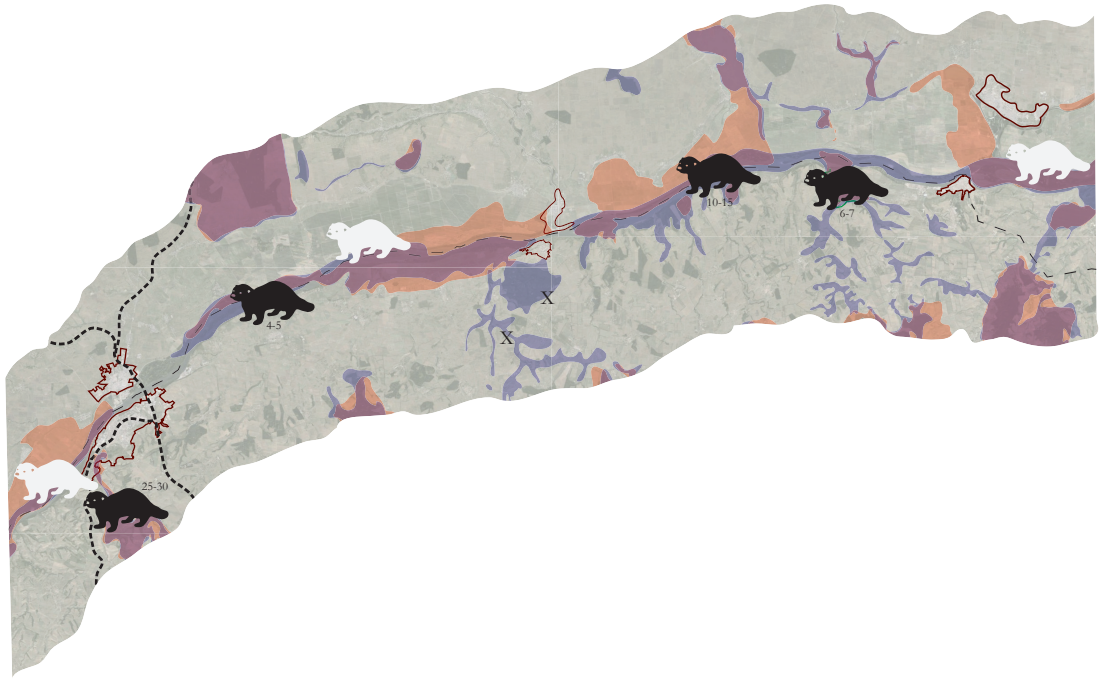


Figure 31: Ecological connections

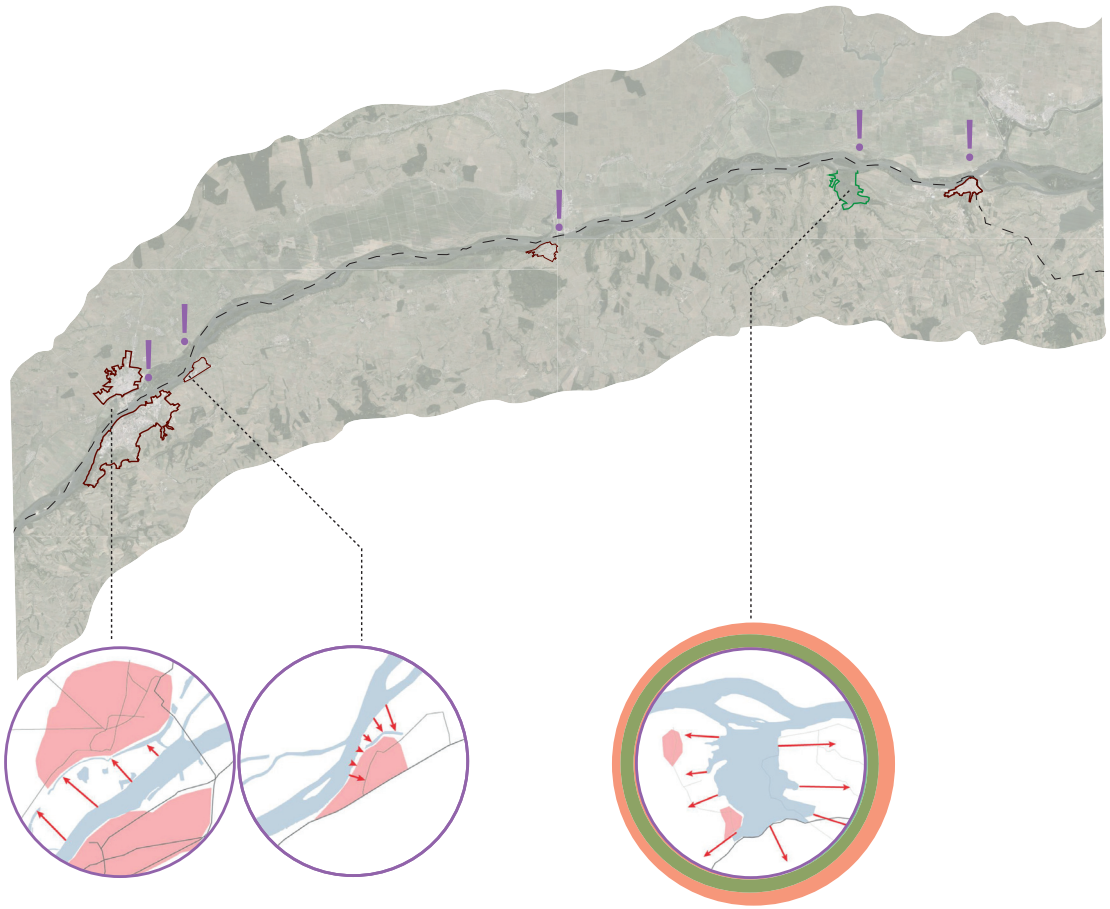


Figure 32: Critical areas in river border landscape

— *5 km*

RIVER BORDER AREA

From the observation most visited places in the river border area turned out to be neglected (figure 32). Srebarna is a special one, since it is part of the recreational and ecological network as well.

PATCH-CORRIDOR-MATRIX-METHOD

At the same time a more theoretical approach started: the patch-corridor-matrix method (Forman, 1995) to compare data in a more scientific way. The patch-corridor-matrix-method is a convenient and commonly used approach, which is based on the idea that a landscape consists of elements forming patterns that can be valued and in this way compared accurately. Forman distinguishes three main groups of elements forming the patterns: patches, corridors and matrixes. These three will be elaborated.

Landscape ecologists use a lot of different terms for the basic elements of a landscape, that are useful for specific user groups or researchers. In Forman's method basic elements are linked to a specific perspective, such as ecology or strictly organisms. These perspective-linked basic elements are called *patches*. From the organism point of view for example a patch may be defined as a unit that differs in fitness or quality for the specific organism. The patch can be applied on different scales: a patch exists on the smaller scale of smaller patches, while it is at the same time part of a mosaic of other patches that altogether form a patch on a larger scale. Because the extent of a patch from a for example organism-centered perspective is dependent to the amount of organisms, the patch is from an organism-centered perspective as well linked to a certain amount of the organisms. Other defined basic elements in this approach are *corridors*: landscape elements that are special because of their linear shape and the contrast with the matrix (the third dominant element of description). There are very diverse type of corridors and because of the intended application on the graduation project it's useful to state the types: the types can be distinguished by function, structure or both.

Reasoned from function four main different corridors can be recognized:
habitat corridor: corridor as a landscape element where landscape relations with other patches start and are being stimulated
movement corridor: corridor as a landscape element where landscape relations with other patches are being stimulated
filter corridor: corridor as a landscape element where landscape relations with other patches are being blocked or reduced
source of effects on the surrounding matrix: corridor as a landscape element that modifies inputs to the surrounding matrix and effects the functioning of the matrix.

Reasoned from structure three types can be distinguished:
line corridor: too narrow for new processes to start
strip corridor: wide enough for new processes to start
stream corridor. strip of vegetation enclosing flowing water, highly stimulating new processes to start

Matrixes are the most comprehensive and connected landscape elements and therefore the most influential elements in the functioning of the landscape. The matrix element is -as well as patches- dependent to its linked phenomenon and scale of research. Mostly this matrix is obvious to the researcher, because it's obviously visible, but in some cases it is not (for example soil could be a matrix, while concerning a geomorphological process at a specific scale).

APPLICATION OF PATCH-CORRIDOR-MATRIX-METHOD

Since the three landscape elements of the approach are dependent on the scale and phenomenon of interest, it's important to define these. Natura 2000 protected sites data show the appearence of otters as well in surrounding flood

Figure 33: Aerial photograph of L-scale

forests in the area. The (flood) forest stand will be used as the phenomenon of interest on different scales within the determined frame of study.

On the **L**-scale the matrix (view fig 34c), the most present and connecting element, is agricultural area. Forests, in dark green, are the patches, that differ from the surroundings. The Danube forms the corridor: it clearly differs on both sides from the agricultural area and has a linear shape. Reasoned from function it is a habitat corridor: at this place relation with other patches start and are being stimulated (several forest patches can be seen close to the river, in particular on the side of Bulgaria). Reasoned from structure it is a stream corridor, as a consequent strip of vegetation - (flood) forest - is surrounding the flowing river of the Danube.

In the final design the patches on this scale will be used as stepping stones for an interconnected green structure. The corridor forms the carrying structure to which the patches are connected. How this works in the design will be described on pages 103 and 113.

On pages 57 and 69 the patch-corridor-matrix method is elaborated for respectively the **M**-scale and **S**-scale.

Figure 34a: patches

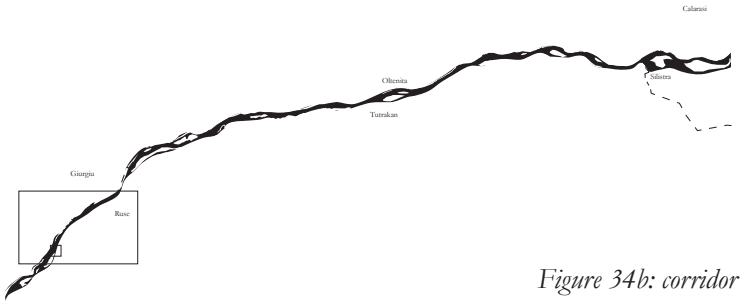


Figure 34b: corridor

Figure 34c: matrix

N

— *5 km*

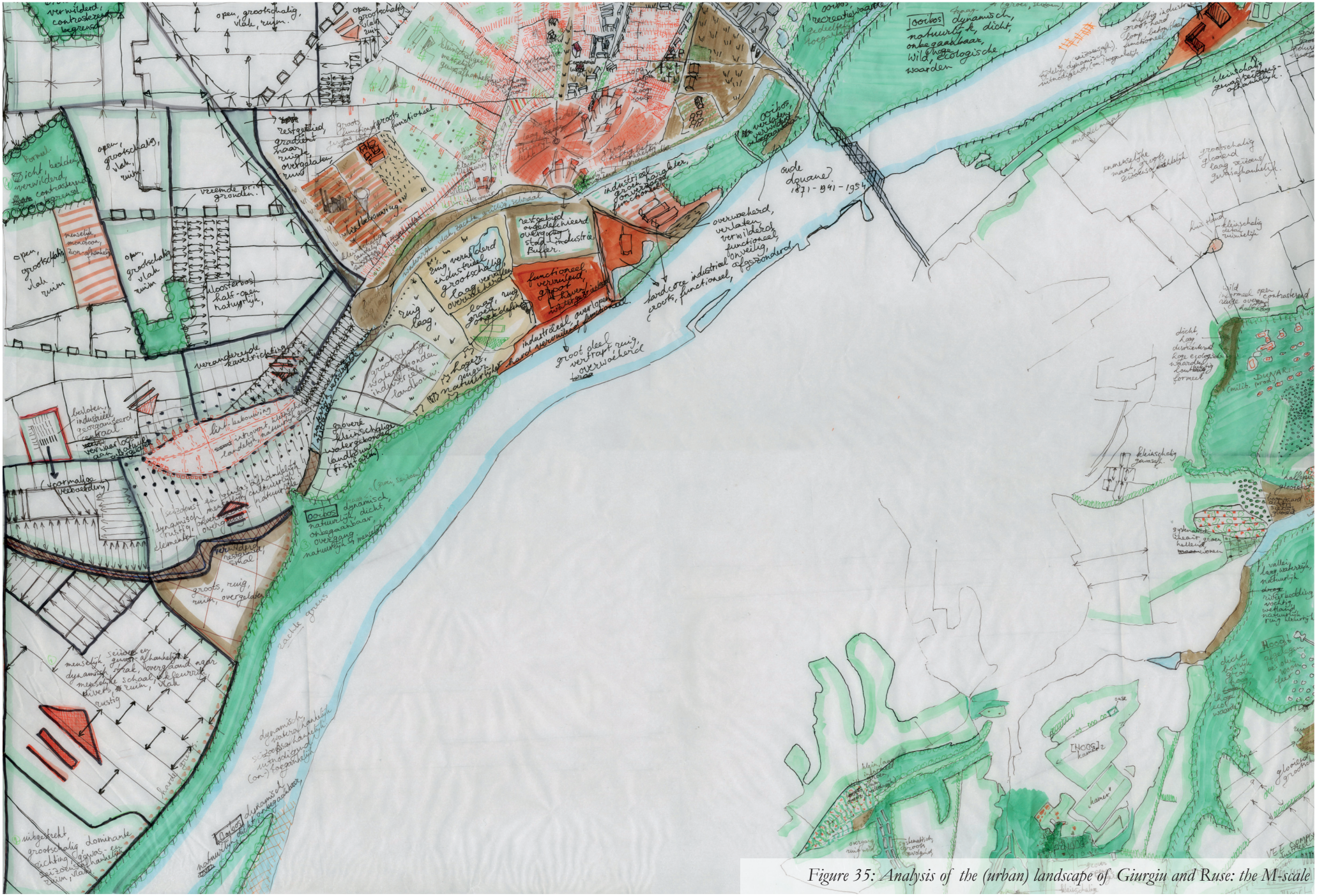


Figure 35: Analysis of the (urban) landscape of Giurgiu and Ruse: the M-scale

M-SCALE

On the left page in figure 35 is shown how the **M**-scale was analysed in a manual way: by sketching. From aerial photographs and street view pictures the surroundings of Ruse and Giurgiu were explored and drawn in structures, colours, textures, small drawings and text. Since the observation focused on the centre of Ruse, for this analysis Giurgiu and its surroundings, and the surroundings of Ruse were investigated first (as the analysis shows).

This is a very intensive way of analysing, but to get to know an area from a distance (when you can't visit the place), it is recommended to work like this. At the same time patches can be recognised and analysed in depth. This is useful for the elaboration of the patch-corridor-matrix method (Forman, 1995).

Figure 36: Recreational hotspots

RECREATIONAL NETWORK

In the recreational network several hotspots can be found on both sides of the river. At the same time some of them are ecological hotspots as well. In the city center of Ruse most of the recreational hotspots are linked through a pedestrain zone. Remarkably, this is not well connected to the pedestrian zone along the Danube. In the south (where there's the terrace) the recreational zone with the Luliaka hotel complex is also not yet well connected to the city center. A more elaborated map of the recreational network can be found on page 117. Furthermore, pages 118-122 and 126-127 consider the recreational network on the **M**-scale.

1 km

Figure 37: Ecological hotspots

ECOLOGICAL NETWORK

In the ecological network most of the ecological hotspots are recreational hotspots as well (figure 37). The national park Rusenski Lom takes in an important place. There are different marked routes in the park that allow tourists to observe its biological diversity. Although it's a very important place in the network, connections can be improved. During the visit the roads were very wet with puddles of mud because of a rainy day. It was not really fun to walk. Besides that a visitors center is missing. By trying to get in contact with the department of natural park Rusenski Lom, there was no response. A more elaborated map of the ecological network can be found on page 116. Furthermore, pages 118-122 and 126-127 consider the ecological network on the **M**-scale.

1 km

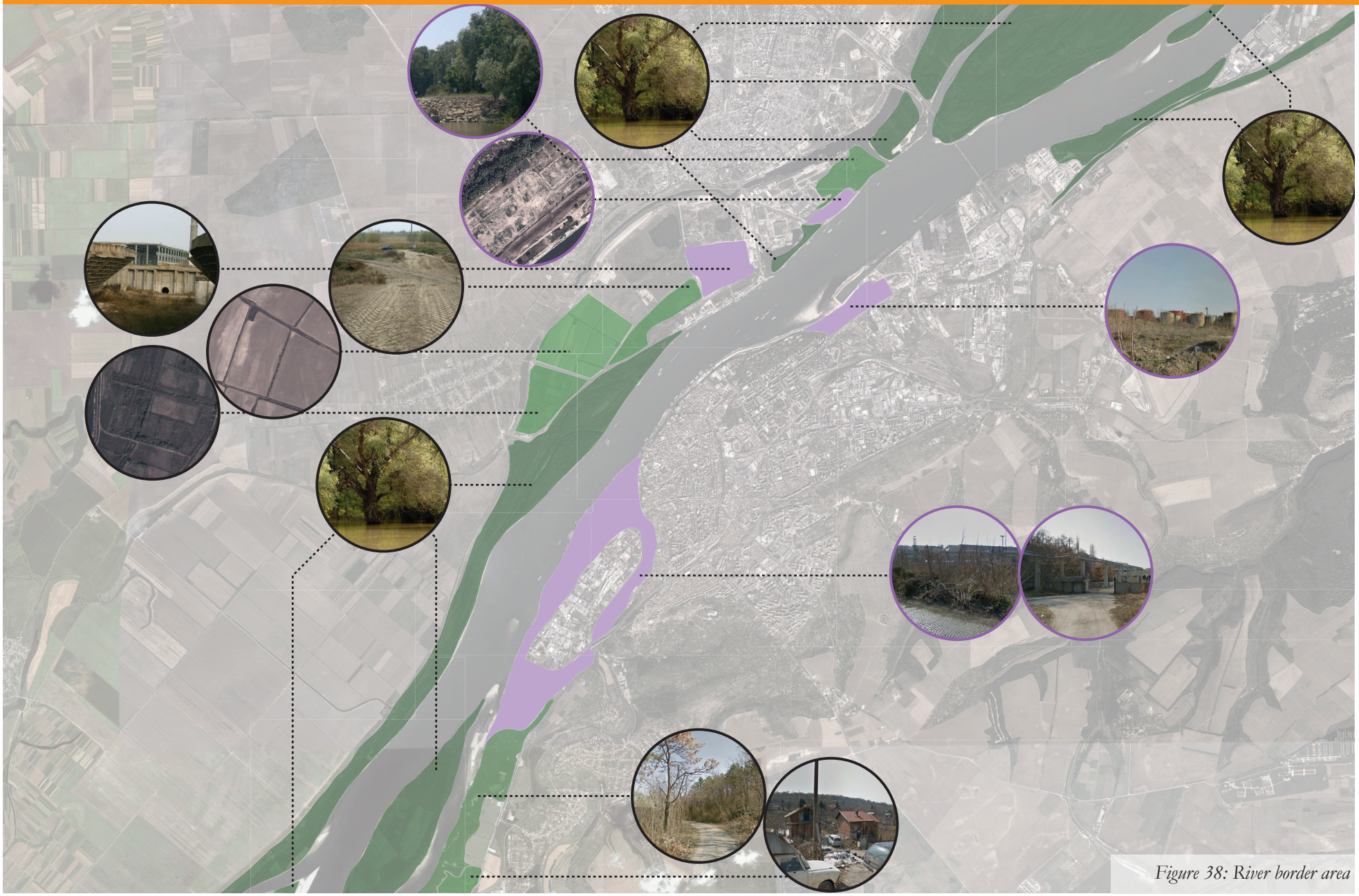


Figure 38: River border area

River border area

neglected green

intermediate value of green

high value of green

N

1 km

RIVER BORDER AREA

On the **M**-scale there are several places that are neglected. In the middle of the map three places are shown that because of the industry are not very attractive, but could play a role in an ecological connection to the ecological and recreational network. Most important is the mouth of the Rusenski Lom, which is covered by industry and therefore neglected.

Figure 39: Aerial photograph of the M-scale

APPLICATION OF THE PATCH-CORRIDOR-MATRIX-METHOD

Looking again at Forman's method, still agricultural area is the dominating element on the **M**-scale: the matrix stays the same (agricultural areas) and the Danube stays as a corridor as well. Patches are being formed by different (flood) forests, visible in dark green. These are obviously different on both sides of the corridor. Inland patches on the Romanian side have strict boundaries, while inland patches in Bulgaria have different, more fluent shapes, with loose boundaries. Coves and lobes along an edge provide greater habitat diversity than a straight edge encouraging higher species diversity (Dramstad, 1996).
Interesting is the presence of a lot of areas of urban development. These areas could be considered as patches, if for example the phenomenon was focused on urban landcape elements (e.g. industrial areas). Since the defined phenomenon is (flood) forest, these urban areas are not considered patches and do not join the landscape mosaic. Compared to the larger scale, although the matrix is the same landscape element, the matrix is less dominant. This is probably because of the impact of the urban area on the landscape.

The patches and corridor are used in the design to create an interconnected green network. How this works in the design will be described on pages 103 and 113.

On pages 47 and 69 the patch-corridor-matrix method is elaborated for respectively the **L**-scale and **S**-scale.

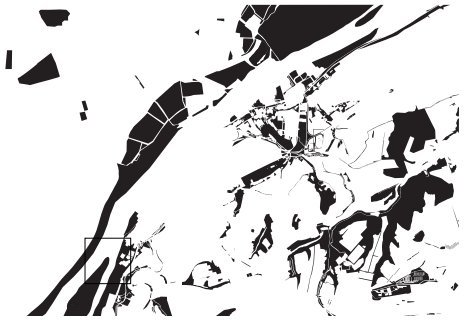


Figure 40a: patches

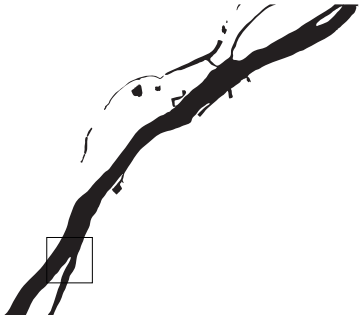


Figure 40b: corridor

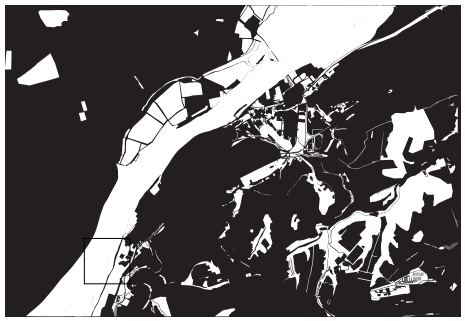
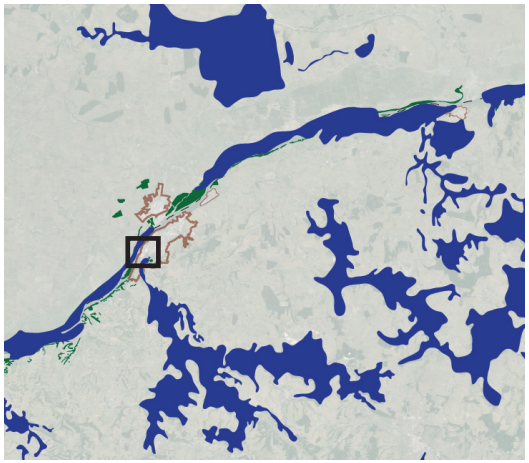


Figure 40c: matrix

N

1 km

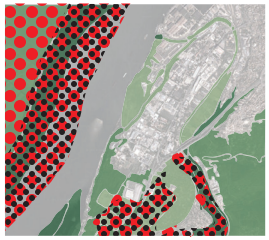
Reason for possible interweavement: missing link in natura 2000 areas (M-scale)



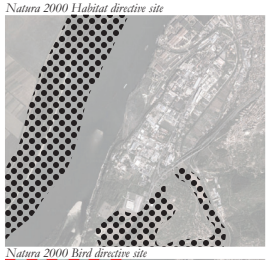
10 km

Zoom

Ecology structure

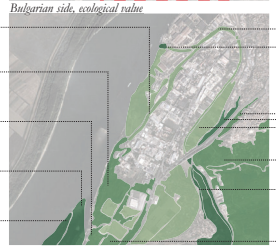


Natura 2000 Habitat directive site



Natura 2000 Bird directive site

Bulgarian side, ecological value

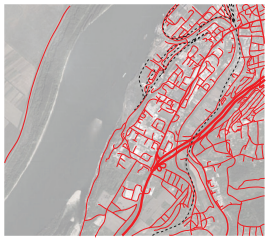


Romanian side, ecological value

Water structure

Rusenski Lom

Infrastructure

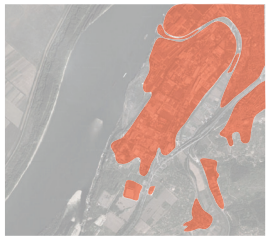


secondary roads

primary roads

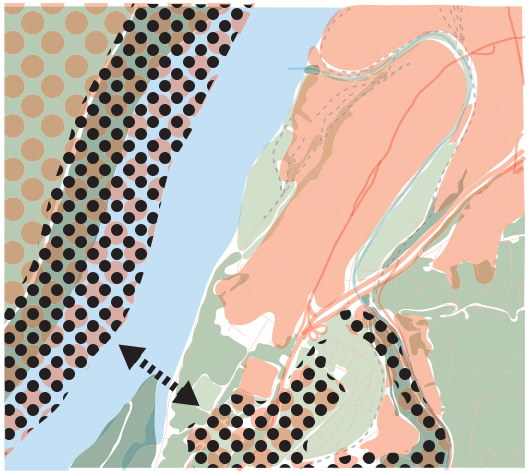
railroads

Urban structure



Maps of conclusion:

Industry and highway poison connection of high ecological value (mouth of Rusenksi Lom)



Shortest connection between Natura 2000 areas defines possible place of interweavement

M & S-SCALE

From this moment a general analysis from maps on **M**- and **S**-scale started, inspired by the methodology lecture of Sybrand Tjallingii. During this lecture Tjallingii showed a method of analysis to put different layers on top of each other (green, blue red) to find out in an experimental way whether there are conflicts between the layers.

On the left a picture is shown on the scale of Ruse and Giurgiu (**M**-scale) of the Natura 2000 habitat directive sites. The black framework is the place on which is zoomed in. In the other pictures this zoom is elaborated and analysed in four categories: ecology structure, water structure, transport structure and urban structure.

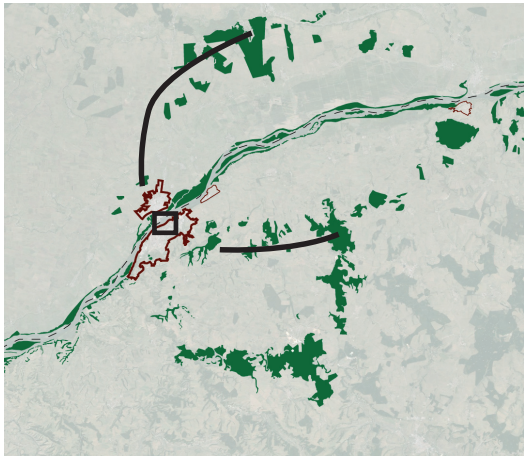
In the ecology structure one could see an important gap in the Natura 2000 bird and habitat directive sites. Below the ecological value is shown by adding a certain value to the different areas. The darker the green, the better the ecological value seems to be.

In the water structure the small stream and national park Rusenski Lom is designated. The mouth of the Rusenski Lom is built over by industry.

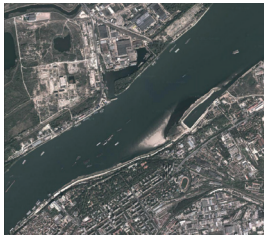
The infrastructure shows an important highway (E85) is crossing the area, which ensures the hick-up in the ecological connection. The urban structure displays that this part is situated outside of the city of Rousse.

In the maps of conclusion the hick-up in the ecological connection is shown and the shortest connection between the Natura 2000 areas. The hick-up in the Natura 2000 area is the reason why later on in the design this spot (the outer northern point of the island Luliaka) is chosen to elaborate in detail.

Reason for possible interweavement: missing link in foreststst (M-scale)



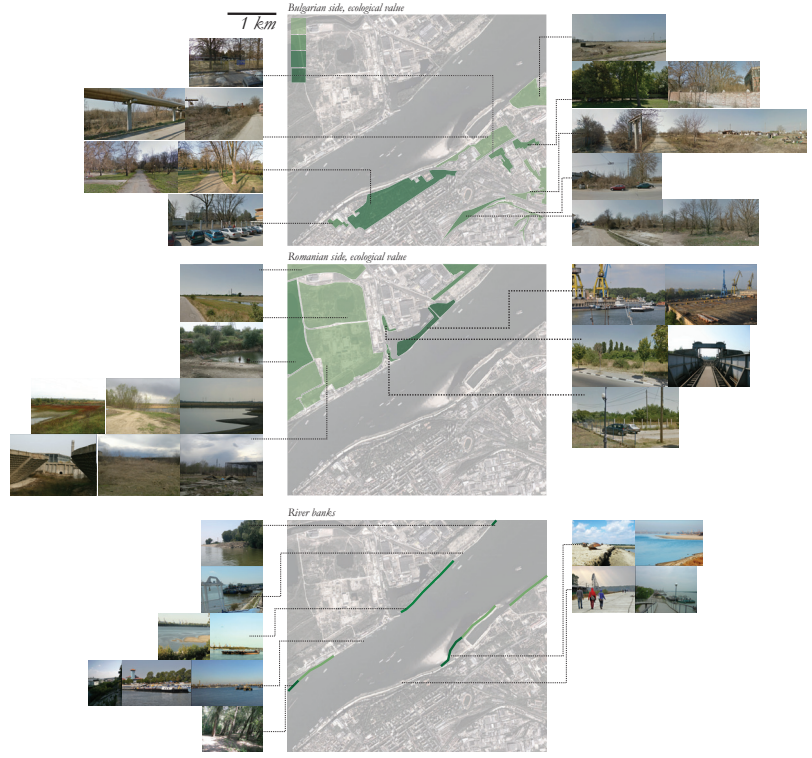
Zoom



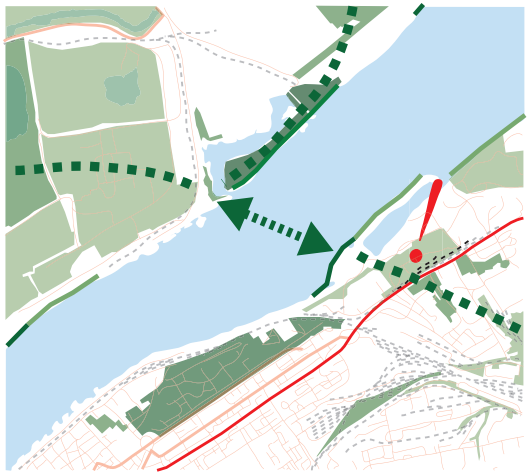
Ecology structure

Water structure

Infrastructure



Maps of conclusion:



- Best way to interweave through city
- Conflict between green, road and railroad

On the left a picture is shown of a sequence of adjacent green areas on the scale of Ruse and Giurgiu (**M**-scale). The black framework is the place on which is zoomed in. In the other pictures this zoom is elaborated and analysed in three categories: ecology structure, water structure and infrastructure.

In the ecology structure the ecological value is shown by adding a certain value to the different areas. The darker the green, the better the ecological value seems to be. For a good ecological connection some areas need to be upgraded. The water structure shows on Giurgiu side some places of water besides the Danube.
The infrastructure shows road and railroad are crossing the area, which ensures a hick-up in the ecological connection.

In the maps of conclusions a conflict in the ecological connection is shown and the best way to interweave through the city. Here's the best sequence of green areas found.

Figure 41: Recreational hotspots

S-SCALE

RECREATIONAL NETWORK

On the **S**-scale only one hotspot of recreation can be found, a small pier. The area is used for canoeing and fishing and sometimes in August the water level of the river is so low, that you can walk to the island Luliaka. The sand banks are used as small beaches then.

100 m

Figure 42: Ecological hotspots

ECOLOGICAL NETWORK

On this scale the site contains a lot of places with high ecological values. The flood forest of the island Luliaka, and the flood forest of the river banks of Romania. Besides that it is situated near the "Prista" park, which is a forest with hilly parts. Between the island Luliaka and the river banks of Bulgaria from time to time (mainly in summertime) sand banks appear which act as wetlands. "*Wetlands are hotspots of biodiversity and provide a meriad of benefits and services, including flood protection, drinking water, nutrient removal, tourism and recreation, fish and fowl*" (WWF, 2015)

100 m

Figure 43: River border area

River border area

neglected green

high value of green

N

100 m

RIVER BORDER AREA

On the **S**-scale some places are neglected. Most important is the line of gypsy dwellings along the river banks. In these dwellings Roma gypsies are living. The main causes for Roma to migrate to the west of Europe is poverty, unemployment, discrimination and hopelessness (Van Baar, 2013). The Roma's therefore have a special way of life, sometimes accompanied with begging and they could be very brutal or threatening to passers. This became as well clear from observations during the trip.

Furthermore the buildings of the industrial area are a bit outdated and neglected.

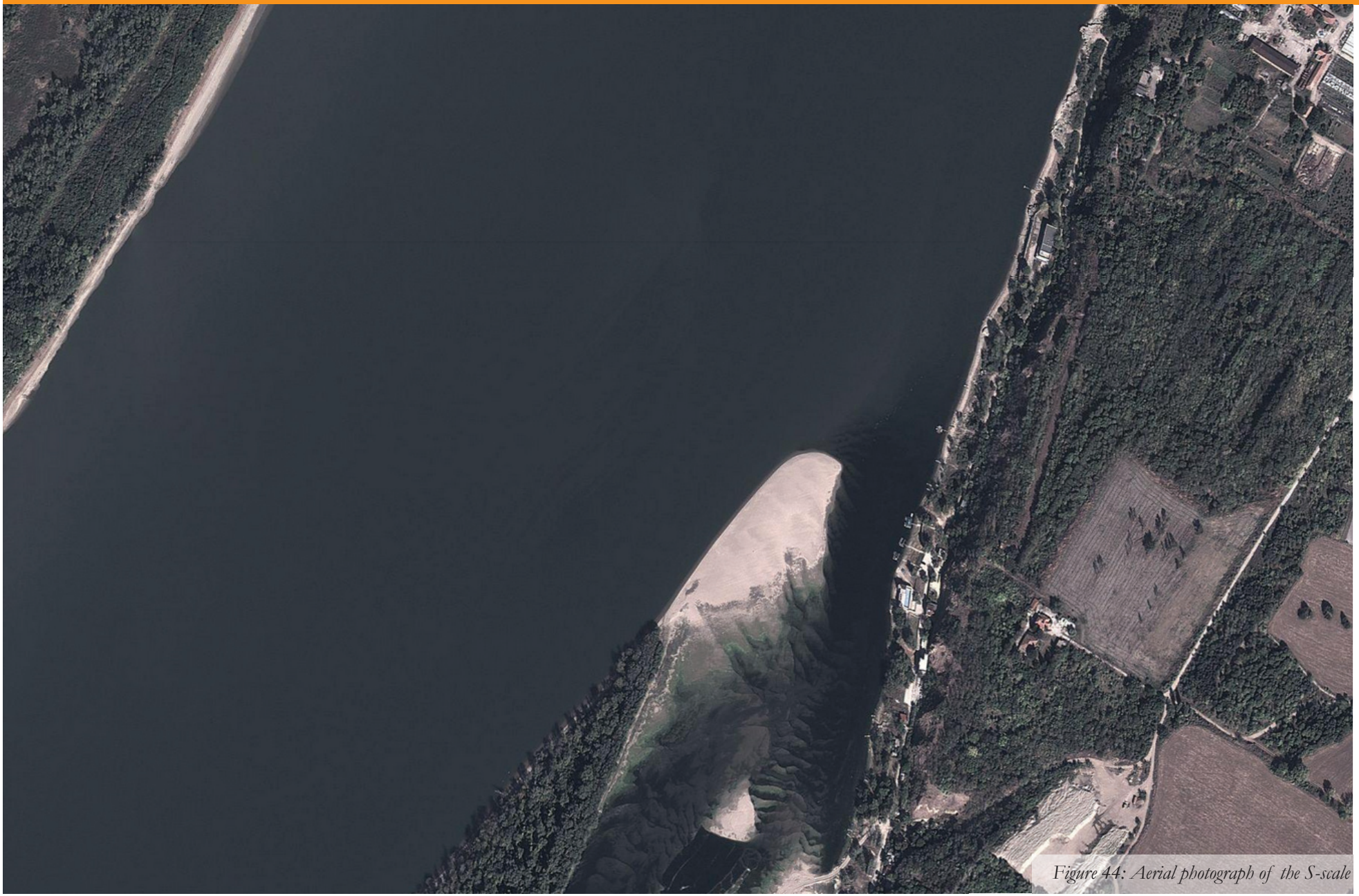


Figure 44: Aerial photograph of the S-scale

APPLICATION OF THE PATCH-CORRIDOR-MATRIX-METHOD

On the **S**-scale the agricultural land is not dominating anymore (figure 44): (flood) forests form the matrix as the most influencing landscape element. Differences in boundaries or densities and small groups of trees form the patches, which differ on both sides of the river. On the side of Bulgaria the edge is more frayed, which indicates more human presence.

The patches and corridor are used in the design to create an interconnected green network. How this works in the design will be described on pages 103 and 113.

On pages 47 and 57 the patch-corridor-matrix method is elaborated for respectively the **L**-scale and **M**-scale.

Figure 45a: patches

Figure 45b corridor

Figure 45c: matrix

N

100 m

Table 1. Stomach contents of 14 Rumanian otters

Prey type	Percentage of diet
Fish	78%
Frogs	8%
Mammals	6%
Invertebrates (crustaceans, molluscs, insects)	8%

Figure 46: Stomach contents of otter

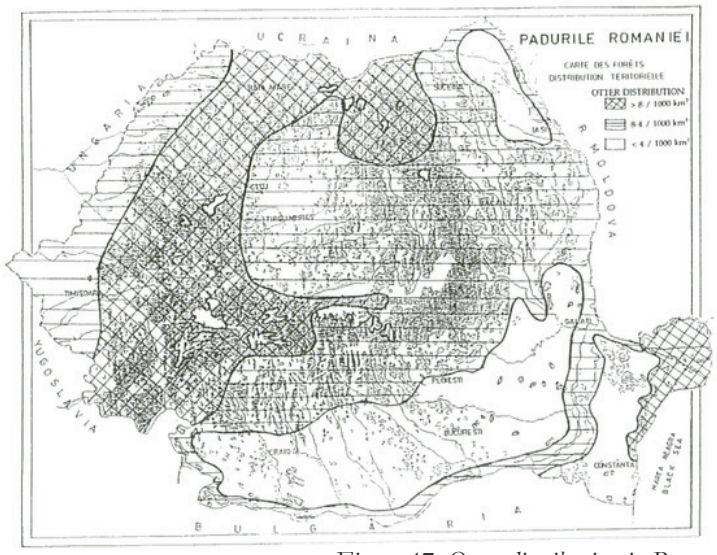


Figure 47: Otter distribution in Romania

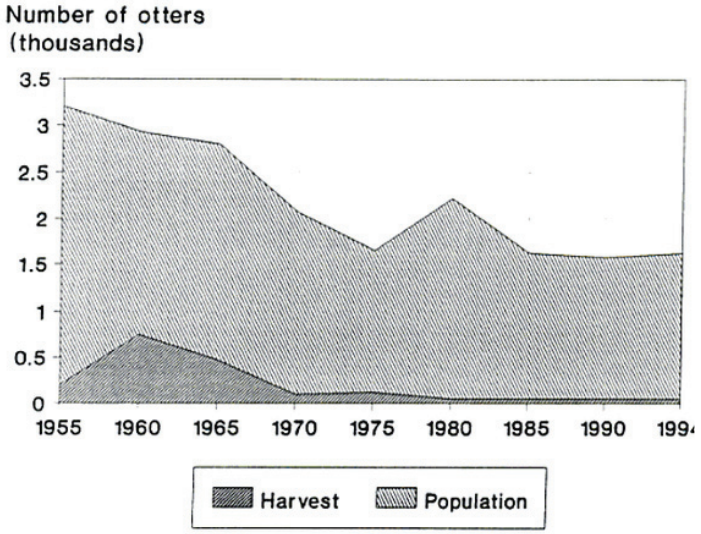


Figure 48: Otters in Romania

THE OTTER

Although the distribution is not uniform, in Bulgaria and Romania do live otters, respectively 920 in Romania in 1993 and 1000 to 1400 in Bulgaria in 1989. (Council of Europe, 1996)
"*Otters are indicators of healthy aquatic environments, as animals at the top of the food chain. Any measures, which successfully benefit this species will prove beneficial to the wetland ecosystems as a whole"* (Kadlecik, 1993)
In Romania the attitude of people towards otters is indifferent due to a lack of information. Because of this the Council of Europe will do a large public relations effort - books, stamps, posters, films - "to resuscitate the image which the species deserves and to awaken the latent feelings of sympathy and goodwill among the people" (Council of Europe, 1996)

In Bulgaria public awareness campaigns are needed to policy and decision makers and general public and co-operation with the neighboar countries Romania, Greece and Turkey. (Council of Europe, 1996)

From this information can be concluded that the attitude of people towards otters is almost the same in both countries: indifferent. The design on both sides of the river (both countries) involves a social aspect and a landscape aspect. Since the attitude on both sides of the river towards otters is the same, the design on both sides of the river will therefore be shaped in the same way. The landscape aspect will be described later on page 163.

The design will optimise the conditions for the otter. The otter will be taken as a symbol for a healthy aquatic environment.

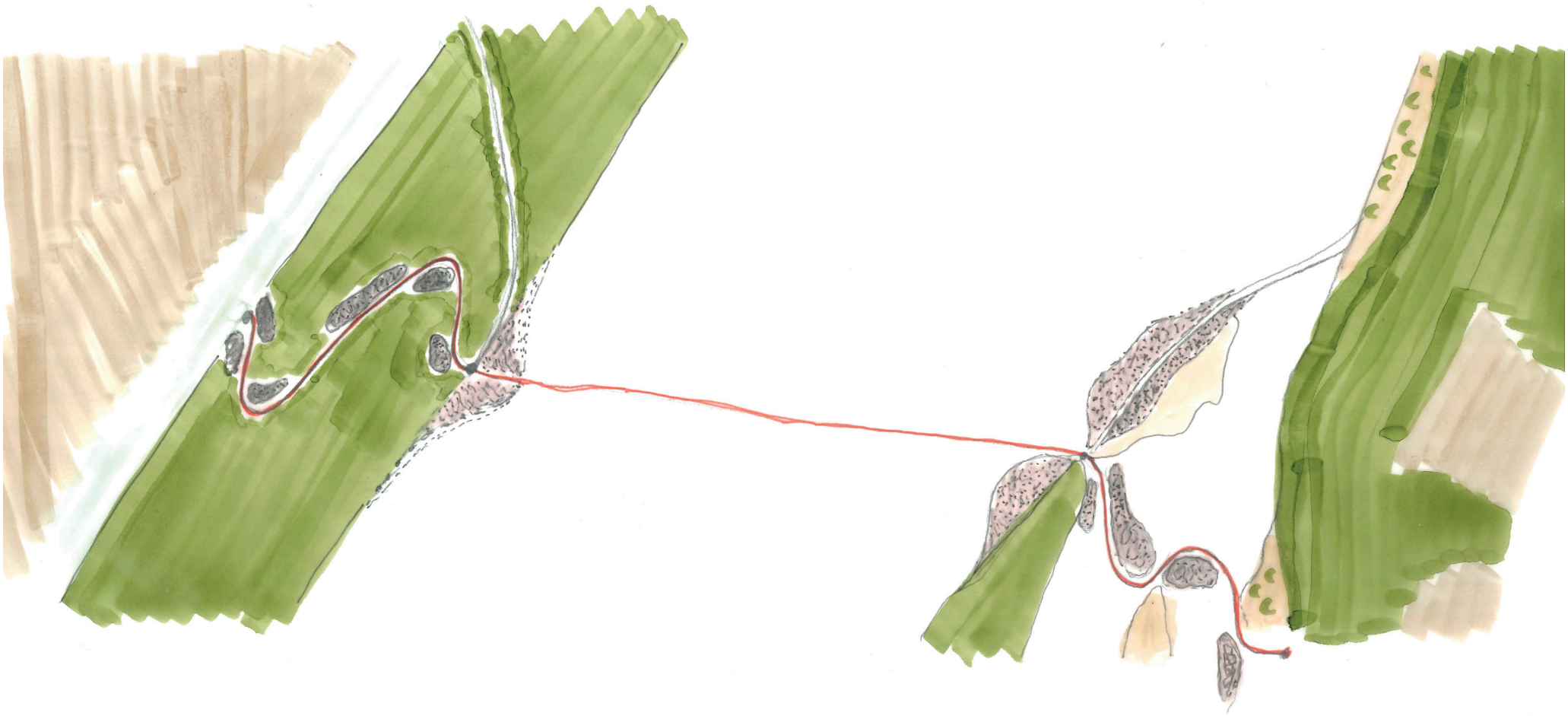


Figure 49: First sketch of plan on the S-scale

Figure 50: Sketch of pond for otters and people

In figure 49 a first sketch of a plan of the design is shown, with a lot of reed beds for the otter. Figure 50 displays the idea of an otter pond: a pond that navigates between the two sides and where there's place for as well the otter as visitors. This was in this stage a first idea, but will come back later during the report.

Figure 51: View on the Danube

In this stage a different approach starts: a practical period, a period of excursions and experimenting with models. Moreover, I have studied on the life -the behaviour in particular- of beavers and otters. This has brought me a new vision on the assignment. Besides that it has brought me spirit and new inspiration. Afterwards the consequences are shown in analytical and design drawings.

Figure 52: Scale models 1:20 of a beaver lodge and of two types of otter holts

Figure 53: Otter holt type 1, from beams directly out of nature

SCALE MODELS: BEAVER AND OTTER HOUSING

To get to know more about the living environment of the otter and beaver and to get a grip on the scale, three different scale models (1:20) were made. The first and second (shown in fig. 53 and 54) are reproductions of a so called otter holt. An otter holt is the name for the den of an otter. A holt is essentially a hole in the ground which is used by an otter for sleeping and resting (Northern Ireland Environment Agency, 2011).

An otter can built it's own otter holt, but there are some ways to help the otter to hide. Two versions are shown here. The first version is made from wooden beams, taken from a place close to the otter holt. The otter holt is placed next to the water and has a separate sleeping chamber.

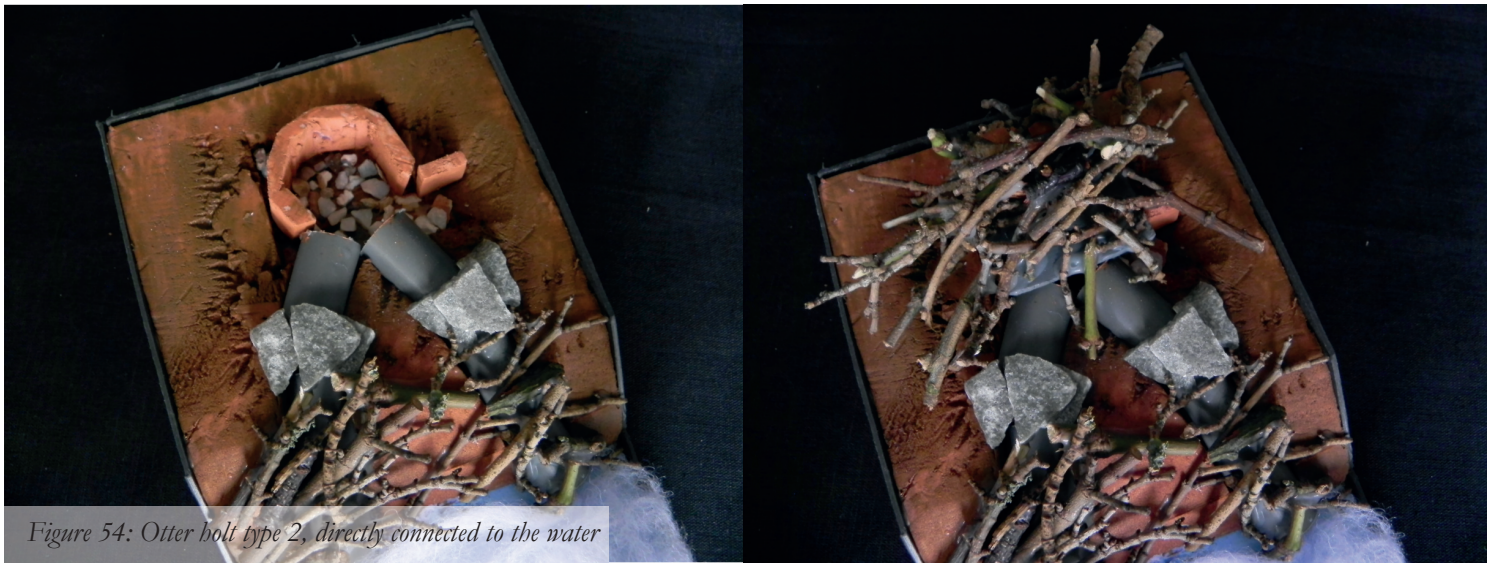


Figure 54: Otter holt type 2, directly connected to the water

The second version (shown in fig. 54) is as well human-made. It exists of brick and tubes of PVC or concrete and is covered with stones of slate and branches. This time the holt has a direct connection to the water (via the tubes). From the sleeping chamber there is as well an opening to the "mainland".

Figure 55: A beaver lodge and dam, as built by beavers

Fig 55 shows the scale model of a beaver lodge as built by beavers, existing of stone, branches and mud. In high river banks beavers dig a way up from under the water level, so that the entrance is under water. Then they widen up the corridor to create a wet room and a dry room. Beavers enter the lodge via the wet room in which they shake of the water. Thereafter they go to the dry room where they sleep and feed their whelps. The dry room is covered with shredded branches that are refreshed regularly. The beaver lodge often has more than one entrance. (Dekker, 2012)

Besides the beaver lodge a beaver dam is shown. The beaver dam is built up from logs, rocks, branches and mud. With a beaverdam a beaver influences the water level, in order to be at least 50 cm high. Otherwise the water level is to low for the beaver to swim with food to its lodge. It is very important for a beaver to do so, while moving on land is a lot harder to do. (Vreugdenhil, 2010)

Figure 56: Nieuwkoopse plassen, Nieuwkoop

Figure 57: Nieuwkoopse plassen, Nieuwkoop

EXCURSIONS: PARKS & LANDSCAPES

In order to get a good image from what kind of park the design should be like, trips were made to different kind of parks and landscapes.

DE NIEUWKOOPSE PLASSEN, NIEUWKOOP

14th of December 2014

This started with a visit to de Nieuwkoopse Plassen, a landscape where the otter lives. In Nieuwkoop even a special featured road has been built to create safer crossings for the otter. The landscape is a typical "lake landscape", with lots of reed and water. A typical landscape for the otter, but -since the otter is very shy and rarely seen- it was not seen during the visit.

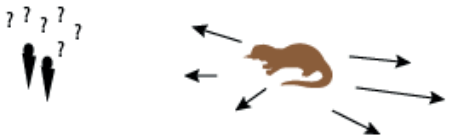


Figure 58: Het Beverbos in Dordrecht

HET BEVERBOS, DE BIESBOSCH, DORDRECHT
22nd of January 2015
The Beaverbos was a fenced park for beavers. To walk around the fence took about 20 minutes. There was a fake beaver lodge and -as the staff told us- the beavers created a real one a certain time after the fake one was built. Sometimes they occupy the fake lodge, other times they occupy the "real" beaver lodge, but that they use both is for sure. At the moment of visit, no beavers could be seen.

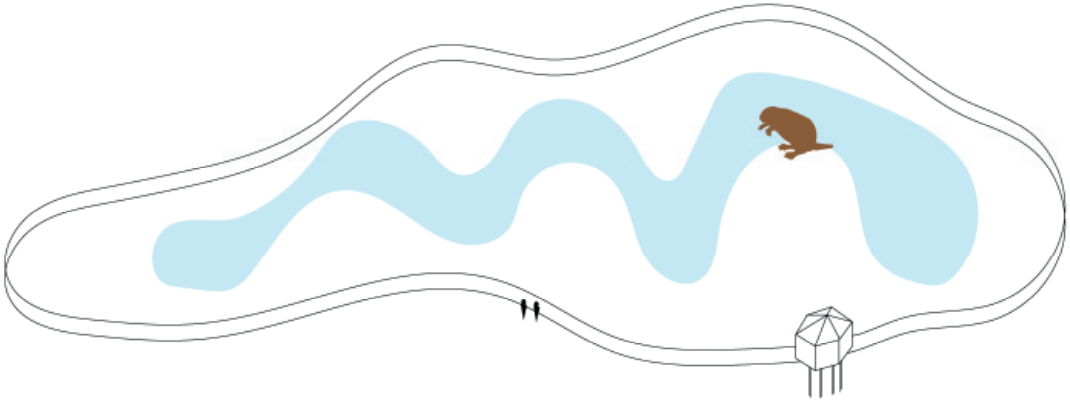


Figure 59: De Gelderse Poort in Nijmegen

DE GELDERSE POORT, NIJMEGEN,
4th of February 2015
De Gelderse Poort is a river landscape and has otters and beavers as well. In 2014 an amount of four otters was added to the Gelderse Poort. (Beekers, 2014) Otters and beavers were not seen during this visit, although the mystery of the presence of the otters and beavers was extant. The visitors centre is visited as well, where one could see a stuffed beaver and otter.

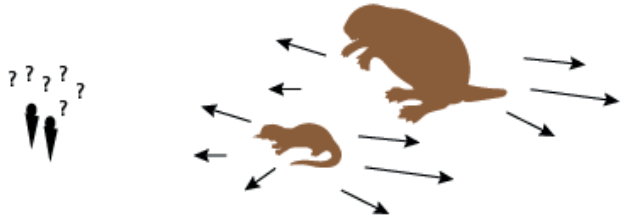


Figure 60a: Stay of the Oriental small-clawed otters in Aqua Zoo, Leeuwarden

Figure 60b: Stay of the Canadian beaver in Aqua Zoo, Leeuwarden

Figure 60c: Stay of the Canadian otters in Aqua Zoo, Leeuwarden

AQUA ZOO FRIESLAND, LEEUWARDEN
8th of february 2015

This zoo was originally built as a special park for otters. Through the park is a meandering stream which still reminds of this, although it has changed to a zoo with totally different animal species.

The first visited stay is of the Oriental small-clawed otter. These otters are very playful and can be seen all day long. The path of this stay runs, slightly elevated, through the stay, so the audience can come really close to the otters.

The stay of the beaver was full of water and in the stay there's a beaver lodge placed. The lodge is placed in a lodge for visitors, so sometimes the beaver comes into it's lodge while visitors are very close.

The third stay, of the Canadian otter, was partly occupied by raccoons. The otters could be viewed behind glass, so the experience was less thrilling than the stay of the Oriental small-clawed otters. This stay seemed to be empty at first sight, because these otters are very shy. Still after some time of waiting, the otter appeared from behind the trees and walked in a circle through the stay and disappeared again for some time.

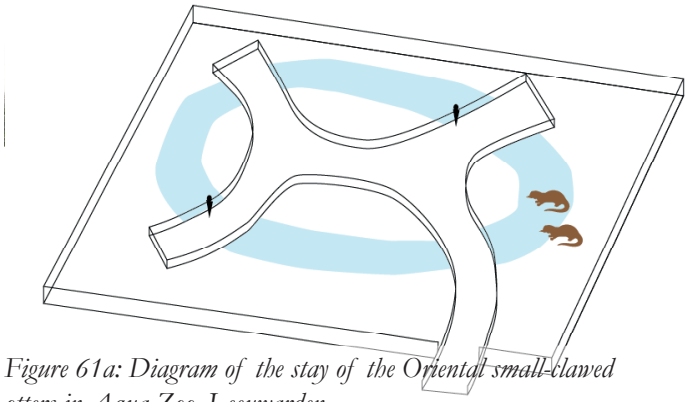


Figure 61a: Diagram of the stay of the Oriental small-clawed otters in Aqua Zoo, Leeuwarden

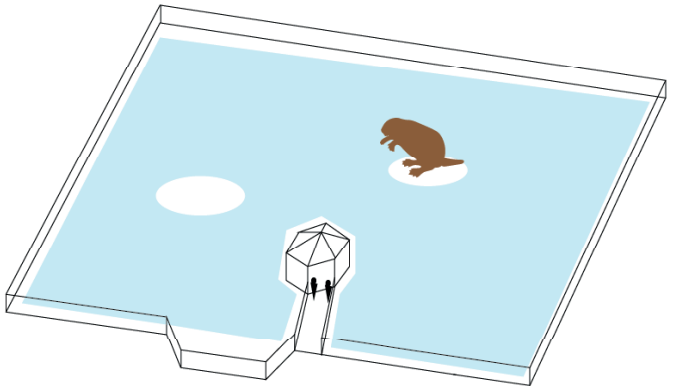


Figure 61b: Diagram of the stay of the beavers in Aqua Zoo, Leeuwarden

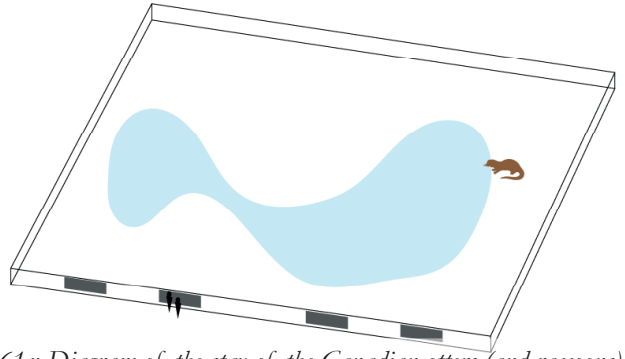


Figure 61c: Diagram of the stay of the Canadian otters (and raccoons) in Aqua Zoo, Leeuwarden

Figure 62: Beaver lodges tour in Werkendam

BEAVER LODGES TOUR, DE BIESBOSCH, WERKENDAM, 3th of April 2015

During the beaver lodges tour several beaver lodges were visited. By a whisperboat with about forty people a tour was made through national park "de Biesbosch". The guide showed places where the beaver was often seen, but during this tour no beaver was spotted. The tour was during the afternoon, but the best moment to see a beaver would be in the twilight. At the middle of the tour two sea eagles were seen and traces of the beaver, like gnawed tree trunks, were seen as well. From time to time people were wondering if they saw a beaver. Although the beaver wasn't spotted, it was a nice tour. Remarkable was that there seemed to be a big demand for the tour, as seen by the people that could'nt be taken on the tour.

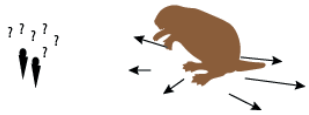


Figure 63: Natuurpark Lelystad, Lelystad

NATUURPARK LELYSTAD, LELYSTAD

4th of April 2015

In Natuurpark Lelystad, originally built as a country retreat of the Artis zoo of Amsterdam, both the beaver and the otter are living. Otters are being bred in a special stays. In Aqua Zoo Friesland Oriental small-clawed otters could be seen in the stay, but in this park the European otter lives as well. The Oriental small-clawed otters were seen at different times of the day, playing with each other; the European otter could only be seen at feeding time, these are again very shy. The platform in the middle provides a nice view over all the otter stays. The difference with Aqua Zoo Friesland is that there's no path running through the stay, which makes the stay of Aqua Zoo Friesland more exciting.

The beaver does not have a certain stay in the park, but roams through it and could be seen. However, during the trip the beaver didn't show up.

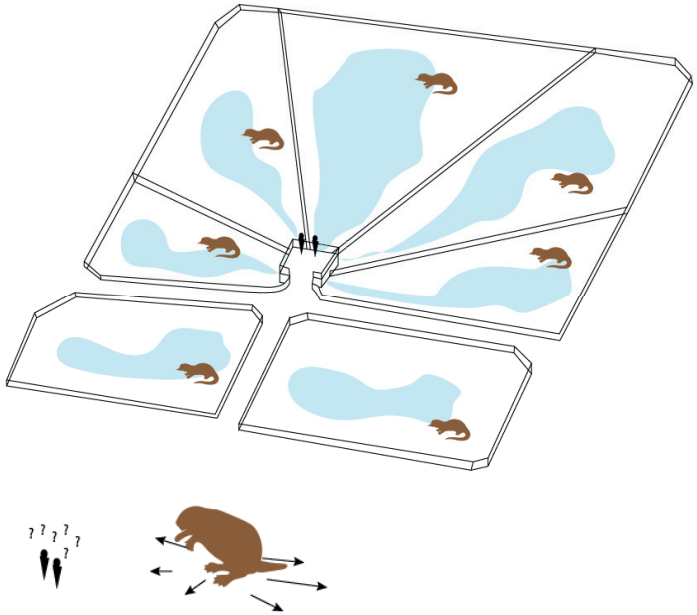


Figure 64a: Nicely detailed transition from bridge to entrance of Ravelijn bridge, Bergen op Zoom, RO&AD Architects

Figure 64b:
Ravelijn bridge, Bergen op Zoom, RO&AD Architects

Figure 65: Moses Bridge, Bergen op Zoom, RO&AD Architects

EXCURSIONS: BRIDGES

As paths are very important for nature parks, because they define the image of the park for a large part, it seemed useful to explore the possibilities and visit some interesting paths in the Netherlands. The first one visited is the Ravelijn bridge (shown in fig. 64). This bridge is floating on water and is acurately detailed.

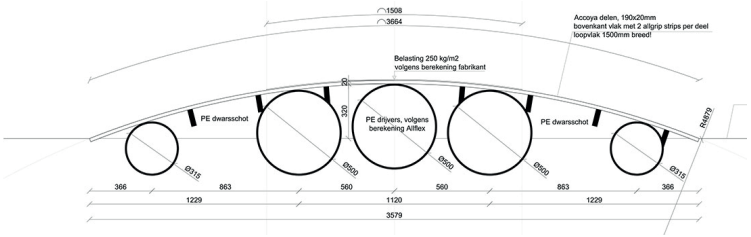


Figure 64c: Detail of Ravelijn Bridge, Bergen op Zoom, RO&AD Architects

The second bridge is the Moses bridge (view figure 65). This bridge makes it possible to walk very close along two high surfaces of water, which is a very uncommon experience. Although the experience is extraordinary, it is hard and expensive to realise this path in a nature park with changing water levels, since the water level should be regulated.

Figure 66: Park van Luna, Heerhugowaard, Hosper and DRFTWD Office associates

EXCURSION: PARK VAN LUNA, HEERHUGOWAARD

During the visits to several nature parks, the mystery of the search for something (the otter/beaver) caught the imagination. It would be great to be able to incorporate en strenghten this type of mystery in the design by the search for the way: the use of a maze or labyrinth. "Het labyrinten boek" already shows there's an important difference between a maze and a labyrinth: "*The labyrinth contains one single path and has ritual aspects. A maze is a puzzle with splits and choices.*" (Fischer, 2006)

By visiting the "Park van Luna" the design of the labyrinth was investigated. The landscape and routing is shaped in such a way that you have different experiences all the time. Besides that the program -with elements as a one-day-camping-site and a water purification labyrinth- of the leisure park was interesting.

The final design for the routing on the island Luliaka has become a combination of a labyrinth and a maze.

CONCLUSION AFTER EXCURSIONS

By doing the excursions different things became clear. The most fascinating and attracting during the visits was the mystery around the otter and beaver: will the otter or beaver show up? For example at de Nieuwkoopse Plassen (where you find the signs "watch out for crossing otters") and de Gelderse Poort. In the design this feeling of mystery will be emphasized. Furthermore the experience of walking through the stay of the otters in Aqua Zoo Friesland (page 85 and figure 61a) was very attractive. The same experience will therefore appear in the design.

CHOICE FOR THE ISLAND

As mentioned on page 59 the hick-up in the Natura 2000 area is the leading argument in the choice for the island. On the base of the excursions and observations the surroundings of Luliaka with wetlands and flood forests is very appropriate to transform into an area for animals such as otters and beavers as keystone species. Moreover, the program in the area is a bit outdated and neglected. This area needs an additional program to represent its value.

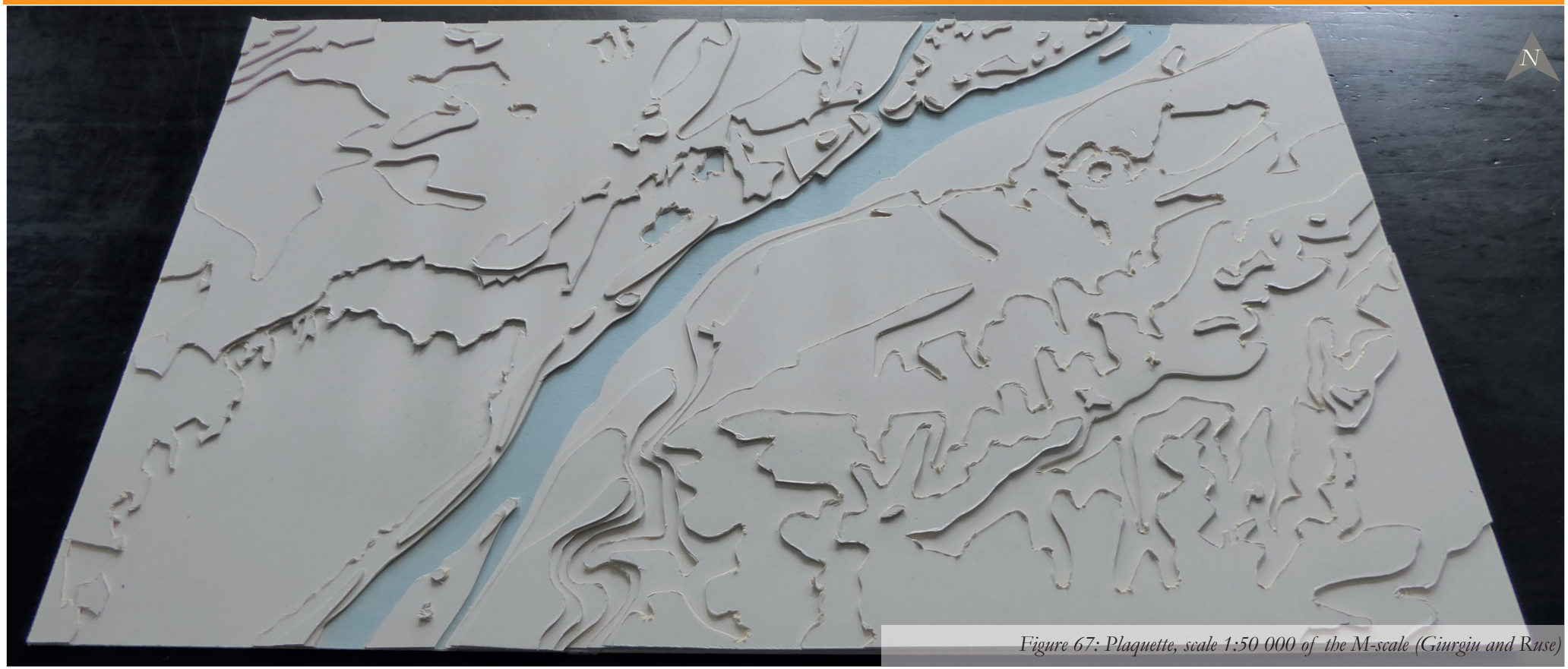


Figure 67: Plaquette, scale 1:50 000 of the M-scale (Giurgiu and Ruse)

SCALE MODEL: RUSE AND GIURGIU

This is a special scale model, a plaquette, of the **M**-scale. To get a grip on the height differences of the area these differences are emphasised. The height differences do not precisely match the realistic dimensions, only the most important height differences are pointed up. In this way the landscape is better readable for the design and will provide a better overview of this complex landscape on the **M**-scale during the project.

The model is very convenient to use for the green structure, because the way the precipitation flows (from high to low) explains how the existing green structure is built up and can be strengthened or extended. This helps to find the best way to interweave the river border area with the ecological network.

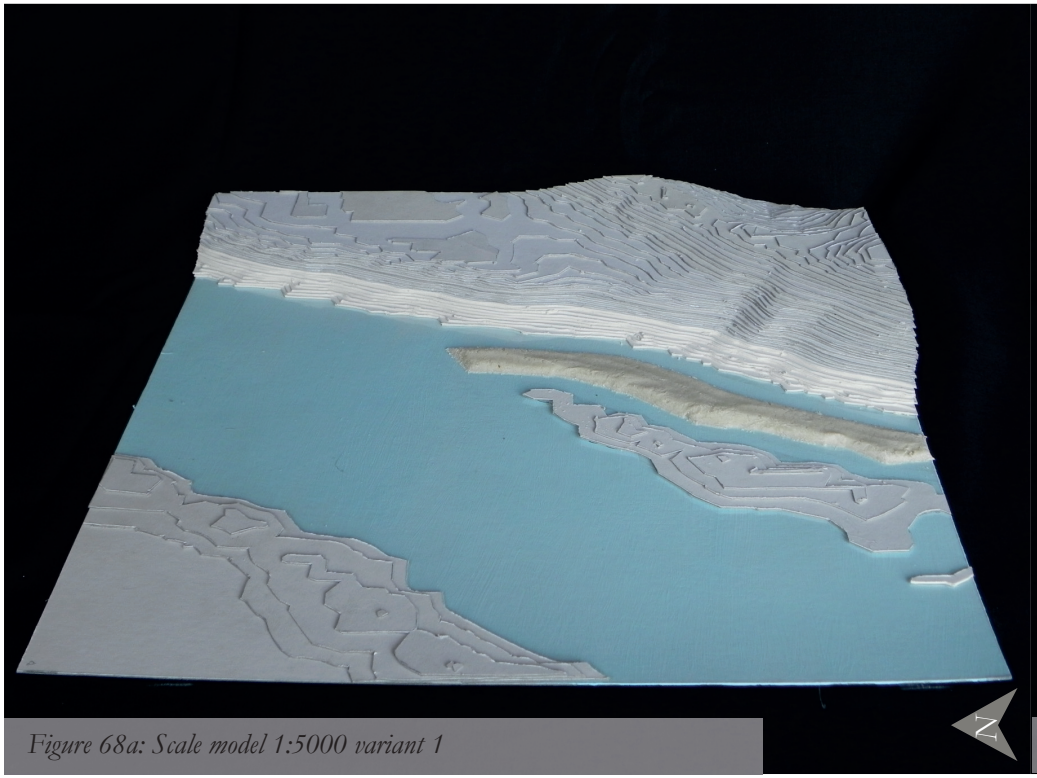


Figure 68a: Scale model 1:5000 variant 1

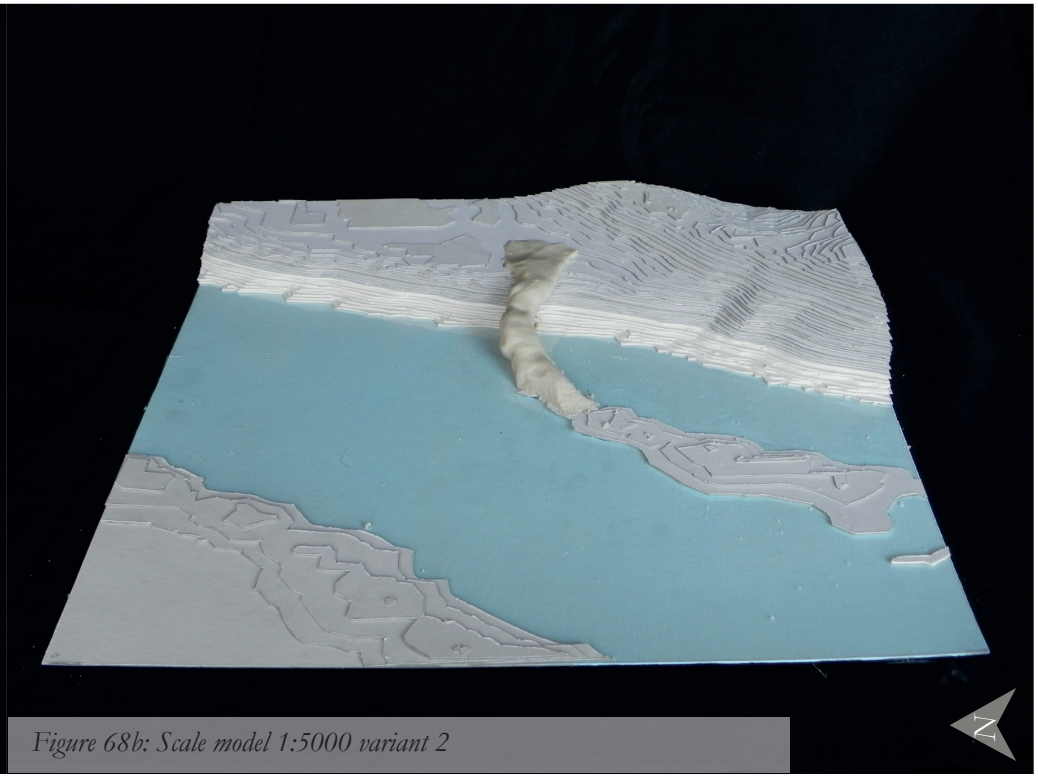


Figure 68b: Scale model 1:5000 variant 2

SCALE MODEL: SURROUNDINGS OF THE ISLAND LULIAKA

A scale model is made of the **S**-scale, including the end of the island Luliaka in the middle of the borders of Romania and Bulgaria. The scale model clearly shows the side of Bulgaria is much higher than the side of Romania. By the use of bread dough different shapes of land have been added to the water, in order to see what is the spatial consequense. A lot of variants were made, but only the most interesting are shown here.

The first one (figure 68a) is a kind of "shadow island" between the banks of the river of Bulgaria and the island Luliaka. On the one hand this shape adds more land to design, on the other hand it takes a lot of place in the water.

The second variant (figure 68b) shows a connection from the island Luliaka to the Bulgarian river banks. This connection could be made by a small bridge or by adding a large shape of land. This reduces the "island-feeling", but encourages the visit to the island.

The third variant (figure 68c) shows an extention of the island Luliaka. In the same way as the second variant this one reduces the "island-feeling", but the extention creates a certain bay on

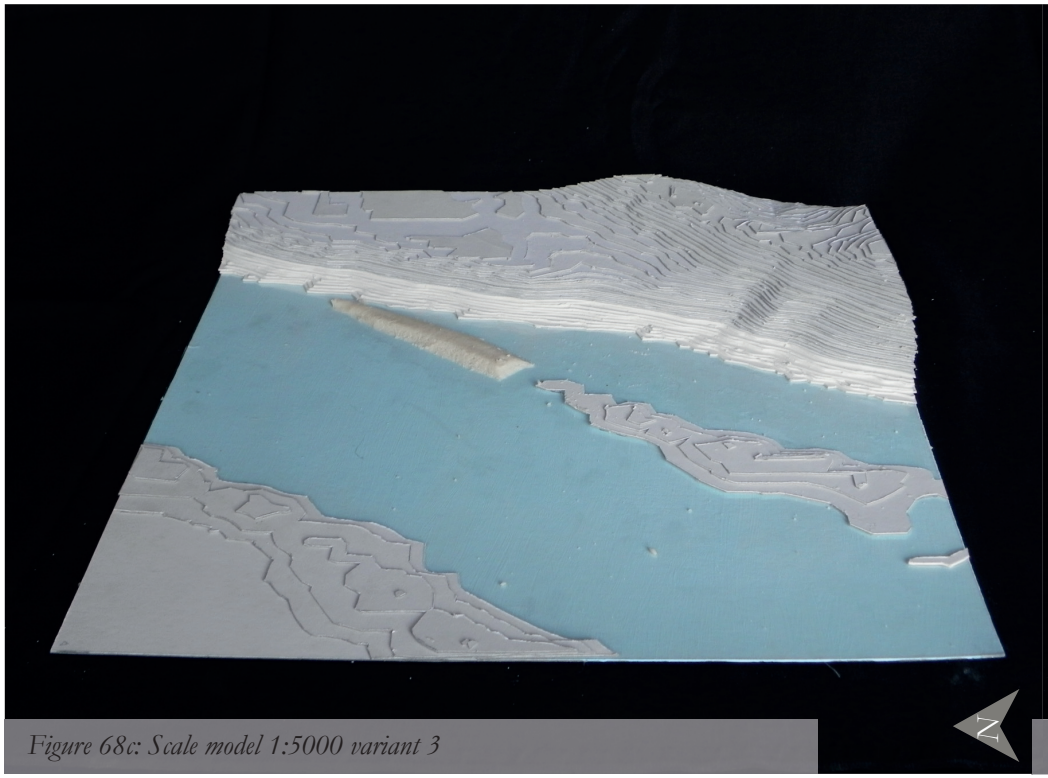


Figure 68c: Scale model 1:5000 variant 3

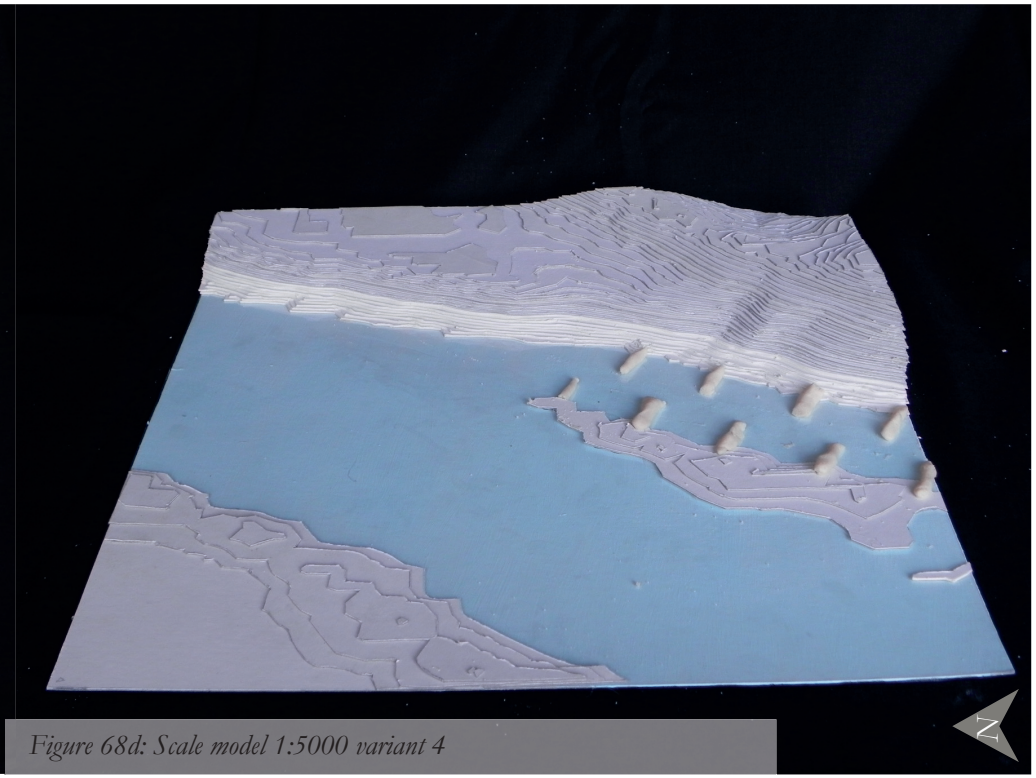


Figure 68d: Scale model 1:5000 variant 4

the Bulgarian side. This could possibly contribute to a better biodiversity. Still, this extention looks unnatural, because it's blocking the stream of the Danube.

The fourth variant (view figure 68d) shows a more human-made shape, which is derived from the cribs in rivers, to improve the waterway. It seems these shapes are the least fitting to the nature world of beavers and otters.

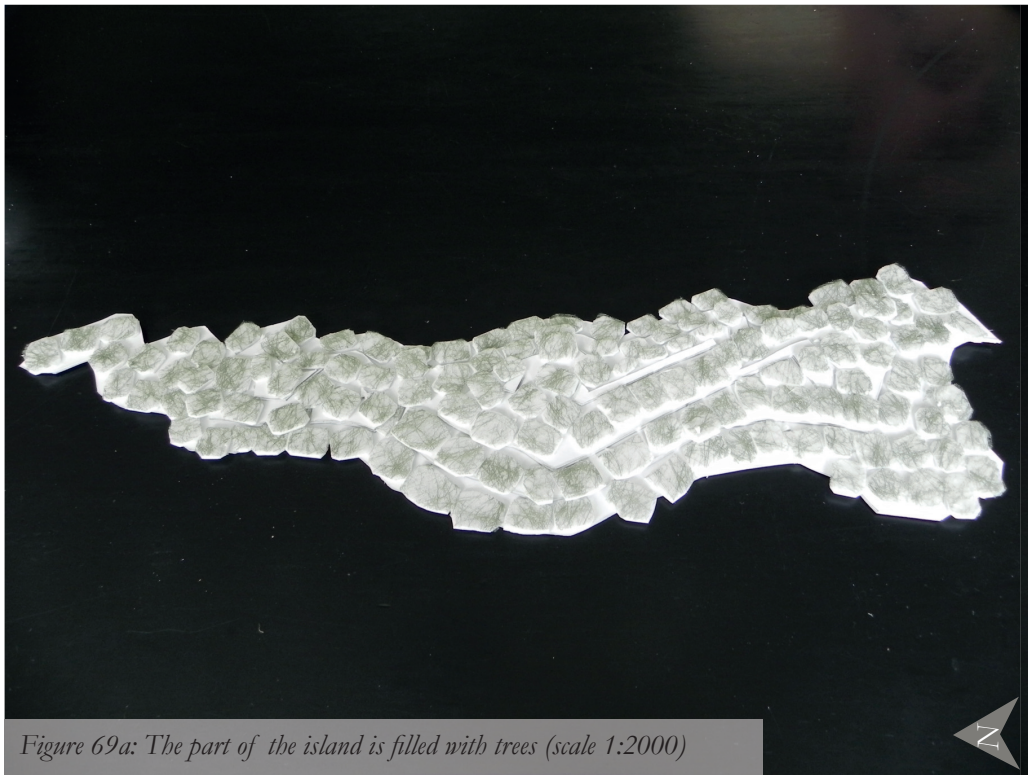


Figure 69a: The part of the island is filled with trees (scale 1:2000)

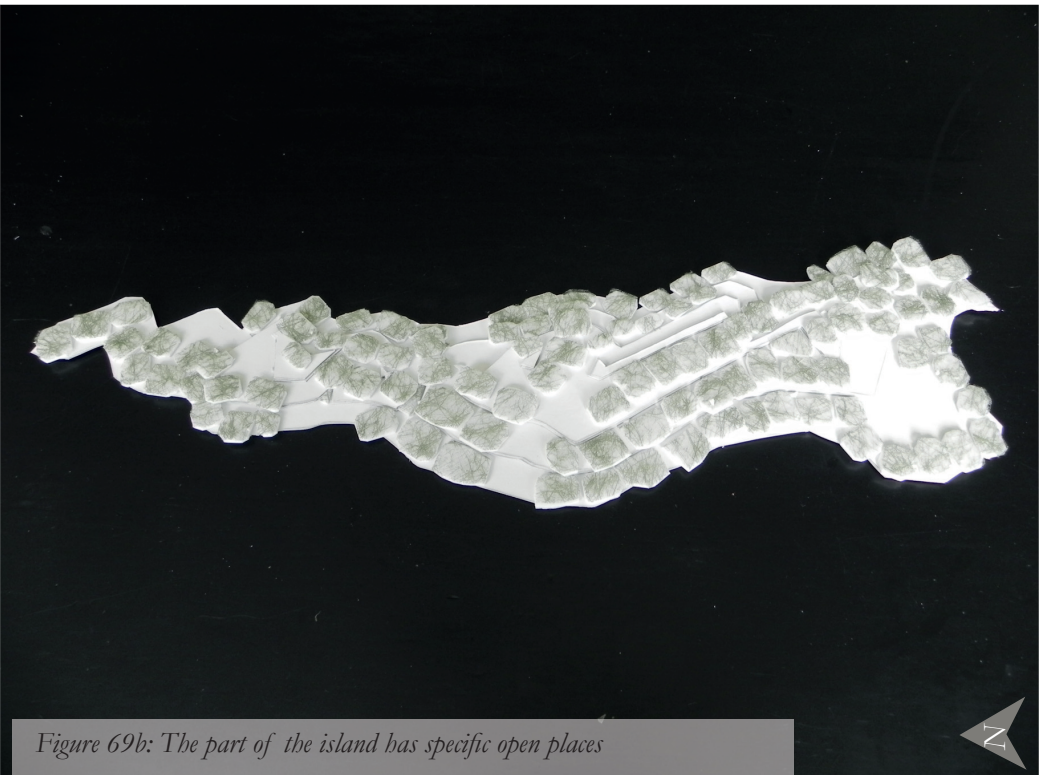


Figure 69b: The part of the island has specific open places

SCALE MODEL: PART OF THE ISLAND LULIAKA
This scale model shows only the end of the island Luliaka, the piece that's part of the previous 1:5000 model. It was used to find out what the best way is to place trees and vegetation.

Figure 69a shows what the island looks like when it's completely filled with trees.

The second variant (figure 69b) displays specific open places to create openings and perspectives. In this way the final layout with viewing axes was discovered: the axes were interconnected to realise a good overview over the island, inspired by the classical hunting forest.

Variant three (figure 69c) shows a gradient from north to south. This is spatially interesting because it influences the spatial experience of the whole island: every spot will have a different experience because of this intervention. In the design this intervention was used for the trees.

The fourth variant(figure 69d) is a right-angled variant of figure 69c: closed to the side of Bulgaria, opened to the Danube side / Romanian side. Finally this was used for the lower layer of plants in the design.

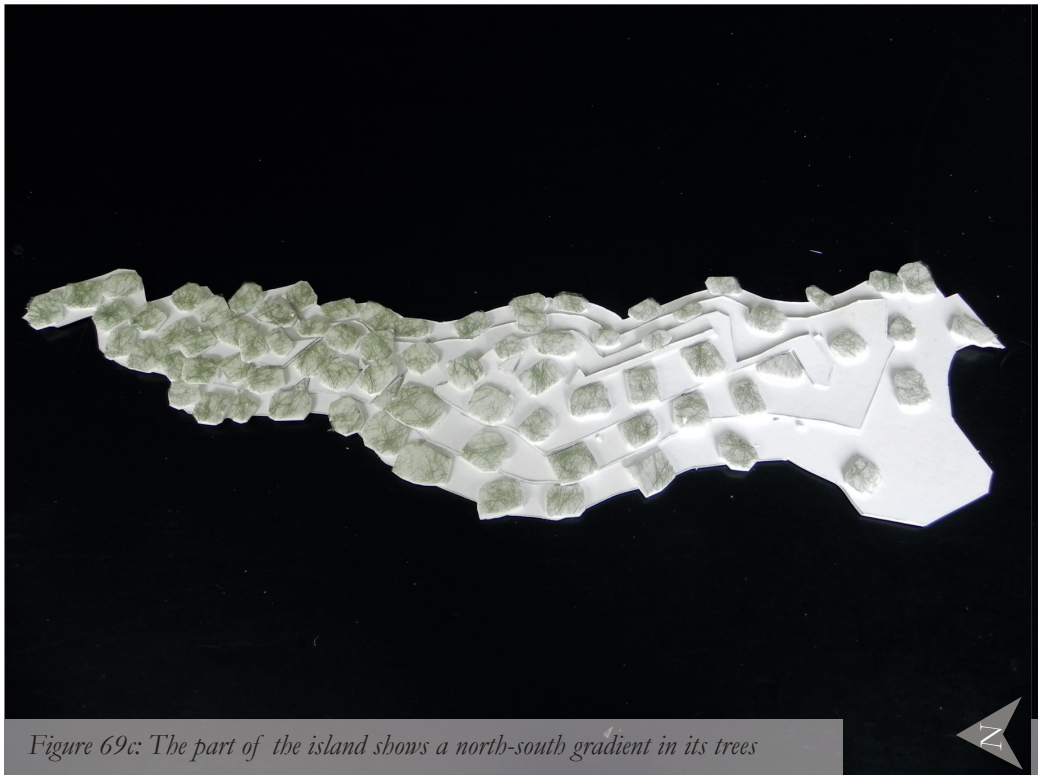


Figure 69c: The part of the island shows a north-south gradient in its trees

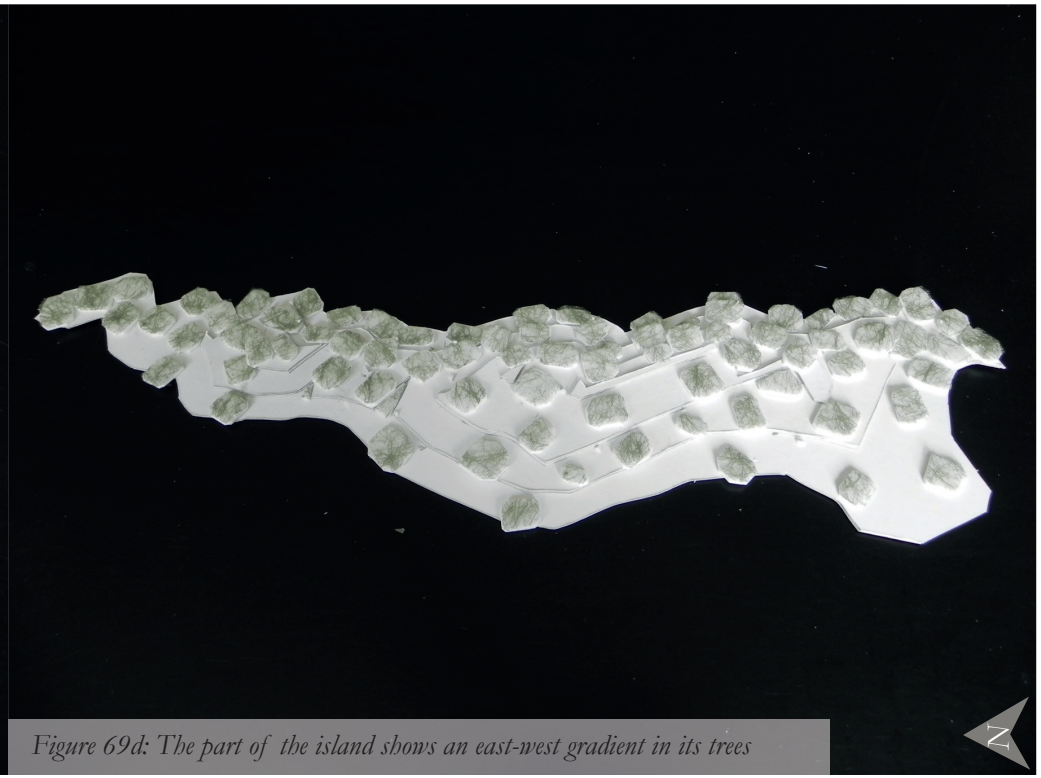
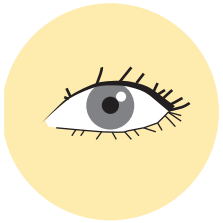


Figure 69d: The part of the island shows an east-west gradient in its trees



On the next two pages an overview is made of the differences and similarities between otters and beavers.

Vertical section of tail

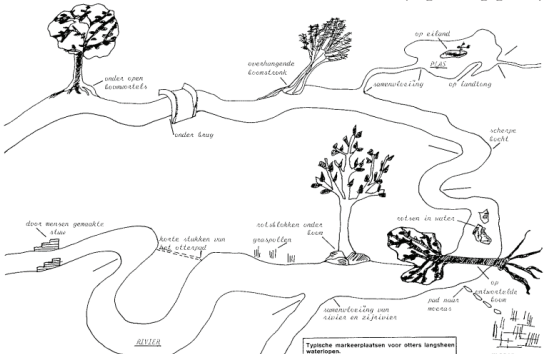
	(Lutra lutra) Eurasian otter		European beaver (Castor Fiber)
Basic info	mammal “indicator/keystone species” nocturnal animal		mammal “indicator/keystone species” nocturnal animal
	>100 otters marten-like/ predator slender, hairy tail fore + hind legs webbed eats almost everything that lives in and around the water: fish + other species (sometimes mice + birds) individualists (in mating season they sometimes chase together) *(Vroege vogels, 2014)*		+/- 1000 beavers rodent flat, squamous tail only hind legs webbed eat tree bark / twigs in winter *(Vroege vogels, 2014)*
	eyes, nose hairs and ears in one line (while swimming these stay above the water) highly developed sense of smell (1000 x stronger than human) *(Zoogdiervereniging, 2015)*		eyes, nose hairs and ears in one line (while swimming these stay above the water) good sense of smell *(Dekker and Vreugdenhil, 2012)*
	lives particularly on the land, but in water as well is able to swim for 40 seconds under water is able to swim for eight hours serried *(Leeuwen, J. van, 2015)*		lives particularly in the water is able to swim for 15 minutes under water average swimming time is 15-25 minutes *(Dekker and Vreugdenhil, 2012)*
	1988 extinct in NL 2002 start of reintroduction *(Vroege vogels, 2014)*		1826 extinct in NL 1988 reintroduction in NL *(Vroege vogels, 2014)* around 1900 almost extinct in EU (*Schweizerische Eidgenossenschaft, 2014)*
	walks a lot on land, this is dangerous are able to make use of the holes, lodges and dams of beavers *(Vroege vogels, 2014)*		mostly propels through the water *(Vroege vogels, 2014)*
	snout-vent length up to 100 cm, tail length up to 16,5 cm 5-12 kg (*Zoogdiervereniging, 2015)*		snout-vent length up to 95 cm, tail length up to 55 cm 15-35 kg *(Zoogdiervereniging, 2015)*
	clear water > use of eyes turbid water > use of whiskers life > 15 years (*Ark Natuurontwikkeling, 2015*)		vision under water *(Dekker and Vreugdenhil, 2012)*
	rats clamps, fish traps, (busy) roads near water are a threat (*Ark Natuurontwikkeling, 2015*)		rats clamps are a threat (*Ark Natuurontwikkeling, 2015*)
Food	particularly fish < 25 cm like eel, perch, pike, carp, but ook amphibians, water birds, water voles, rats, crayfish, crabs, worms and larger insects		winter > bark and twigs of trees and shrubs, roots and tubers (for example of reeds, nettle, yellow plomp and orris) spring > more varried summer > more herbs (for example comfrey, yellow plomp and agrimony) *(Dekker and Vreugdenhil, 2012)* willow, (aspen), poplar, birch, wild cherry *(wikipedia.org, 2015)*
Behaviour	“Kegelen” to investigate surroundings: stand on lookout, stand on hind legs (*Zoogdiervereniging, 2015*)		strikes with tail on water if when danger threatens *(Dekker and Vreugdenhil, 2012)* appropriates brook that flows easily and leaves over at least half a meter in case of low water (entrance is always under water) is able to transport wood as building material / food at the river bank it builds a construction (lodge), of which the entrance is always under water builds dams as well, of which keeps the same water level within the congestion area and in which the flow speed is remarkably slower they weed out forests they dig channels (to connect housing area’s) by removing the dam, it is often reconstructed in several days digs its constructions in steep river banks, free from infrastructure (*Schweizerische Eidgenossenschaft, 2014)*

very territorial
setting boundaries with spraints (excreta)

an average of 16 km, 1-40 km shoreline length, or several m2 wetlands

artificial shelter: otter holt
- if river entrance floods, other exit has to stay open
- extra sheltered space, free from wind
(*Lhflevoland, 2014*)
not to steep river banks
many meanders, to create differences in depth and water speed (spawning grounds for fish)
Every 1 or 2 km a piece of 30cm depth x 50-100 m long
coverage area: 50 cm high vegetation in which the otter is able to hide during the day
(screen if necessary, to keep dogs /cattle / people away.
crossing of way-waterway: make sure that otters can pass safely
pods: provide them with a net, to prevent that otters will drown
(Jansman, 2014)

usually difficult
through prints and excreta (spraints)
under bridges with sandy ridges or on bare wet peat
spraints are recognizable by the smell of fish and fish bones
(*Zoogdiervereniging, 2015*)



Territory

very territorial, sometimes heavy fights
setting boundaries with scent trails (castoreum)
(Dekker and Vreugdenhil, 2012)
<13 km

Design

river banks steeper than 32° for beaver constructions/lodges
smoothed river banks prevent the construction of earthworks by the beaver (inclination < 19 up to max 32°).
construct infrastructure at least five meters from a slope (beavers do not dig any further landward)
main rule: "less is more" (in case of an appropriate spot, where the water level and flow capacity are good, it is recommended to do nothing, in order to effectuate the least disturbance to the ecology
- the best is to cut the wood as far as possible from the beaver and use the chainsaw only supportively. (otherwise the beaver runs out of food and is going to search for wood somewhere else)
- if constructions / lodges collapse by the river banks, it's better not to close the holes. A better solution is a so called "bio reinforcement": to place deep rooting trees, such as willow and alder. In this way the "manager" will recognize it and will stabilise the river banks. On the long term a "trampled riparian vegetation" will develope in this way.
- the smaller the site is, the better. If mowing happens in sections, beavers will search for refuges closeby.
- around the congestion area of beaverdams arises an enrichment of nutrients. This will promote the grow of vegetation and will accelerate silt. In very flat and much sediment transporting area's the process can be slowed down by the installation of sand traps.
(*Schweizerische Eidgenossenschaft, 2014*)
conifers are shunned by beavers, they prefer trees standing by the water
(wikipedia.org, 2015)

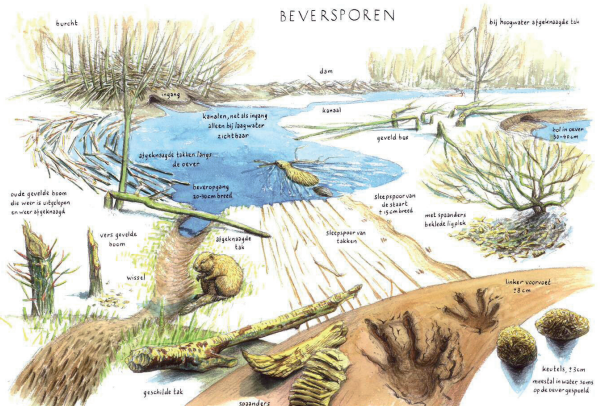
Bedreiging

waterways can destroy beaver dams
beaver dams can cause flooding in adjacent cultural landscape. (it involves flat land and still it is only 10 - 20 m of river bank width)
(lattices could be a solution, but are expensive. One can better choose for the extention of room for the water.)
flattened shore lines prevent the constructions of the beaver. (inclination < 19 up to max 32°).
(*Schweizerische Eidgenossenschaft, 2014*)
wolf, fox, bear, lynx and people (hunting, cutting down forests and motorboats)
(*Dool, M. van, 2015*)

Advantages in the landscape

the beaver can make big dredging unnecessary (with several adjustments for the beaver, it can shape the landscape naturally
the beaver can prevent flooding problems of small waters
(*Schweizerische Eidgenossenschaft, 2014*)

Observe



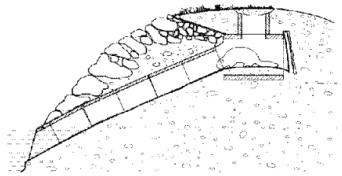
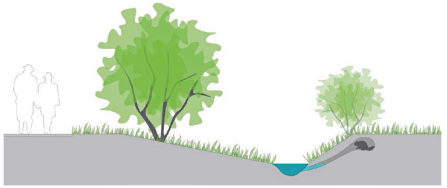


Fig. No. 5.: Artificial beaver burrow



lhnet.org/eurasian-beaver/#Maps

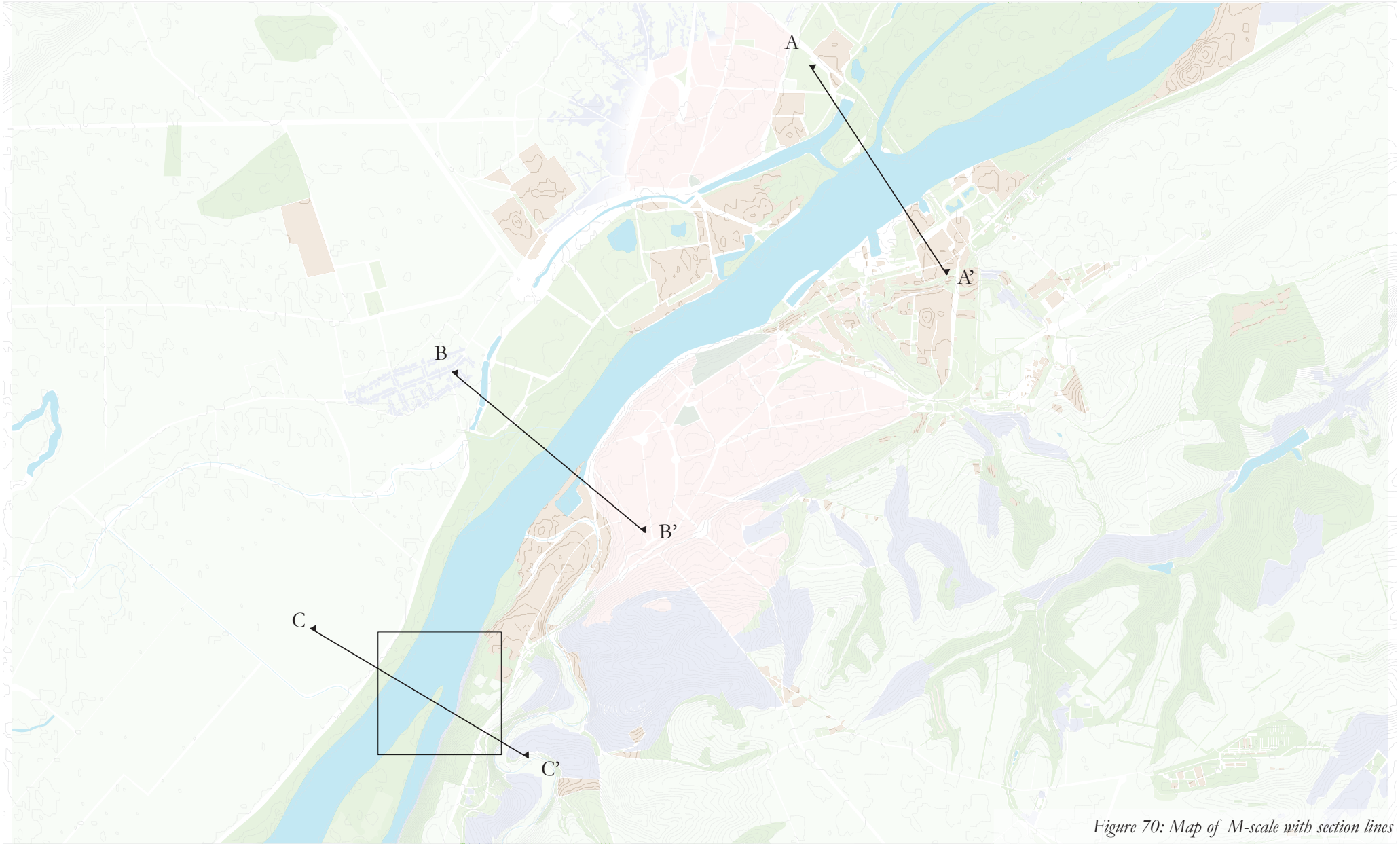


Figure 70: Map of M-scale with section lines

M-scale

- *highly urbanised area*
- *industrial area*
- *rural housing*
- *highly urbanised green*
- *green of high quality*
- *green of low quality*
- *agricultural area*
- *water*

N

— *1 km*

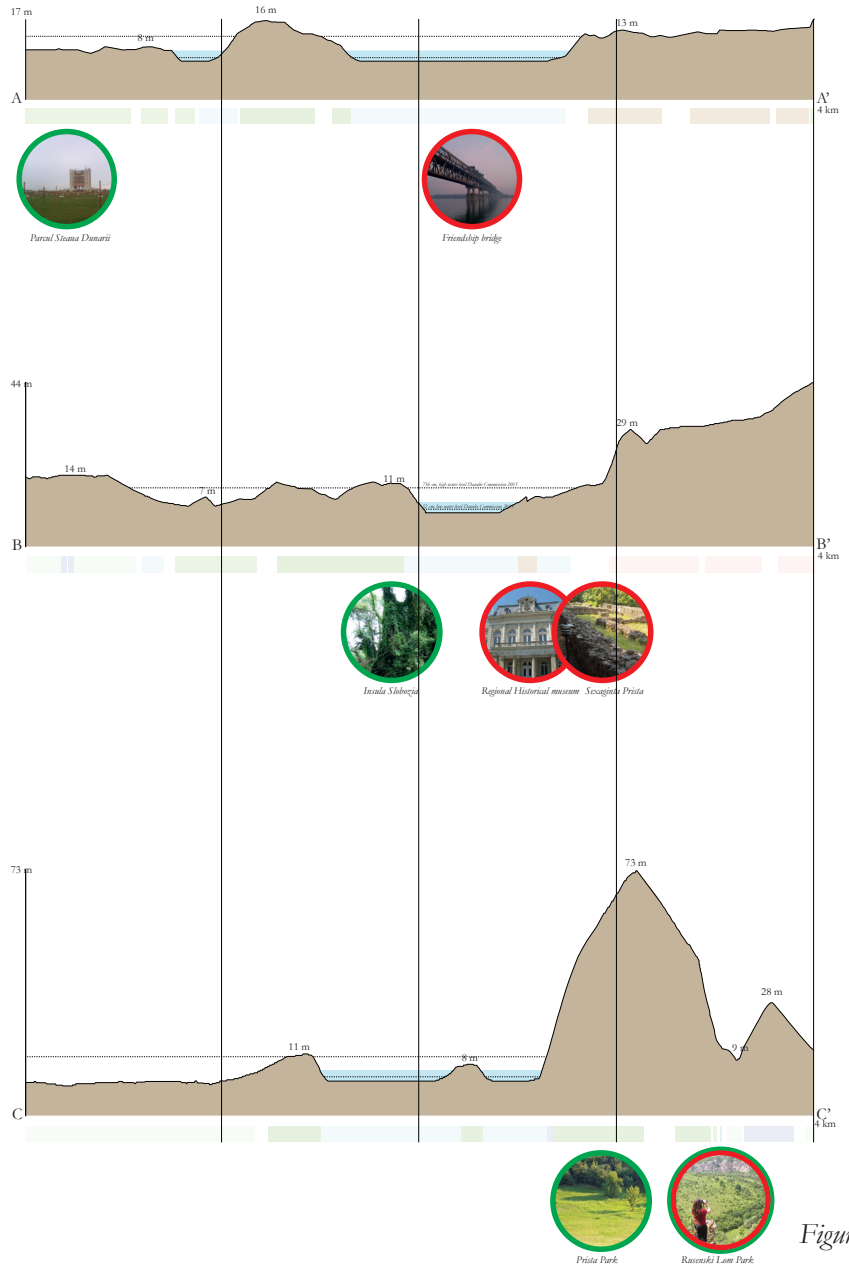


Figure 71: Sections

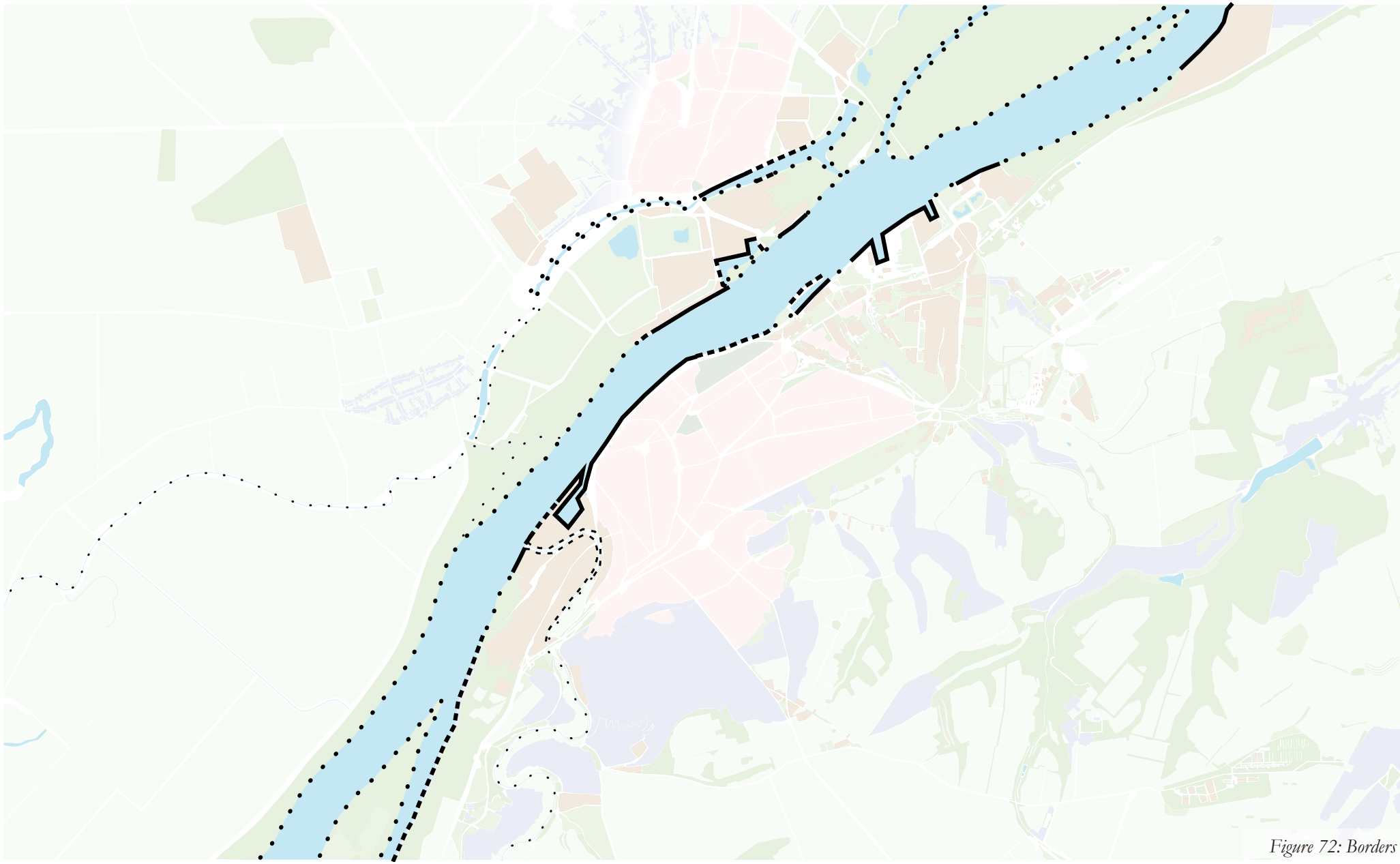


Figure 72: Borders

Borders

hard border

medium hard border

soft border

BORDERS

In figure 72 an overview is made of the hardness of the borders in the river border area of the Danube around Giurgiu and Ruse. On both sides the industry is mostly the reason of the hard border.

Ruse and Giurgiu used to be two centers of industry during the communism. After the communism, the industrial centers showed a significant decline, because they were not competitive on the free market. The last decade the industrial cores showed a refresh, because of investments of local and foreign investments. Nowadays both cities are active in the industrial sectors food, textile & clothing, steel, chemical, naval, construction materials, electronics, machine construction and automotive. (Municipality of Ruse, 2012)

N

1 km

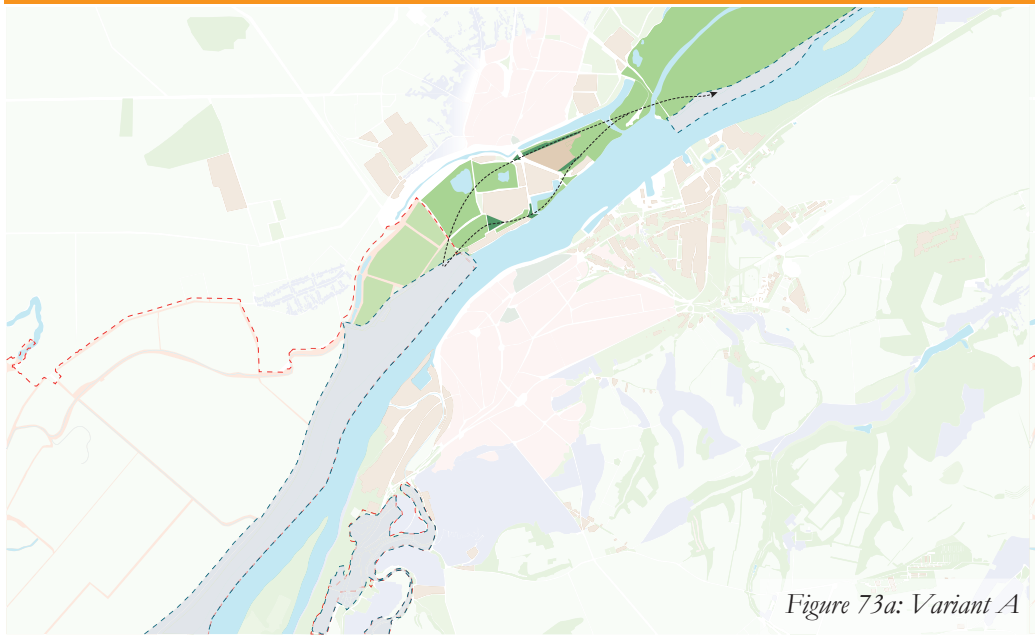


Figure 73a: Variant A

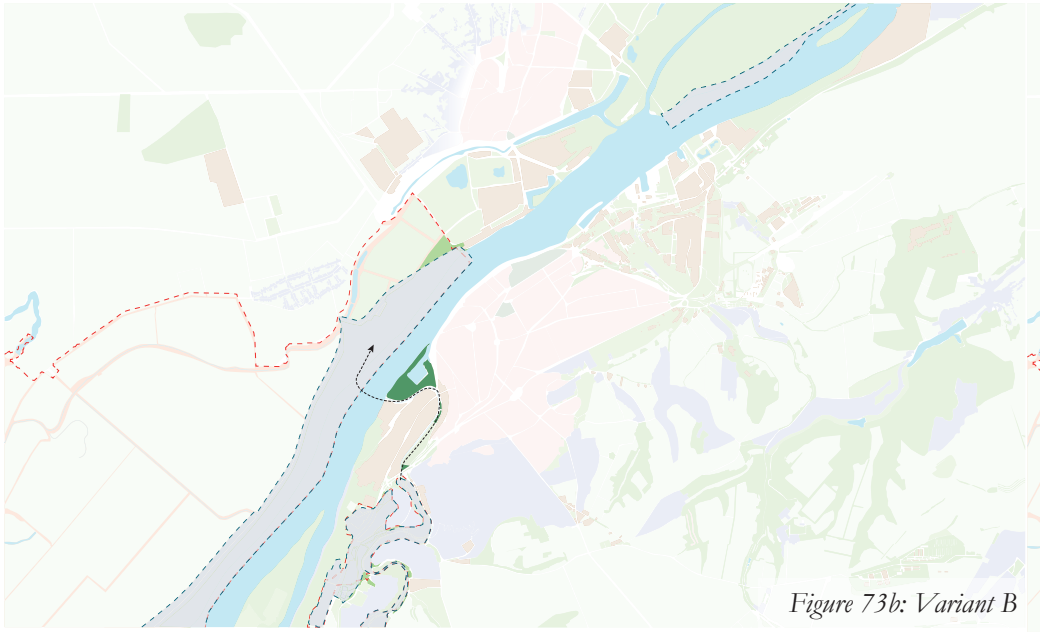


Figure 73b: Variant B

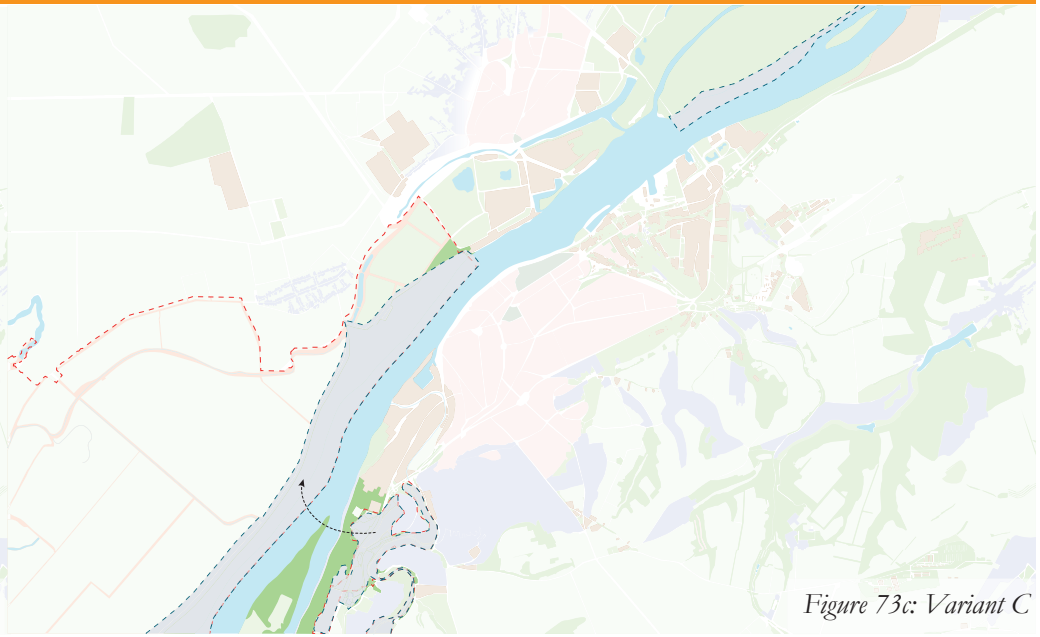


Figure 73c: Variant C

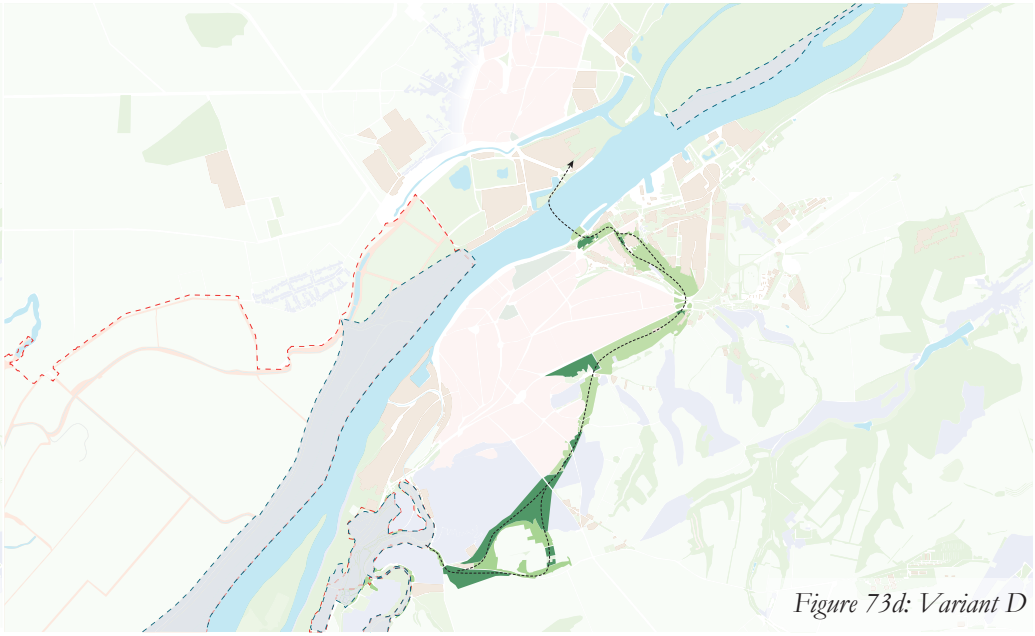


Figure 73d: Variant D

Variants

green with high ecological value

green to be upgraded

Natura 2000 bird directive site

Natura 2000 habitat directive site

N

5 km

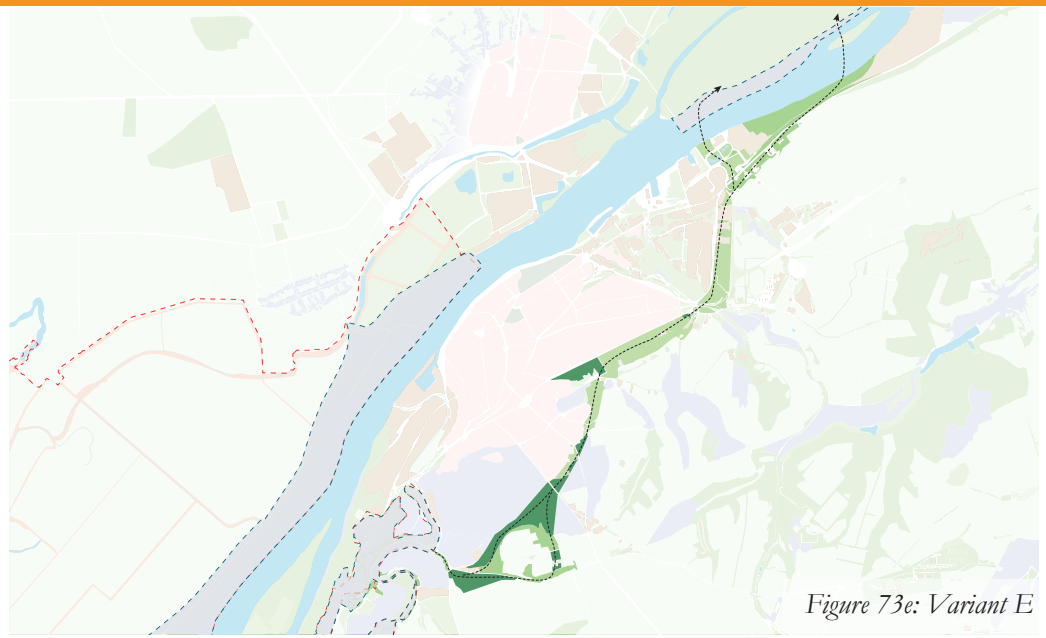


Figure 73e: Variant E

BORDER STITCHING IN THE ECOLOGICAL NETWORK

At this point the transition is made from the **L** to the **M**-scale: from patchwork to border stitching (how to connect the patches). On the **M**-scale several variants are shown of how to connect the river border area to the ecological network of the hinterland.

Important for this part and elaborating on the patch-corridor-matrix-method is the connectivity concept. Connectivity is "*a measure of how connected or spatially continuous a corridor, network, or matrix is. (The fewer the gaps, the higher the connectivity. Related to the structural connectivity concept; functional or behavioral connectivity refers to how connected an area is for a process, such as an animal moving through different types of landscape elements).* (Forman 1995) This concept is the base for the green infrastructure: *An interconnected network of natural areas and other opens spaces that conserves natural ecosystem values and functions, sustains clear air and water, and provides a wide array of benefits to people and wildlife."* (Benedict, 2006) A green infrastructure is what is been searched for in these illustrations (View figure 73)

Variant A (figure 73a) shows a completion between two Natura 2000 areas. Via a split greenway through the port of Giurgiu a difficult connection is created. Variant B (figure 73b) shows a connection via the old mouth of the Rusenski Lom. A solution needs to be found for the now existing industry in this part. Figure 73c shows variant C, the shortest connection between two Natura 2000 areas: via the island Luliaka. This variant will be elaborated. On page 59 and 90 is described why this area is chosen to elaborate. Figure 73d shows the complex variant which leads through the city of Ruse. The last variant, variant E (Figure 73e) shows an ecological route around the city of Ruse, as a kind of *green belt*. Again this variant connects two Natura 2000 areas.

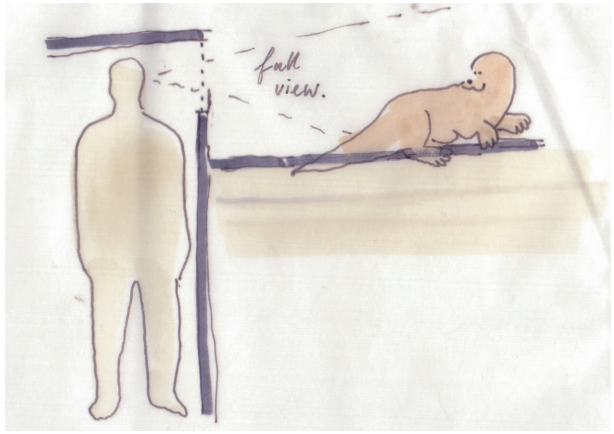


Figure 74a: Visitor sees the animal in its full appearance

Figure 74c: Visitor meets animal by surprise

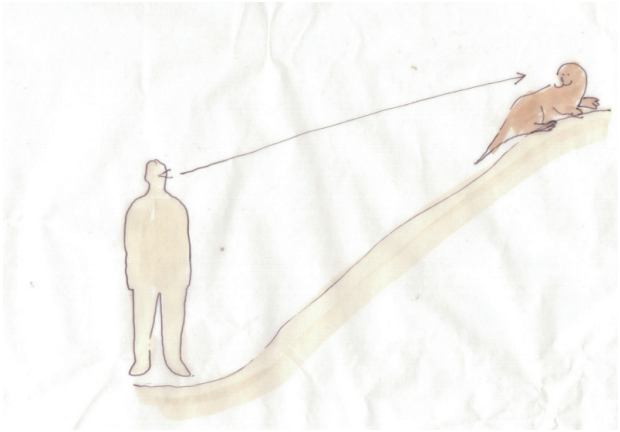


Figure 74b: Visitor looks up to the animal

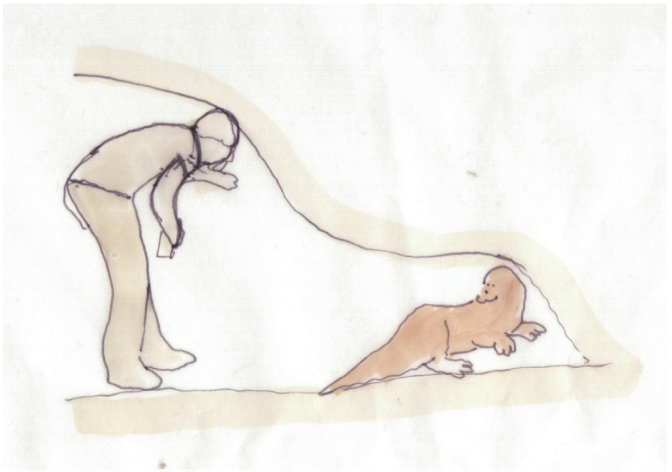


Figure 74d: Visitor in new, unknown setting, sees animal in appropriate setting

FROM ROUTING TO EXPERIENCE AND ANIMAL BEHAVIOUR

At this point the project zooms in from the **M**-scale to the **S**-scale: from routing to experience and animal behaviour. Animal behaviour will be considered below and experience will come later in the report.

BEHAVIOURAL CONCEPTS

On the **S**-scale, where people and animal meet, there's quite some research about the interaction between animals and visitors. John Coe has an interesting point of view, which is helpful in the design. He defines in his article (Coe, 1985) 8 concepts that mind the behaviour of visitor and animal, which are fundamental for the design. I simplified all the behavioural concepts into readable drawings, a couple of them are shown on the left in figure 74.

1 Getting attention: how to let the attention last? Show appropriate stimuli.
2 Making the zoo experience memorable: how to get a zoo experience for the long-term? For example by **creating an expectation** and making sure there's no distraction. By a new experience, a **fullfilled expectation**, involvement of emotions and strengthening by telling the story again to friends.
3 The importance of first impressions: first impressions influence later experiences.
4 Subordination as an education tool: A subordinate position can make somebody susceptible to learn and to be guided.
5 Antropomorphism as an education tool: The transfer of human characteristics and motives on animals. This can be done by specificly designed situations, in which the viewing relation of the animal is made superior to the visitor.
- visitor enters room which is occupied by the animal
- visitor is on the edge of the space, animal is in the center
- hidden visitor watches the animal in its full appearance (figure 74a)
- visitor looks up to the animal (figure 74b)
- visitor meets animal by surprise (figure 74c)
- visitor in a new, unknown setting, views the animal in an appropriate setting (figure 74d)
- visitor meets the animal in its shelter
- visitor appears to be surrounded by the animal

6 Making the message clear: animals in their natural surroundings with natural behaviour often guarantee a better appreciation for their place in nature by the visitor.
7 Making the zoo experience enjoyable: added elements of drama, mystery and a sequense of personal experiences make the zoo experience memorable.
8 Making the zoo experience real: by imitating reality as good as possible the experience for most of the visitors will be new and the memory will be remembered for the long-term. (Coe, 1985)

Another interesting article is from E.J. Fernandez et al. (Fernandez, 2009). This article, about animal-visitor interactions in the zoo, focuses on primates (a member of the highest order of mammals, i.e. monkeys, apes, lemurs), but is as well interesting for other kind of animals. Good to realise is that a zoo has five aims: animal welfare, conservation, education of the public, research, and entertainment. Most zoos focus on the first four, while the majority of the visitors come for entertainment. (Fernandez, 2009)
During the article some possible interventions are described to improve the animal-visitor interaction. For example, to place less people in front of the animal's stay, to remind visitor of what not to do, to get to know which actions are harmful for the specific species, to place signs or caretakers as education, to use sound absorbing materials, to use dB-meters. Furthermore the **placing of a camouflage net** prooves to be useful, to **adjust the height of observance** and to **provide more control for the animal** (room to retreat, enough altitude, 2-way screens). (Fernandez, 2009)

Figure 75: view on Luliaka hotel (left) and Luliaka island (right)

L-SCALE

On the **L**-scale Ruse is the largest city in the stretch by far. (Figure 76). Most large cities in this stretch are situated along the Danube.

Figure 77 shows two touristic routes: The Roman emperors and Danube wine route and the Sultan's trail.

The Roman emperors and Danube wine route is a route connecting 20 ancient roman sites and 12 wine regions along the Danube. It crosses the four countries Bulgaria, Croatia, Romania and Serbia. In the investigated stretch are roman sites in Svishtov (The Roman legion Camp Novae), Ruse (Sexaginta Prista) and Silistra (Roman tomb). Around Ruse there is as well a wine region (The Northeast/Black Sea). The organisation proposes to take the airplane to fly from city to city and undertake activities in and around the Danube like cruising or cycling. (Sorges, 2013) The Roman Emperor and Danube wine route seems a perfect occasion to connect to in the design.

The last one, the Sultan's trail, is an old pilgrimage route, a wandering route between Vienna and Istanbul. The route crosses Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria and the north of Greece and Turkey. The trip ends at the tomb of Süleyman I, behind the Süleymaniye mosque in Istanbul. (Stichting Sultan's Trail, 2015) At this moment the routing of the Sultan's trail still has to be developed, but the organisation suggested to incorporate the design in the route. The organisation tries to create a route along interesting hotspots for walkers and wants to generate an impulse to the economy of the surroundings of the route.

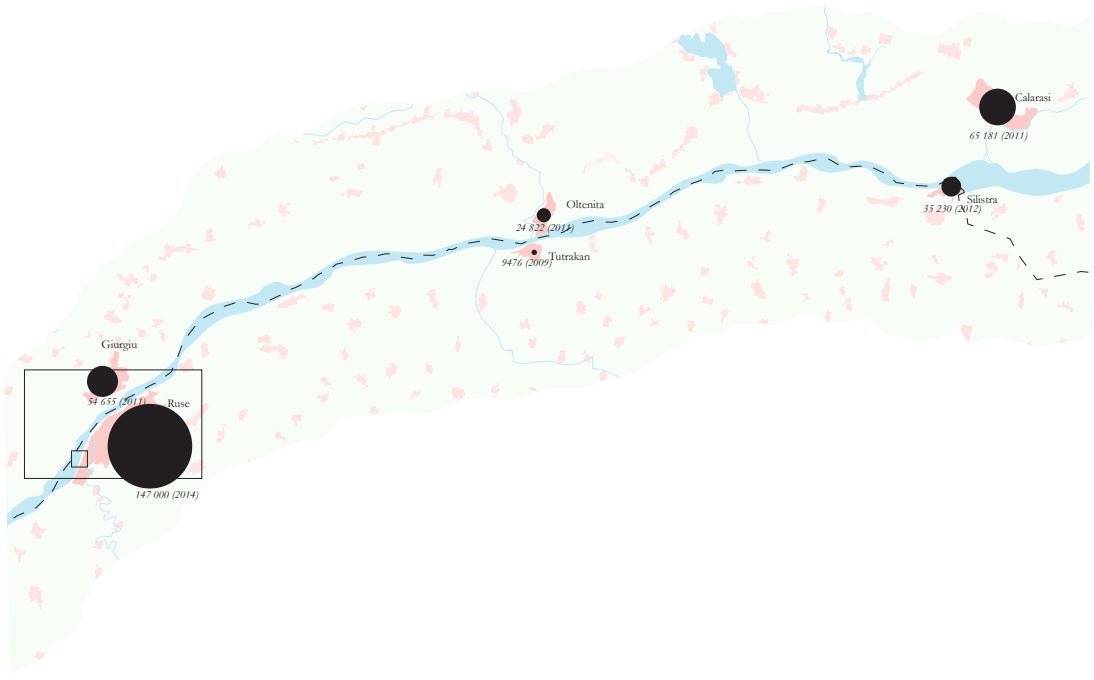


Figure 76: Inhabitants of cities on L-scale

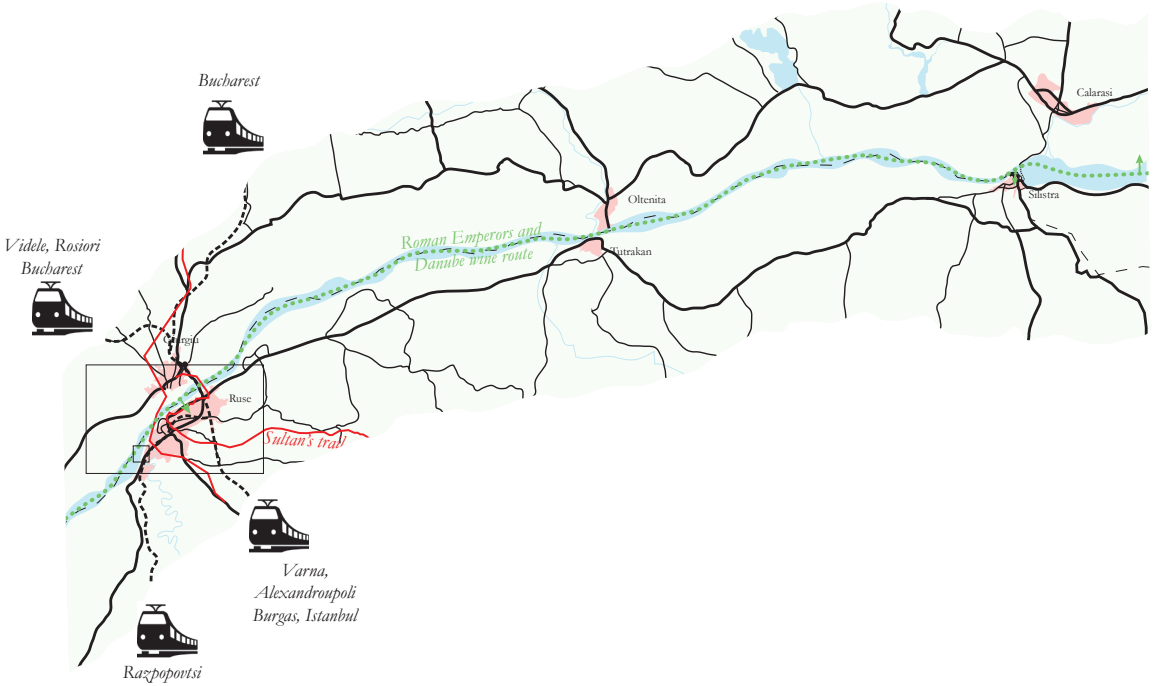


Figure 77: Routing on L-scale

Figure 78: Ecological hotspots on L-scale

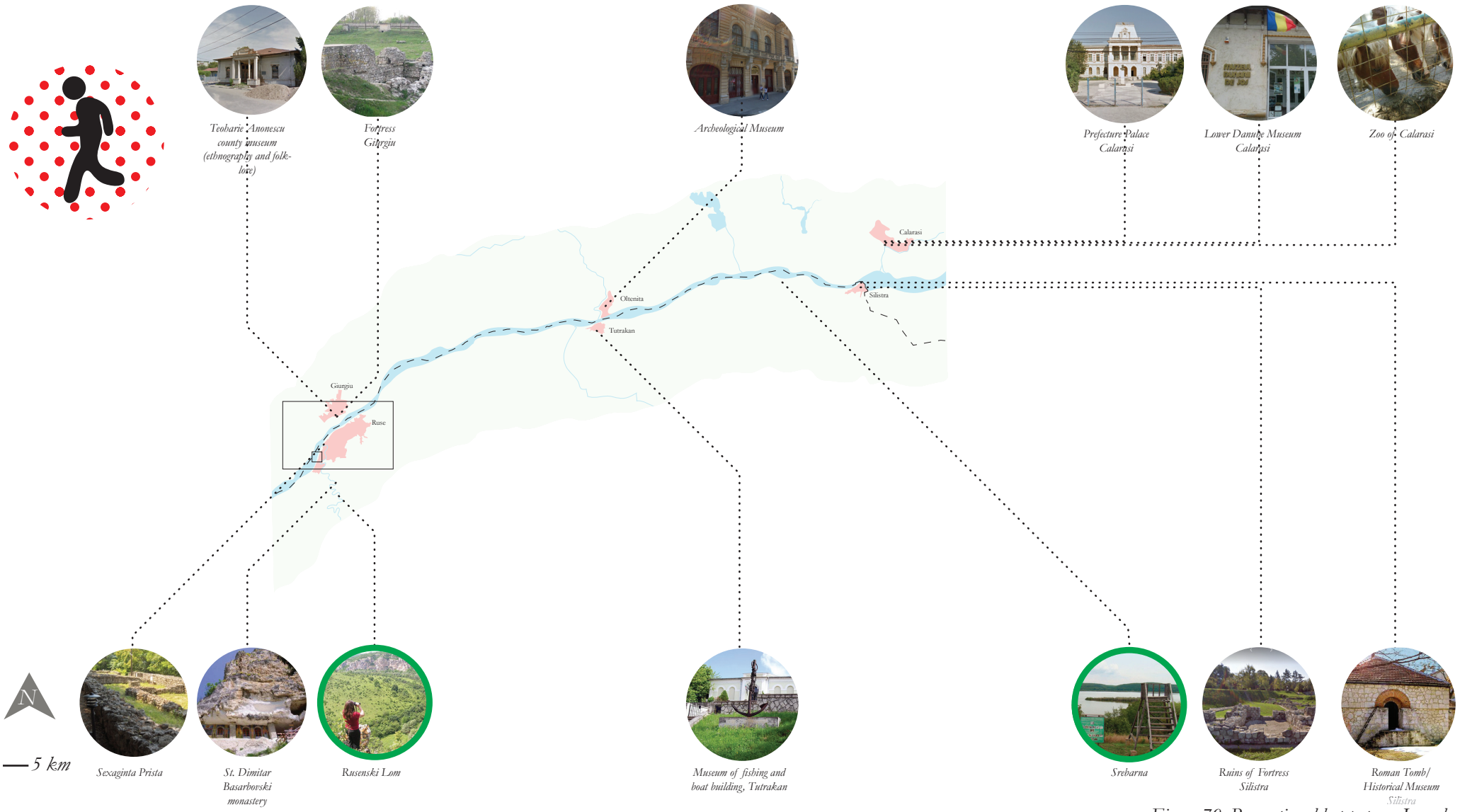


Figure 79: Recreational hotspots on L-scale

Figure 80: Regional plan on L-scale

Regional plan

existing recreational route

new recreational route

new recreational route for bicycles

ecological route

5 km

REGIONAL PLAN

At page 103 is the theory of connectivity and forthcoming from this the green infrastructure discussed. Dramstad clarifies the green infrastructure by showing several illustrations, such as figure

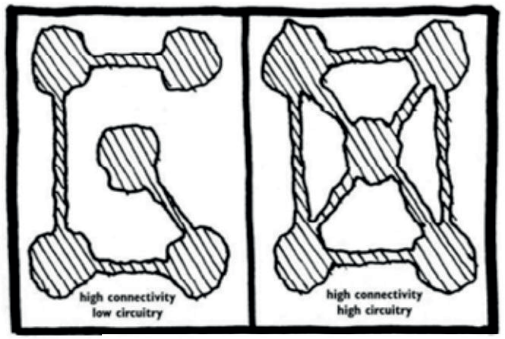


Figure 81a: Connectivity and circuitry

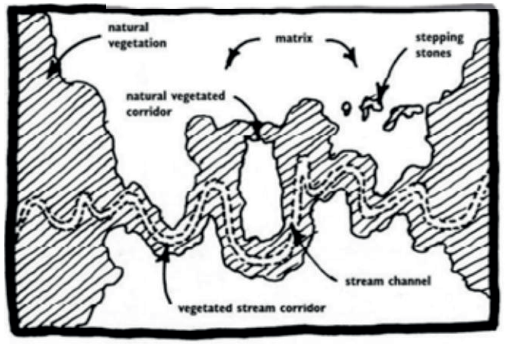


Figure 81b: alternative routes in a network

81. Figure 81a shows that "*network connectivity, combined with network circuitry indicate how simple or complex a network is, and provide an overall index of the effectiveness of linkages for species movement.*"(Dramstad, 1996). Figure 81b displays "*alternative routes or loops in a network reduce the negative effects of gaps, disturbances, predators and hunters within corridors, thus increasing efficiency of movement*" (Dramstad, 1996). This forms the basis of the ecological network in the regional plan shown in figure 80: high connectivity and high circuitry, with alternative routes provide a good network for species movement. Every time interweavements are made in both the recreational network and the ecological networks. In the ecological network patches are connected on two sides to form circuits. In the recreational network all routes form circuits to make it easy to change from car to bike and make a round. At several points there are Danube crossings by ferry or bridge to achieve these circuits. In this way both networks pursue high connectivity and high circuitry in the design of the regional plan.

The ecological and recreational hotspots shown in figure 78 and 79 are connected by the recreational network that is part of the regional plan. It consists of existing recreational routes and new pieces that have been added, for example a new recreational route for bicycles along the Danube. In the Ergo masterplan of Ruse and Giurgiu one can read a bicycle path is a welcome added value: *"In other countries (e.g. in Germany and Austria), the Danube route attracts over 100,000 cycling tourists a year, boosting the economic activities of a chain of hotels and pensions and many other tourism establishments, institutions and organisations along the route."*(Pan Plan-Lassy-Bulplan Consortium, 2012)

Figure 82: Phasing of construction on L-scale

PHASING

In the phasing of the **L-scale** at every turn a more urban area and a more rural area are simultaniously under construction. In urban projects different companies are involved than in rural ones and this is the reason why the phasing is planned in this way. The first phase involves Ruse (Luliaka included), Giurgiu and the adjacent southern rural area. In the second phase the area of Tutrakan and the adjacent northern rural area will be constructed. In the third phase Silistra and its adjacent rural area will be completed. Eventually the most western rural area will be developed.

5 km

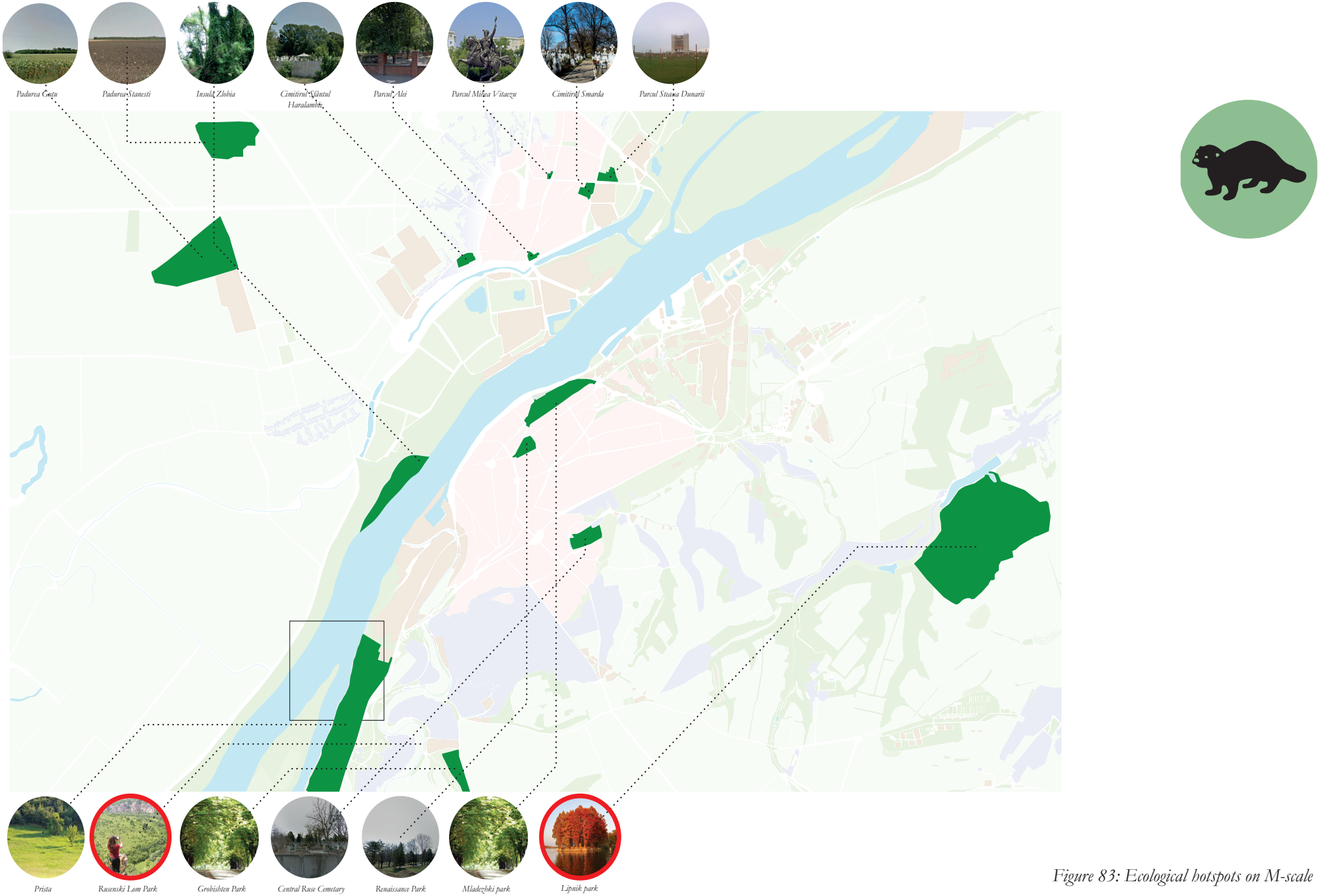


Figure 83: Ecological hotspots on M-scale

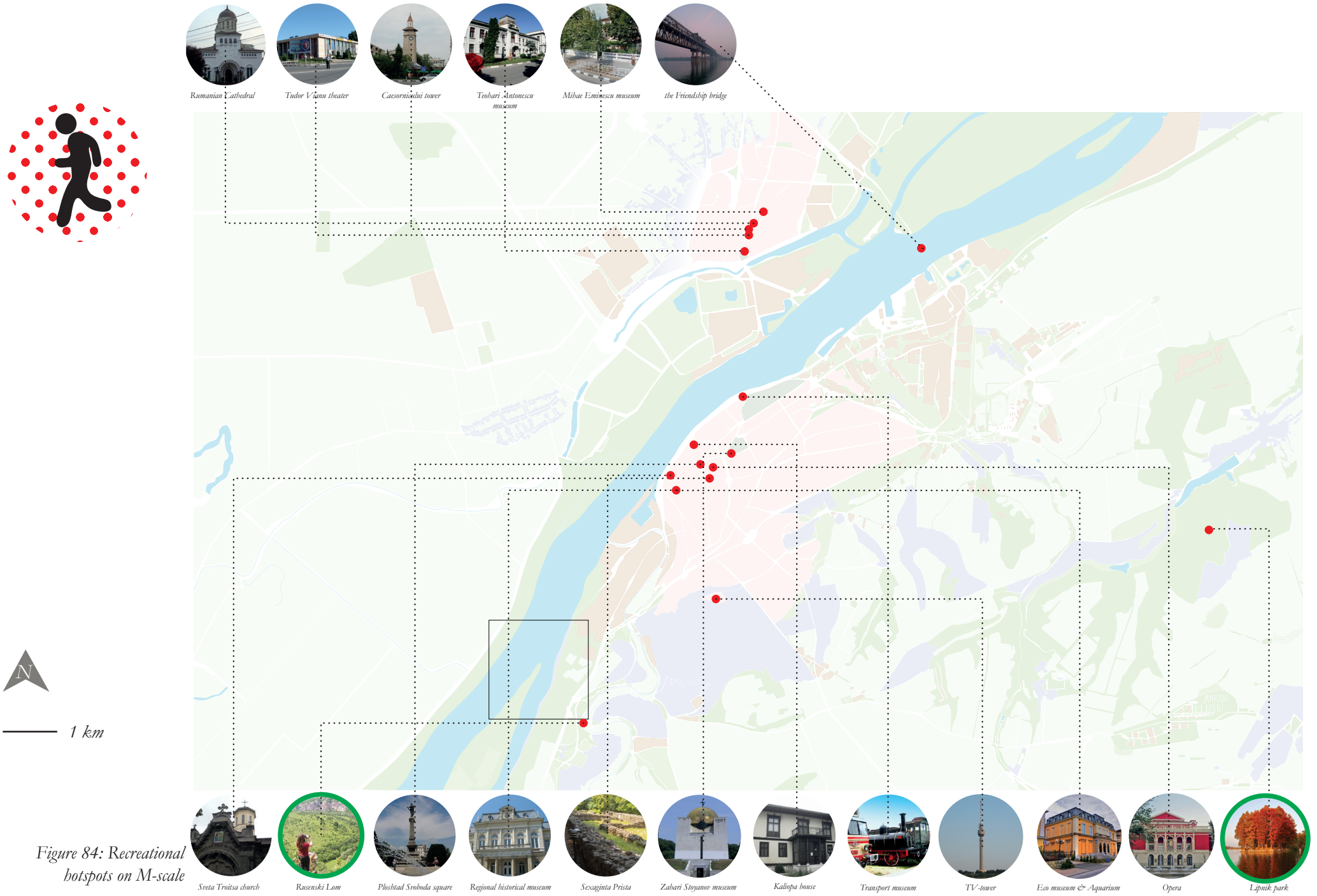


Figure 84: Recreational hotspots on M-scale

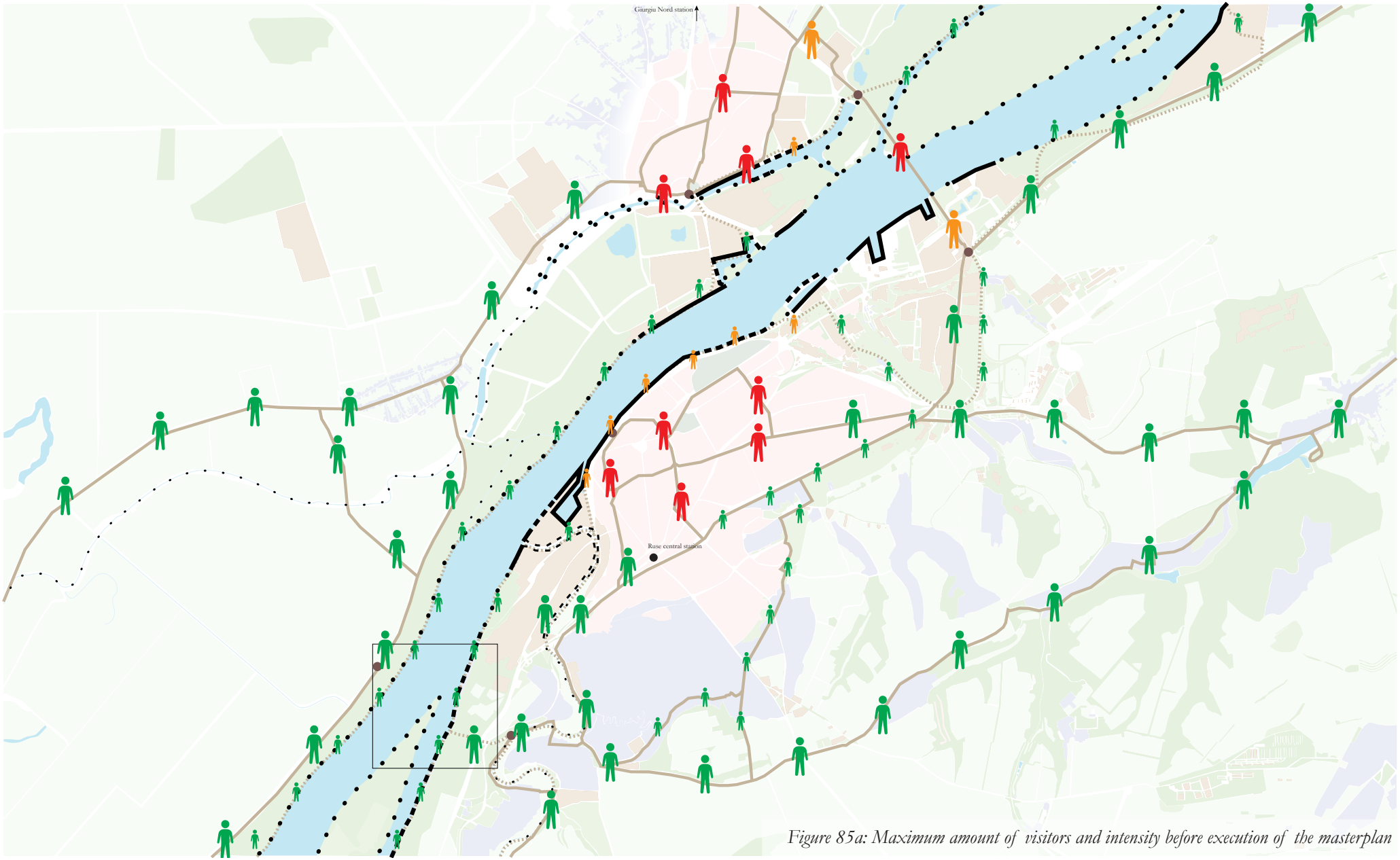


Figure 85a: Maximum amount of visitors and intensity before execution of the masterplan

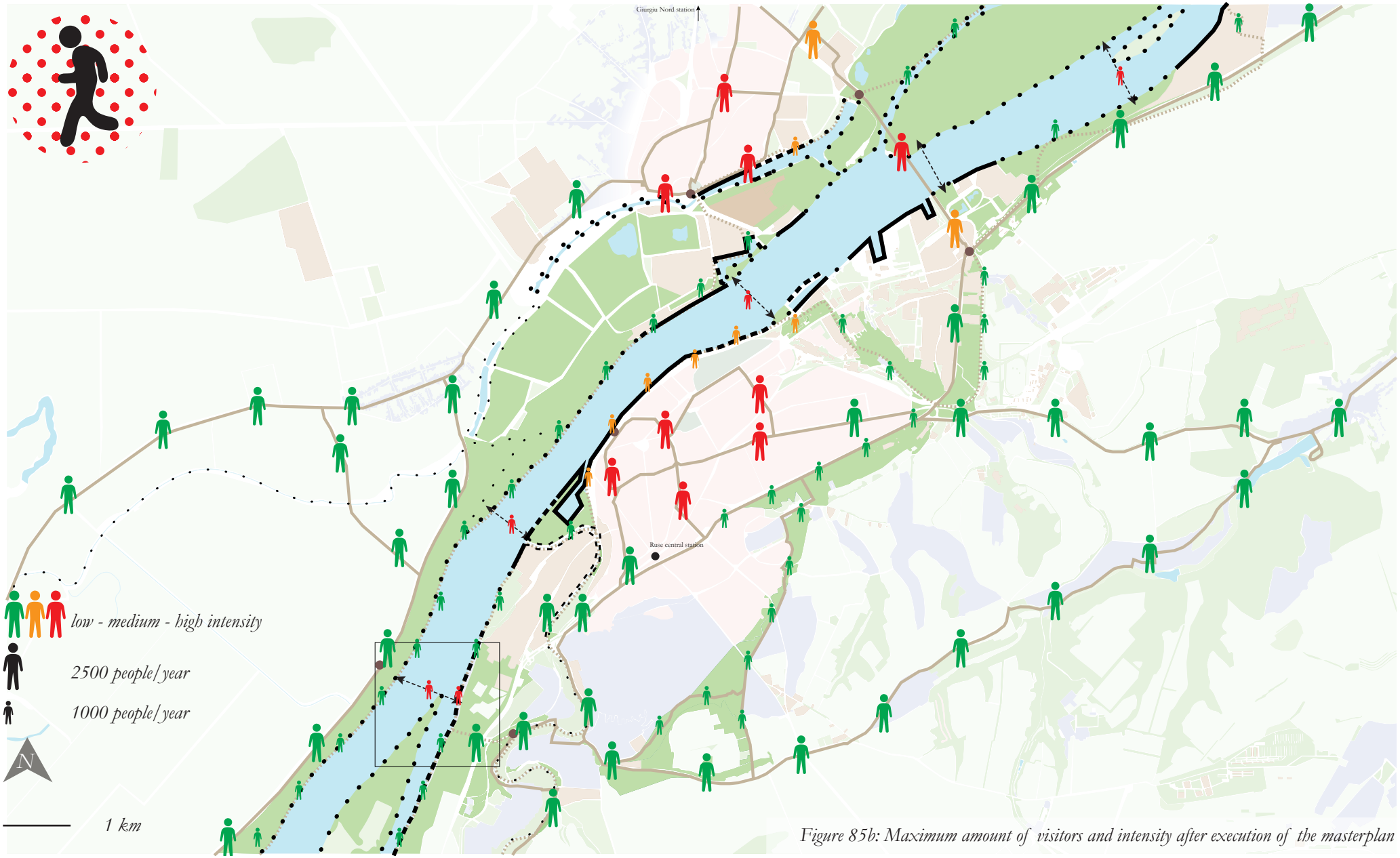


Figure 85b: Maximum amount of visitors and intensity after execution of the masterplan

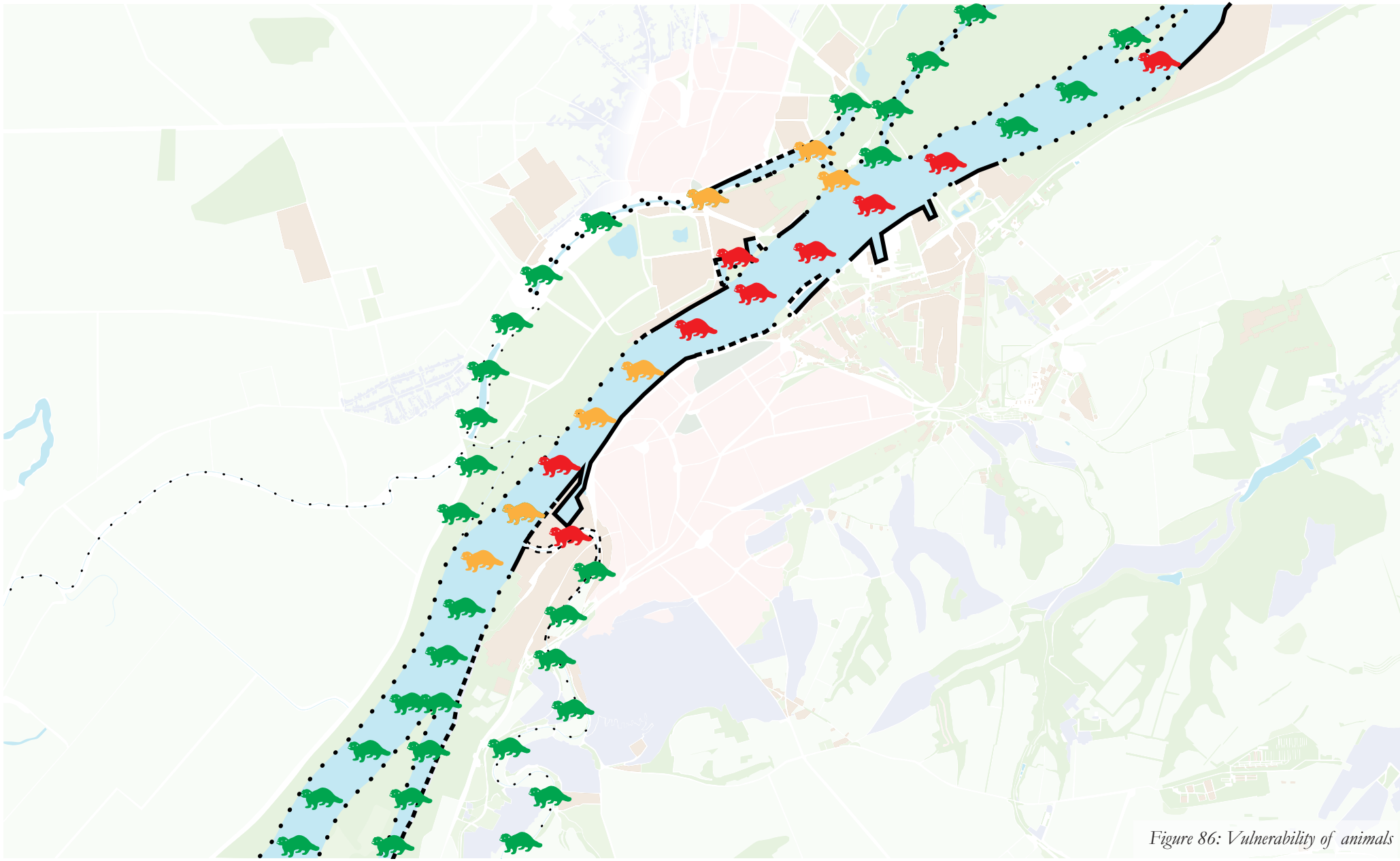


Figure 86: Vulnerability of animals

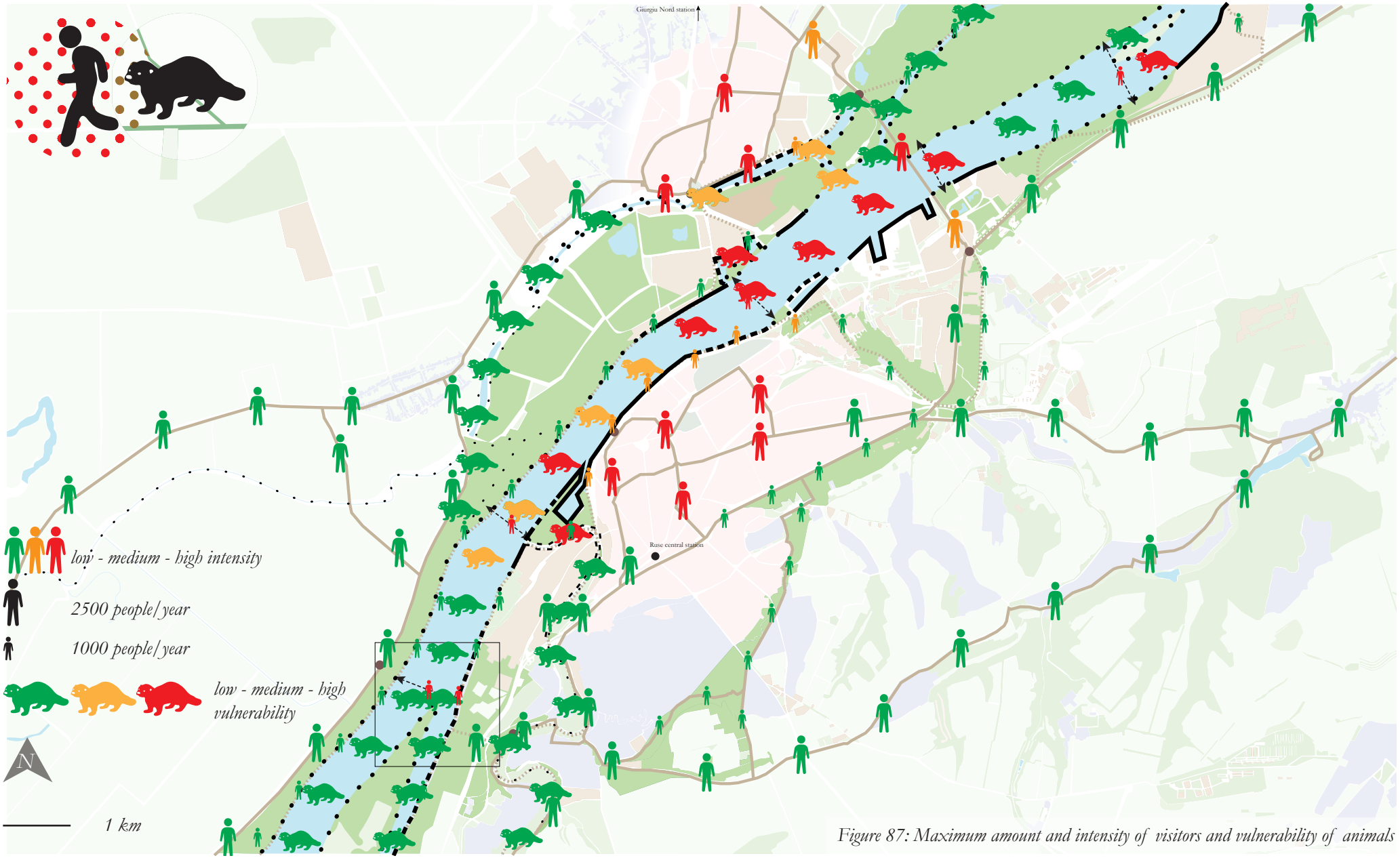


Figure 87: Maximum amount and intensity of visitors and vulnerability of animals

M-SCALE

ECOLOGICAL AND RECREATIONAL HOTSPOTS

In figure 83 and figure 84 are respectively the elaborated ecological network and recreational network on the **M**-scale displayed. Remarkably, in both the ecological network and the recreational network the Lipnik park and the Rusenski Lom are hotspots. These hotspots will be assimmilated in the final design.

MAXIMUM VISITORS AND VISITOR INTENSITY

On the base of the statistical documents of Romania (National Institute of Statistics, 2015) and Bulgaria (Republic of Bulgaria, National Statistical Institute, 2014) a calculation is made.

Tourists:	
Province of Ruse (BG)	83000
Province of Silistra (BG)	23000
Southern provinces (RO)	36500
	+
	142500
Inhabitants:	
Province of Ruse (BG)	235000
Province of Silistra (BG)	119500
Southern provinces (RO)	265500
	+
	620000

5% of 620 000 inhabitants (expected visiting inhabitants) = **31000**

Expected tourists and expected visiting inhabitants per year:
142500 + 31000 = **173500**

These are the expected visitors of the area of the masterplan. In figure 85 this is elaborated: the dimensions of the male icon display the maximum amount of visitors (1000 or 2500 a year). Moreover, the colours of the icons display the expected intensity. Figure 85a shows the situation before the execution of the masterplan, figure 85b shows the situation after the execution of the new plan.

ANIMAL VULNERABILITY

Figure 86 shows the places of vulnerability of otters and beavers in the masterplan. Most vulnerable places are situated around the city centers. This map is placed together with the illustration of figure 85b in figure 87. The south, the north and the west are safe areas for otter and beaver. At the city centers the maximum amount of people, the expected intensity of people and the vulnerability of otters and beavers is high: these are critical areas. A design solution is needed. Following the certain bypass via the west could be an option for otters and beavers. Furthermore the water crossings form critical points: at these points the intensity of people is high and again a design solution is needed. People have to be guided along otters and beavers without generating too much stress for the animals.

Figure 88: Routing and Sultan's trail on M-scale

Routing

Sultan's trail

roads

railroads

1 km

ROUTING

On the **M**-scale the routing is displayed for Ruse and Giurgiu. The recreative pilgrim's route Sultan's trail is indicated as well. It's not clear how the route passes (there are two possible routes that indicate the Sultan's trail), but it could probably be adjusted for the design. After contacting the organisation of the Sultan's trail, the routing at the point of Ruse turns out to be not developed yet. At this moment the routing of the Sultan's trail still has to be developed, but the organisation suggested to incorporate the design in the route. The organisation tries to create a route along interesting hotspots for walkers and wants to generate an impulse to the economy of the surroundings of the route. Most likelijk the sultan's trail will pass the ruins of Sexaginta Prista, which is in the old city center of Ruse and is as well part of the routing of the Masterplan.

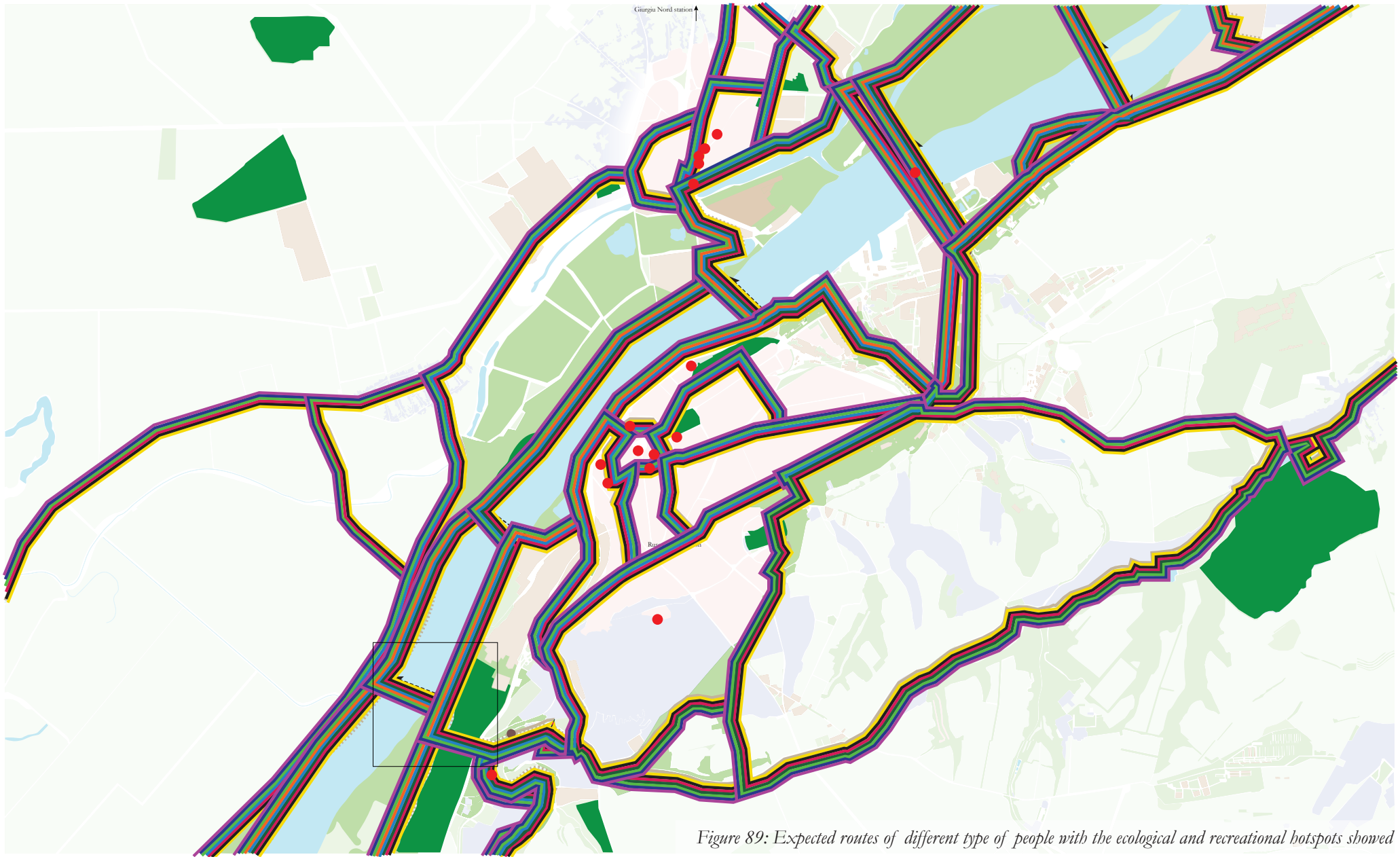
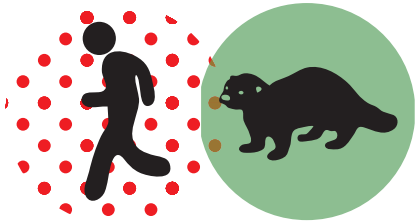


Figure 89: Expected routes of different type of people with the ecological and recreational hotspots showed



ROUTING AND TYPE OF PEOPLE

On the **M-scale** the expected flows of different type of people are showed in figure 89. The colours of the lines in the map represent each a different type of people. This involves from left to right disabled people, Romanian people, Bulgarian people, nature lovers, tourists, bathers, children, hikers and bikers (view figure 90). It provides an overview of the largest groups of different customers of the masterplan.

Divergent in this are the flows of nature lovers, tourists and bathers. Nature lovers will probably follow the most green routes. The flow of tourists has had a closer look based on the article of Lew (Lew, 2006). Lew explains that the flow of tourist will depend on the trip origins (accommodation locations), trip destination (attraction locations) and transportation accessibility. Furthermore the tourist characteristics influence the flow ("time budgets", "motivations interests and composition" and "destination knowledge and emotional value"). Although it's hard to predict, in figure 89 the flow of tourists is expected around the accommodation locations, attraction locations and between these. The design of the "Horti Danubii", (indicated by the frame) will probably attract a new flow of tourists. The last divergent group is the flow of bathers. These are expected around the banks of the Danube.

Based on this information new routes could be created. On page 137 the flows of the different type of people are drawn for the **S-scale**.

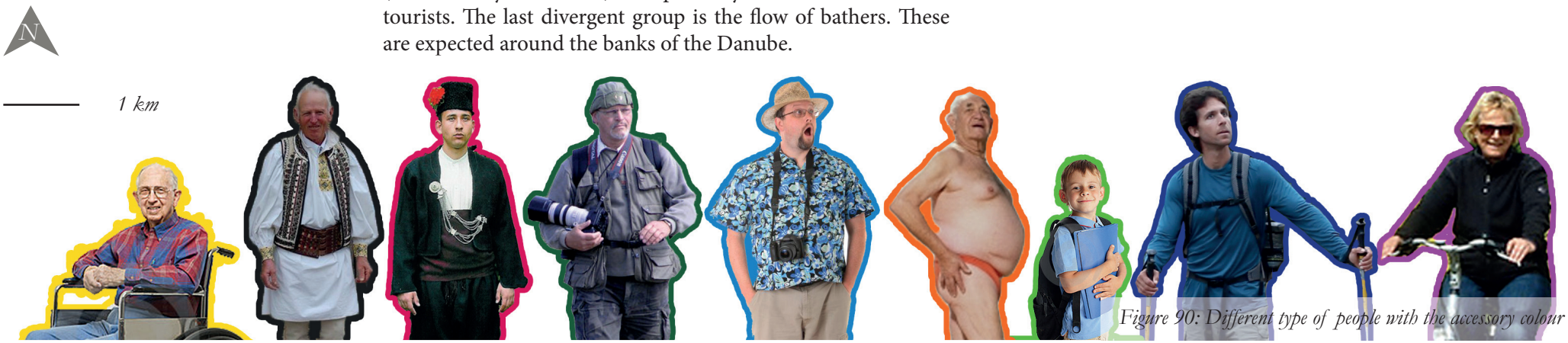


Figure 90: Different type of people with the accessory colour

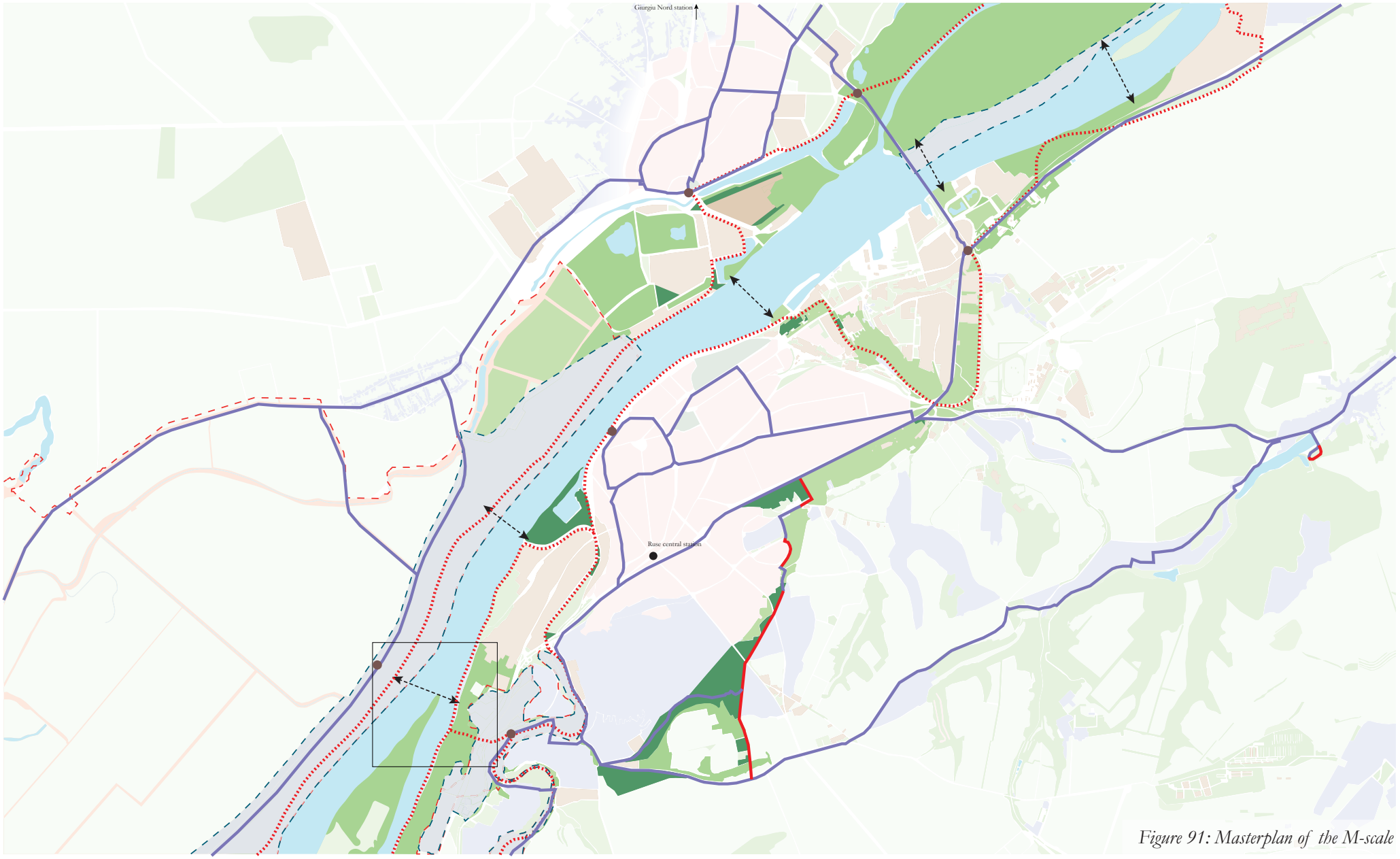


Figure 91: Masterplan of the M-scale

green with high ecological value

green to be upgraded

Natura 2000 bird directive site

Natura 2000 habitat directive site

existing recreational route

new recreational route

new bicycle route

N

1 km

MASTERPLAN

On the **M**-scale, the scale of Ruse and Giurgiu, on the base of previous drawings of the hotspots of the area, this masterplan is prepared. On the one hand this is done by creating recreational circuits for car and bike and to add a new bike route along the Danube. On the other hand this is done by connecting the Natura 2000 areas on the base of connectivity. A green infrastructure will connect these Natura 2000 areas to the existing green areas in the region. *Species movement between two patches is likely to be greatest along a continuous corridor* (Forman, 2014) Therefore several green areas need te be upgraded: the areas need to be refurbished and maintenance should be done. The system of green infrastructure encourages leisure: "*major radial vegetation-corridors also facilitate the movement of wildlife and walkers/bikers into and out of the city.*" (Forman, 2014)

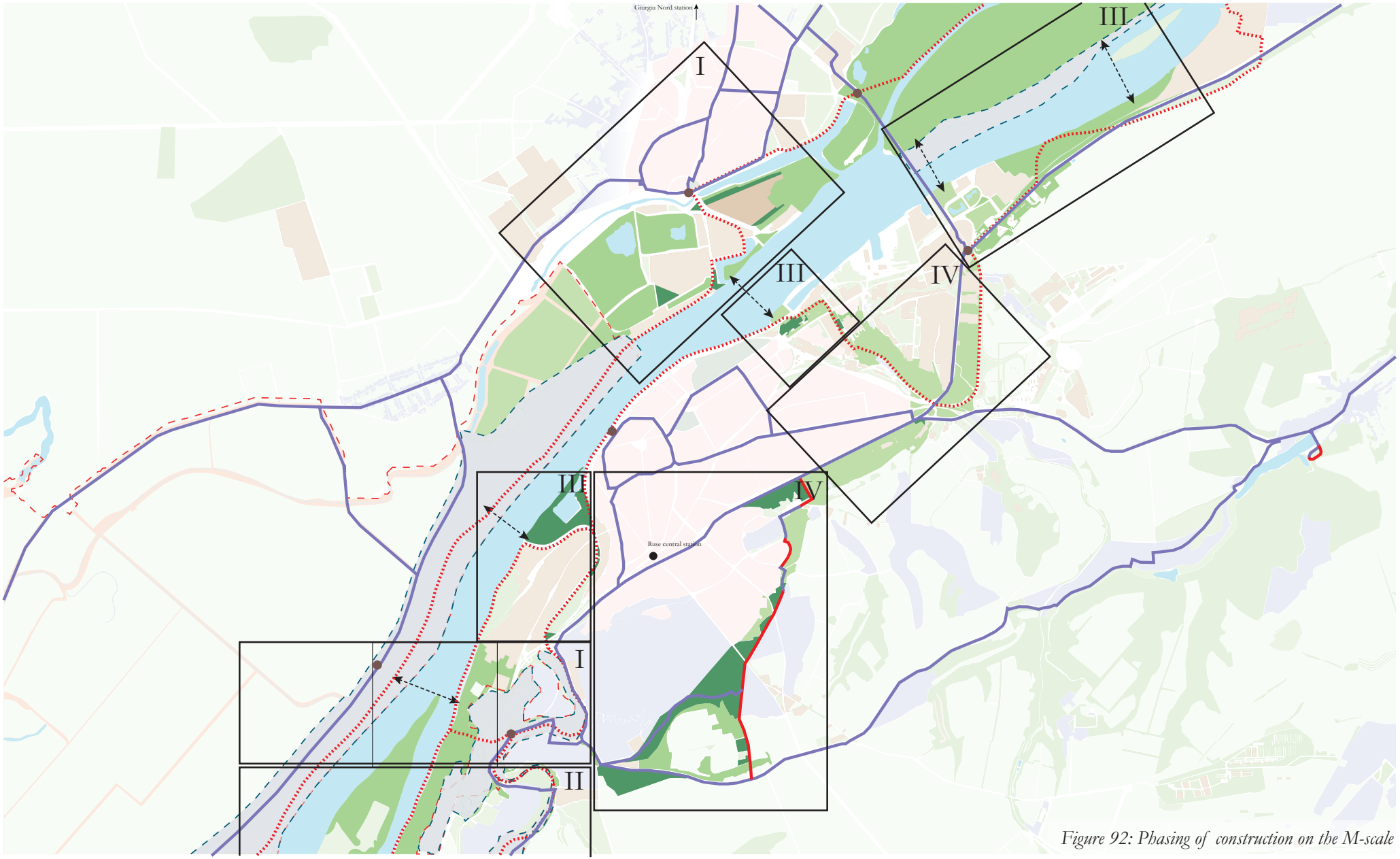


Figure 92: Phasing of construction on the M-scale

PHASING

In figure 92 an illustration is made of the phasing on the **M-scale**. The first phase involves the first part of Luliaka and its surroundings. At the same time the bypass for otters and beavers will be constructed, being a very important intervention to prevent the animals from dying. The second phase involves the extention of the island Luliaka. In the third phase the water crossings will be completed. These places form very important points in the recreational network (described on page 122). Eventually the more inland situated areas will be constructed, to complete the ecological and recreational network on the masterplan scale.

N

1 km

1984

1988

1992

1996

N

1 km

Figure 93a: Morphology of the island Liulaka and its surroundings

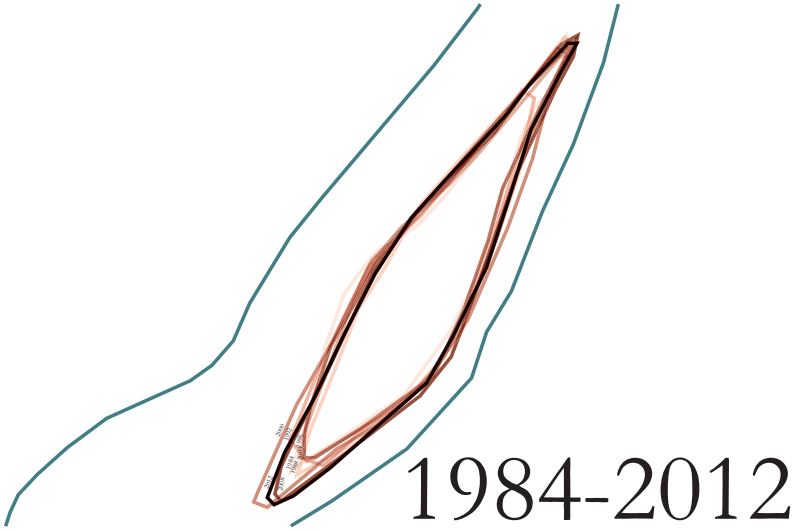


Figure 93b: sequence of previous maps in one illustration

S-SCALE

MORPHOLOGY

On page 132 the morphology of the island Luliaka and its surroundings is displayed. The sequence of these maps is showed in one illustration in figure 93b. On the southside the island seems to be growing over the years. In the design this should be kept in mind by placing the treshold. The treshold will probably not be at the outer point of the island after years have passed.

1 km

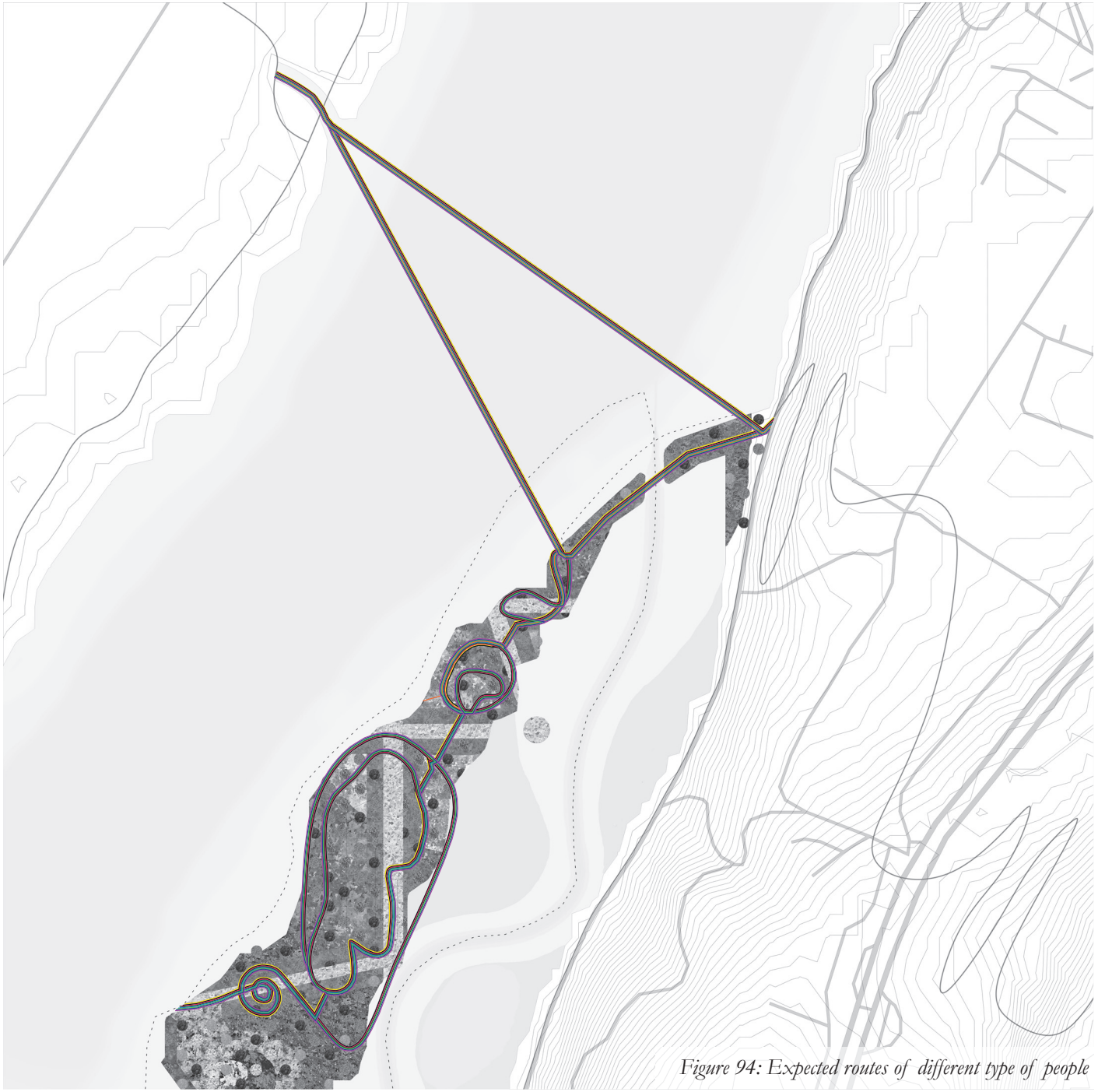


Figure 94: Expected routes of different type of people

ROUTING AND TYPE OF PEOPLE

Elaborating on the previous part on page 126 about types of people on the **M-scale**: on the **S-scale** the expected flows of different type of people are shown in figure 94. This involves from left to right disabled people, Romanian people, Bulgarian people, nature lovers, tourists, bathers, children, hikers and bikers (view figure 95). It provides an overview of the largest groups of different customers of the plan.

Divergent here are the flows of disabled people, tourists and bathers. These people will probably take the shortest routes to their destination. For bathers this is the small beach, for tourists and disabled this is the end of the park, where the otter and beaver stay is situated.

Based on this information new routes could be created.

Figure 95: Different type of people with the accessory colour

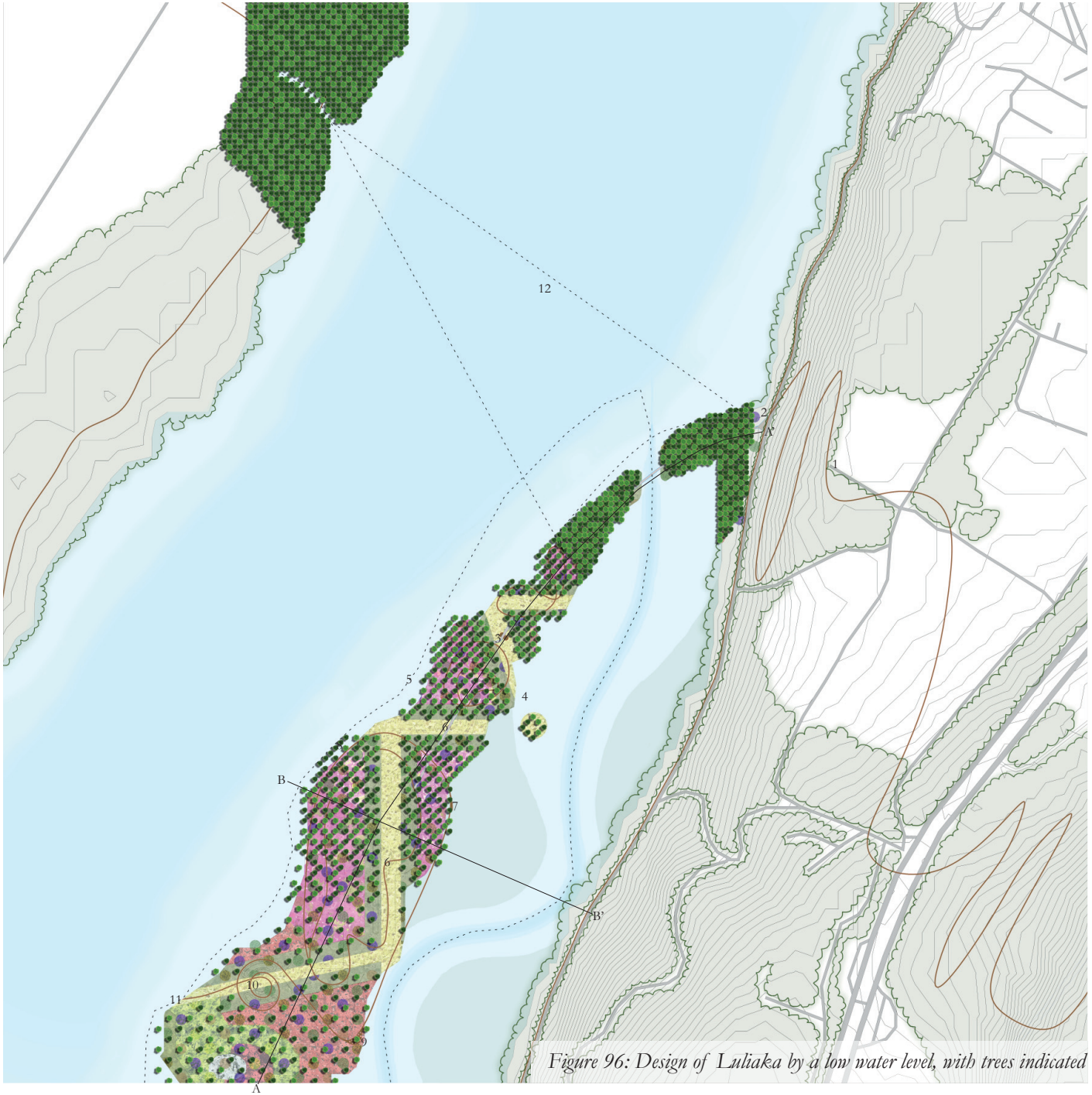


Figure 96: Design of Luliaka by a low water level, with trees indicated

1 parking and donkey stable
2 park entrance
3 fish restaurant
4 Tyrolean traverse
5 beach
6 animal viewpoint

7 fishing pond
8 canoe storage
9 fish farm
10 otter and beaver stay
11 starting point whisper boat
12 otter pond

100 m

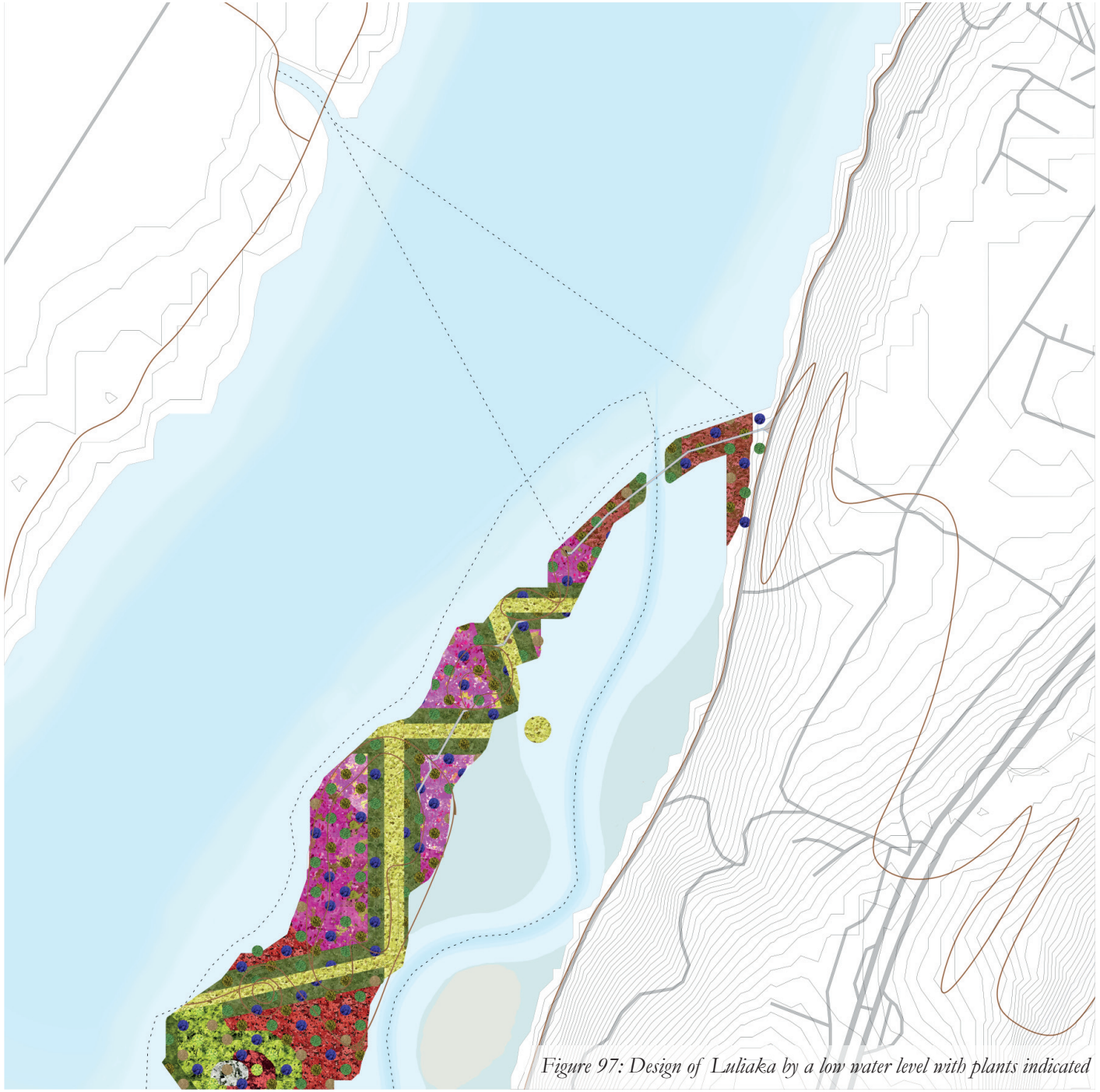


Figure 97: Design of Luliaka by a low water level with plants indicated

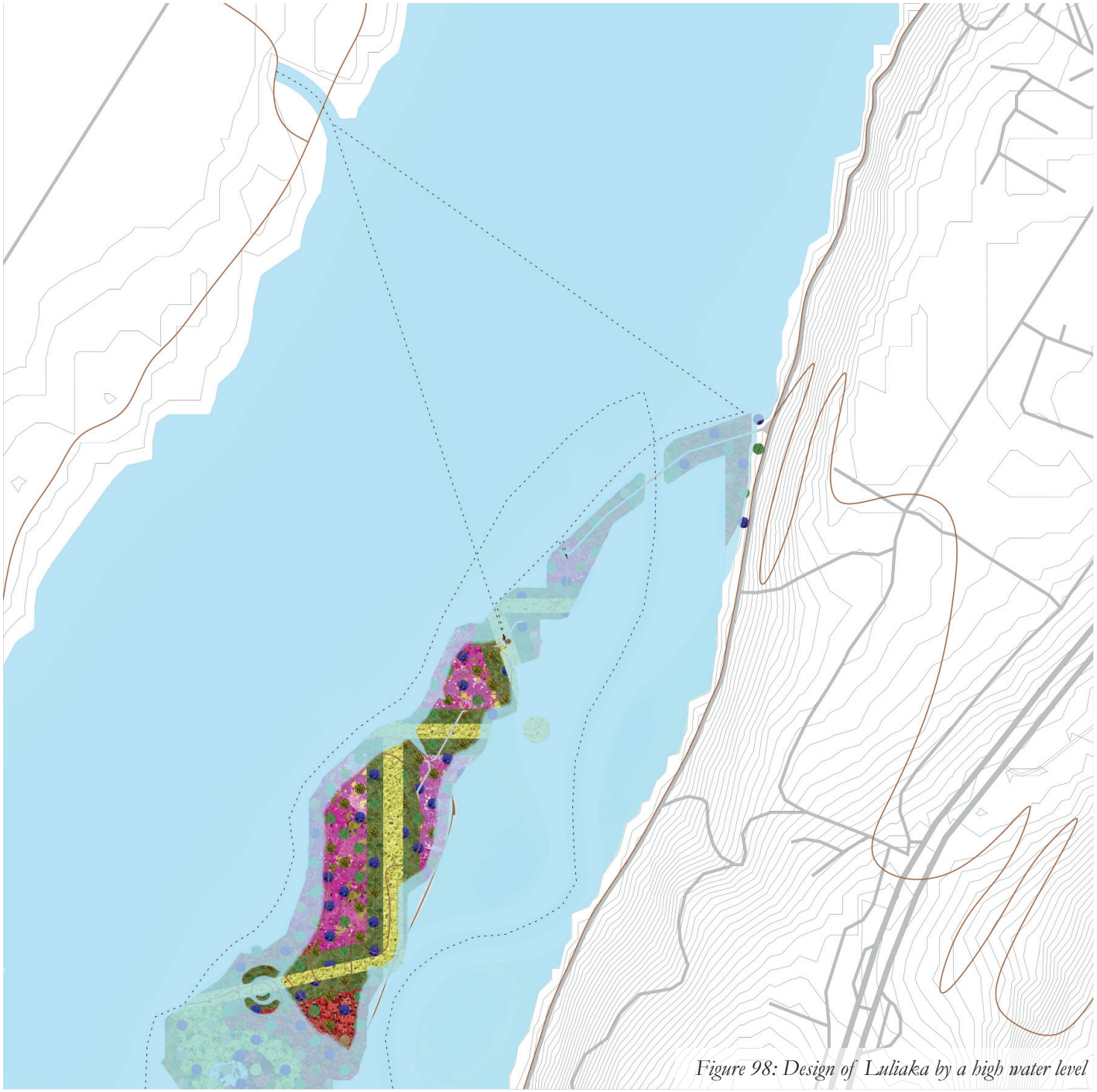


Figure 98: Design of Luliaka by a high water level

DESIGN

Displayed on the **S**-scale of the island Luliaka, are a plan with trees (figure 96), a plan with only the plants (figure 97) and a plan with a higher water level (figure 98).

PROGRAM

The program consists of a fish restaurant, with fish from the Danube, a tyrolean traverse, two bird, otter and beaver viewpoints, a fishing pier, a canoe pier, a small beach, a fish farm and a beaver and otter stay. The amount of activity is decreasing to the south.
Furthermore there are donkeys for handicapped people and to carry luggage.
The fish farm will house fish that's edible for otters. Therefore an inspection of existing population should take place. A visit to the ecomuseum and aquarium with fish from the Danube already gave an impression. Otters eat most fish smaller than 25 cm like eel, perch, pike and carp. According to the museum there is pike-pearch, bream, pike, catfish and common carb swimming in the Danube. The own research shows as well that there's perch and carp in the direct surroundings of the island. This fish would be good to harvest in the fish farm.

TREES

The tree population exists of willows and populars, like the existing population. These trees were found by the observation (View page 145).

MANAGEMENT

A minimum operation would be the best fitting. In this way could be seen what the beaver changes in the landscape. Sheep will mow the grass in designated areas. Furthermore the sand will be taken away by excavators every year during summer, when the water level is low. In this way the meandering stream will be achieved.

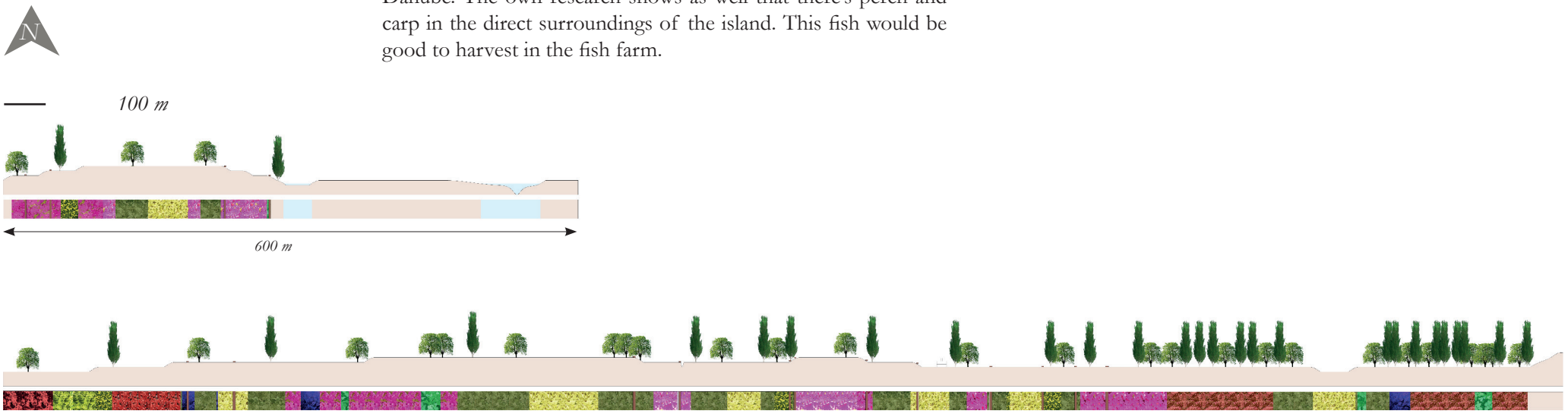


Figure 99: Design of Luliaka by a high water level

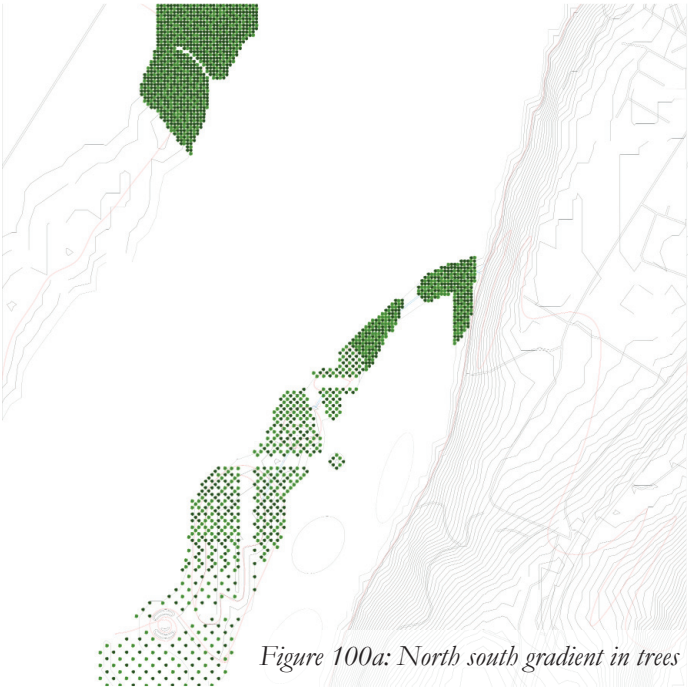


Figure 100a: North south gradient in trees

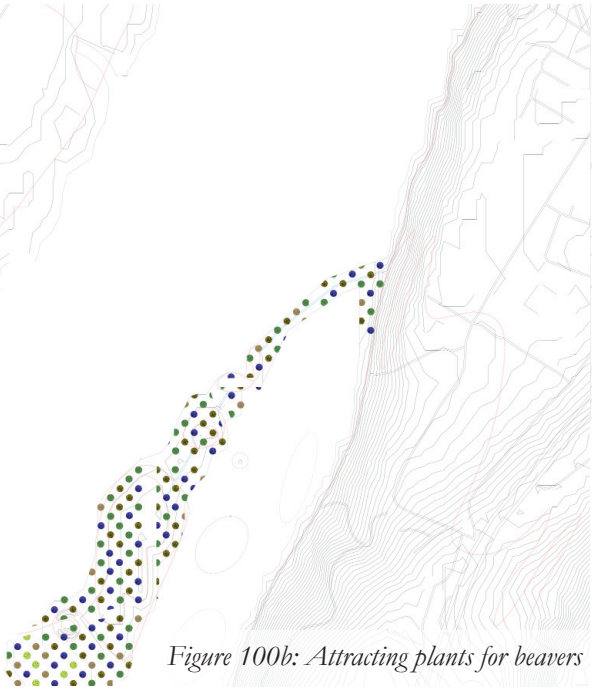


Figure 100b: Attracting plants for beavers

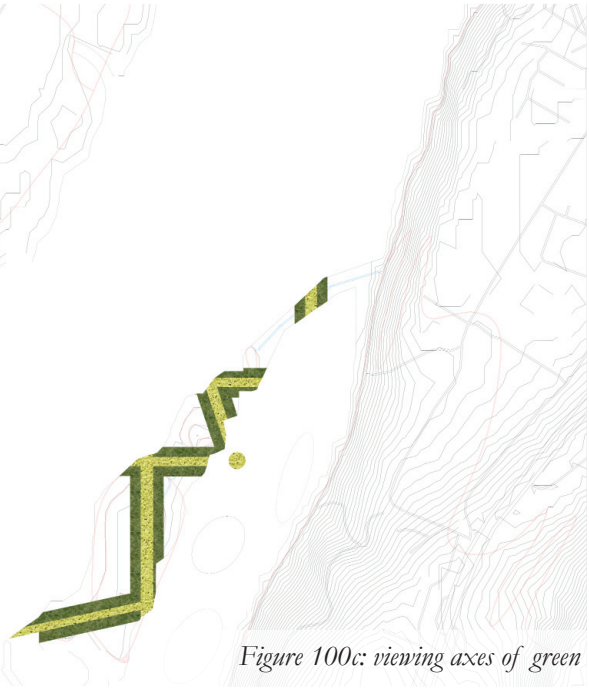


Figure 100c: viewing axes of green

DESIGN LAYOUT AND EXPERIENCE

First of all, the trees are placed in a gradient (figure 100a). From north to south the distance between the trees becomes larger. This creates diverse spaces and a transition with the rest of the island, which is more open. The trees are placed in a polka-dot pattern, so that one could see clearly which trees the beaver has moved. This will clearly show the interaction between people and animals. People shape it in a very geometrical way, the animals will not take this into account.

Attracting plants for beavers (Nuphar Lutea, Phragmites australis, Symphytum officinale, Urtica dioica and Iris pseudacorus) are placed in circles on the island (figure 100b).

Furthermore viewing axes are created of grass and a buffer is created with Typha angustifolia (view figure 100c). In this way the topography of the island is visible and animals can be spotted over the entire island, since animals are often viewed along the edges of forests. The axes of green are connected like in the classical hunting forest, in order to realise that strategically any place is covered to see animals. The axes will clearly show that it's a human intervention: the straight corners and strict borders emphasize the planning of people.

In the document "*Macrophytes, River Corridor, Land Use, Habitats: A Multifunctional Study in the Danube Catchment Based on a GIS - Approach*"(MIDCC, 2003) an inventarisation is made of the plants in the Danube in the stretch between Ruse and Silistra. I sorted these plants and chose eventually the plants by colour of the flower. A gradient was made with especially purple flowers,

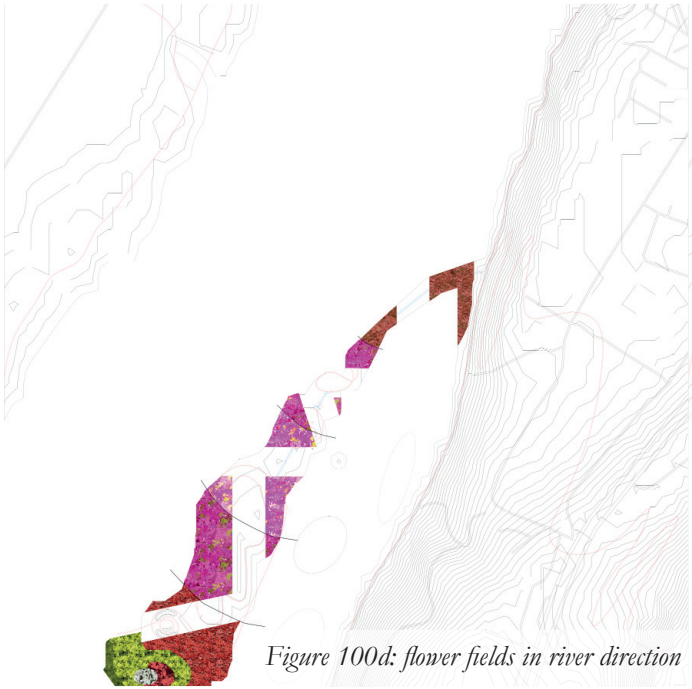


Figure 100d: flower fields in river direction

Figure 100e: routing in park

Lavender - PMS 264 *Positive:* romantic, nostalgic, fanciful, lightweight, lightly scented

Mauve - PMS 5145 *Positive:* wistful, sentimental, thoughtful

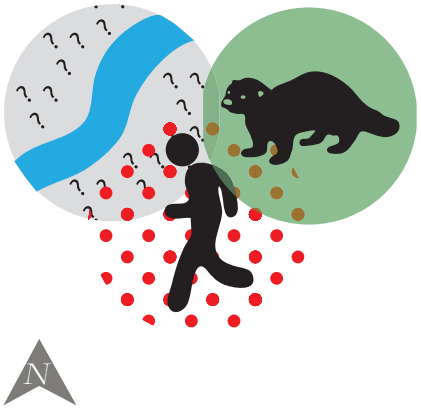
Amethyst - PMS 2573 *Positive:* curative, protective, peace of mind

Blue Purples - PMS 267C *Positive:* contemplative, meditative, spiritual, soul-searching, intuitive, mysterious, enchanting

Red Purple - PMS 2602C *Positive:* sensual, thrilling, intensely exciting, dramatic, creative, witty, expressive

Deep Purple - PMS 2627C *Positive:* visionary, rich, royal, prestigious, subduing, distant, introspective *Negative:* aloof

Figure 100f: meaning of color



consisting of five different fields, all placed in the direction of the river (figure 100d). The colour purple and adjacent colours are chosen because of the meaning of the colours (figure 100f): contemplative, meditative, spiritual, soul-searching, thoughtful, mysterious, protective, piece of mind, rich and royal are fitting to the area of Ruse or the intention of the park. In this way the park has a different experience because of the colour codes. It will emphasize the feeling of roaming and mystery, which is mainly generated by the routing.
In the south of the island different colours are used to make a distinction, because these are all water plants.

Finally the routing is displayed in figure 100e. The routing consists of two types of path, a wooden, small one of two meters wide with high parapets and a concrete wider one of four meters wide without parapets. The wooden path every time turns to infinity to contribute to a special experience: creating the feeling of roaming with possibly a contemplative twist. The concrete path opens up and creates shortcuts between the "infinite" wooden paths. In this way the visitor will understand that he walks on another path, with another experience.

Figure 101: Leafs found at Luliaka

TREES AND PLANTS FROM OBSERVATION

In figure 101 leaves that are found on the island Luliaka are displayed. The wild vine (vitis sylvestris) seemed to be rampant in a lot of places. The Himalayan indigo (indigofera heterantha) is found on the island as well and used in the planting plan. Besides these plants and trees a lot of poplars were found on the island Luliaka. The new planted trees in the design will all be poplars or willows to adapt to the existing trees.

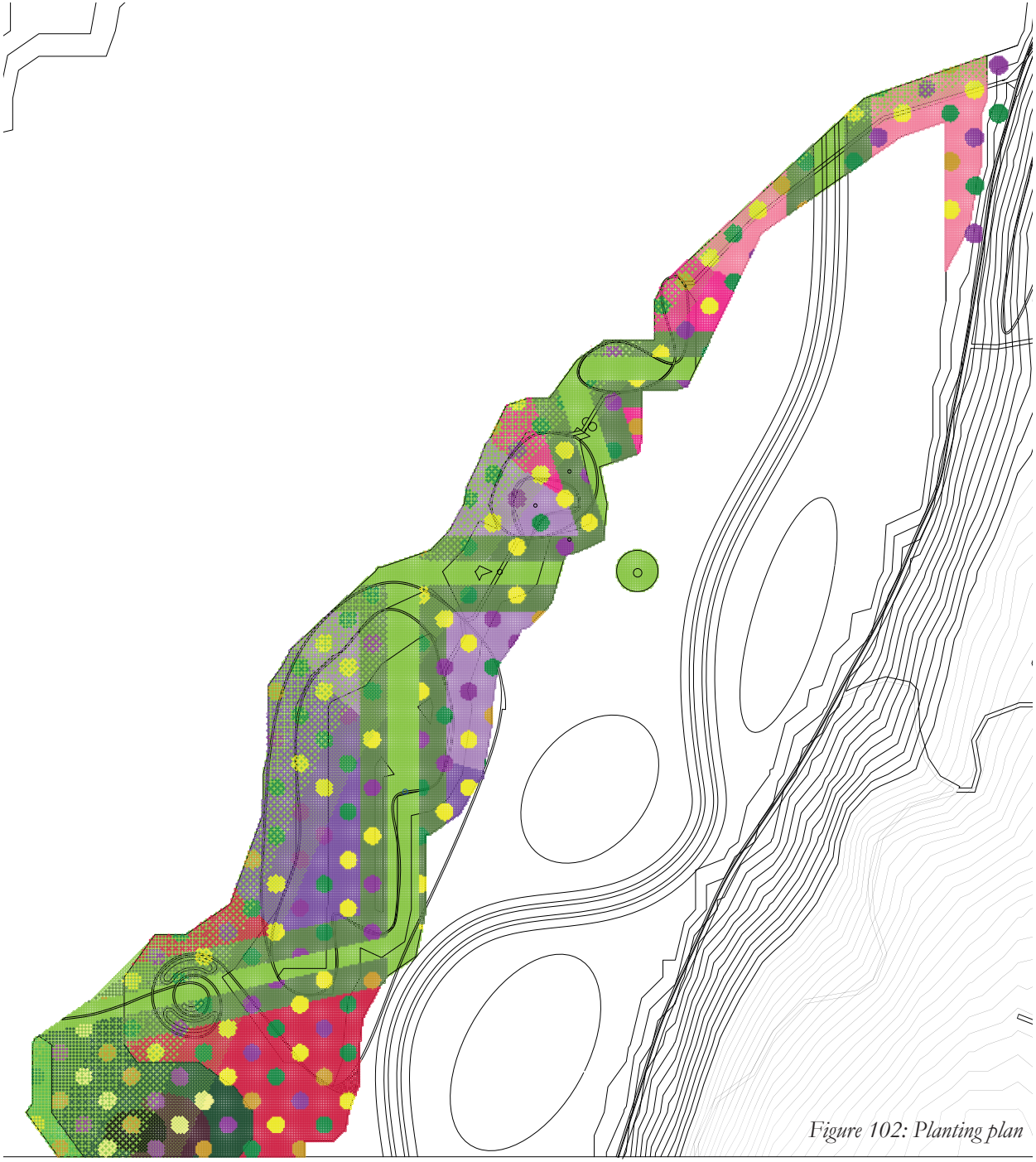
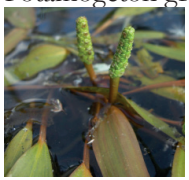


Figure 102: Planting plan

Echinochloa crus-galli

Europese Hanenpoot
green flowers (brown or purple gradient)
10 - 120 cm
july - october

Potamogeton gramineus



Ongelijkbladig fonteinkruid
green flowers
30 - 100 cm
june - august

Berula erecta

Kleine watereppe
white flowers
30-60 cm
july - september

Juncus effusus

Pitrus
red/brown flowers
20 - 140 cm
june - august

Lythrum salicaria

Grote kattenstaart
purple/red flowers
60 - 120 cm
june - september

Persicaria amphibia

Veenwortel
rose/red (sometimes white) flowers
20 - 300 cm
june - october

Mentha aquatica

Watermunt
rose flowers
30 - 90 cm
july - september

Indigofera heterantha

Indigostruik
rose flowers
200 - 250 cm
june - july

Eupatorium cannabinum

Koninginnekruid
rose-white/rose-red flowers
50 - 150 cm
july - september

Nuphar lutea

Gele plomp
yellow flowers
60 - 120 cm
may - august

100 m

Phragmites australis

Riet
brown/red flowers
100 - 300 cm
july - october

Symphytum officinale

Gewone smeerwortel
purple, rose or white flowers
30 - 100 cm
may - august

Urtica dioica

Grote brandnetel
green flowers
30 - 130 cm
june - july

Iris pseudacorus

Gele lis
yellow flowers
40 - 120 cm
may - july

Agrostis stolonifera

Fioringras
green, white or purple-brownflowers
8 - 60 cm
june - september

Typha angustifolia

Kleine lisdodde
yellow or green flowers
100 - 300 cm
june - august

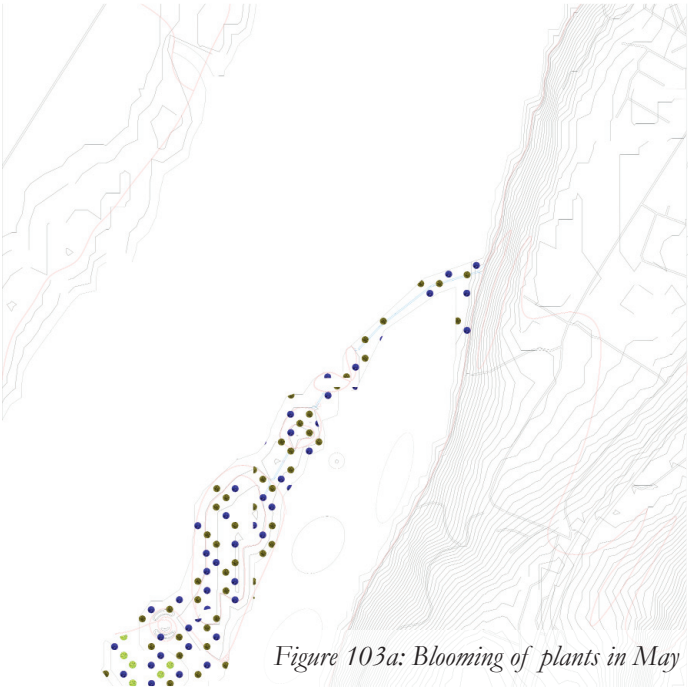


Figure 103a: Blooming of plants in May

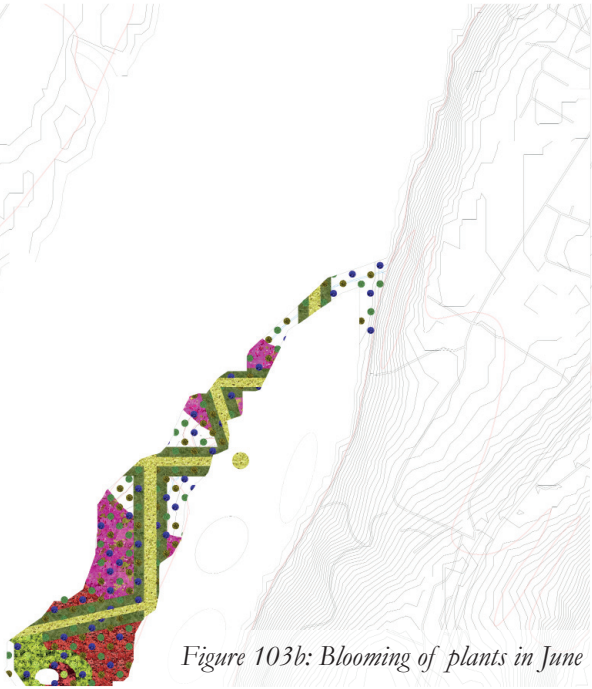


Figure 103b: Blooming of plants in June

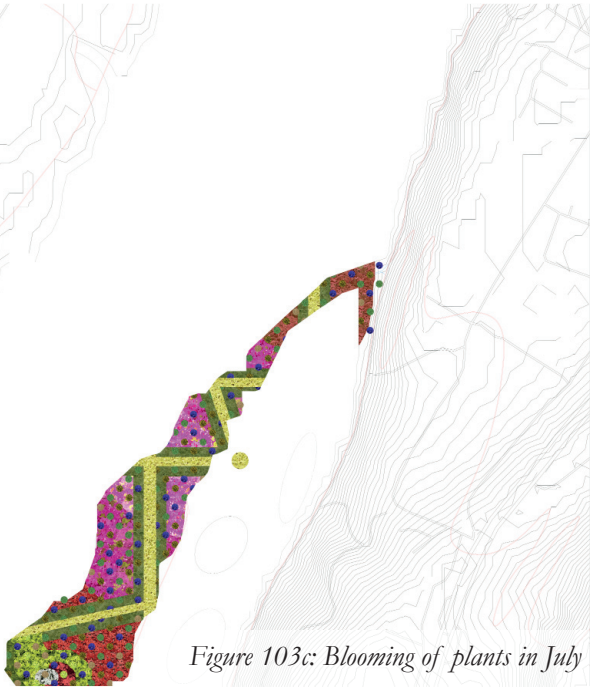


Figure 103c: Blooming of plants in July

FLOWERING

Figure 103 displays when the different type of flowers of the plants bloom. Most of the for beavers attractive plant species flower already in May. In July all the plants are flowering and again in the end of the flower season, in October, some of the for beaver attractive plant species still flower.

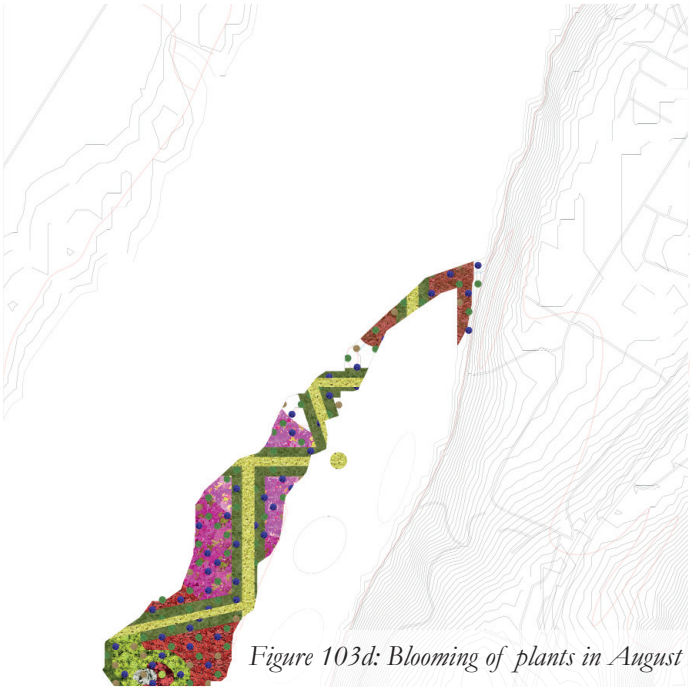


Figure 103d: Blooming of plants in August

Fig. 103e: Blooming of plants in September

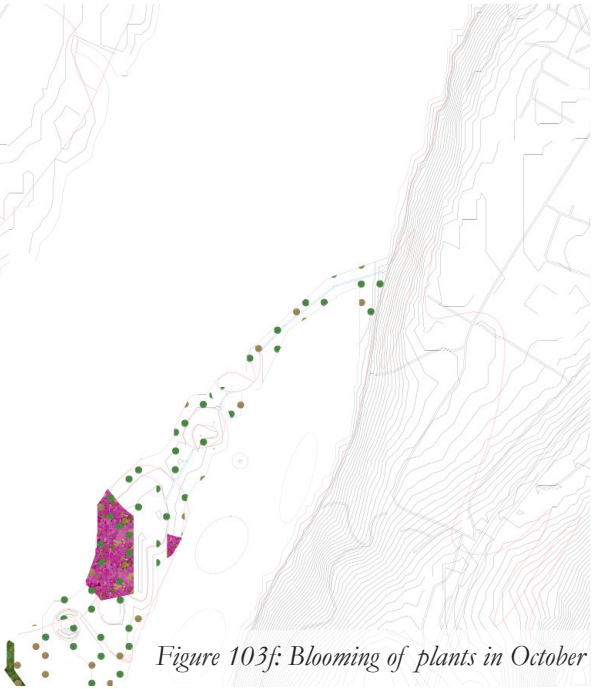
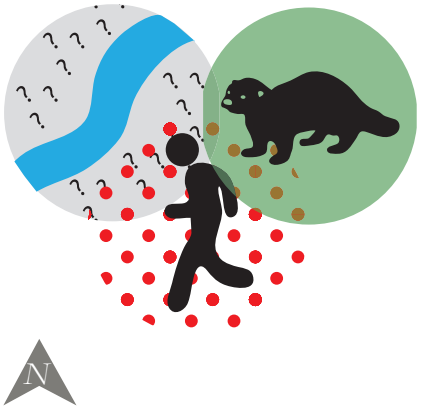


Figure 103f: Blooming of plants in October



— *100 m*

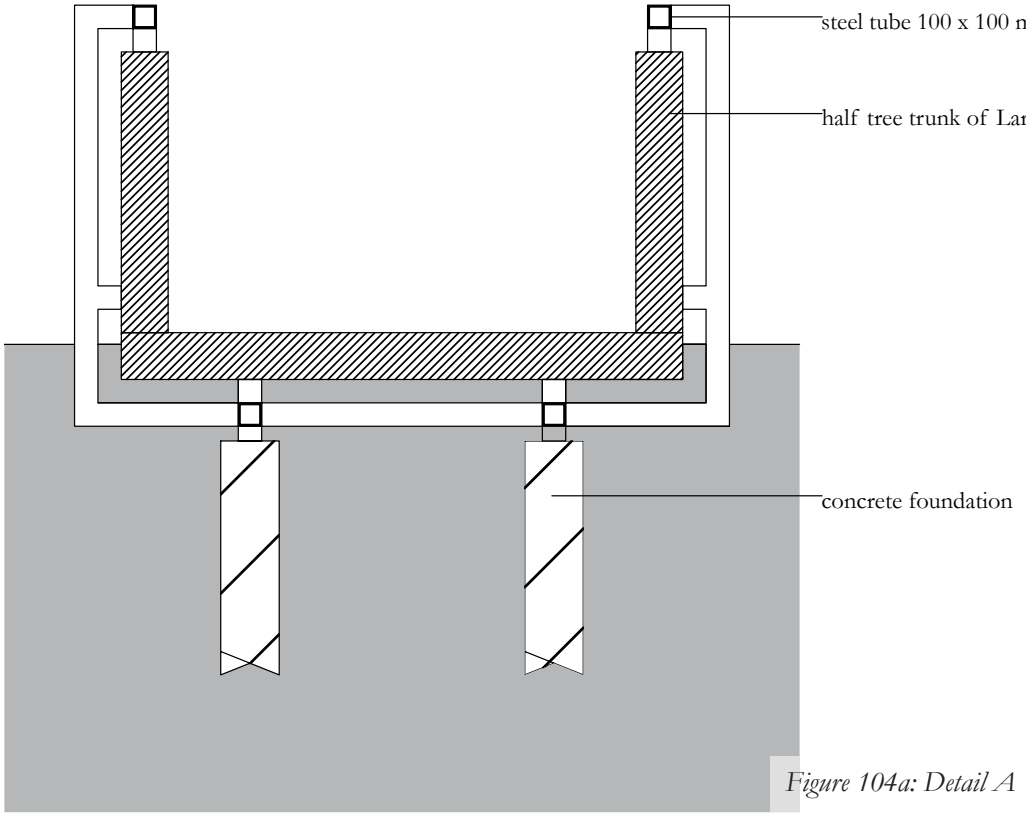


Figure 104a: Detail A

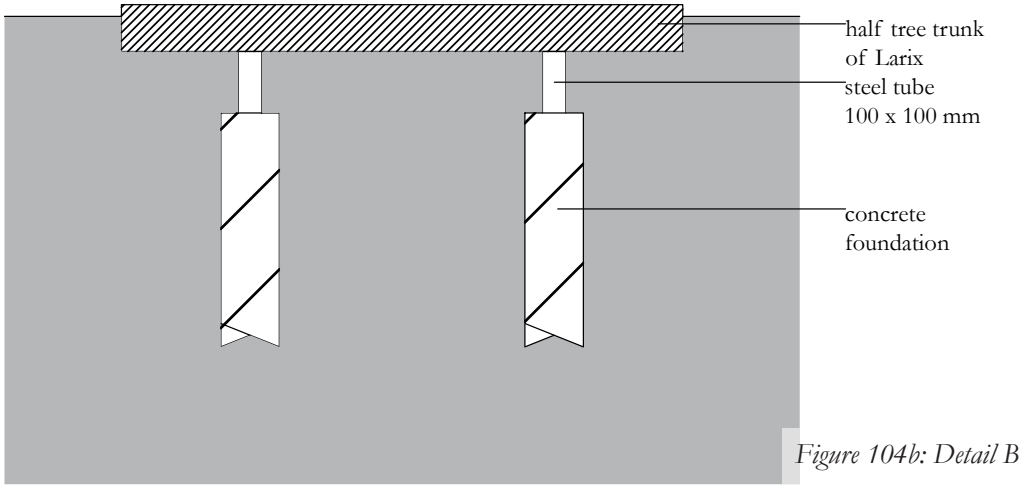


Figure 104b: Detail B

DETAILING

Three details are shown in figure 104. Depending on the quality of the bottom, one of these three details will be chosen. The first one is the main element. This was inspired by the design of Pushak architects in figure 104d. In the current design wooden beams of the Larix-tree will be used, since the beaver will not eat or ruin this type of trees. The bark will be visible on the outer side of the tree, so the designed element will blend in the surrounding trees.

The other two details (figure 104b+c) will be used at places where the bottom is very good, at higher places. Here it is possible for visitors to leave the path. In figure 104e a detail is shown to create a bridge, needed for higher constructions.

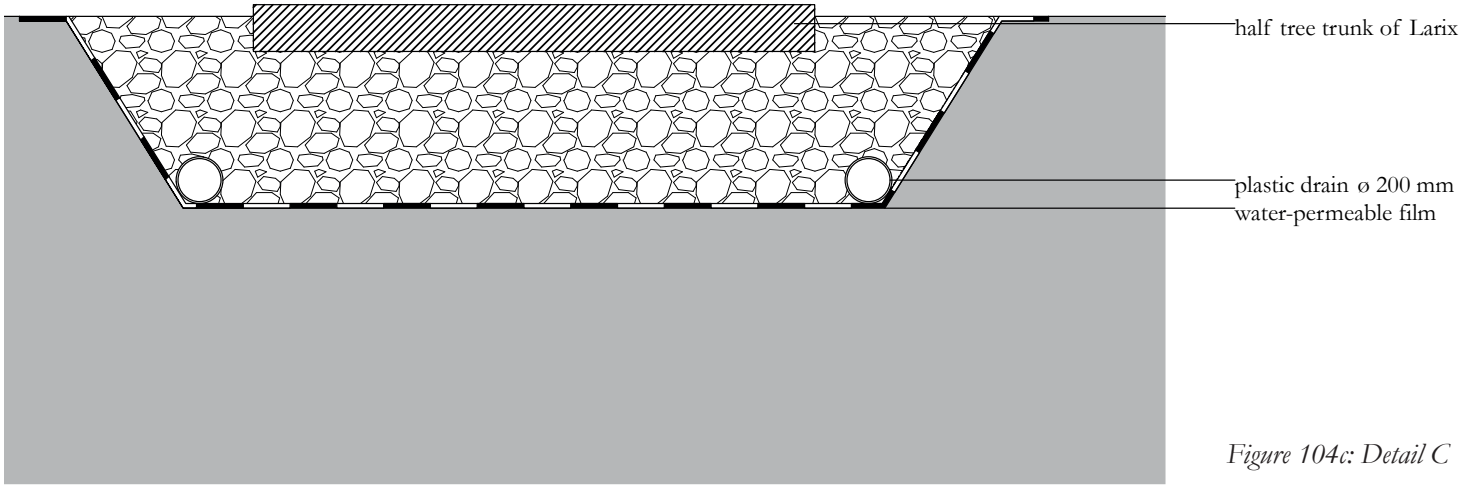


Figure 104c: Detail C

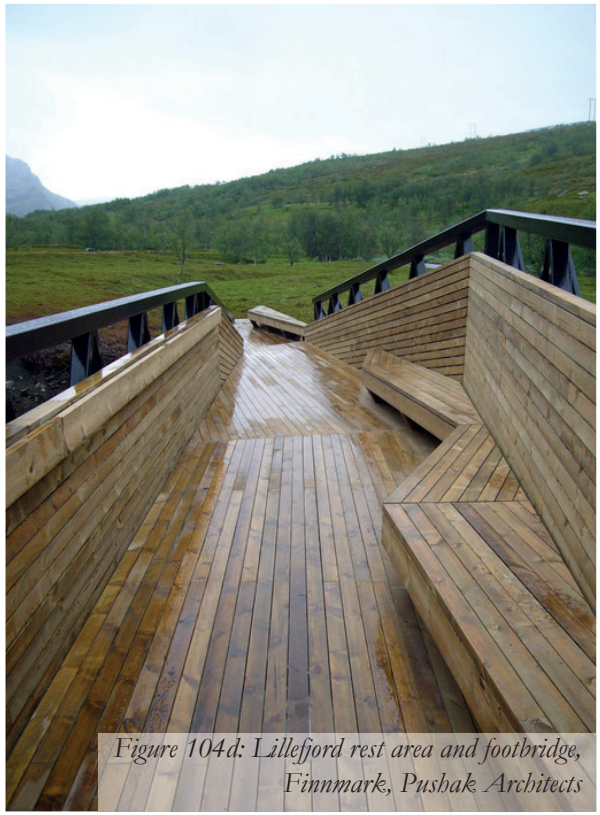


Figure 104d: Lillefjord rest area and footbridge, Finnmark, Pushak Architects

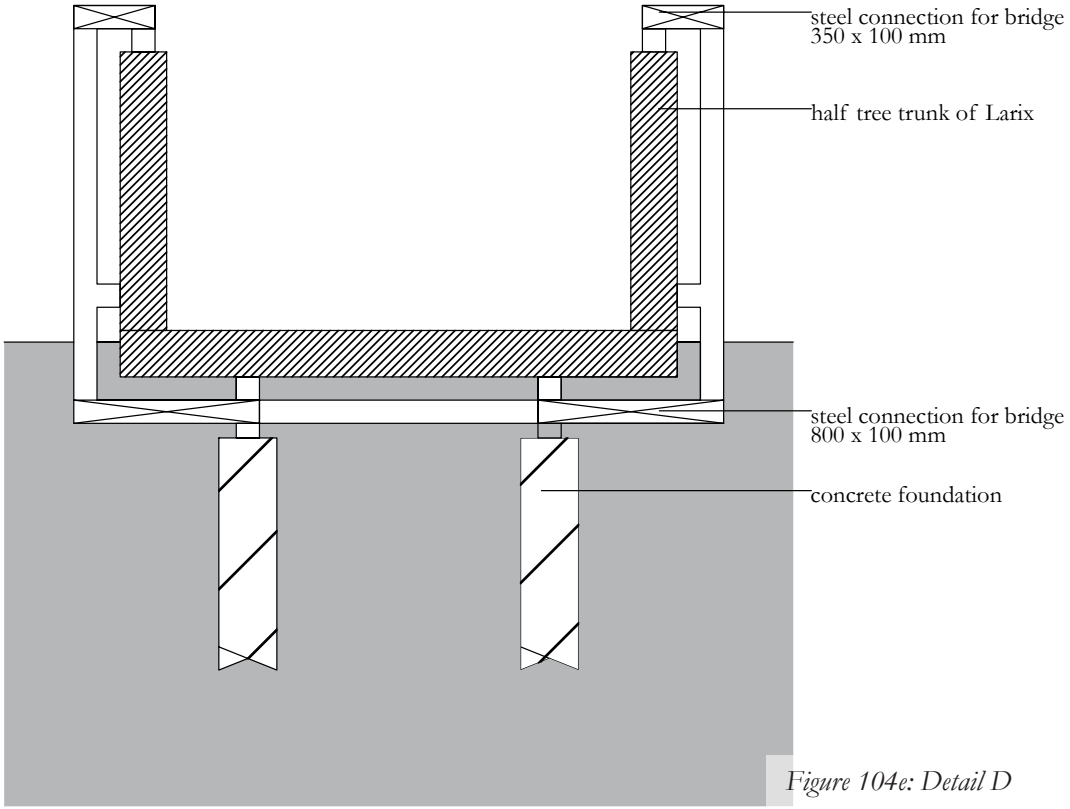


Figure 104e: Detail D

Figure 105: Impression

Figure 106: Impression

FIRST IMPRESSIONS

These impressions shown on the left are made after reading the theorie discussed on page 105. “Hidden visitor sees the animal in its full appearence” (Coe, 1985) is applied to figure 105. “To adjust the height of observance”(Fernandez, 2009) fits to figure 106. The illustrations were not used as final impressions, but were used as inspiration for the design.

Figure 107a: Sketched impression

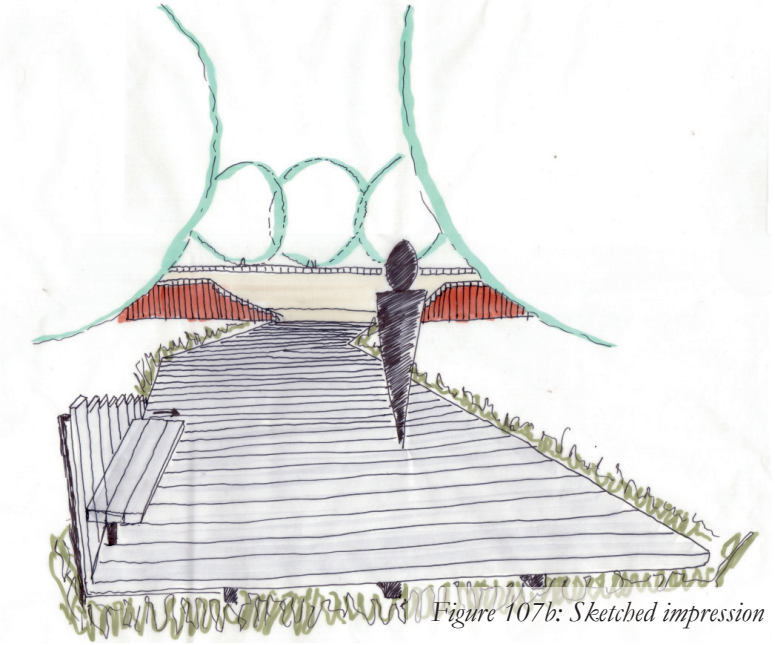


Figure 107b: Sketched impression

Figure 107c: Sketched impression

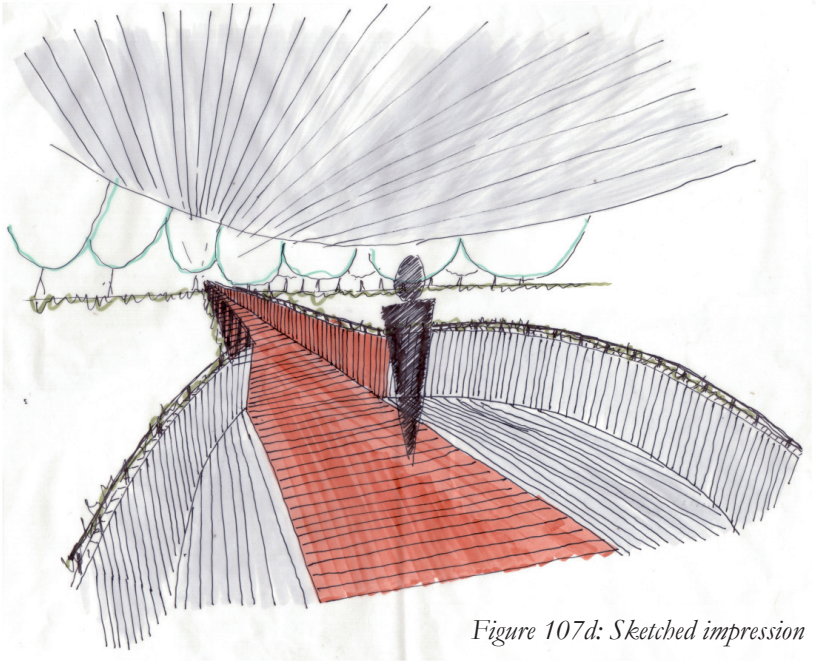


Figure 107d: Sketched impression

Figure 107e: Sketched impression

SKETCHES

The images on these pages show first sketches of impressions of the designed nature park. On the next pages of the report the final impressions are placed.

Figure 108a: Impression of animal-watchers blind

Figure 109a: Impression of secondary path

Figure 108b: Detail of stool in animal-watchers blind

Figure 109b: Detail of turning stool

Figure 110: Impression of primary path with spyhole

Figure 111: Impression of surroundings of restaurant

Figure 112: Impression of otter and beaver stay

Figure 113a: Impression of beaver pond

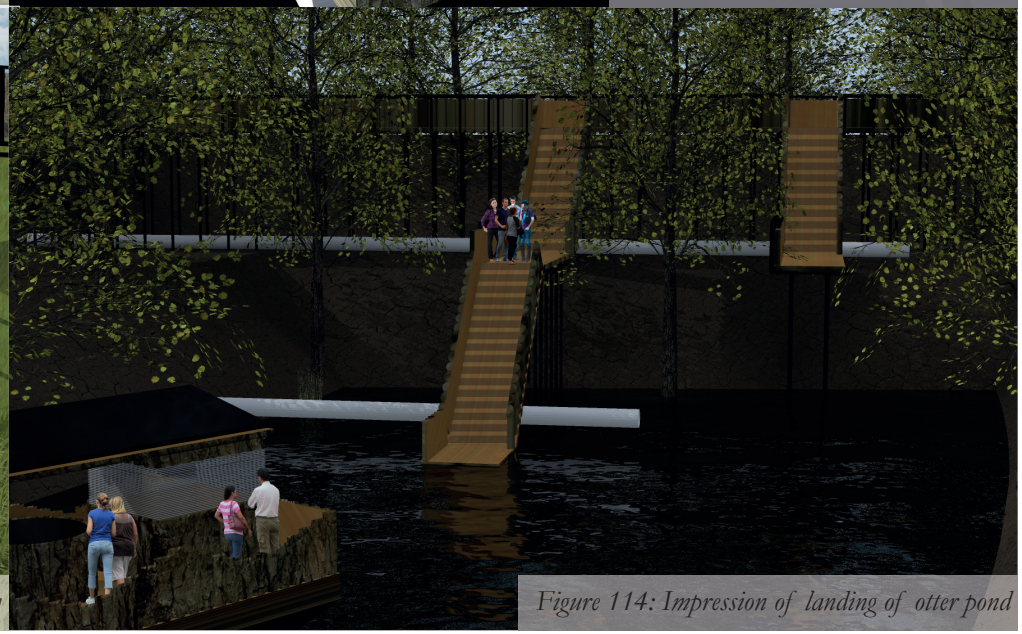


Figure 114: Impression of landing of otter pond

Figure 113b: Impression of otter pond

IMPRESSIONS OF HORTI DANUBII: THE EXPERIENCE

With the impressions shown on page 158-161 the experience of the park (the **S**-scale) could be described in the best way.

First of all, one of Coe's concepts of animal behaviour (Coe, 1985, page 105) is applicable on the routing of the **L**-scale, **M**-scale and on the routing and experience of the **S**-scale. Namely, the idea that an otter or beaver could be near, could make the experience memorable, because in this way an expectation is created.

Figure 108a shows the animal-watchers blind. This is created with the model of figure 53 in mind on page 77. The otter holt has a certain enclosed space for sleeping and breeding. In the animal-watchers blind a certain enclosed space is shaped as well. Figure 108b shows a detail of the stool of the animal-watchers blind. The stool is made from wooden trunks, like the parapets of the path.

Figure 109a shows the secondary path. This path is totally open, to make the visitor aware he is on a different path than the more enclosed primary path. At this secondary path there are stools and the path will stimulate to stand still and look around. Conversely, the primary path is narrow, has no stools (the animal-watchers blinds form an exception) and will stimulate to move on. A detail of the turning stool is shown in figure 109b. The stool can turn against its parapet to find shelter, or it can turn to the open field to look at the animals and nature. View for a model and technical detail page 170 - 173.

The narrow primary path is shown in figure 110. The path is made of wood from the Larix, because beavers will not eat them. Moreover, the path exist of half tree trunks: on the inside they will look bright and smooth, on the outside they look unruly as nature. In this way the path will on the outside blend with nature from a distance. Besides that a spyhole is shown, which enables visitors to look down in nature and spot an otter or beaver. Furthermore the parapet is lowered down at certain places, in order to realise that children can look around as well.

Figure 111 shows the fish restaurant on a viewing axis. The viewing axis of grass will be kept in shape by sheep, which will graze the grass in deposed areas. Furthermore, the fish that visitors will eat in the restaurant, will mostly come from the fish farm on the island. At the top of the restaurant there's a Tyrolean traverse which will lead you to a tiny island.

The otter and beaver stay is displayed in figure 112. The typical way of moving through space is derived from a theme park attraction in Bobbejaanland (view figure 115a): moving in circles like in a vortex with a final nosedive in the center. In this way different concepts of animal behaviour according to Coe's theory (Coe, 1985) come together in one place. After the created expectation, the expectation will be fullfilled by reaching the otter and beaver stay. Moreover, "the visitor is on the edge of the space, animal is in the center" is one of the subconcepts of antromorphism as an educational tool. Another is "visitor looks up to the animal", which happens at the end of the path. Furthermore, Fernandez (Fernandez, 2009) states that adjusting the height of observance will improve the animal-visitor relation.

In fig 113a a detail of the otter and beaver pond is shown that navigates between Romania, Bulgaria and the island. It will usually navigate two times a day, in order make it possible for the otter to crawl on board. In busyer times, the pond will navigate more, but the chance will decrease to see otters and beavers. Visitors can look down into a kind of well through a one-way screen (visitors can see the animal; but the animals will not see the visitors). On the roof of the pond solar panels will be placed. Furthermore periscopes make it possible for visible to look under water.

Figure 115a: Special experience in El Rio in Bobbejaanland, Lichtaart in Belgium

Figure 115b: Translation of experience in Bobbejaanland to the design

Figure 114 shows the landing of the pond on the side of Giurgiu, Romania. There are two piers, one when the water level is between 0 and 5 meters; another when the water level is between 5 and ten meters. The piers (and the stairs) will move with the shifting water level. Behind the piers there are pipelines (shown in white) which will be connected to the pond to let the otters and beavers on board. These pipes will lead away from the visitors, directly into nature, to interweave with the ecological network. Earlier discussed are the social and landscape aspect of the design on both sides of the river. The impression of the landing shows that on the Romanian side the design is shaped in the same way, because from social point of view the attitude is the same (the people's attitude towards otters is the same: indifferent, view page 71) and from a landscape point of view, the landscape of the island and of the Romanian side is the same: flood forest (view page 64).

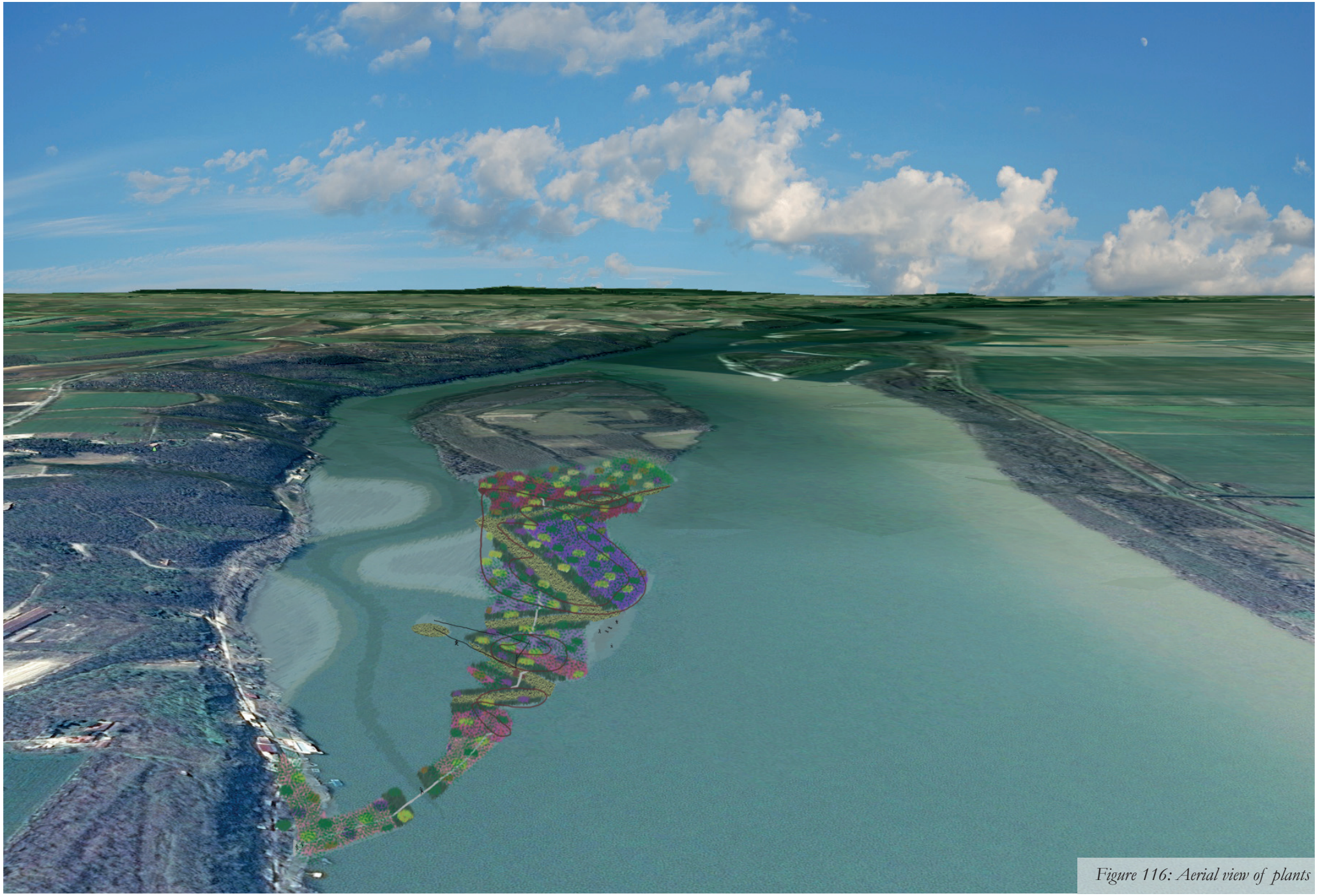


Figure 116: Aerial view of plants

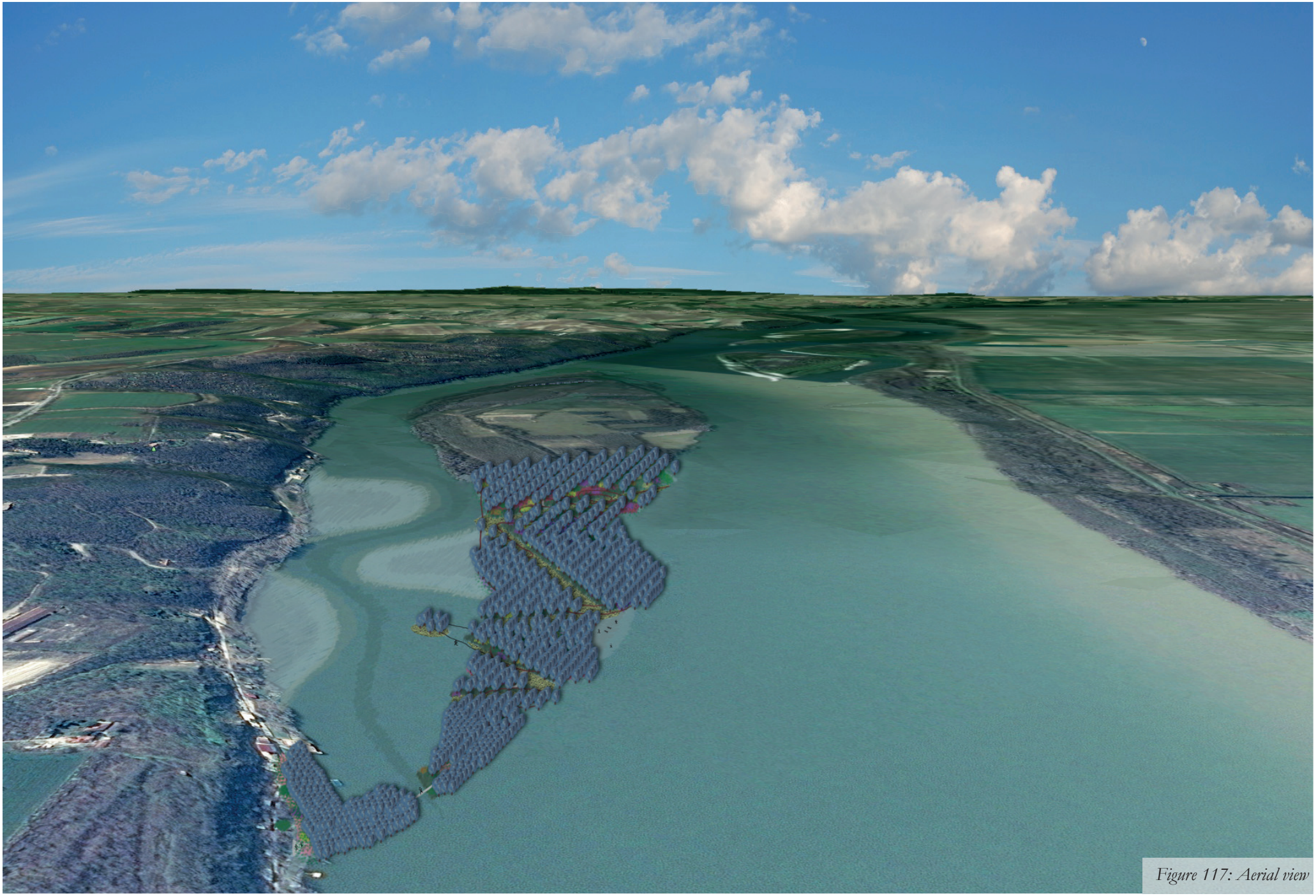


Figure 117: Aerial view

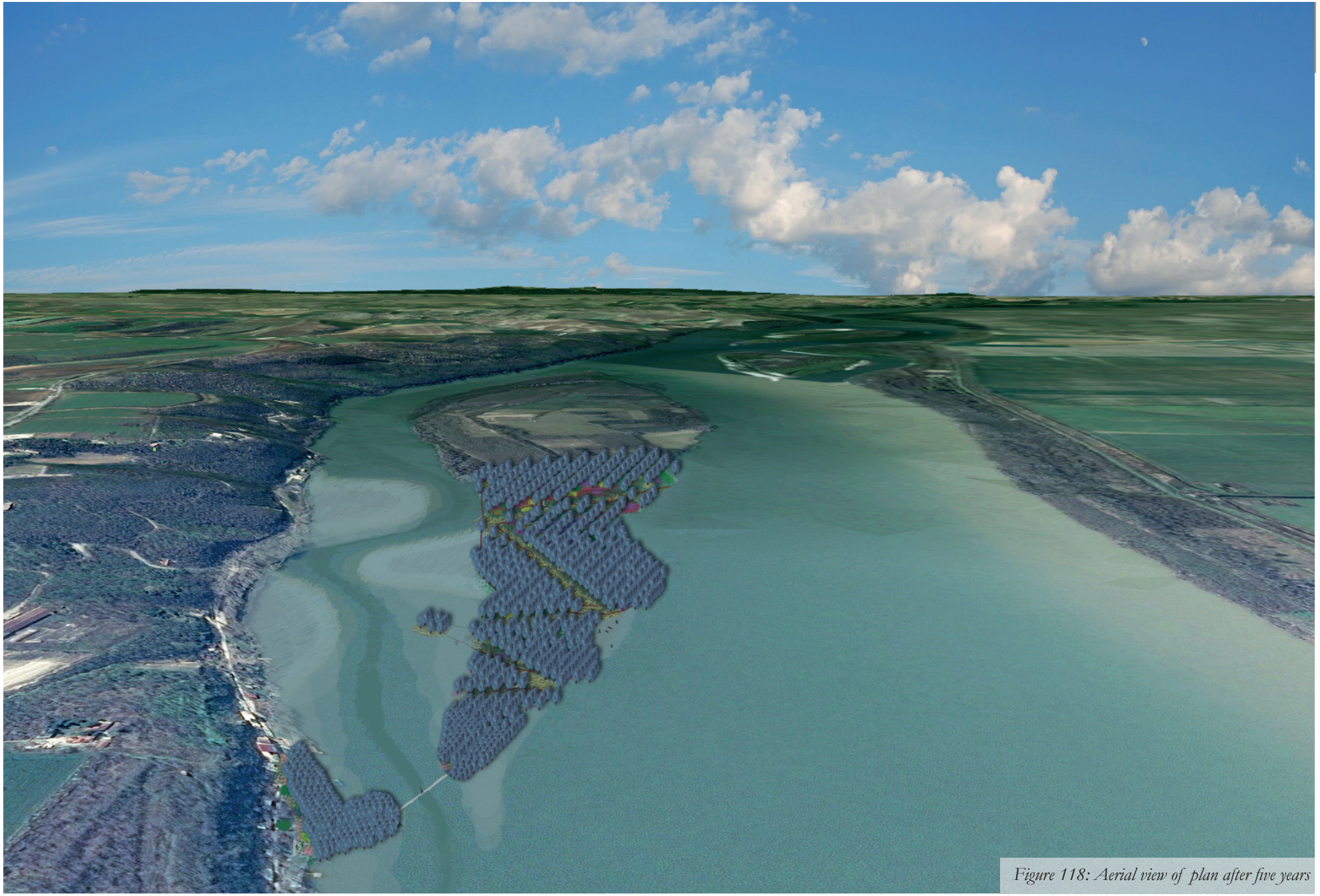


Figure 118: Aerial view of plan after five years

AERIAL VIEWS

On page 164 an image is created of the underlaying layer of plants. Page 165 shows the aerial view with the trees indicated as well. In the last situation on page 166 the outflow is worn and the sandbanks have shifted in the direction of the outflow. This is the predicted situation five years after the completion.

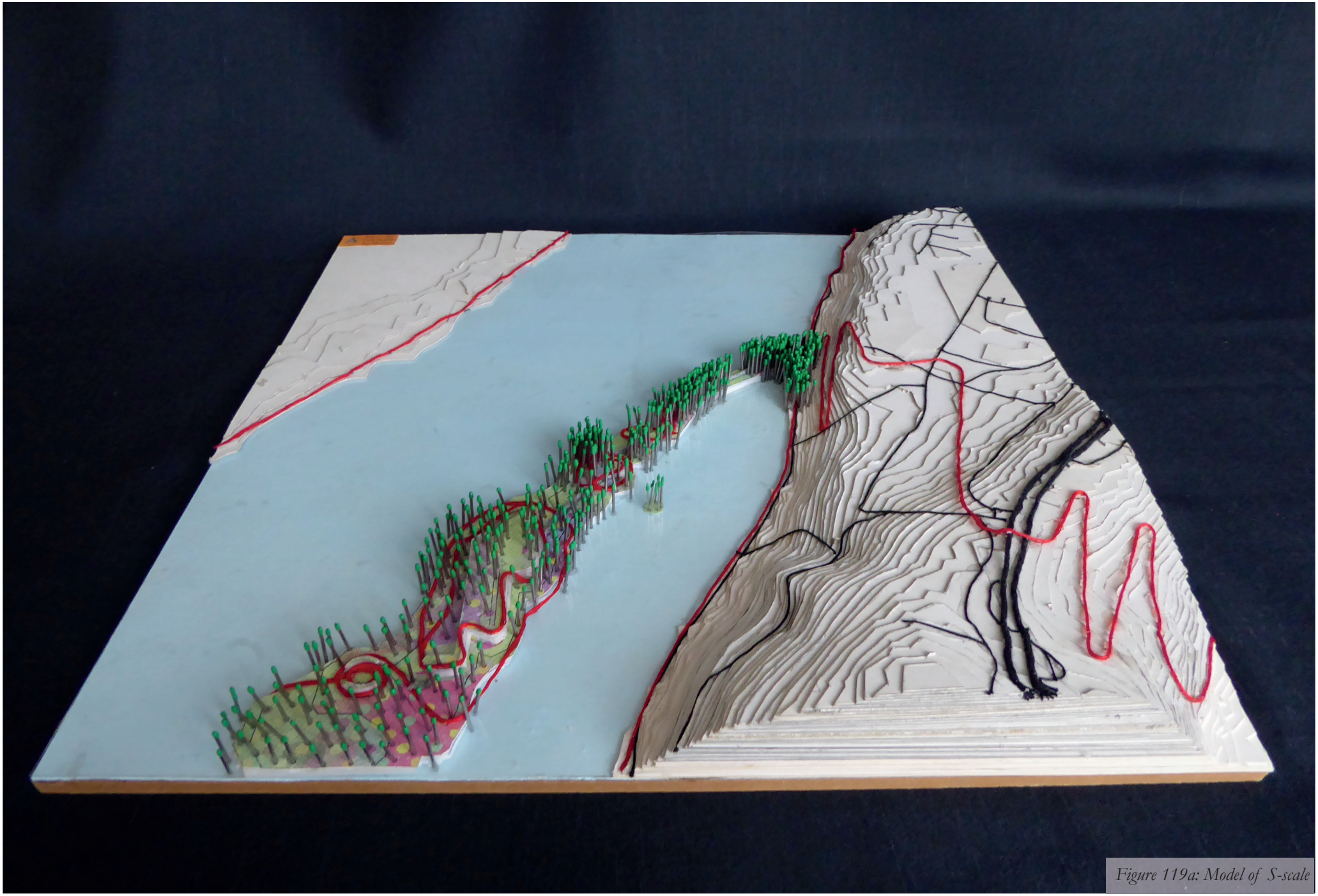


Figure 119a: Model of S-scale

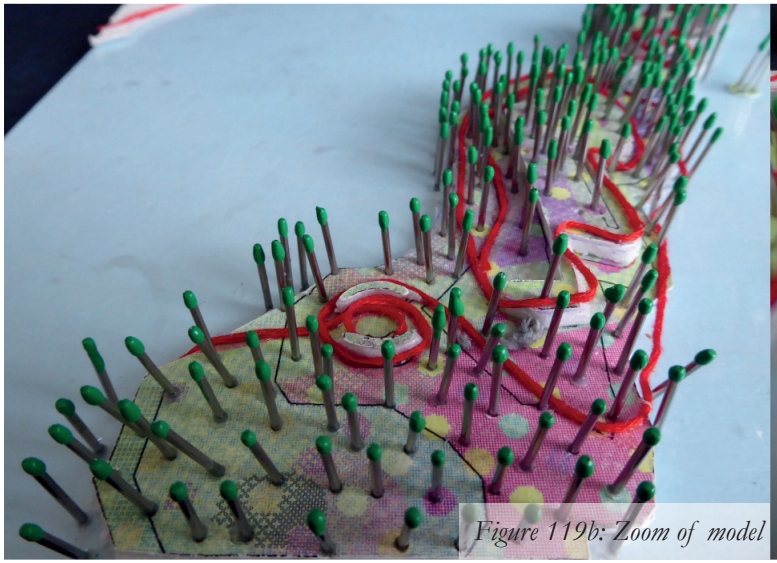


Figure 119b: Zoom of model

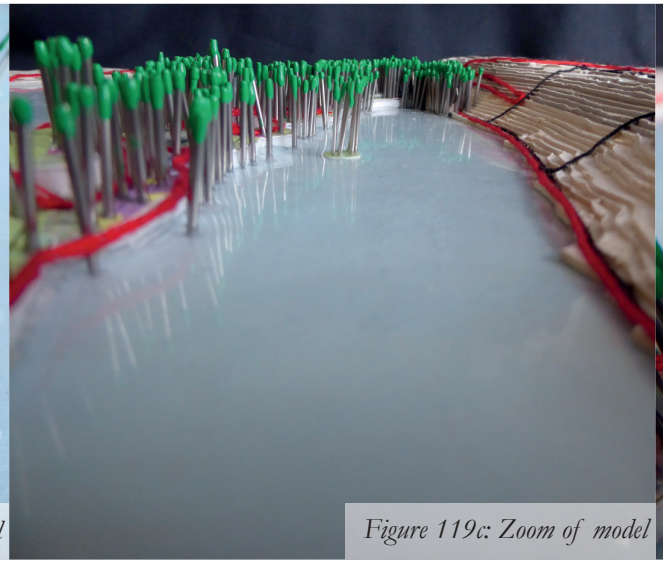


Figure 119c: Zoom of model

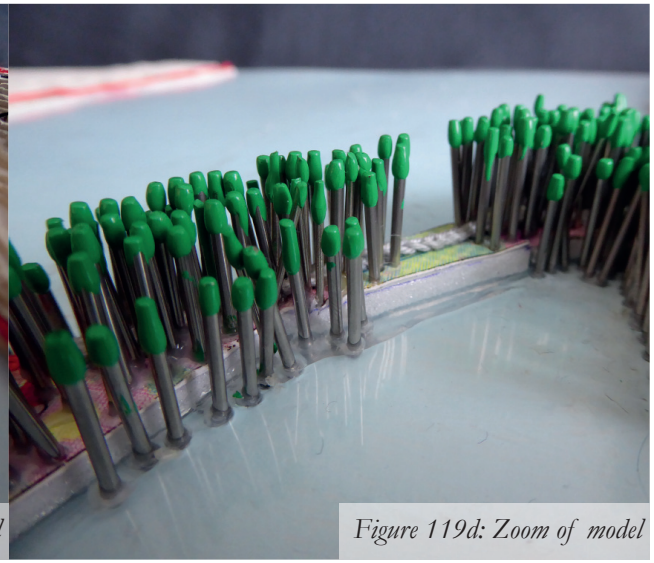


Figure 119d: Zoom of model

SCALE MODEL: S-SCALE

In figure 119 a model, scale 1:5000, is showed of the S-scale. The red string displays the routing, the nails show the trees. Furthermore the plants are printed on a layer of cardboard.

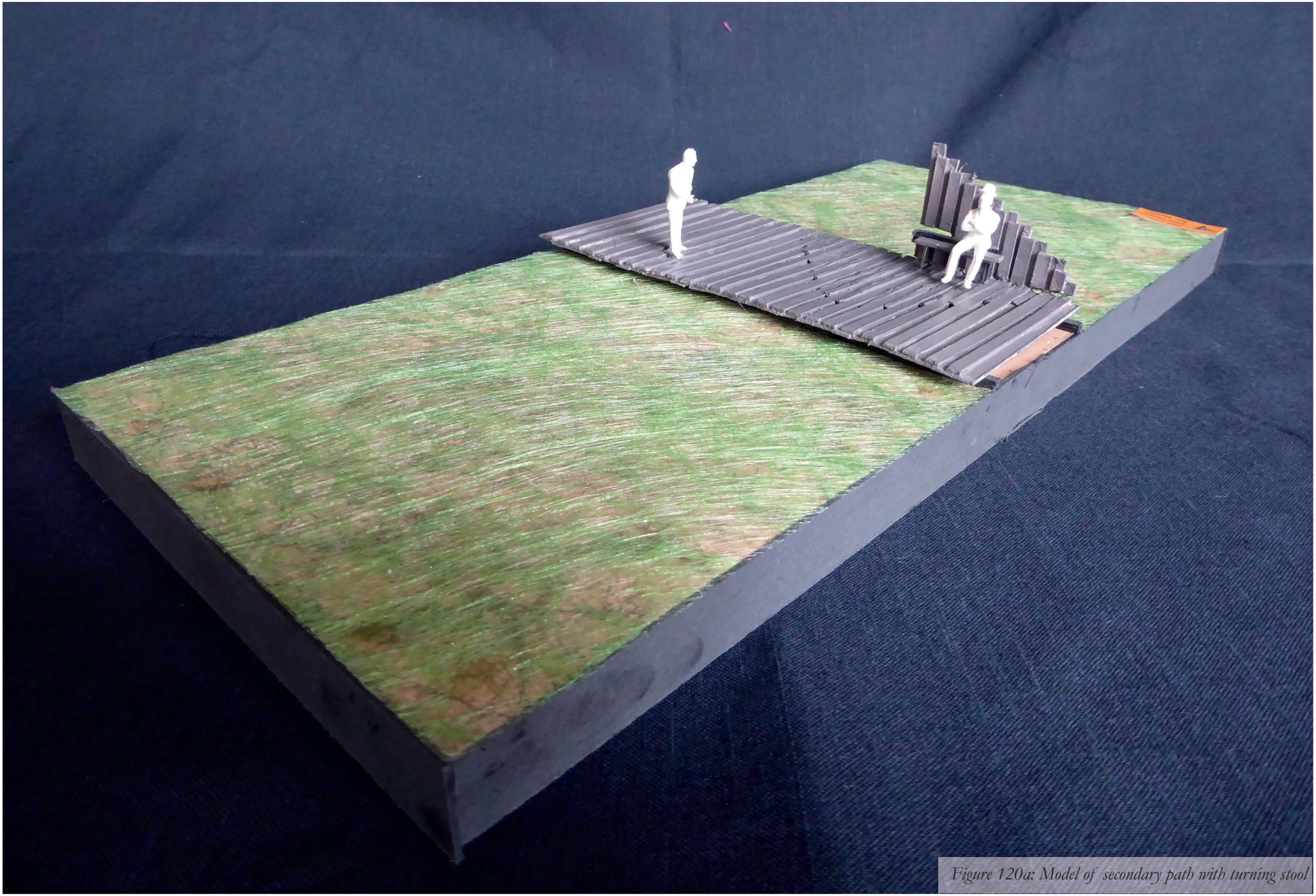


Figure 120a: Model of secondary path with turning stool

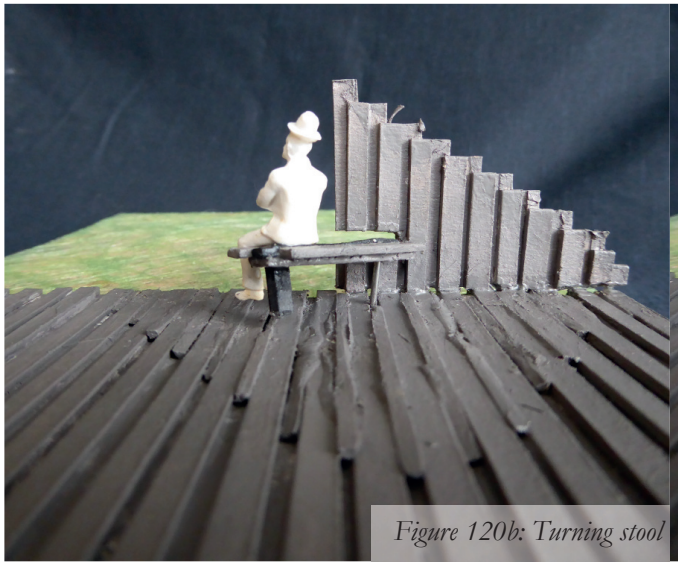


Figure 120b: Turning stool

Figure 120c: Turning stool

Figure 120d: Turning stool

DETAIL: TURNING STOOL

In figure 120a a part of the secondary path is displayed in a model, scale 1:50, and in figure 120bcd the turning stool is showed. This turning stool is a feature that returns at different spots in the park. On the one hand the stool can be turned to the shelter to find protection against the wind, on the other hand the stool can be turned to the open side to have a view on the landscape and have a chance to see an otter or beaver.

In figure 121 a detail of the turning leg of the stool is displayed. In this way the turning leg can be installed on site: at first the prefab element is placed, than the lower piece of steel, which will be attached to the concrete prefab element. Subsequently the grouting with cement will take place and at last the upper steel element will be attached, seperated by a ring of ball bearings.

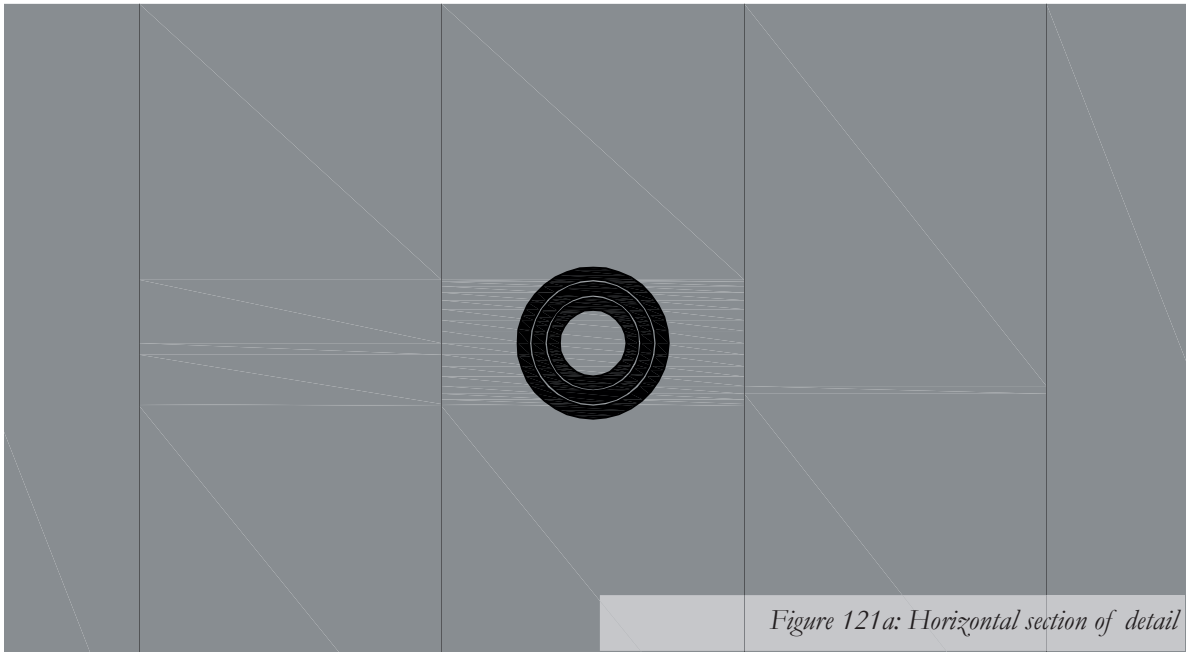


Figure 121a: Horizontal section of detail

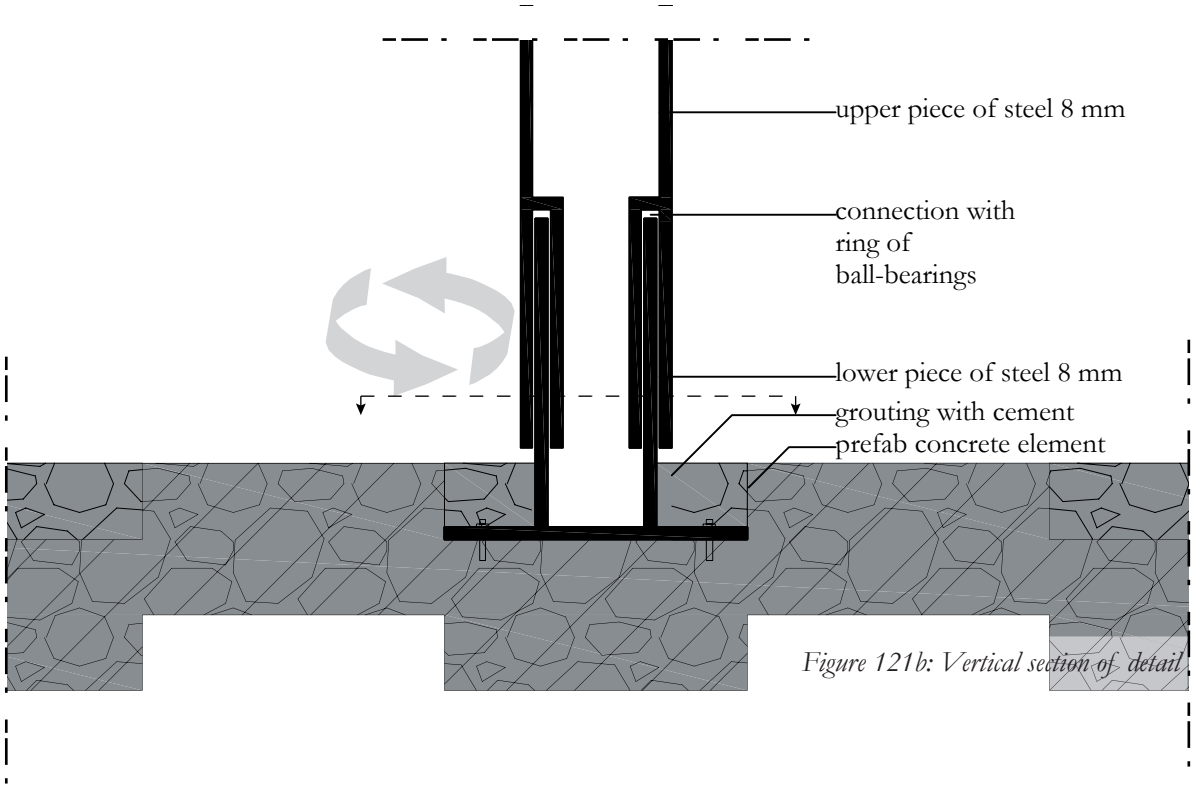


Figure 121b: Vertical section of detail

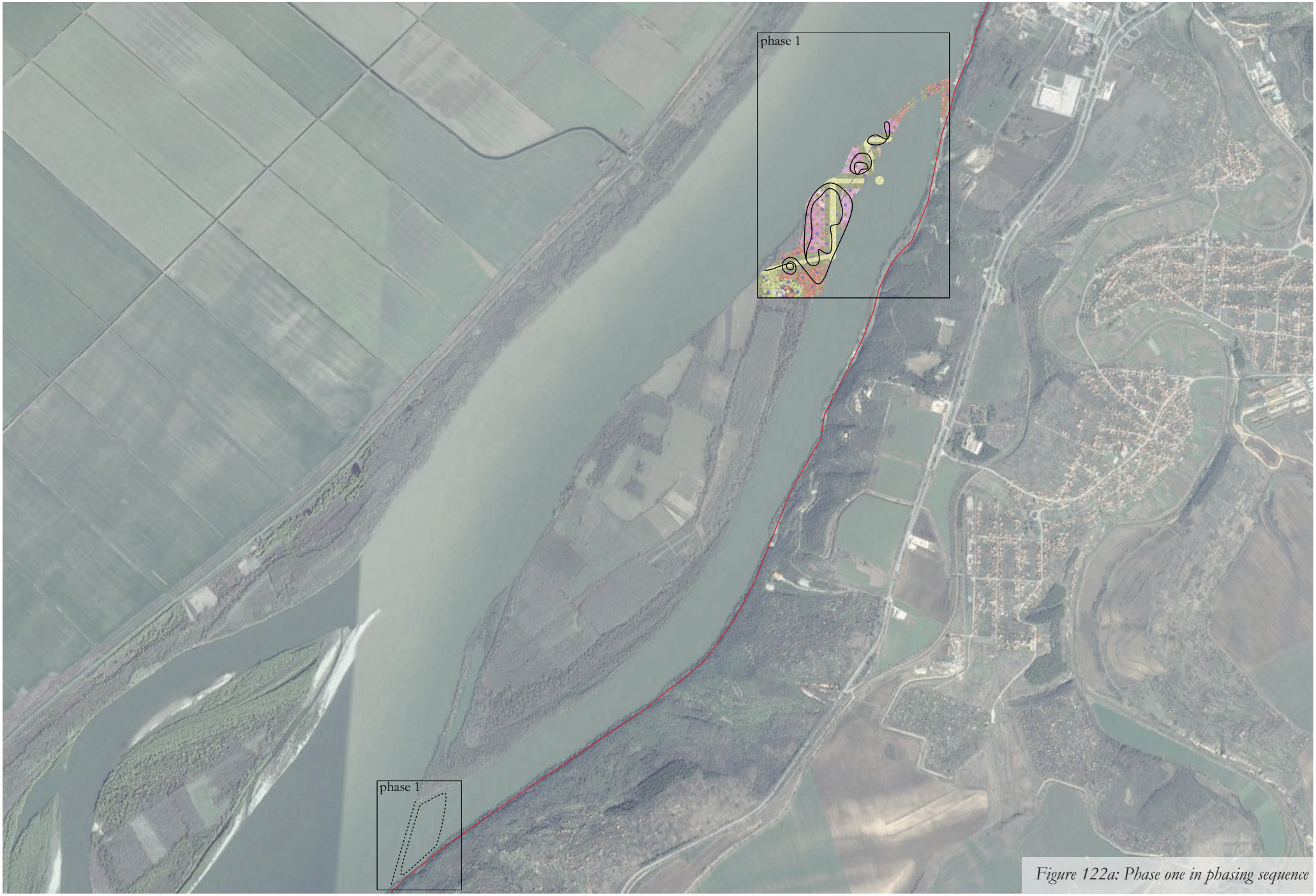


Figure 122a: Phase one in phasing sequence

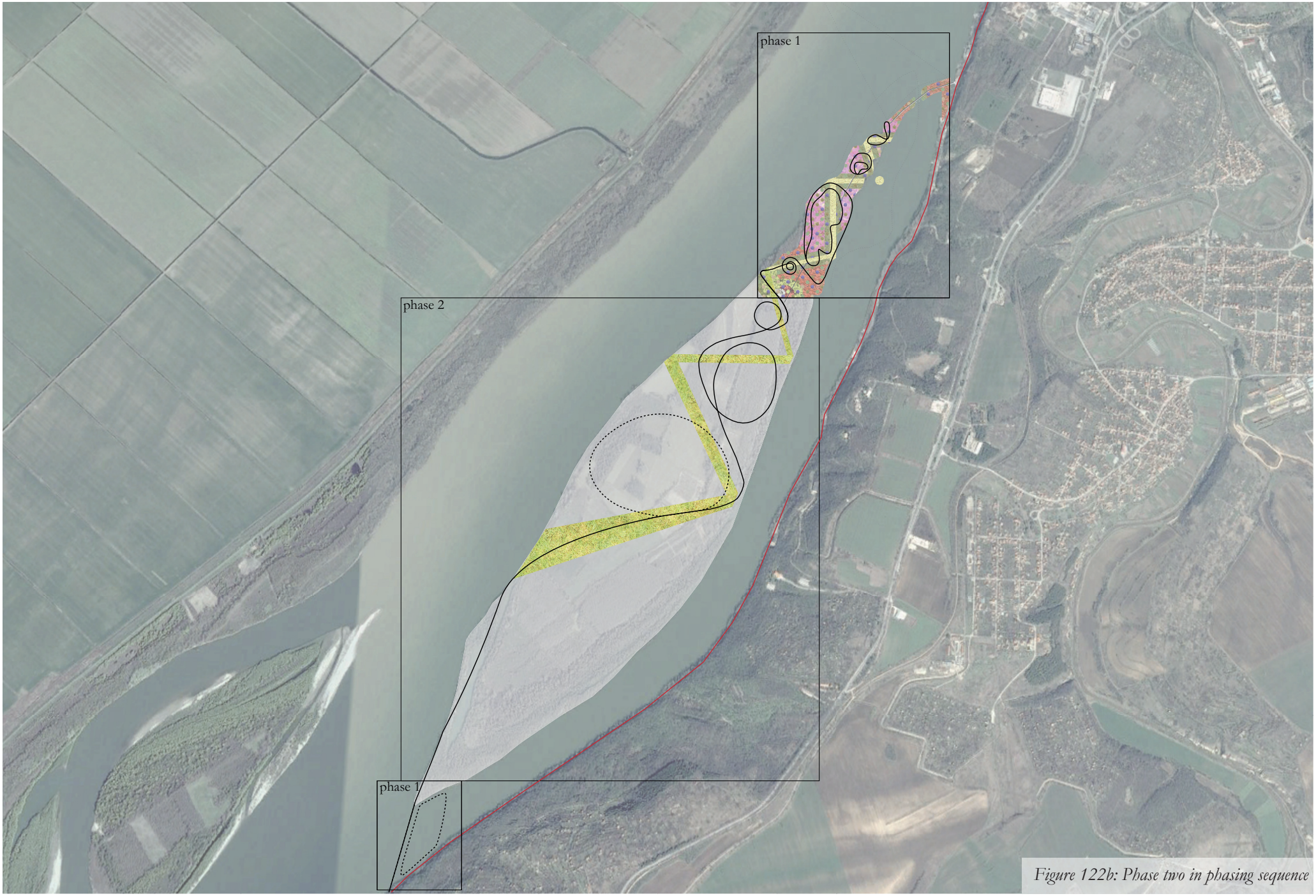


Figure 122b: Phase two in phasing sequence

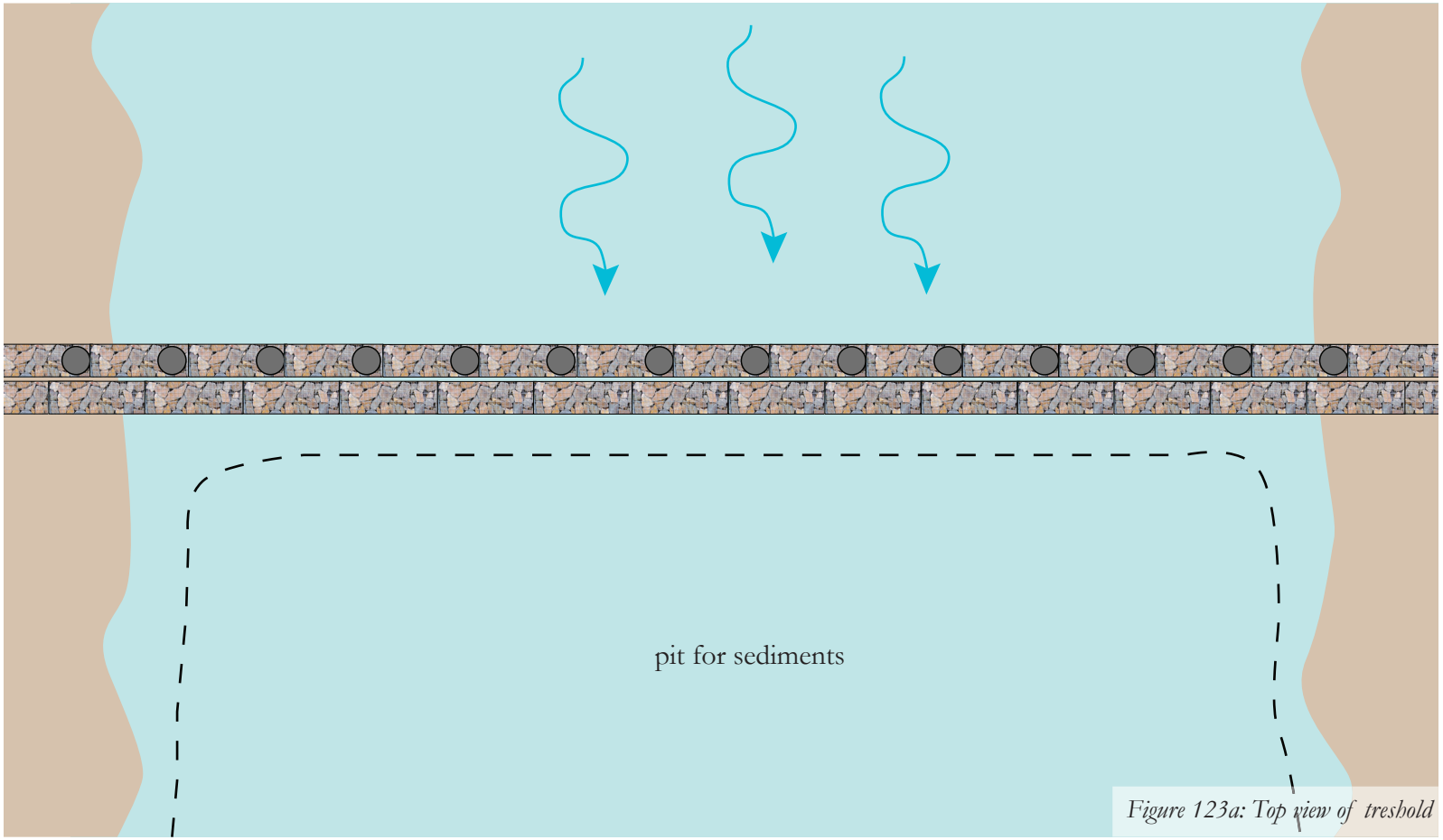


Figure 123a: Top view of treshold

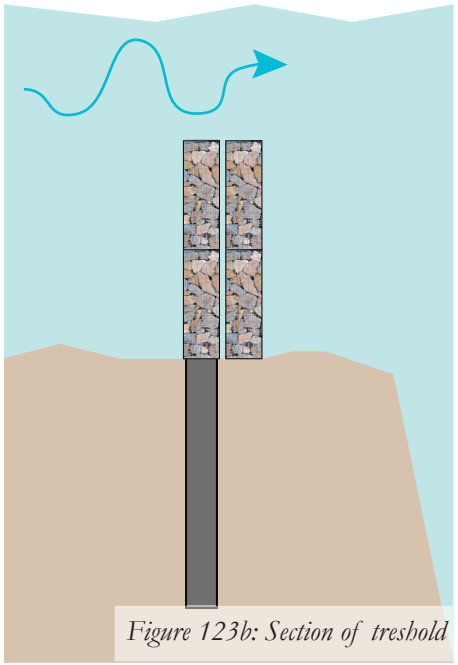


Figure 123b: Section of treshold

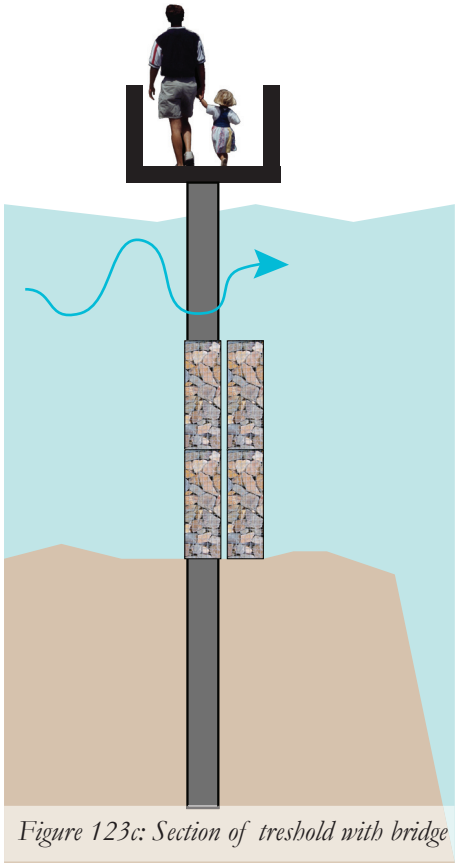


Figure 123c: Section of treshold with bridge

PHASING

In figure 122 the phasing sequence on the **S-scale** is showed. In the first phase the design will be executed as displayed in figure 122a: the upper part of the island and a treshold will be built (view figure 123ab). The need for this treshold is explained on page 186. In the second phase (view figure 122b) the viewing axes and path will be extended. The end of the last viewing axis is making a connection to the secondary channel on the other side. Furthermore the ferocity of the shaping of the path is decreasing to the south. In this way there will be more resting space for the otter and beaver to the south. Finally on top of the treshold a bridge can be built (view figurre 123c), so that again a circuit is formed in the routing.

Figure 124a: Example of treshold in Gameren

Figure 124b: Example of treshold in Klompenwaard

After showing the impressions of the treshold to ir. Pepijn van Denderen, researcher in side channels, he told me in Holland most tresholds used to be made of rubble or riprap (view figure 124). Because this could be older techniques, he advised me to contact Rijkswaterstaat. After posing my question to the "helpdesk water" (Rijkswaterstaat), I am waiting for the answer and am not able to process the answer in my report anymore.

"How to interweave the river border landscape of the Danube between Bulgaria and Romania with the surrounding ecological and recreational network?"

METHODOLOGY

During the project different methods were used. On the one hand a personal method, based on observation. On the other hand Forman's patch-corridor-matrix-method (Forman, 1995) and elaborating on this, the theory of the green infrastructure. The personal method seems to be the best fitting to the circumstances of the project. Forman's method is a welcome replenishment on this.
The patch-corridor-matrix method leads to interesting new insights for the graduation project. With a relatively very quick scan with this approach on different scales, differences become very clear. On the scale itself, but even more between scales. Accurate comparisons can be made and it facilitates thinking through scales -which is encouraged during the graduation project-.
The use of the fixed scale makes it easy to compare the same frame of a certain site with another area of a same extent: the mosaic creates a clear comparable view of aspects that play a role. Moreover, the application of the fixed phenomenon ensures a targeted research: main elements that need further research become more clear and the investigator is able to focus on important elements and distinguish superfluous details. The book contains a lot of detailed scientific information to analyse these important elements.

Compared to the personal method, an earlier application of Forman's method during the graduation project would probably not lead to the same "animated" design theme specific for this location. Forman's method is reasoned from an aerial view, what makes the tangible human scale harder to grasp. However, the added value is unmistakable, since the availability of international written information and maps about the area is limited. The application could have helped to get to the point earlier and compare data in a scientific way.
The application of Forman's method is urgent in this project, to create missing (scientific) links and especially to involve human processes and the urban environment. Still, ecological aspects should be kept in mind as a starting point, and intuition should not be suppressed to get to an animated design.

During the process I learned by reading Thomas' book (Thomas, 2011) that it's important not to generalise. Therefore I had to adjust the text and revise some analytical and concept diagrams. Furthermore I learned that it is important to create a certain sequence in the storyline in which is referred to the research question many times.

DESIGN

To come from research questions to design different types of research on different scales were started. Practical research was done by excursions to (otter and beaver) nature parks and making various models. The mystery of the otters and beavers (when do they show up) and the pleasant close approach of the otters in Aqua Zoo Friesland were used for the design as conclusions. Furthermore research was done on the animal-visitor relation: different concepts on how to reduce the stress for the animals and achieve a closeby approach for the visitor helped by the design. Mainly on the small scale this led to adjustments in the design.
Research was done as well on the water, on how to get to a balanced water system (prevent the side channel from silting). By adding a treshold this can be achieved. In this way the Danube will function as corridor in the best way and interweavements will be formed between border landscape and ecological and recreational networks.
In the last place the patch-corridor-matrix method is studied.

CONCLUSION

This is the most important factor in the answer on the research question. The solution on how to interweave the river border landscape of the Danube between Bulgaria and Romania with the ecological and recreational network is found in the concept of connectivity and, arising from this, green infrastructure.
The construction of a green infrastructure will "*contribute to the connection of existing nature areas and will improve the global ecological quality of rural areas as a whole.*" Furthermore it "*contributes to the conservation of healthy ecosystems, in order to realise that these ecosystems can keep on providing their valuable qualities to society, for example with clean air and fresh water*" (European Commission, 2010). On all scales this leads to a satisfactory resolution. On the **L**-scale, the 100 km stretch between Ruse and Silistra, a green infrastructure provides a sequenced habitat for different animals, which is all possible to experience by a recreational network, consisting of circuits.
On the scale of Ruse and Giurgiu, the **M**-scale, both the city and rural side enjoy the benefits of the green infrastructure. This is achieved by connecting the Natura 2000 habitats with each other by upgrading the green structure and adding green elements to strengthen the links. On this scale again circuits create the recreational network and make it possible for visitors to explore the nature areas by foot or by bike.
On the **S**-scale, the island Luliaka, as one of the five linking crossings of the Danube on the **M**-scale, is elaborated. This crossing used to be a hickup in the connection between two Natura 2000 areas. This area eminently is an example on how to interweave, boost the surroundings and achieve the aim. A part of Luliaka is transformed into an otter and beaver nature park. This is the scale where visitor and animal meet. The behavioral concepts of Coe and Fernandez have helped to make this meeting both exciting and secure.

The investigation of the study area seems to be useful for other fields or specific disciplines, different from landscape architecture as well. For example parts of the research investigate zoo design or the visitor-animal relation. In fields of education, sports and leisure this could be helpful. Furthermore the research could be used in fields as nature protection and climate control.

Since it seems that I found an answer on the research question and the design solutions on all scales are satisfactory, I achieved the aims of my research project, namely how to interweave the river border landscape of the Danube between Bulgaria and Romania with the surrounding ecological and recreational network. Moreover, the enthusiasm of the local population in helping me to accomplish the project shows that - with some publicity- it has a chance to succeed.

Roel Muselaers.

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LECTURE JURRIAAN VAN LEEUWEN ABOUT THE OTTER

Below a report of the lecture "Komt de otter in de Reeuwijkse plassen?" about the otter of Jurriaan van Leeuwen on the 25th of february 2015 is placed.

Main question: will the otter come over to the Reeuwijkse plassen?

- The area is divided into zones for sailing/canoing: some parts only for canoes, motor boats mainly on large lakes.
- In 2014 a new manager is appointed, who starts a new plan.The team searches for an animal that can generate attention: the bat.

The 2nd of januari there was news: camera's in the area captured the otter! When the sd-cards were viewed in december this led to a lot of reactions: the otter became the new central animal for attention.

In the Nieuwkoopse Plassen the otter died out in '78. Last was not shot, but found on the "weg bij Nieuwkoop".
(Showing a picture of mr. de Beer) He had killed about 160 otters by sitting and waiting at an ice hole and stabbing them with an otter spear. This took place between 1900 and 1940, afther that time the hunting on otters was forbidden, with exemptions until 1960. Why did they hunt on otters? Because of the coat, the meat and for competition with the fishery. Otters die in pods, formerly pods were not that strong, and not really a problem for the otter.

In '88 the otters died out in Holland and in 2002 they were reintroduced in the Wiede Weerribben. 20 pieces from Poland, Russia and Latvia, with diverse dna-profiles, to prevent from inbreeding.

The otter found its own way to Nieuwkoop, while it is very fastidiously: it needs fish, clean water and is at the top of its foodchain. After world war II there were more pesticides and the team of Nieuwkoop worked hard to get the water on its healthy level again.
Krabbescheer on lakes displays the water is clean.

When the otter was seen, a lot of positive reactions from tv-stations came in (RTL, Hart van Nederland, TV West, etc.).
The otter looks a lot like other animals and can be confused with them. For example a fox in the water, a beaver (which is for sure able to live in de Nieuwkoopse Plassen, is able to live together with the otter, and is even seen in the city center of Gouda.) Furthermore they look like the stoat, weasel, polecat, beaver rat and musk rat (which is good in digging and is therefore caught).

The otter is 80-140 centimeters from head to tale, weighs 12 kg, does not have a lot of fat (has a slim body), has good requirements for swimming, but is in fact a land animal. Water is very important, because of the food; the otter is only in the water for hunting. It has a coat of down and a topcoat. The otter is a fish eater, but sometimes it eats young chickens, mice and frogs as well, so it can be considered as a carnivore. It can swim for eight hours, is active at night and searches for quiet places.
One can find the otter by looking at its traces. In '93 excreta were found in the area. Later on camera traps were places in the whole area. Sometimes an otter runs by, but always one, they're hoping to see young animals one day.

At the presentation they showed us a "spraint" (excreta from the otter) which you could smell. It smelled like fish.

Otters go through the whole area, so it is possible to spot "switches". Mostly it's doubtful if the switch is from a fox or a hare. Spraints are often placed near a switch.

Jurriaan started a competition with colorings of otters. The forester would take the five winners to the Nieuwkoopse Plassen.

Eventually there were 470 entries.

- Dead otter was found on the A12. It was sent to Alterra Wageningen for autopsy.
- How big is its territory? Jurriaan says it's a difficult question. Multiple wifes can live with 1 male otter. Their behavior possibly changes if the area available for the otter is smaller (than the Nieuwkoopse Plassen).

- They started crowdfunding for a fauna passage and gained about 20 000 euro. The government says that it is responsible for fauna services for endangered animal species, so the project will be done by the province who is owner of the road.

- For the otter it's important to have dry tubes and over boards. Furthermore the grids that have to be placed in the pods are really important to prevent otters from dying.

After mating, the male otter leaves and does not interfere with the upbringing, hunting, etc. The mating dance lasts for a few hours, in which they swarm around each other.
A wife gets 2 or 3 young animals. After five weeks the young animals will open their eyes, and after 3 month they take their first dive. It is important that they have a quiet resting place. The young animals and the wife sit in a nest or beaver hole. The mother whistles to the young animals. One time the mothers were dead and the team of the Nieuwkoopse Plassen went into the area and found the youn animals by whistling.

Jurriaan together with a dog found an otter in a ditch. The otter was larger than a muskrat. He went to Wageningen for autopsy. The otter was probably drowned, which is possible by an (illegal) pod.

CONVERSATION WITH PEPIJN VAN DENDEREN

Because of the interventions in the water two persons were contacted. From TU Delft Dr. ir. Astrid Blom, specialised in morphodynamics of sand-gravel rivers; from UTwente ir. Pepijn van Denderen, Phd Student, doing research on the dynamics of side channels as rehabilitation measures.

Below a report of the conversation on the 7th of october 2015 with ir. Pepijn van Denderen is placed.

Does the gully silt in the designed situation?
Secondary channel > you almost create a dam, which decreases the speed of the flow. In this way you can expect the gully to silt. It depends on the water level and water flow in winter.
In response to the picture on page 165: quite a broad entrance of the gully, than it narrows down because of the meandering, and finally the gully widens again. This creates differences in the speed of the flow and causes sedimentation. One can expect a lot of sedimentation at the entrance of the gully, because of the blockade at the end. And just before the exit it will.

Try to create the gully as uniform as possible.

In Holland they tried to create meanders, but often it turned out to be difficult to make it a balanced system (a gully that doesn't silt).

What are possible interventions to make it work better?
In Holland they create often a "treshold" at the beginning, to decrease sedimentation. E.G. the Vreugderijkerwaard. Constant amount of water is flowing in and a hole is created to catch the sedimentation. This forms a balanced system, but not a natural system because of the hole.

Remember you have to empty the treshold. Depending on the flow once per year or once per five years.

Is the situation realistic?
It seems to be realistic, but the situation will be different in five years. The sandbanks will grow in the direction of the outflow.

Do you have some examples of projects in secondary channels?
Yes, The Vreugderijkerwaard and others, I'll send you the information.

After this conversation a treshold was added to the design, to create a realistic image. Furthermore a new illustration was made with an image which displays the changes in 5 years after construction. This illustration can be viewed on page 166.

APPENDIX B