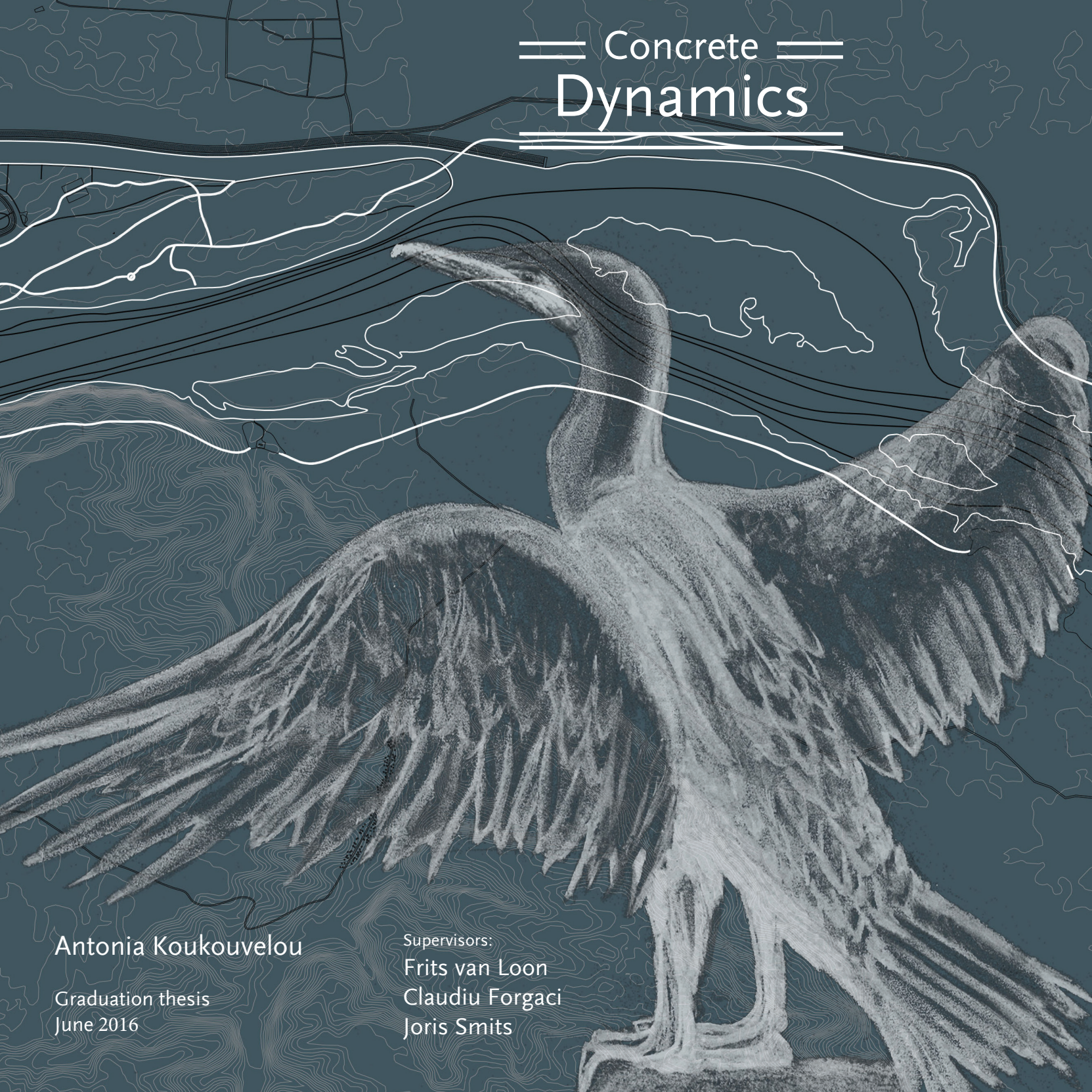
Concrete Dynamics



Antonia Koukouvelou

Graduation thesis
June 2016

Supervisors:
Frits van Loon
Claudiu Forgaci
Joris Smits

Concrete Dynamics

MSc Thesis

Antonia Koukouvelou
antoniakoukou@gmail.com
+31 (0) 630899711
linkedin, facebook, issuu

Keywords
bridge; landscape infrastructure; connection; symbol; natural processes

TU Delft, Faculty of Architecture, Department of Urbanism
Chair of Landscape Architecture

Graduation studio
Flowscapes

Supervisors
TU Delft, Faculty of Architecture, Department of Urbanism
Chair of Landscape Architecture
Frits van Loon

TU Delft, Faculy of Architecture, Department of Urbanism
Chair of Environmental Technology and Design
Claudiu Forgaci

TU Delft, Faculty of Architecture, Department of Architectural Engineering + Technology
Chair of Structural Design
Joris Smits

External Examiner
TU Delft, Faculty of Architecture, Department of Architecture
Chair of History of Architecture and Urban Planning
Charlotte van Dijk

TU Delft Delft University of Technology

LANDSCAPE ARCHITECTURE

Chapters

Prologue
7-18

Topos
19-32

Connection
33-38

Geometry
39-44

Choreography
45-90

Epilogue
91-100

Appendix
101-112

Acknowledgements

I wish to thank various people for their contribution to this project. Firstly, I would like to give my special thanks to my three mentors who helped me to go through my design thesis. With their guidance and knowledge, they provided me with great material to use in the process of my design. Their energy and devotion drove me to make this project thorough and relevant.

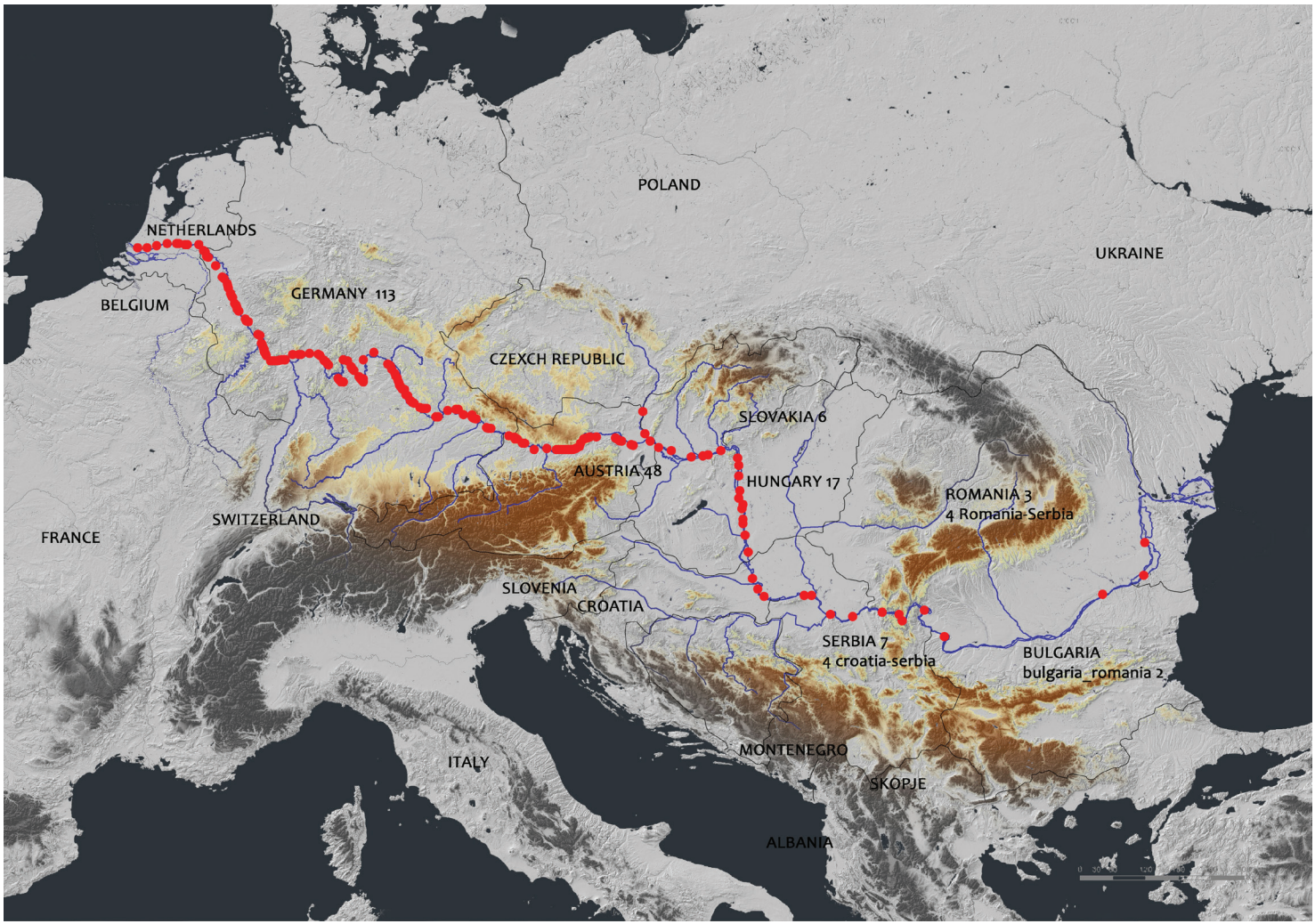
Being in the Landscape team for 2 years now, I became a member of a whole new family who supports me at every moment. I appreciate all the long talks with my fellow students and the time spent on my project. Special thanks should be given to Sarem Sunderland who encouraged me from the beginning of my graduation project, supported my ideas and helped me carrying out the project as calmly as possible.

In addition, I would like to mention the support of my neighbors. I appreciated every help I was given. By borrowing the Veronika Paessler's car, I managed to carry all my model materials and also enjoy the ride. Having Rufus, Veronika's dog, by my side during the long sleepless nights, my tiredness went away.

During my visit in Bulgaria and Romania, I met interesting people who provided me with information to understand the place and its dynamics. I appreciated a lot the help I had from Martina Varkinova which I met at the Bulgarian border, Belene island. With her calm spirit and specific knowledge, I was able to dive deeper into certain aspects of my project.

Finally, I wish to thank my parents who, even though are away to Greece, they were always supporting and encouraging me. I am always grateful for supporting my decisions and letting me develop to the person I am today.

Prologue



Site selection

Introduction

Bridges are both landscape and infrastructure elements. Looking through the eyes of a landscape architect, bridges become a continuation of the landscape; a manmade action that heals the misconnections of the landscape. The problematique of infrastructure as a type of landscape and connecting element is a crucial topic which influences the landscape and its function. Connecting infrastructures such as bridges provoke urban, economic and cultural development.

The challenge for landscape architects is to investigate in conceptualizing and illustrating a design approach that involves the landscape-urban connection and influences the society, economic growth and natural processes. The design of a bridge is a multidisciplinary task which requires a lot of understanding of the landscape, natural processes and engineering. The framing of the landscape through the infrastructure, sense of orientation, symbolism, imageability and adaptability of the design form the method which a landscape architect should follow in order to design a landscape infrastructure.

In my graduation project I focused on the border between Bulgaria and Romania which follows the Danube River for more than 600km. Having in mind that there are only two bridges connecting the two countries, I started my investigation to form my graduation problematique. By researching the relations of the two countries and their needs, I formulated my project.

My graduation project focuses on the connection between Romania and Bulgaria regarding multiple flows. Transportation, green and water infrastructures are the flows which will form a new connection for the two countries. A bridge is going to be designed and implemented nearly in the middle of their long border line. My main research question is to design this bridge in a way that is going to propose an international public space, uniting the two countries in a social, cultural and economic level.

How can the bridge influence the urbanization and the landscape around it? How can we as designers stimulate the urban flow so as to interact positively with the environment and its natural processes? These were the research questions that drove my project from the beginning.

Posed problem

How can a bridge become the symbol among different countries, offer a recreated common public space, heal the misconnection and adapt to the landscape on both sides?

Research questions

1. Which is the essential relation between a bridge and a public space? Can they be shaped together by one common structure?
2. What are the different ways of implementing bridges that connect different landscapes?
3. What are the different users of a bridge and how do they use it?
4. How to protect/preserve the environment from degenerating due to the changes that an international infrastructure might bring?

The Golden Gate Bridge is a symbolic landscape bridge with both geometric and timeless forms.

A bridge reacts as a symbol when it enhances stimuli of its observers. The function of the Erasmus Bridge is to formalize the crossing between the Northern and Southern areas of Rotterdam.

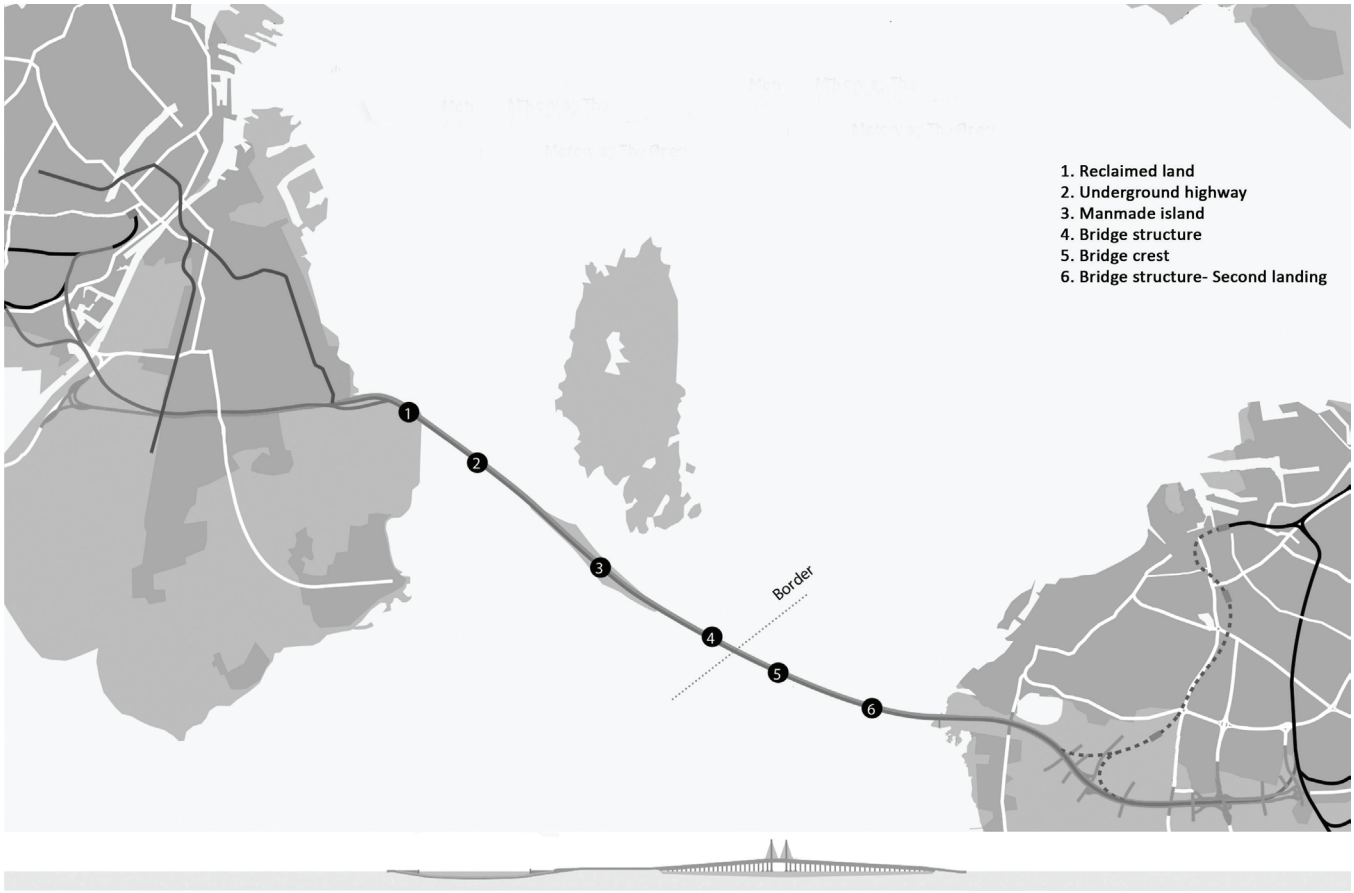
Bridge as landscape infrastructure

Nature is appropriated in humanities not as a reality but as a human idea of the reality (Martin Drenthen, 2009) and that is because all landscapes are the product of human cultures, even those thought of as natural or wild (Raymond, 1980). Culture and nature overlap spatially and impact each other functionally (Sijmons, March 2013). Most of the processes around us are a hybrid of nature and human power. What has become clear through the years is that culture and nature are inextricably linked. Bridges belong to the cultural landscape which is defined as a "geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity or person or exhibiting other cultural or aesthetic values." (Charles A. Birnbaum, 1994) Bridges are made by people for people, they are closely related to them and to the imageability of the landscape where they are implemented.

Bridges can change the mental image of a city. A legible city is the one whose parts, landmarks and pathways are easily identifiable and grouped in an overall pattern by people. The imageability of a city reflects to the mental image of an observer. The shape, color and arrangement are elements that can describe the image of a city (Lynch, 1960). Bridges are related to the notions of movement and cessation. They are responsible for orientation and legibility of space. By implementing a bridge, not only a potential landmark is created but also a point of orientation, an intense movement and strong pause. When a bridge is merged smoothly with the existing landscape, it can be part of the imageability and legibility of the city and can be embraced by the beholders. Bridges are meeting points, places where everyone can refer to. The Golden Gate Bridge is a good example of a symbolic landscape bridge implemented in a strong seascape.

Connectivity is important for the dispersal of organisms that live in the landscape. It can be operated either through physical/natural connections such as fallen trees and rocks or through structural manmade infrastructures such as bridges and paths. In order to avoid altering the ecology and biodiversity of the landscape elements, the merging of landscape and infrastructure should be operated carefully.

Bridges have always been symbols of connection and communication. For example the Erasmus Bridge in Rotterdam, Netherlands, was built firstly to connect the two parts of the city and secondly to remind the city of its industrial character. The Golden Gate Bridge was also built to connect two different landscapes and to celebrate the entrance in each one. Ecological bridges as well, are manmade structures but they can be adapted completely by nature. Humans create the conditions for nature to come and settle. Bridges are symbols of strength. They represent barriers, paths, crossings and they are implemented in everyday activities. They are symbols of hope, destination, progress and connectivity.



The bridge structure is harmoniously integrated with the landscape. It inspires rhythm and creates a new horizon, a new perception of the seascape.

Bridges frame the landscape and this framing is an important aspect of its design. Bridge structures can be harmonious and integrated within the landscape when they are in the correct scale, alignment, color and material. The design should inspire rhythm and harmony. For example, a smooth deck that is aligned with the horizon gives a harmonious view to the driver that drives through the bridge. Another example is the perception under the bridge, where the pillars meet the water and give a rhythm by creating a pattern to the horizon. The framing of the horizon that the Oresund Bridge creates is an important characteristic of the area. The strong shape of the bridge and the taller pillars in the middle, accompany the driver through different landscapes and mark the biggest span of the river for the boats while creating a climax at the crest. By framing the landscape through a bridge structure, the bridge reacts as a measuring system for the landscape which each beholder can use.

Altering the landscape surrounding of the bridge is an important design assignment. In the example of Oresund Bridge, the landscape architects reclaimed a big piece of land in order to land the bridge. They did not want to interfere with the existing ecology, therefore they introduced a new piece of land which created conditions for the nature to adapt and take over. Another important alternation in the landscape was the creation of a new island in order for the bridge to land in the middle of the sea and for the preservation of biodiversity in the ecology of the sea. As it was proved recently, this new island became slowly part of the rest of the seascape; small mammals and birds can be found on the island making the place part of nature. A manmade structure can be adapted completely from nature as long as the right conditions are set. Bridges are manmade structures that have the possibility to become under proper circumstances a new type of nature.

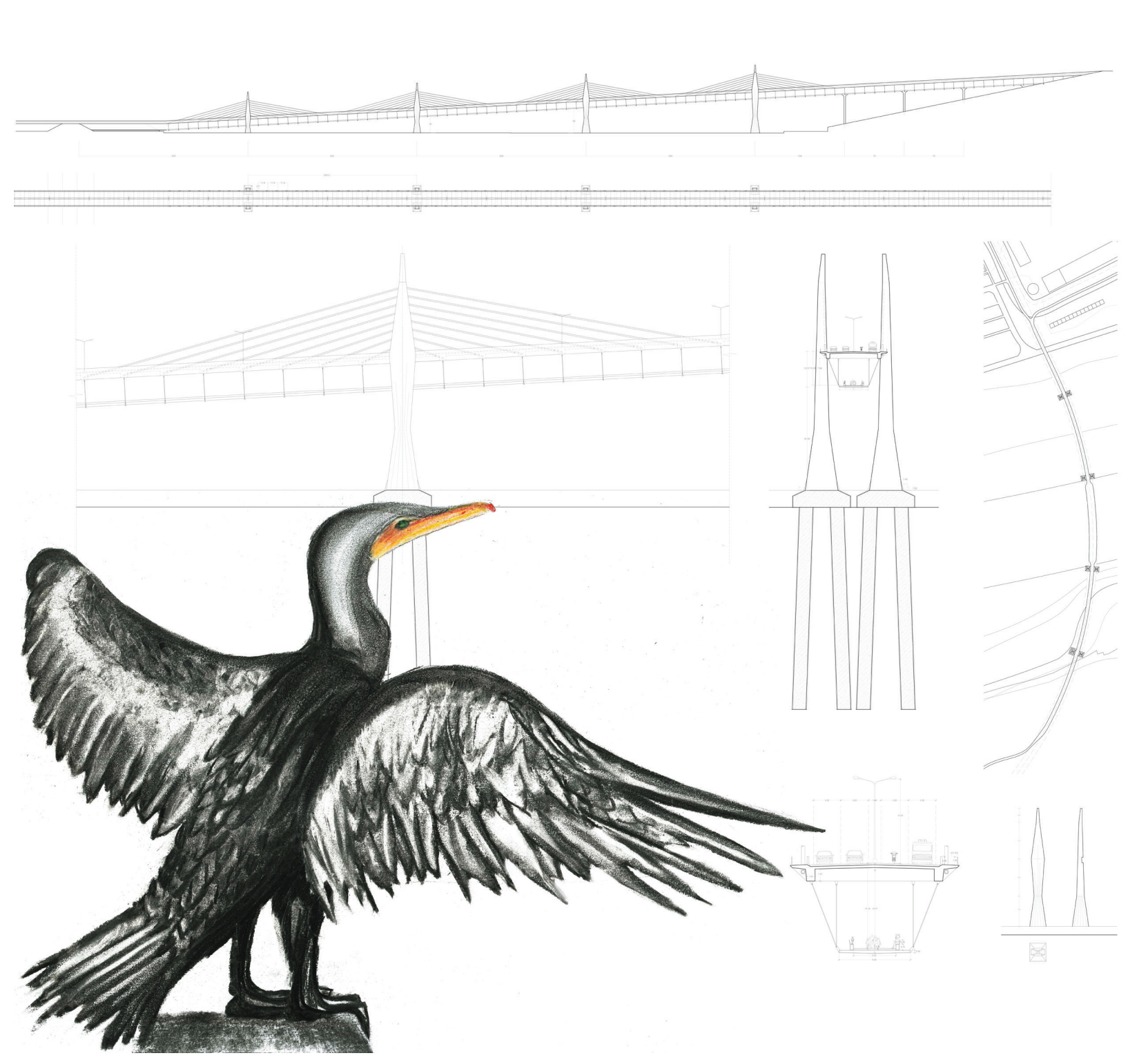
A bridge design refers to all possible scales. It is ostensibly a small connection but its influence to the urban tissue, social, economic and landscape layer is strong. For example the Oresund Bridge was designed not only to connect Copenhagen and Malmo, but also to achieve an international connection between Central and Western Europe to Scandinavia. The Oresund Bridge is a political and economic connection of Scandinavia to the rest of Europe. It was the reason for touristic and economic growth. The bridge became a motive for more investigation in a new urban plan of the city to handle the population growth and further ecological improvement of the Oresund bay.

A bridge design should not only engage with the structure but also with the design of the landscape around. All the elements (structure, landscape, function and people) should function as a whole in order to recite a story for the places they connect. Considering infrastructure as landscape, can be defined as an object oriented approach where the infrastructure is treated as an object in an integrated design which emphasizes the shape and form. On the other hand conceiving landscape as infrastructure, can be understood as a goal oriented approach where landscape is treated as an operative field which focuses on the urban development and ecological/economic processes (Steffen Nijhuis, 2015). When a design obtains both qualities at the same time, it becomes an integrated design which deals simultaneously with spatial, ecological and socio-cultural qualities.

A good bridge design can transform and enhance the landscape itself, it celebrates the landscape and influences all possible scales. Designing and building a bridge is a multidisciplinary design which should involve a lot of areas of expertise. In order for the design to be landscape oriented, it should offer a strong connection appropriated in all scales, frame the landscape through the infrastructure, treat each landing of the bridge and provide a rhythm in the landscape, take into account ecological alternations and finally involve beholder's perception. Designing a landscape bridge offers a better understanding of the infrastructure and its impact on the landscape. Natural processes are a strong element of the landscape design and should be introduced.

My graduation project is focused on creating a highway and pedestrian bridge connection between Romania and Bulgaria over the Danube River. As a result, a landscape bridge is implemented nearly in the middle of the river border line between the two countries. The bridge connects the two landscapes, gives room to the river and provides space for interaction among the countries. The bridge becomes the reference point which reflects ideas and values from both countries. It provides a common place to which both Romanians and Bulgarians can refer and interact with each other.

The landscape bridge connects the two sides of the river and provides an easy access to the other side for both vehicles and pedestrians. The area where it is implemented is a natural reserve called Persina. Its main goal is to preserve and enhance the ecological characteristics of the area. Through the infrastructure of the bridge, the ecology of the river will change for the better. The treatment of the shores around the bridge will help the breeding of fishes. Moreover, the landings of the bridge will be combined with ecological dikes that will protect the mainland from flooding. Finally, the shape of the columns derives from the most important protected bird of the Persina nature reserve, Phalacrocorax (cormorant). As the bird spreads its wide wings to fly from one country to the other, the bridge will fly over the river obstacle and connect the two landscapes naturally.



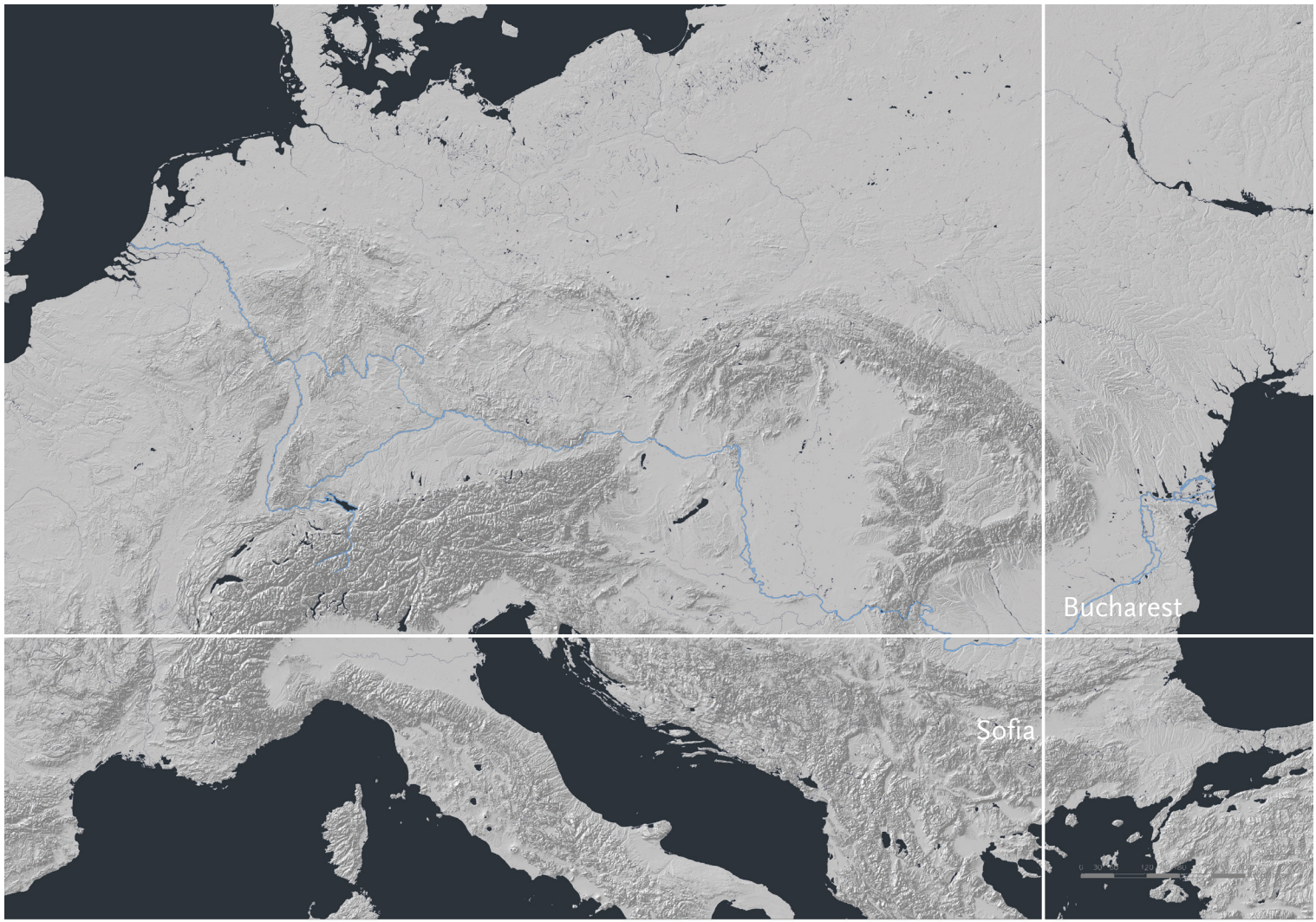
Collage created by the author illustrating the close relation between landscape and engineering.

In addition to the bridge infrastructure, a bypass canal is created on the Romanian side to give more space to the Danube River, improve the biodiversity of the area and introduce a common place on the "border line" where people from both countries can meet. An island is created which will change slowly the identity of the border. Nowadays, the character of Romania is industrial and the one of Bulgaria is more picturesque and historical. By implementing the highway connection a lot of changes will occur. The touristic economy of the place will improve as well as the exchange of services and goods through the harbor and highway. Currently, the area where the island is created, is occupied by a power plant industry and agriculture. In the future plans of the design, the area will have mixed functions of industry, university of linguistic and economic studies, agriculture and residential area. The design idea for the island is to change its function into a more sustainable one. The industry will turn into producing ecological pesticides and other agro-touristic products. The University of Linguistic Studies will help to solve the problem of bad communication because of the different languages. Moreover, the economic studies will provide better knowledge and management of the borderline area. People will settle in the new housing area and the place will become lively all day long. All the new functions are protected from flooding inside a polder landscape. Outside the polder, agricultural fields, flooded forests and marshlands occupy the space and improve the biodiversity of the area.

On the side of Bulgaria, the highway and pedestrian bridges land on top of the Bulgarian mountain where there is a highway stop. The bridge avoids the immediate interaction with the picturesque village in order to preserve its identity but also to provoke further urbanization towards the direction of the bridge. The pedestrian bridge is connected with small paths that lead to areas of importance. For example, at the highway stop on the Bulgarian mountain, the pedestrian bridge is connected with a path that can take someone through an oak forest to a clearing. There the view of Romania through the foliage is spectacular.

In conclusion, concrete dynamics is a multidisciplinary project that focuses on the metamorphosis of the landscape, economic growth and social interactions. The goal of the project is to improve the connection between Romania and Bulgaria and through the infrastructure to benefit to the landscape. Biodiversity, natural processes and people dynamics are strong aspects of the project. My primary motive for the project was to intertwine architecture and landscape into one design where both are equally appreciated.

Topos



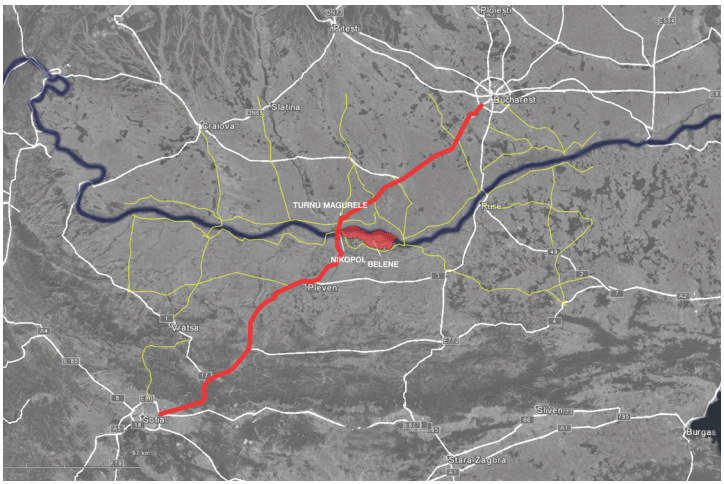
Site





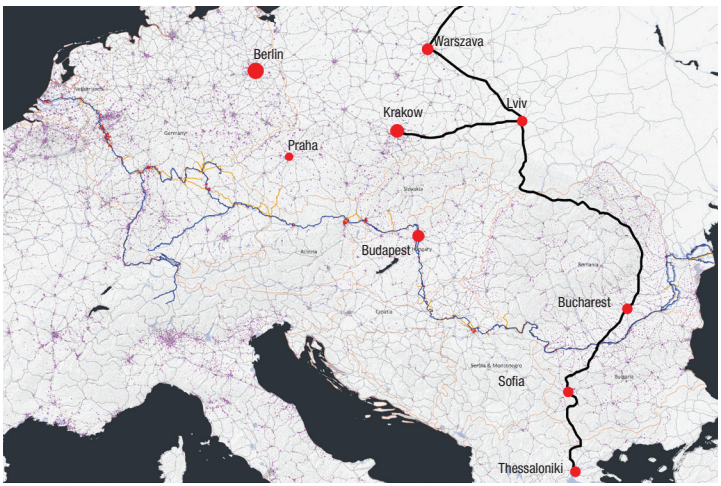

Existing crossing between Turnu Magurele and Nikopol

European Scale



Highway connection extends fom Bucharest to Sofia

The existing connection between Romania and Bulgaria is facilitated with boats and with two bridges on the east and west end of the country. While crossing the oldest bridge on the east of the countries, one might experience several problems of delay. The bridge is usually in restoration which creates a problematic transportation system. The newest bridge on the west of the countries was delivered recently to the public. Its position though does not serve the connection between the two capitals because it is closer to the border with Serbia and Croatia. As a result, the existing bridge connections for the two countries do not serve the capitals which cause a lot of delay in transportation and communication. An alternative way of transportation is by boat. The Danube River is 99% navigable throughout a year. That explains the multiple harbors for freight or people transportation, along its shores.

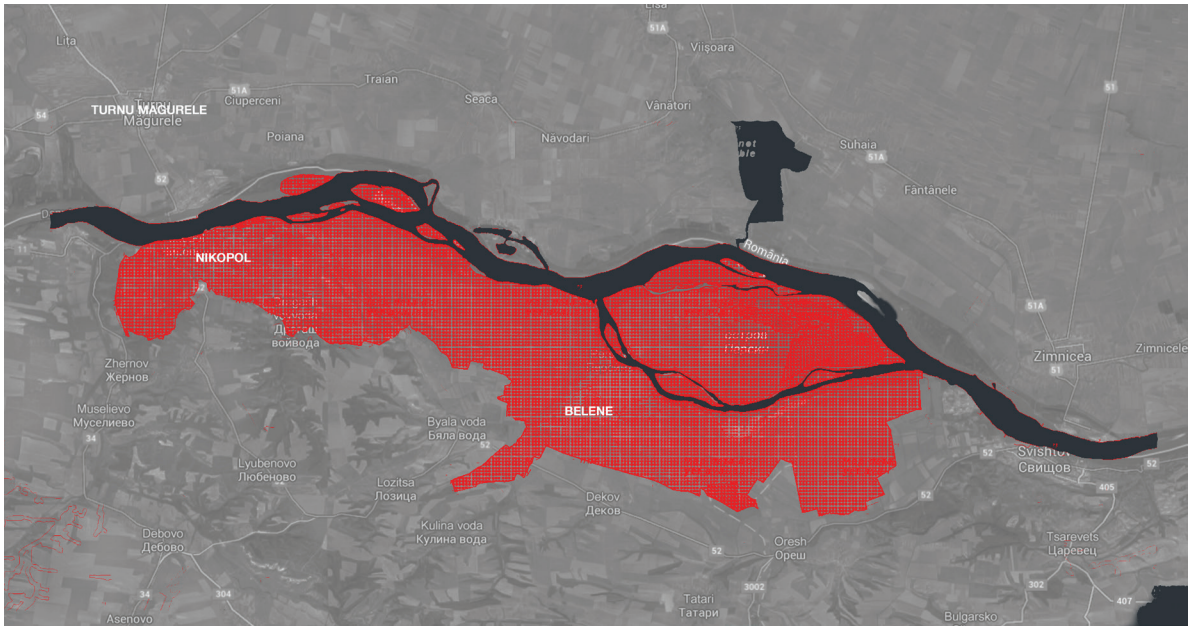


European connection

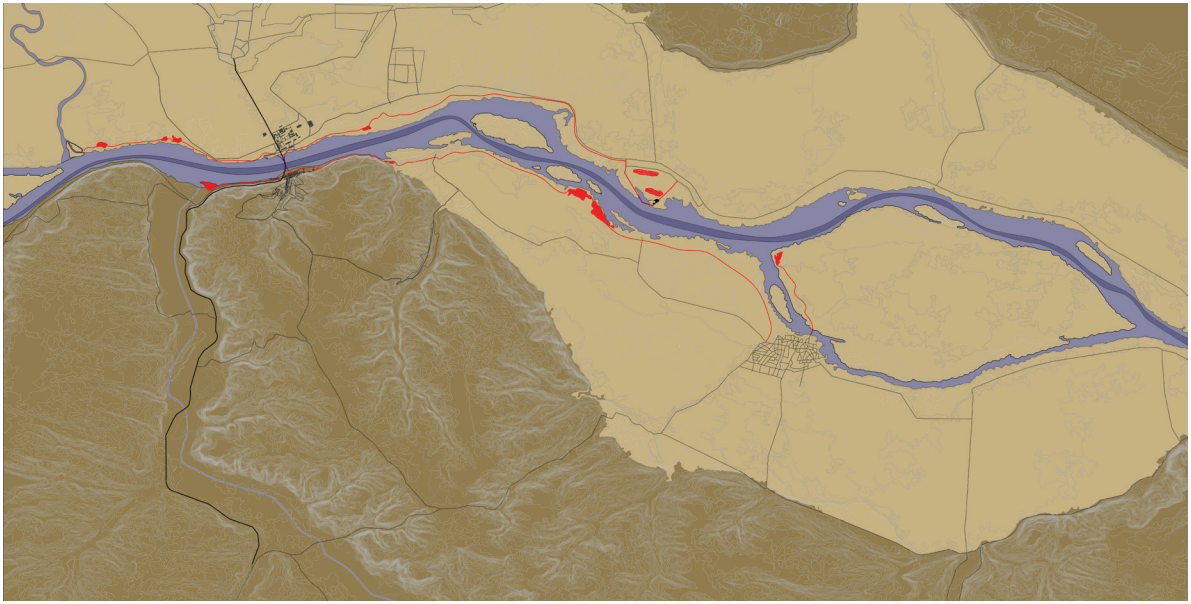
On the selected site, the connection is facilitated through a platform boat which serves the transportation only 3 times a day. That is also one of the reasons why the cities close to the river border do not have much communication.

By connecting through a bridge the two villages of Turnu Magurele and Nikopol, a bigger connection is achieved. The bridge will follow an international road that can connect Sofia and Bucharest in an almost straight line. The time of travelling will be reduced roughly from 6 hours to 3. If we extend the line of connection even further to the north and south; this bridge will connect the whole east of Europe from North to South. A small point of connection can achieve a big international highway which will act as a European spine for transportation of people, services and goods.

Soil types



Natura 2000_Persina natural park



Sandy loess

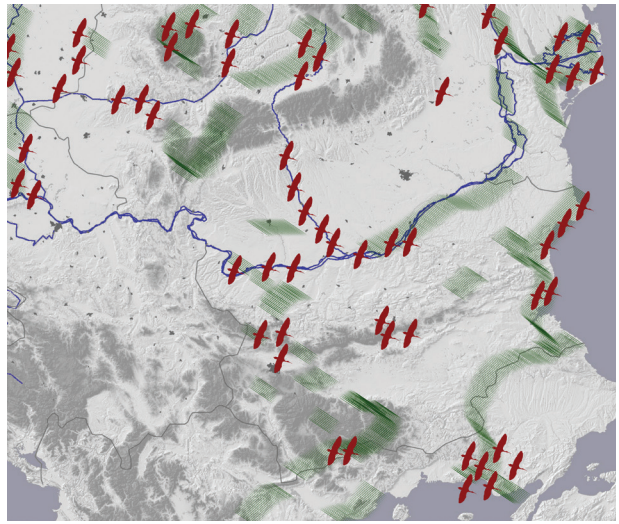
Loess and claye loess

Natural reserve

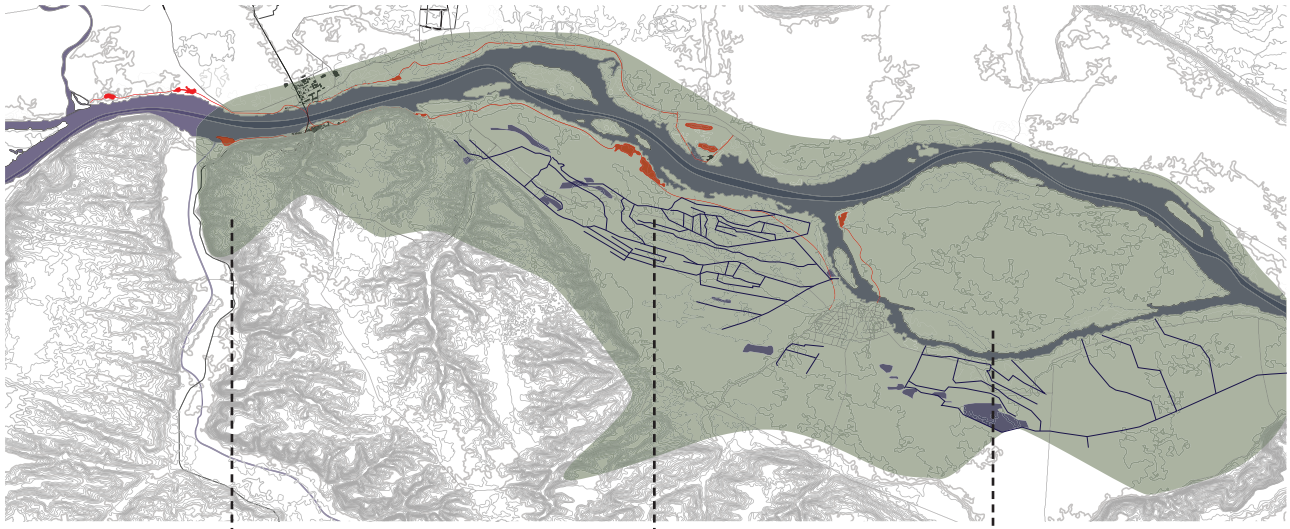
Another interesting aspect of this connection is the interaction of the bridge with the natural reserve areas. By examining the existing soil types and floodplains, we can observe the effect that the bridge will have on the ecology of the place and therefore to a larger ecological connection.

Due to the different morphology of the two sides of the floodplain, the Bulgarian side has narrow floodplains and sudden slopes that reach up to 200m. The Romanian floodplains wide up to 15km currently covered with agricultural fields. The ecology of the Bulgarian side is more developed and also hosts the Persina Park natural reserve. The Romanian side, due to the fact that it is diked and drained constantly for agricultural purposes, does not have as developed ecology. That is why the natural reserve is mainly expanded towards the Bulgarian side.

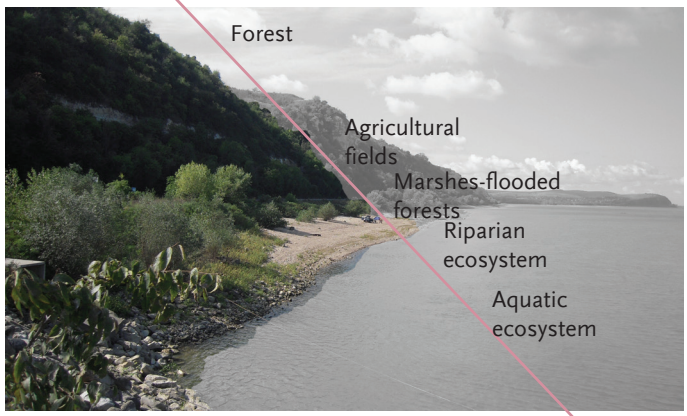
By enhancing the ecology on both sides of the Danube River, we achieve a larger ecological connection with other natural reserves along the east of Europe. The micro climate of the examined area will also benefit ecologically.



Natura 2000 natural reserves



Ecological succession



Bulgarian ecological succession

Romanian ecological succession

Most of the vegetation of the natural reserve is highly connected with the availability of water

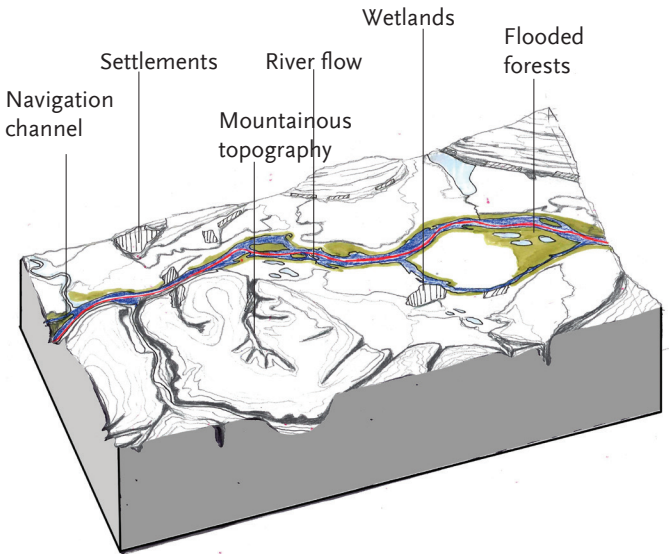
Flooding sequence

The microclimate of the area is different in each country. The Bulgarian river side appears to be more developed than the Romanian one. This phenomenon is highly related to the current floodplains and shores' manipulation on each river side. Due to the implementation of dikes along the Romanian shore, ecology appears to be less diverse. The aquatic plants and small bushes are well developed, but behind the dikes there is no heavy vegetation. The ground is occupied by agricultural fields. The ecological succession finishes with poplars and willows as the highest trees which form the flooded forests, mainly outside of the dike. On the other hand, the Bulgarian side is well developed, from the small aquatic plants until the dense vegetation of the oak trees. That is also another reason why the Bulgarian side is better protected from flooding than the Romanian one. The water is better absorbed from the trees and the sudden slopes than the agricultural fields.

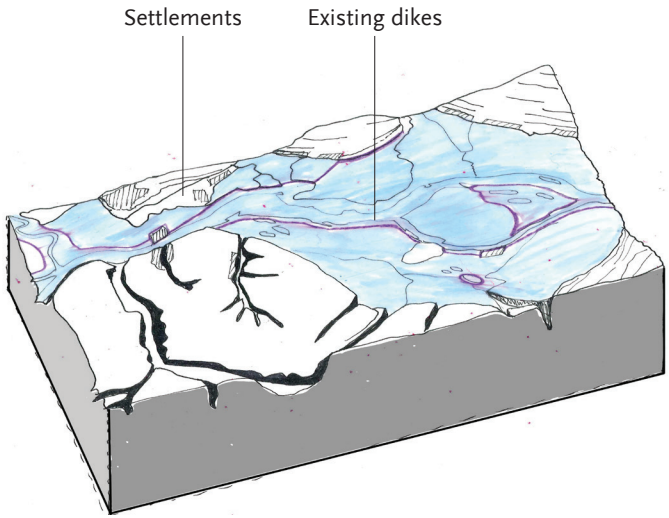
The following diagrams illustrate the flooding effect which takes place in the existing landscape. It is clear that the dikes cannot keep the land safe in case of an extreme flooding. What is proposed through the project is that the dikes should change and the river should gain more space.

By giving more space to the river with more meandering, the biodiversity of the place will increase and therefore the nature reserve area will reach a better state. By making the change in water level visible, residents and visitors will be more aware of the natural processes that take place. This awareness will also make them change their every day life. For example, having in mind the sections of low and high water level, people change their activities depending on the season. During winter, people can be closer to the river and interact with it. On the other hand during summer nature takes over the place and revives. More birds and fishes are close to the shores, they breed and grow their population.

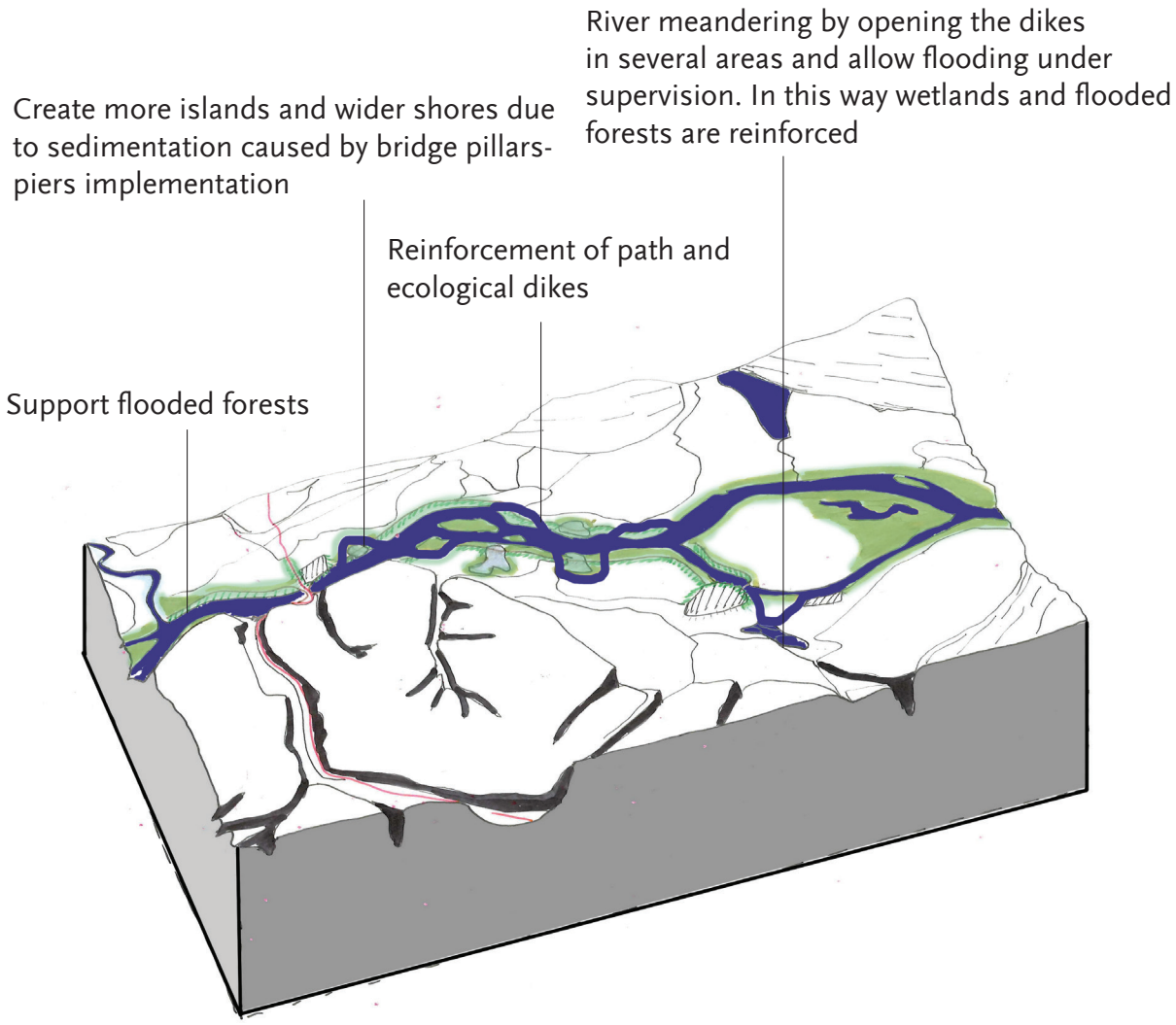
The role of my design in these examples is to reshape the existing dikes in such a way that will benefit the ecology of the place. As said before, the infrastructure of the bridge can already interact with the ecology of the place, maily through the sedimentation.



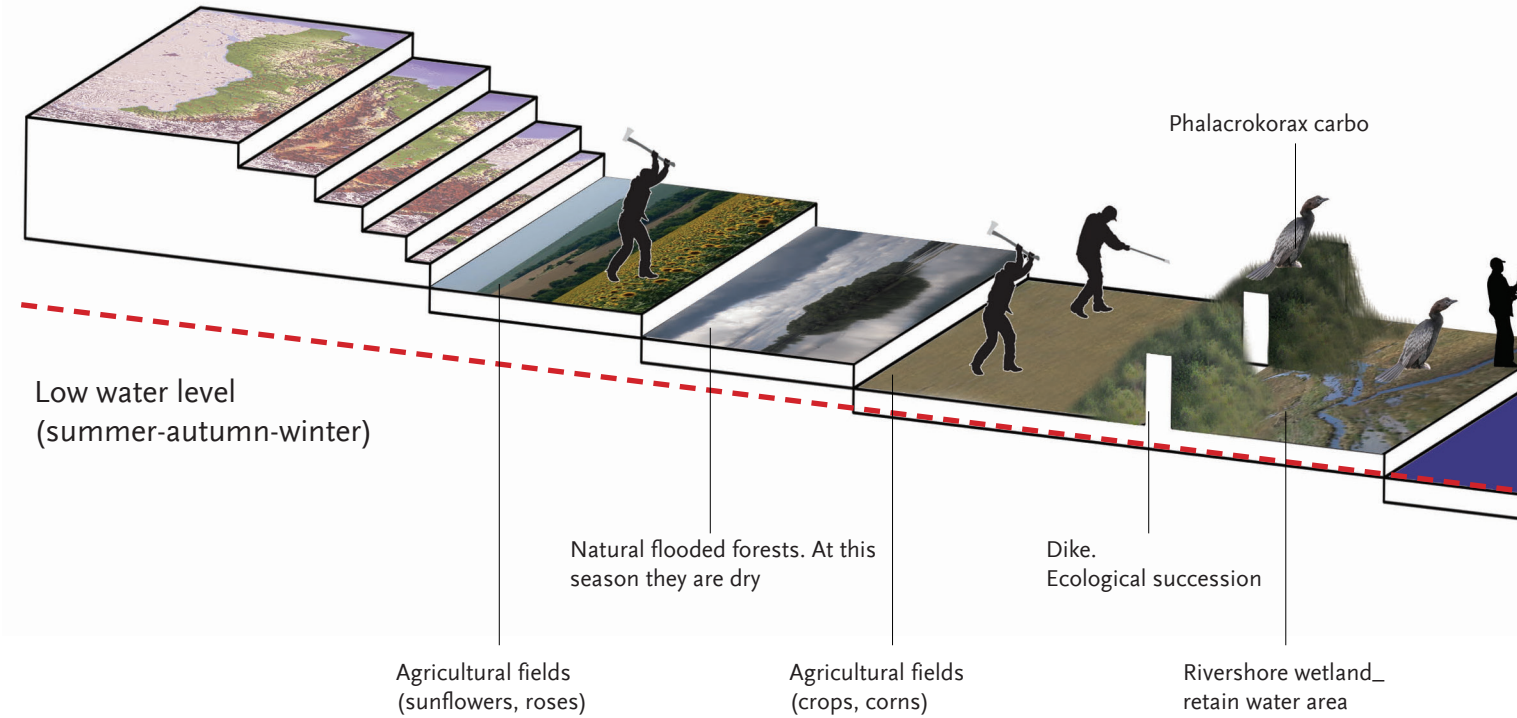
Existing situation

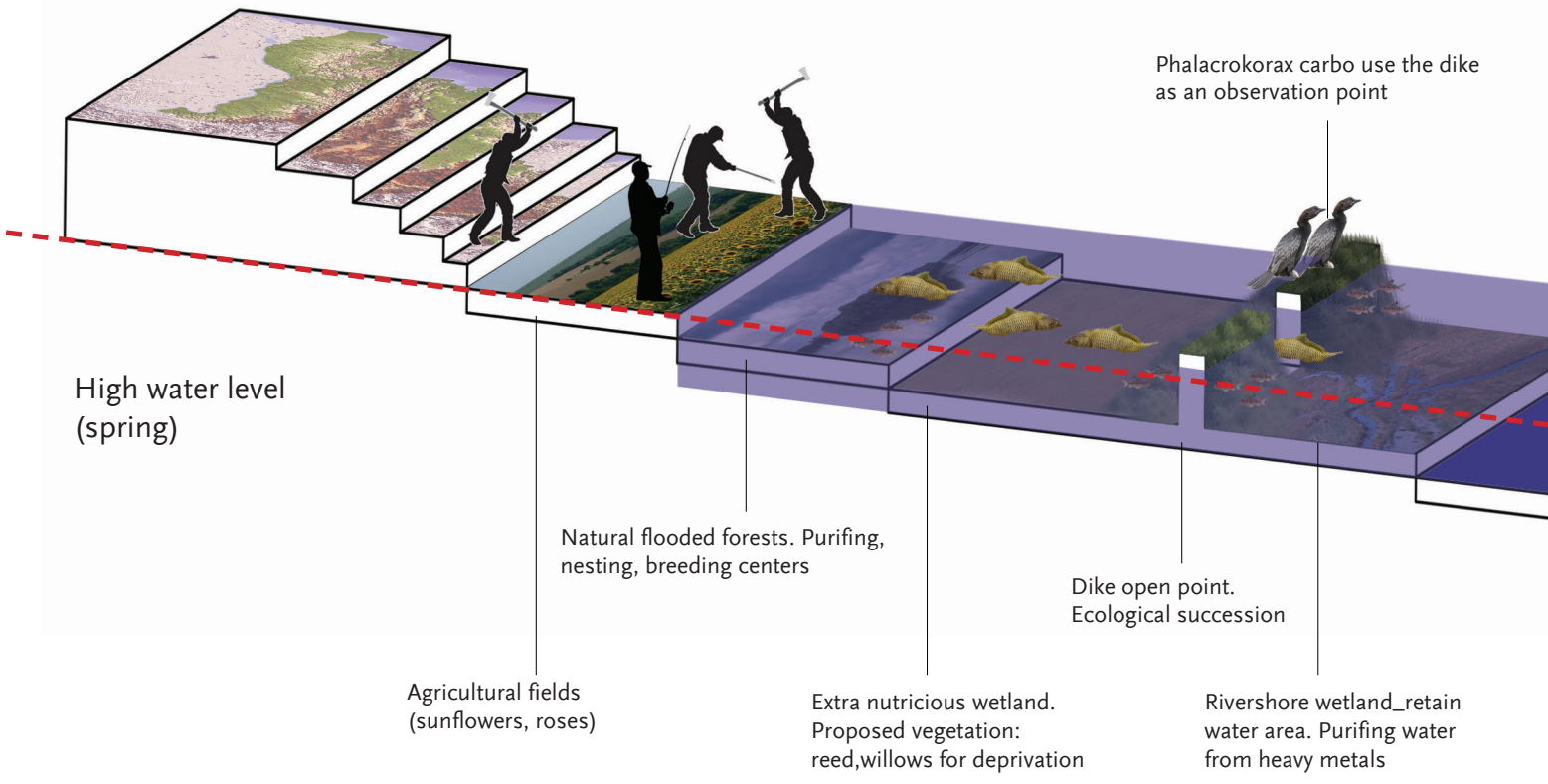


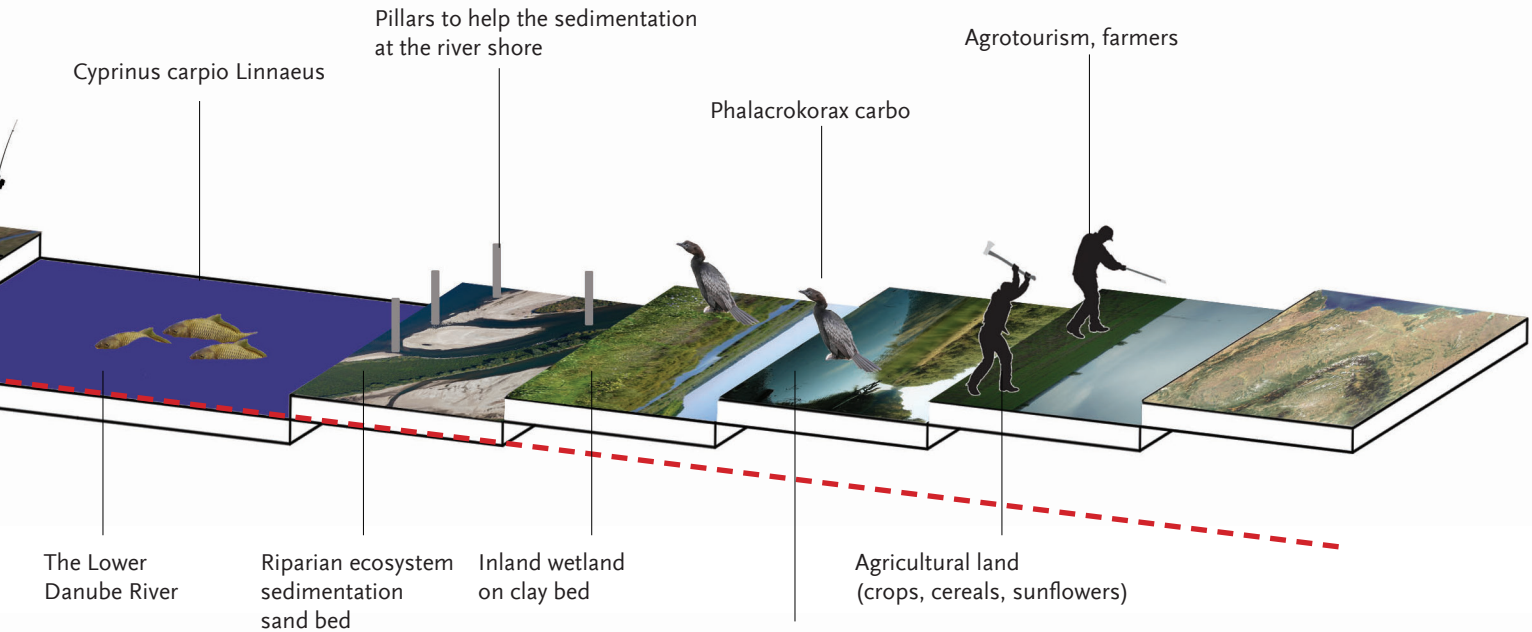
Extreme flood event

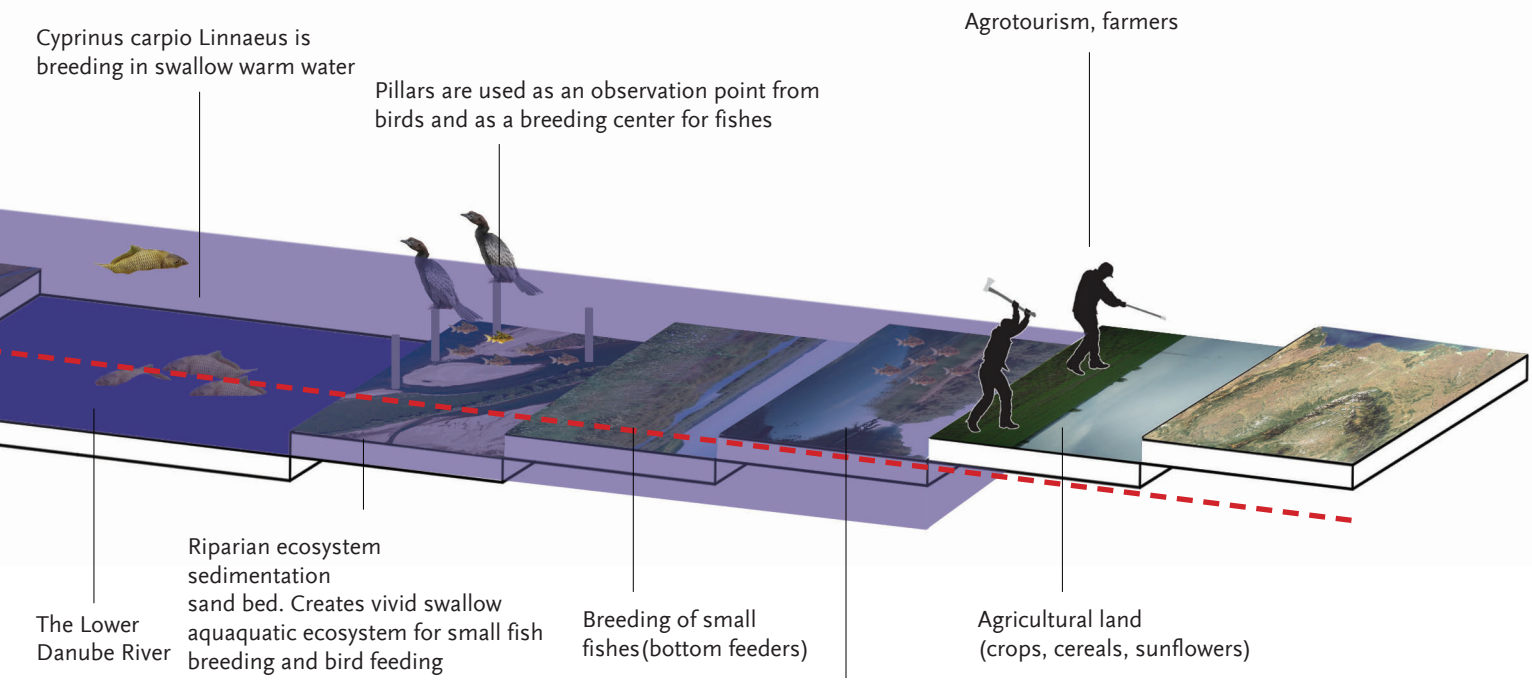


Proposed design regarding the change in water level


Phalacrokorax carbo
Low water level
(summer-autumn-winter)
Natural flooded forests. At this season they are dry
Dike.
Ecological succession
Agricultural fields
(sunflowers, roses)
Agricultural fields
(crops, corns)
Rivershore wetland_
retain water area


Phalacrokorax carbo use the dike as an observation point
High water level
(spring)
Natural flooded forests. Purifing, nesting, breeding centers
Dike open point.
Ecological succession
Agricultural fields
(sunflowers, roses)
Extra nutricious wetland.
Proposed vegetation:
reed,willows for deprivation
Rivershore wetland_retain water area. Purifing water from heavy metals


Cyprinus carpio Linnaeus
Pillars to help the sedimentation at the river shore
Phalacrokorax carbo
Agrotourism, farmers
The Lower Danube River
Riparian ecosystem sedimentation sand bed
Inland wetland on clay bed
Agricultural land (crops, cereals, sunflowers)
Flooded forests. In these seasons, they function as dry hardwood/softwood forests


Cyprinus carpio Linnaeus is breeding in swallow warm water
Pillars are used as an observation point from birds and as a breeding center for fishes
Agrotourism, farmers
The Lower Danube River
Riparian ecosystem sedimentation sand bed. Creates vivid swallow aquaquatic ecosystem for small fish breeding and bird feeding
Breeding of small fishes(bottom feeders)
Agricultural land (crops, cereals, sunflowers)
Flooded forests. Place for nests and breeding

No identified use

Abandoned machines

Abandoned machines can become potential nests and observation towers for birds

Create ecological conditions for endangered birds by providing place for nesting, breeding and feeding

Reinforcement of riparian areas with reeds and grasses to purify the water

No activity

Sheet piles hide the view and horizon

Reinforcement of wetlands
Obtain spatial quality and activities

Ecological transformation of the dike and sheet piles

Take advantage of the river fluctuations for the well-being of the ecosystems

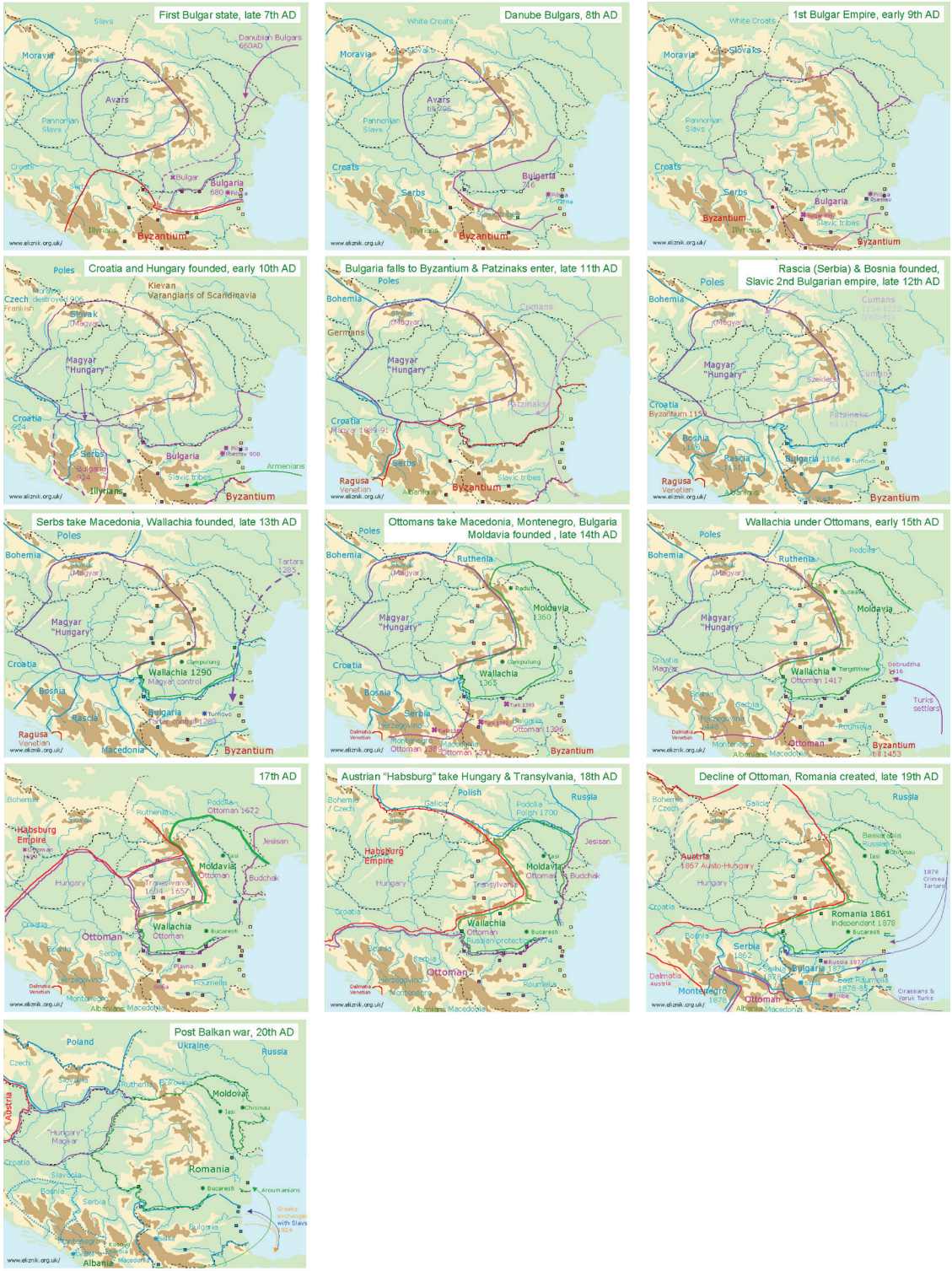
Interventions

By intervening on the existing dikes and the flood control system of the area, the ecology and landscape of the place will change gradually for the better. The replacement of the sheet pile dikes with ecological dikes will attract more ecology close to the villages. Therefore, there will be more areas for bird watching and other recreational activities. Moreover, by reinforcing the wetlands by opening the dikes in certain points, the aquatic ecosystem and small vegetation will improve close to the river shores. Small plants will attract more fishes and more birds, creating a new ecological environment.

Changing the landscape in a controlled way could benefit the existing ecology and enhance activities related to natural elements. A major problem of the area is that people are not connected with the strong ecology of the place. Introducing activities deriving from natural elements would be a good solution to bring people closer to nature and make them realize the natural processes which take place in the area. Nature will become part of the imageability of the area, part of people's everyday life.

Photos taken during the field trip

Connection



Existing situation. Source: http://www.eliznik.org.uk/EastEurope/History/balkans-map/index.htm

The meaning of symbols

. Symbols are part of our everyday life

. Symbols help to form a visual representation of our tastes, choices, values

. Symbols can make people feel that they belong somewhere

. It is a human need to give a meaning to our surrounding. It is fundamental and necessary for the human kind

Bridges as symbols

. Bridges are symbols of strength, barriers, paths, crossings

. People simply enjoy crossing bridges

. People perceive bridges as the only way to reach a destination

. Bridges represent a way to overcome obstacles

. Bridges remind of the crossing over from life to death

. Progress, connectivity, stability

. Symbol of hope

Looking back to historic facts, for centuries both cities were exchanging borders across the Danube River. They have a long history of communication and connection. Although, after 18th AD Romanians changed their language structure from Slavic to Latin. The communication got harder; since then their alphabet and phonetics became highly different.

A	a	I	i	R	r
Ă	ă	Î	î	S	s
Â	â	J	j	Ş	ş
B	b	K	k	T	t
C	c	L	l	Ţ	ţ
D	d	M	m	U	u
E	e	N	n	V	v
F	f	O	o	W	w
G	g	P	p	X	x
H	h	Q	q	Y	y
				Z	z

Аа	Пп
Бб	Рр
Бв	Сс
Гг	Тт
Дд	Уу
Ее	Фф
Жж	Хх
Зз	Цц
Ии	Чч
Йй	Шш
Кк	Щщ
Лл	Ъъ
Мм	ь
Нн	Юю
Оо	Яя

Translation:
My dear friend,

I am waiting for you as soon as possible to my new house near the University on the new island. I hope you are doing fine and I wish you good luck with your new job at the gas station.

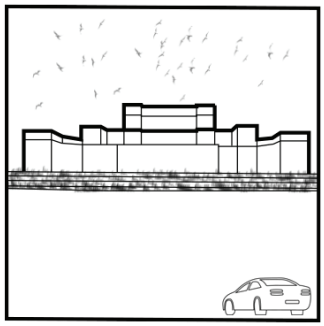
Greetings,
Amalia Duzova

Bridges are strong elements in the imageability of the city. People refer to bridges in their everyday life. The bridge between Turnu Magurele and Nikopol incarnates a strong connection among the two countries.

Romanians and Bulgarians do not interact with each other on a daily basis. By introducing an element that belongs to both countries, the communication will become easier. Especially, if the bridge becomes part of their everyday life then the interaction among them will be greater. For example, the bridge can become a post stamp which will be used in both countries. A point of interest for tourists and locals. The bridge will also motivate more businesses to invest on the border line between the countries and as a consequence, more jobs will be available for both Romanians and Bulgarians. It is not only an infrastructure connection but also an emotional bridging between the countries which have different cultures and civilizations.

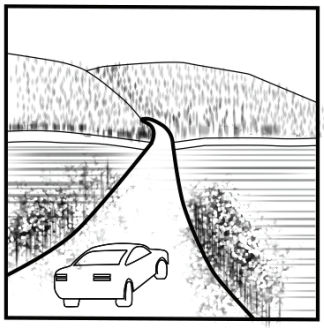
Post stamp created by the author. It illustrates the new bridge. Post stamp are illustrated with pictures which form parts of the imageability of the city.

Geometry

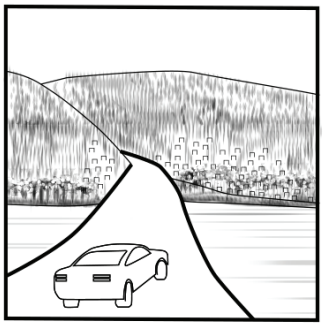


Palace of the Parliament,
Bucharst, Romania

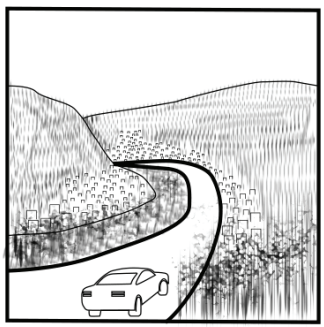
Romanian agricultural fields



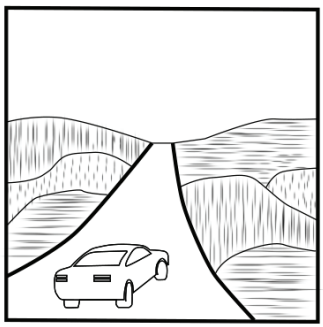
View of bulgarian mountains
from the highway



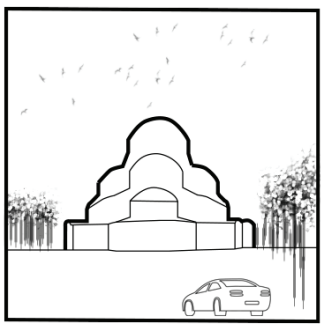
Crossing the Danube via
highway



City of Nikopol
Bulgarian landscape



Bulgarian agricultural fields



Alexander Nevsky Cathedral,
Sofia, Bulgaria

Spatial sequence from Bucharest to Sofia. Different landscape layers.

Sequence

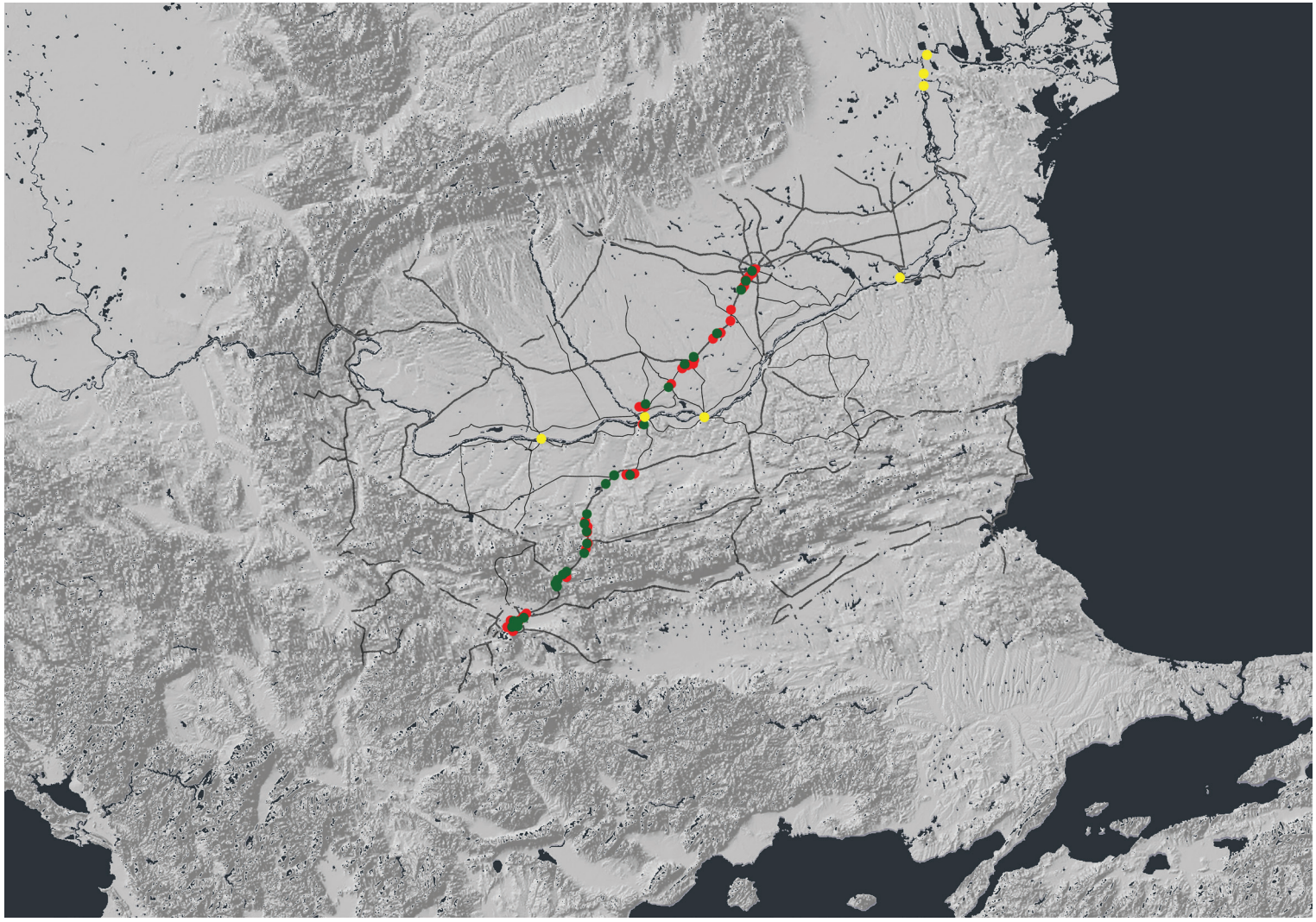
Looking at the landscape sequence driving from Bucharest to Sofia, we pass through different atmospheres. The Danube River is the connecting point where these two different landscapes are merging.

The positioning of the bridge is an important decision for the project because it has to serve both the landscapes and the transportation. By investigating in different possibilities of positioning the highway, I concluded that the best position is between the two cities, Turnu Magurele and Nikopol, where the smallest span of the river is.

By preserving and changing the existing network, a better traffic management is achieved which serves both countries.

In addition, the landscape on both sides of the river is extremely different. The Romanian side is almost flat and the Bulgarian one is mountainous. The chosen position of the bridge does not only benefit the infrastrusture but also creates conditions for the landscape to merge and the ecology to develop equally.

Connection and Exchange



Highway stops

- Gas stations
- Restaurants- Rest areas
- Harbors

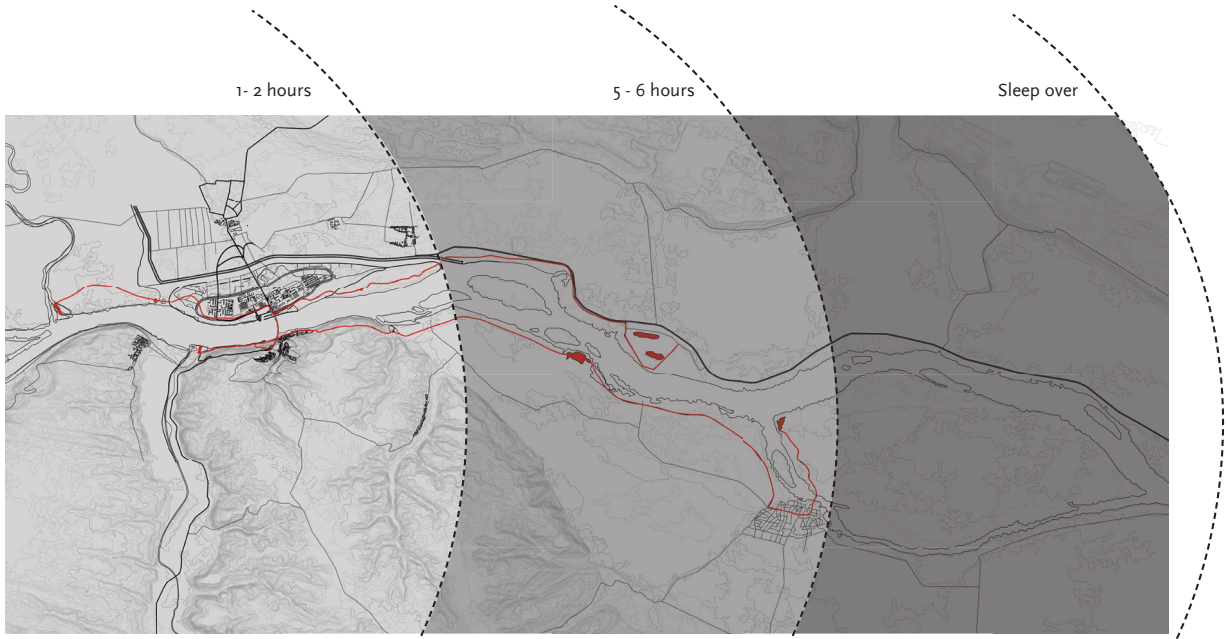
Time frame

The highway stop is an important aspect of the project. An interesting question is how to make people stop, explore the area and enjoy its natural beauty. Once the fast highway is built, there is the danger that people will pass by the area fast without realising the beauty of the landscape.

Persina Natural Park is one of the most important attractions of the area. It extends up to 20 km which means that one can wander by car, bike, horse or boat. If the park extends until the Romanian side and gets enhanced ecologically by the bridge, it will have more value.

Since the area is too large to walk, a time frame makes it tangible. Depending on how much time someone can spend on the area, can choose a different path and means of transportation. For example, if someone has only 2 hours to spend for exploring the area, one can walk up the bridge and visit the opposite site, or cycle to the first recreational spot and enjoy the landscape and its beauty. Otherwise, if someone has more than 5-6 hours to spend, or even sleep over night, there are multiple choices that can accompany one through the landscape. For example, canoe or kayak is a rather common leisure activity in the area. It is also an interesting way to explore the river Danube. Another possibility is horse riding through the flooded forests or just walking and biking freely.

There are a lot of opportunities offered in the area where tourists and locals can enjoy the landscape and experience its diversity on both sides of the river.

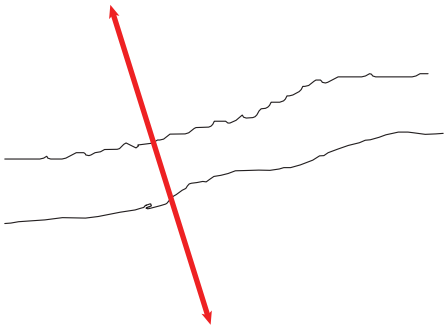


Timeline

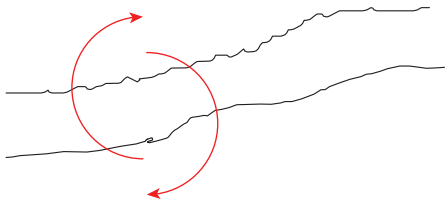
Choreography


FERITI
RAZA DE
ROTIRE A
MACARALEI

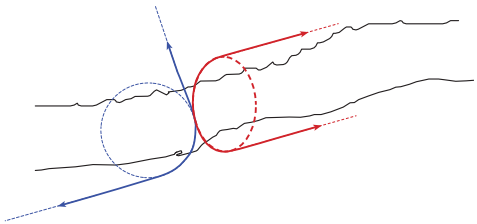
Concept



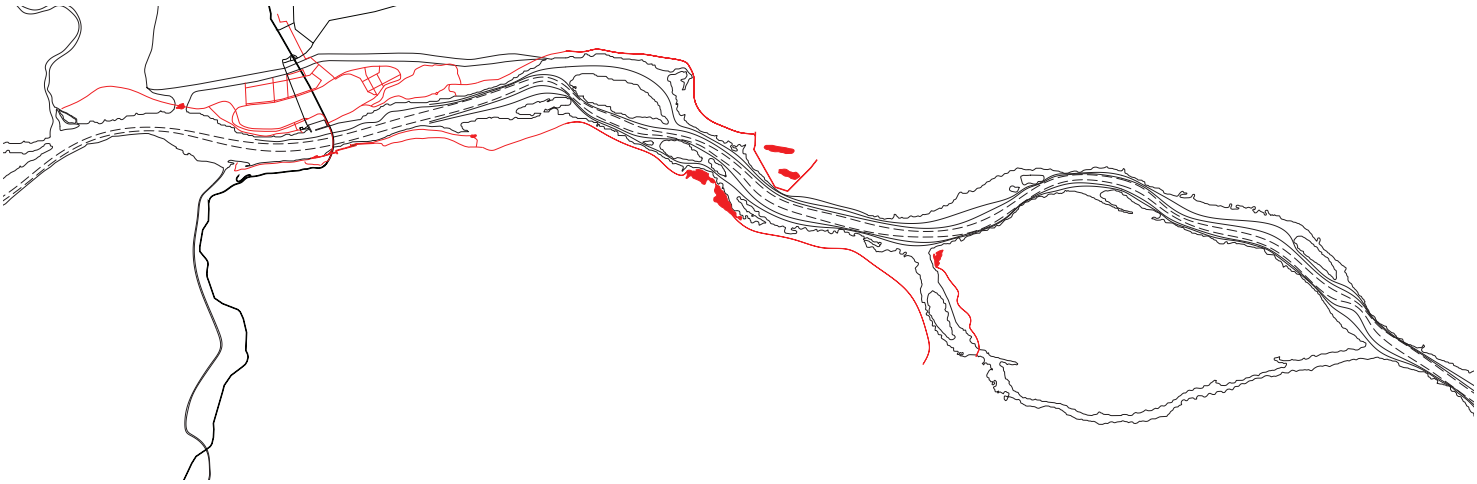
Connection



Symbolism



Geometry



Choreography

Design

The design is divided into four notions. First comes the idea of Connection, which was analysed at previous chapters. Symbolism follows being important for the political border line and emotional aspect of the project. The Geometry of the bridge and the formation of the landscape are the main design assignments. Finally the Choreography is the whole concept of the design. All the elements are tuned to produce a new environment.

The design starts with the implementation of the bridge, both highway and pathway, and its landing on both countries. Moreover, in prevention for severe flooding events, a bypass canal is created to give space to the river and enhance the biodiversity of the shores. The bypass canal creates an island on the Romanian side separating the industry from the agricultural fields. The bridge is going to land on the existing dike and then continue straight until it reaches the ground in the north. On the island a polder landscape is created to protect the existing industry and offer safe grounds for further developments.

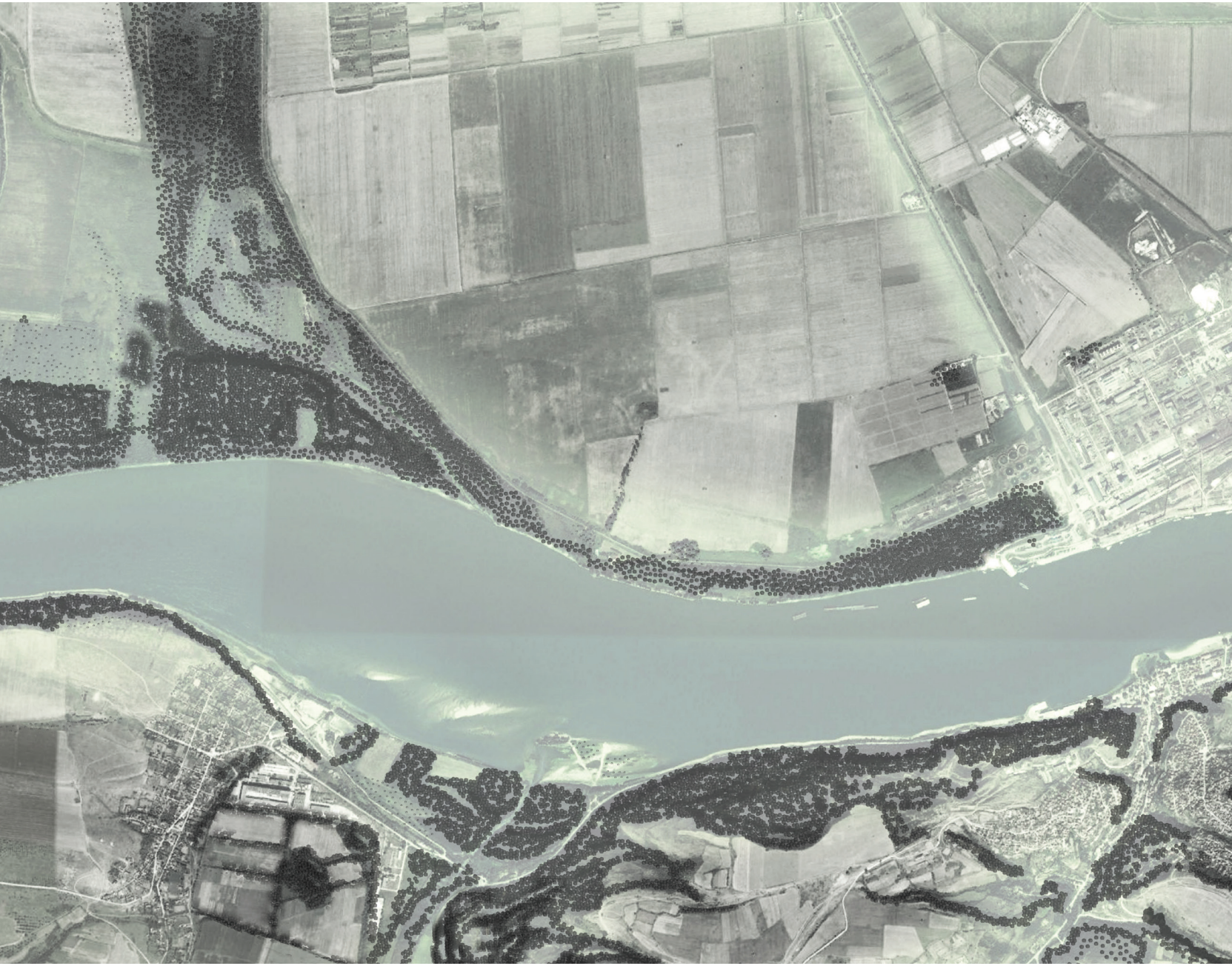
By implementing a new dike on the northen border of the bypass canal, a new attractive place is created that will offer recreational activities to the area. The dike becomes the border between agricultural fields and recreational areas. It is an important area for further development. Another important aspect is the specific treatment of each river shore. For example, in the areas where the riverbed will most probably erode, willow branches are implemented to prevent it. Along the bypass canal, the shores of the river are hard in order not to change in the coming years. Only in a few areas close to the highway exits, the shores are free to accept sedimentation in order to generate beach and other landscape formations and enhace the ecology.

On the Bulgarian side, the existing landscape is hilly which protects the inland from flooding. Some controlled openings on the dike are created in order to let some inland areas flood to benefit the biodiversity of the natural reserve. As it was mentioned in the previous chapters, consant flooding of certain areas on both Romanian and Bulgarian grounds are important for the preservation and improvement of the shores.

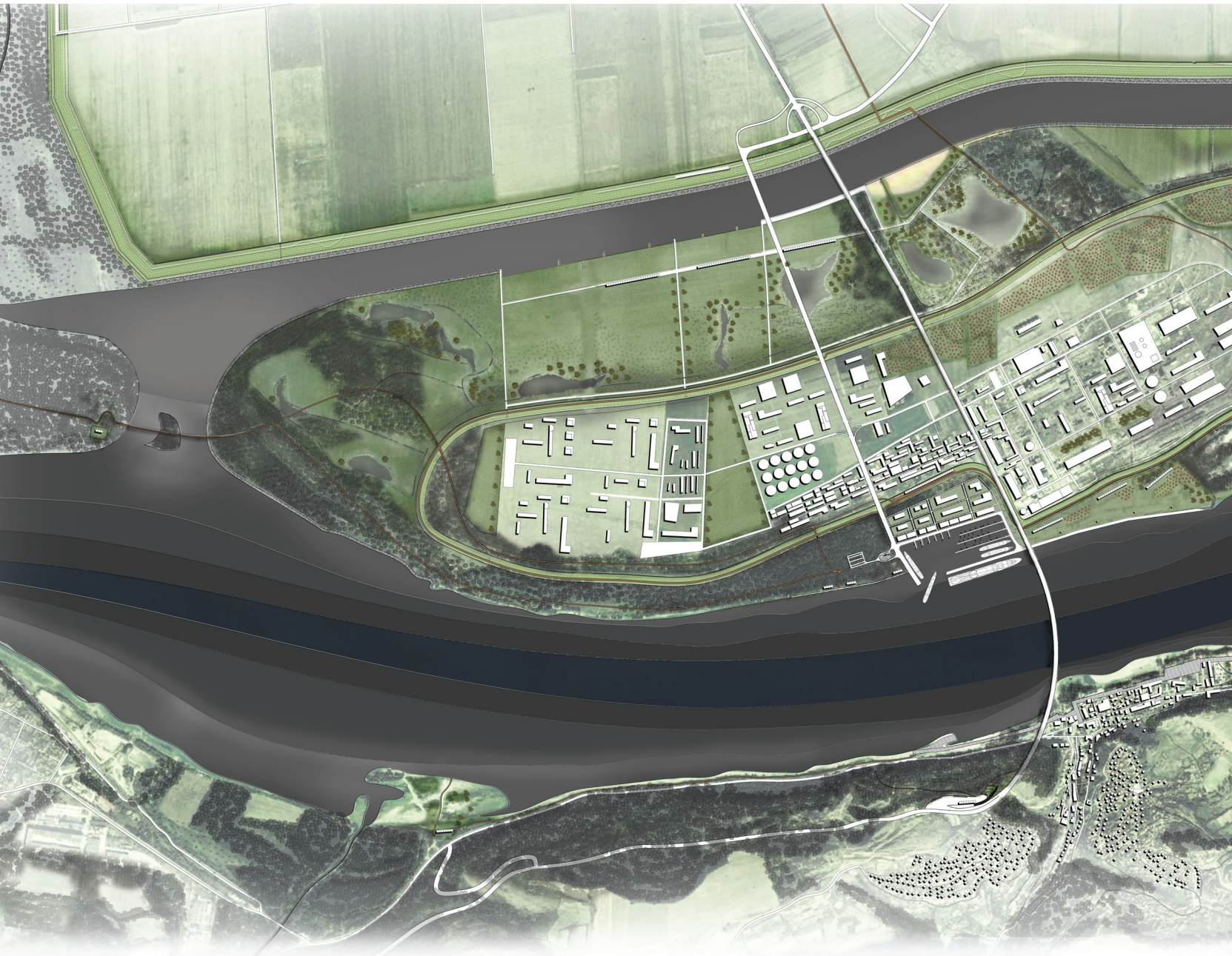
On the island, the polder landscape is currently occupied by an exisitng industrial area. It is proposed to transform it into a more sustainable one in order to reduce air and water pollution. Alongside, a university and settlements are implemented to revive the urban development of the area. The polder will become an attraction pole for students, citizens and workers. The industry will not have the monopoly of the area in the future. A multifunctional area is created to reinforce the economic and social layers.

Finally, under the highway bridge the pedestrian bridge is suspended and drives people from one riverside to the other. It lands on the Romanian dike and scatters into multiple paths that give the opportunity to the beholders to explore. On the Bulgarian side, it lands on the mountain together with the highway bridge and then follows the mountainous landscape. There are multiple stops along the pathways that reinforce the experience of the visitors.

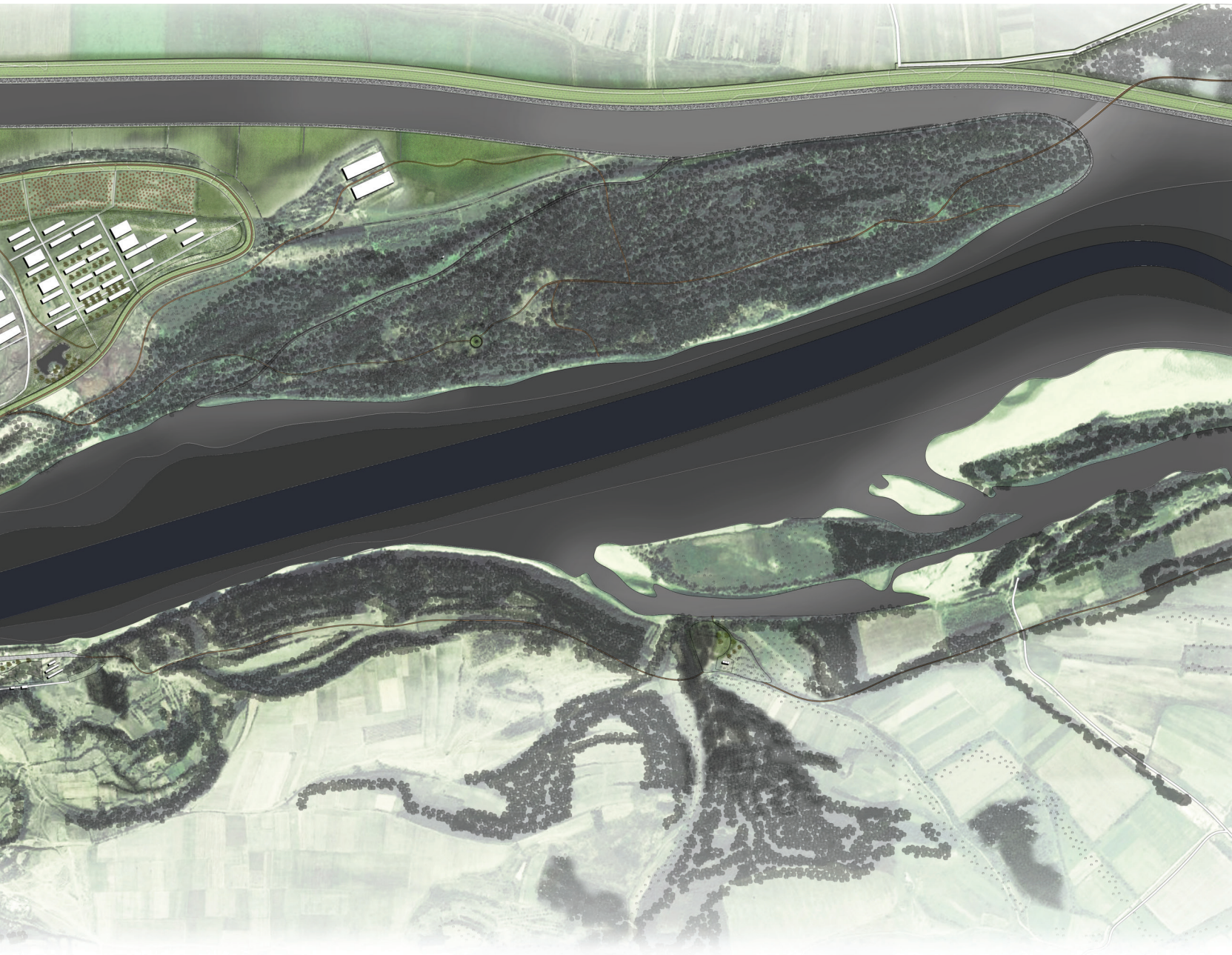
Regional plan

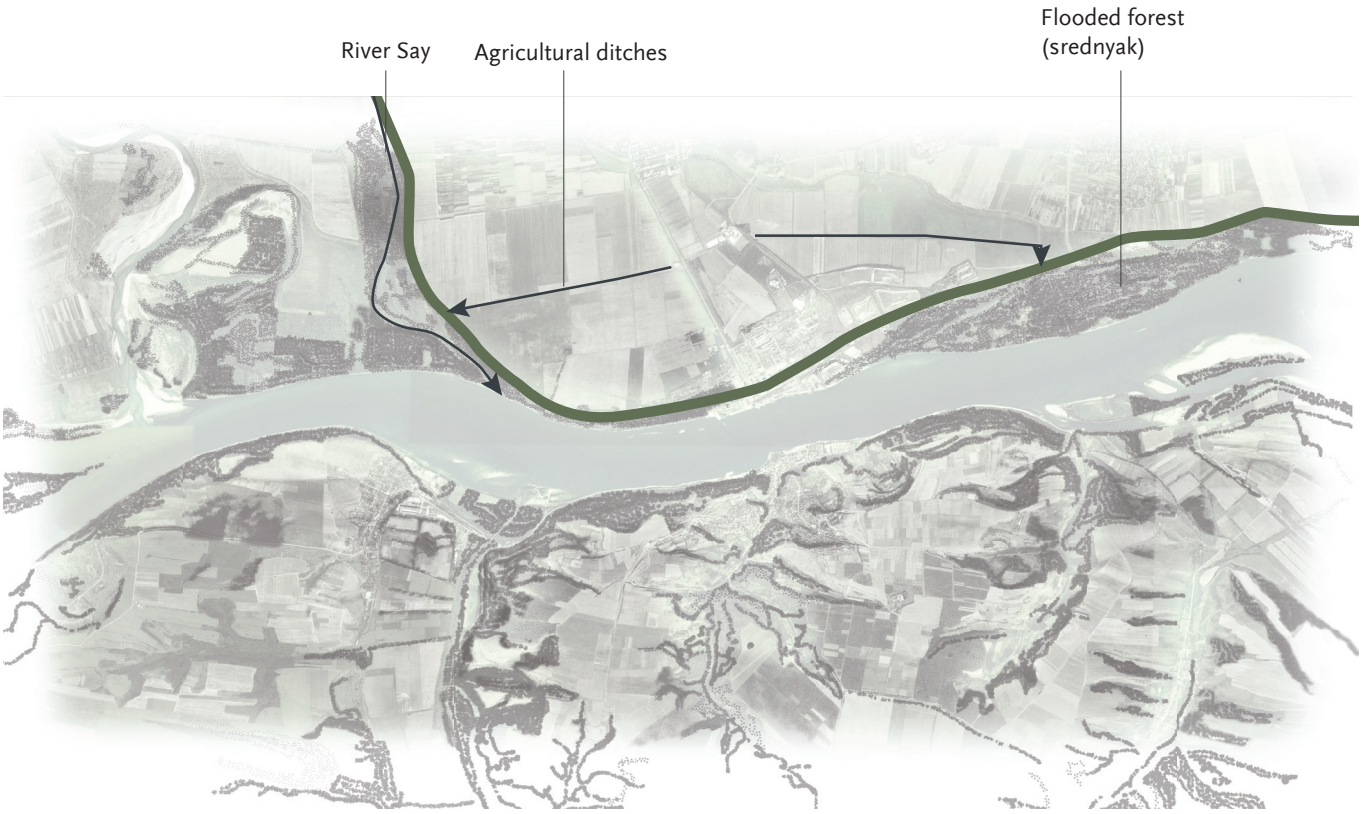


Present situation



Proposed design_Local plan



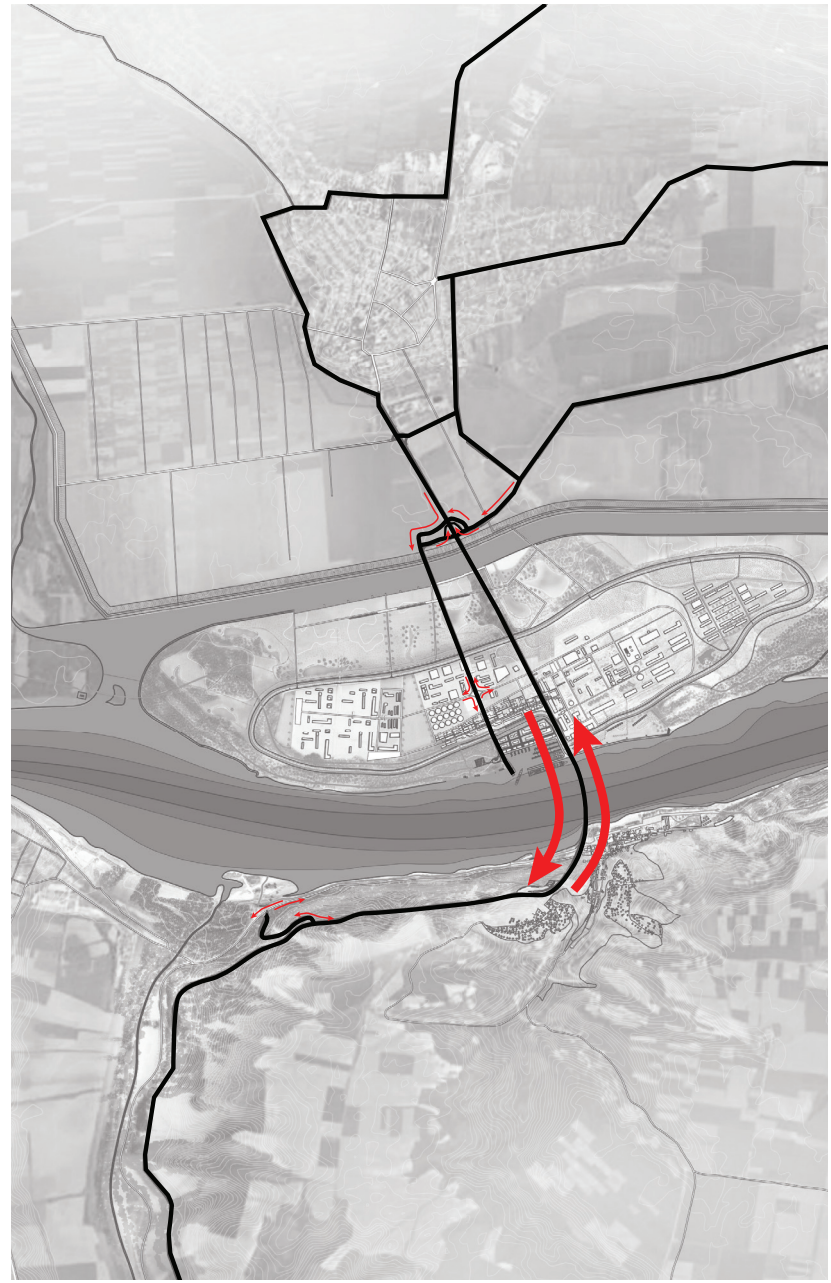


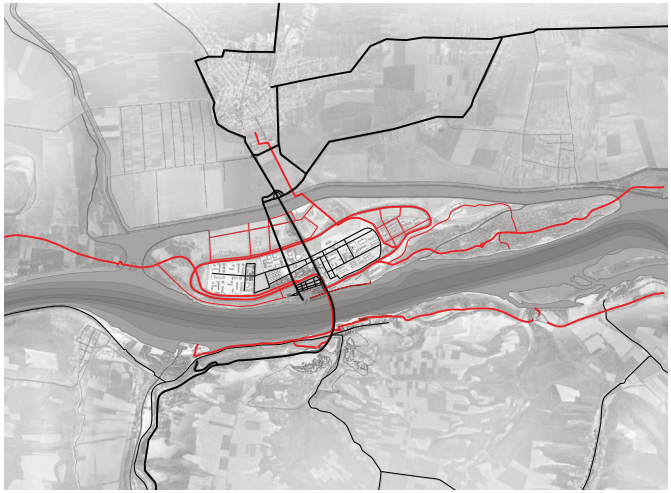
Following the agricultural ditches and river Sai

Island

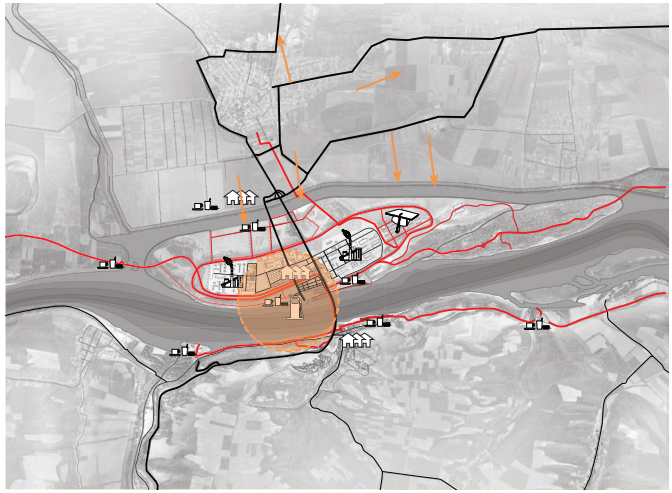
The island is created by following and widening the existing agricultural ditches. It is bordered by natural elements such as the river Say and the flooded forest srednyak (средняк). In order to protect the existing factory facilities and their extension, a polder landscape is created. The bridges land on the dikes of the polder until they reache the ground on the Romanian mainland. The traffic management is arranged around the island with exits in the mainland, from which one is lead to the island and a main exit towards the international harbor. On the Bulgarian side, the highway lands on the mountain where it follows the contours of the mountain. The landing is also accompanied by a stop with urban facilities and a spectacular walk in the oak forest.

There are two harbors in the area, one on each side of the river. The proposed design, offers two different harbors; the international and freight harbor is situated on the island and the touristic harbor on the Bulgarian side. Both harbors collaborate in order to serve the needs of the area.



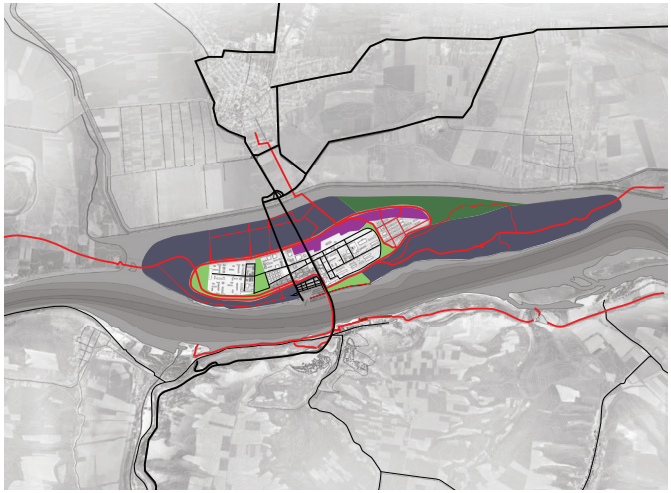


Highway
Local road
Main pedestrian path
Secondary pedestrian path



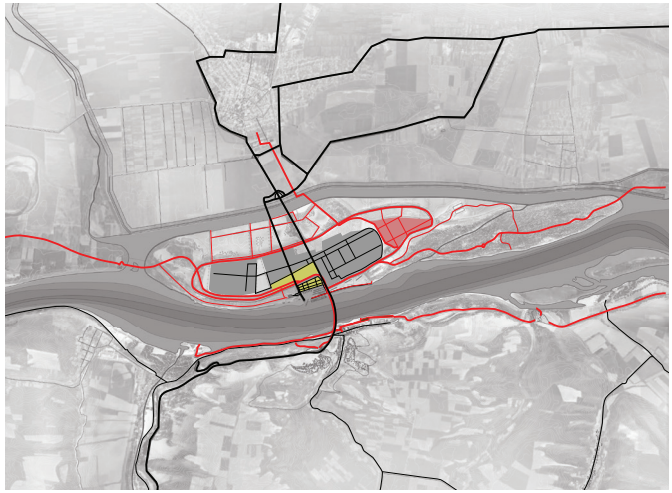
Highway
Local road
Main pedestrian path
Secondary pedestrian path
City expansion tendency

Most important attraction.
Place of interest
Settlements
Restaurant, cafe, toilets, hotels and other urban facilities
Gas station
Industry
University



Highway
Local road
Main pedestrian path
Secondary pedestrian path

Wetland
Agriculture
Green areas that belong to the factory and university
Orchard



Highway
Local road
Main pedestrian path
Secondary pedestrian path

Industry
University
Offices and harbor facilities

The design requires many new facilities to enhance its new identity. The first diagram shows the complete traffic management on the island and all the possible exits from the highway. Each exit identifies a new rest stop as well. The resting areas are either combined with a gas stop or other recreational facilities such as hotels, restaurants and pathways.

The second diagram shows the tendency of the urbanization to approach the new area. On the Bulgarian side, Nikopol will expand on the mountain towards the resting area. The Romanian city will approach the new dike and start expanding along it. The dike will work as a guide to steer the urbanisation and protect the argricultural fields.

Outside of the polder on the island there are new areas of flooded forests and wetlands. There are also touristic attractions, such as beaches, piers and lakes which can offer recreational activities. This area can act as a pole of attraction for combined activities between Romanians and Bulgarians. For example, fishing and canoe/ kayak competitions, cycling and walking routes and bird watching spots.

Inside the polder, on the new island, the factory will expand and slowly will change its activity into a more sustainable one. Next to the factory more facilities are implemented. The university and building settlements are set on the east side of the island and are surrounded by orchards which will be managed by the university students and citizens. The polder will be lively both by day and night and will welcome more facilities related to nature as years pass by and citizens get familiar with the idea.

All the facilities, old and new, are working together like a machine to improve the area and attract more activities. A new identity is created for the border line between Romania and Bulgaria.

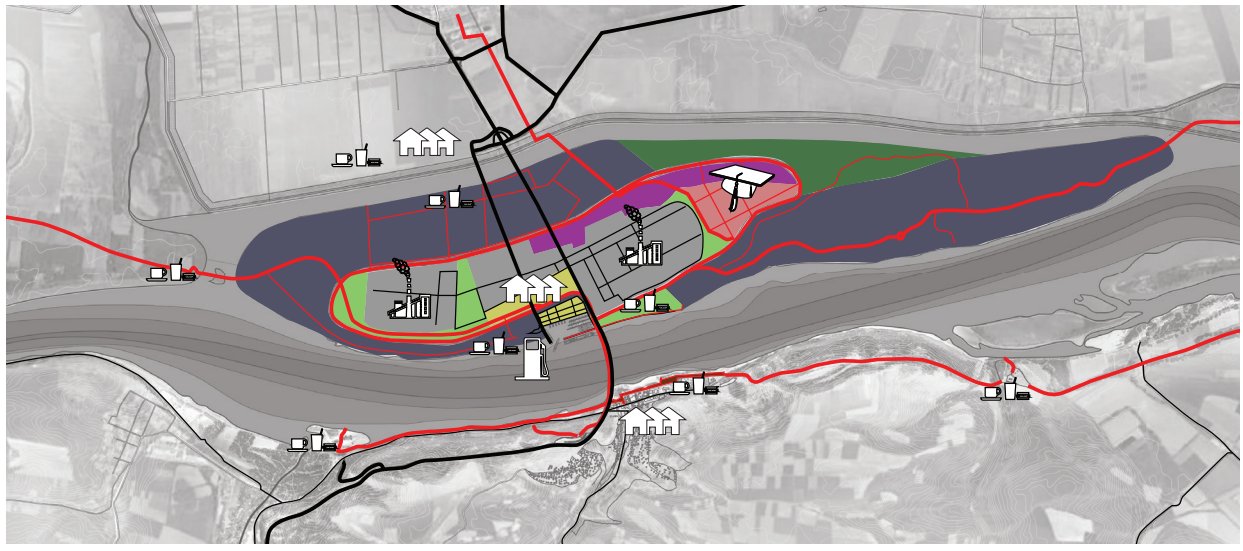
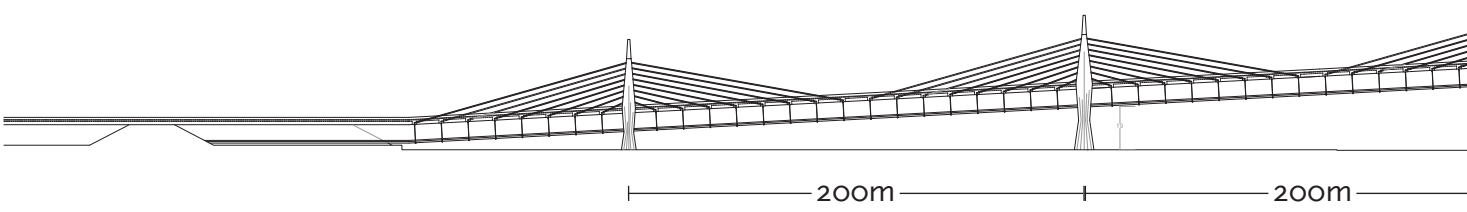
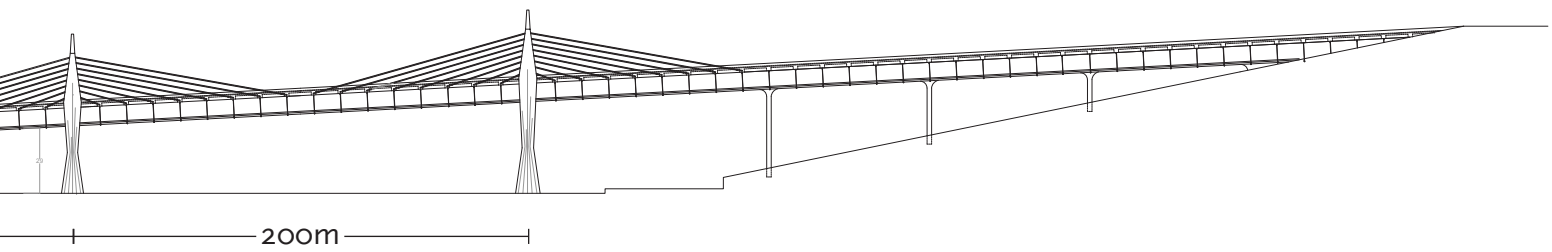
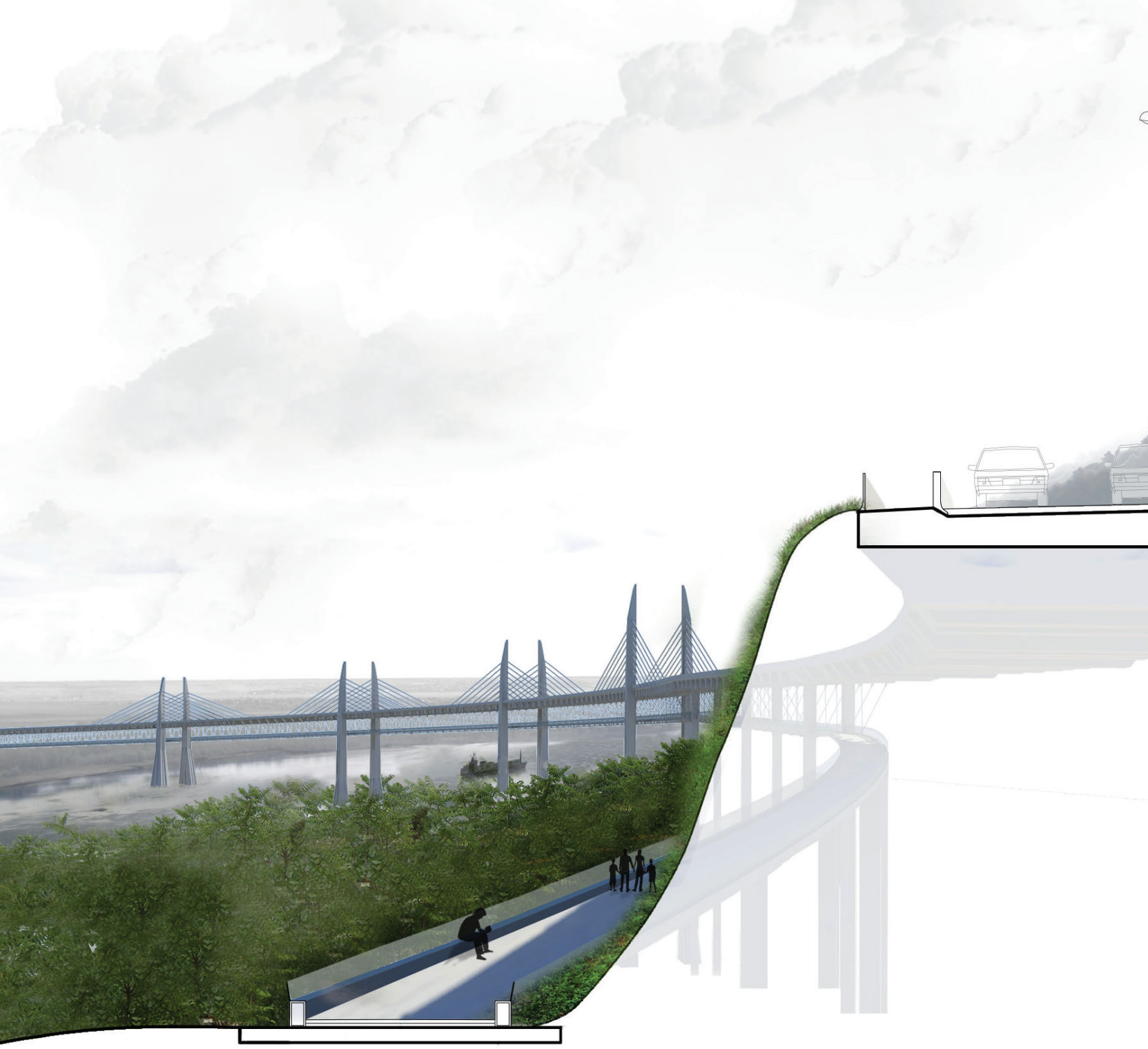


Illustration of the bridge

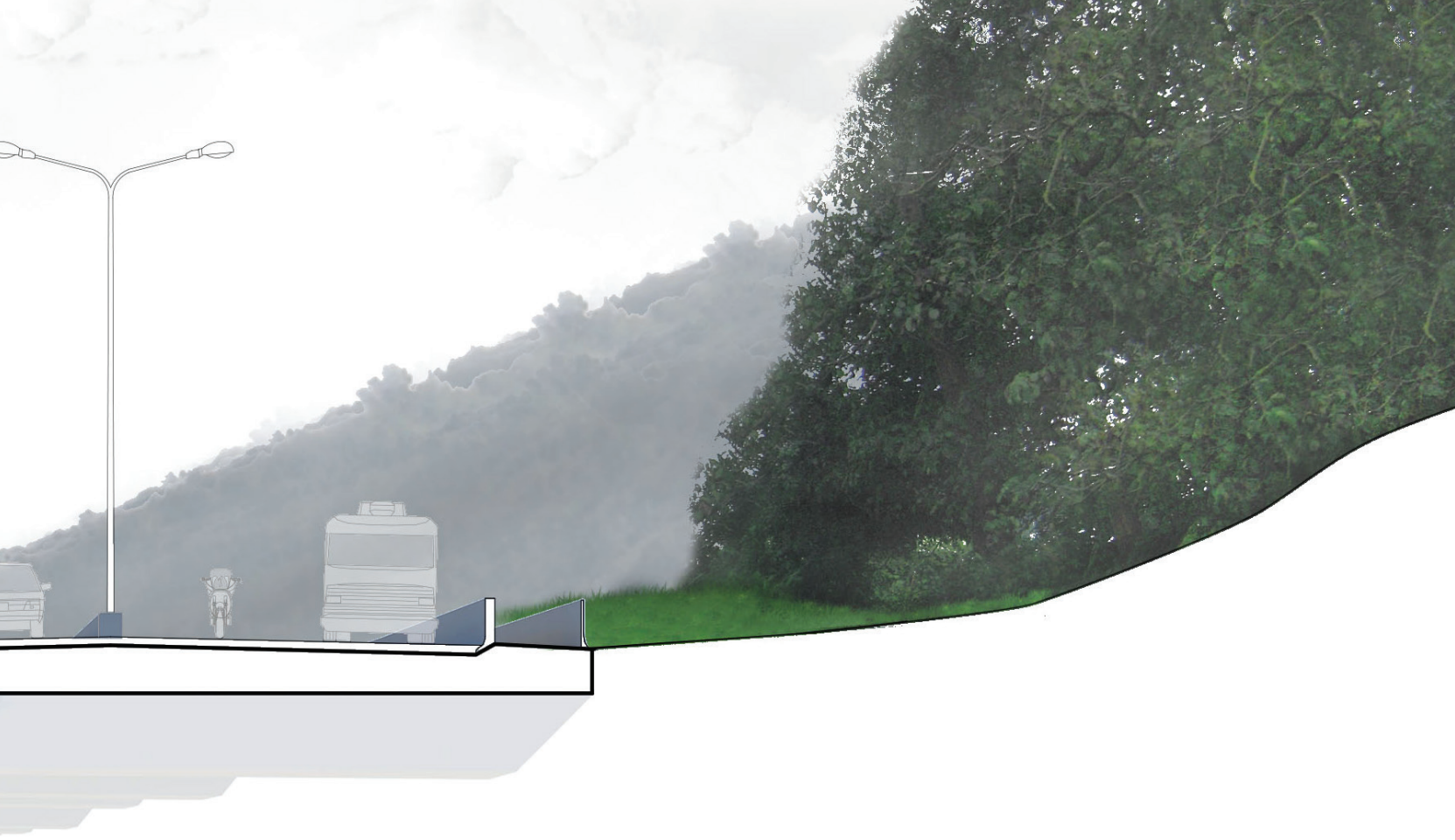


Longitudinal section

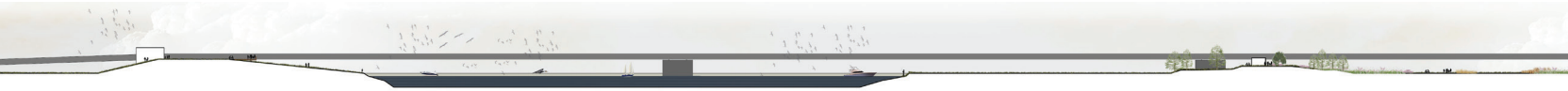

200m



Section GG' illustrating the exit towards the Bulgarian mountain

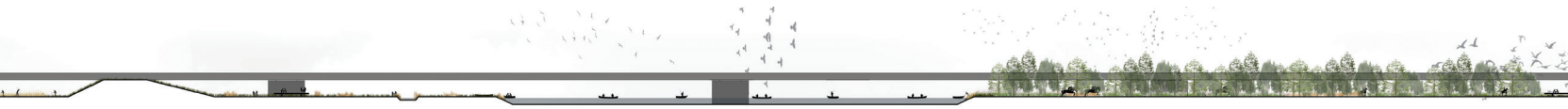


Section FF' illustrating the exit towards the island

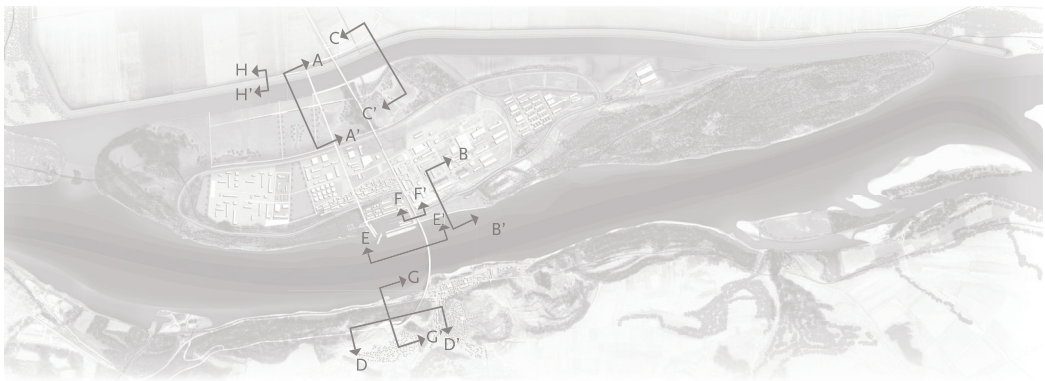


Section A A'

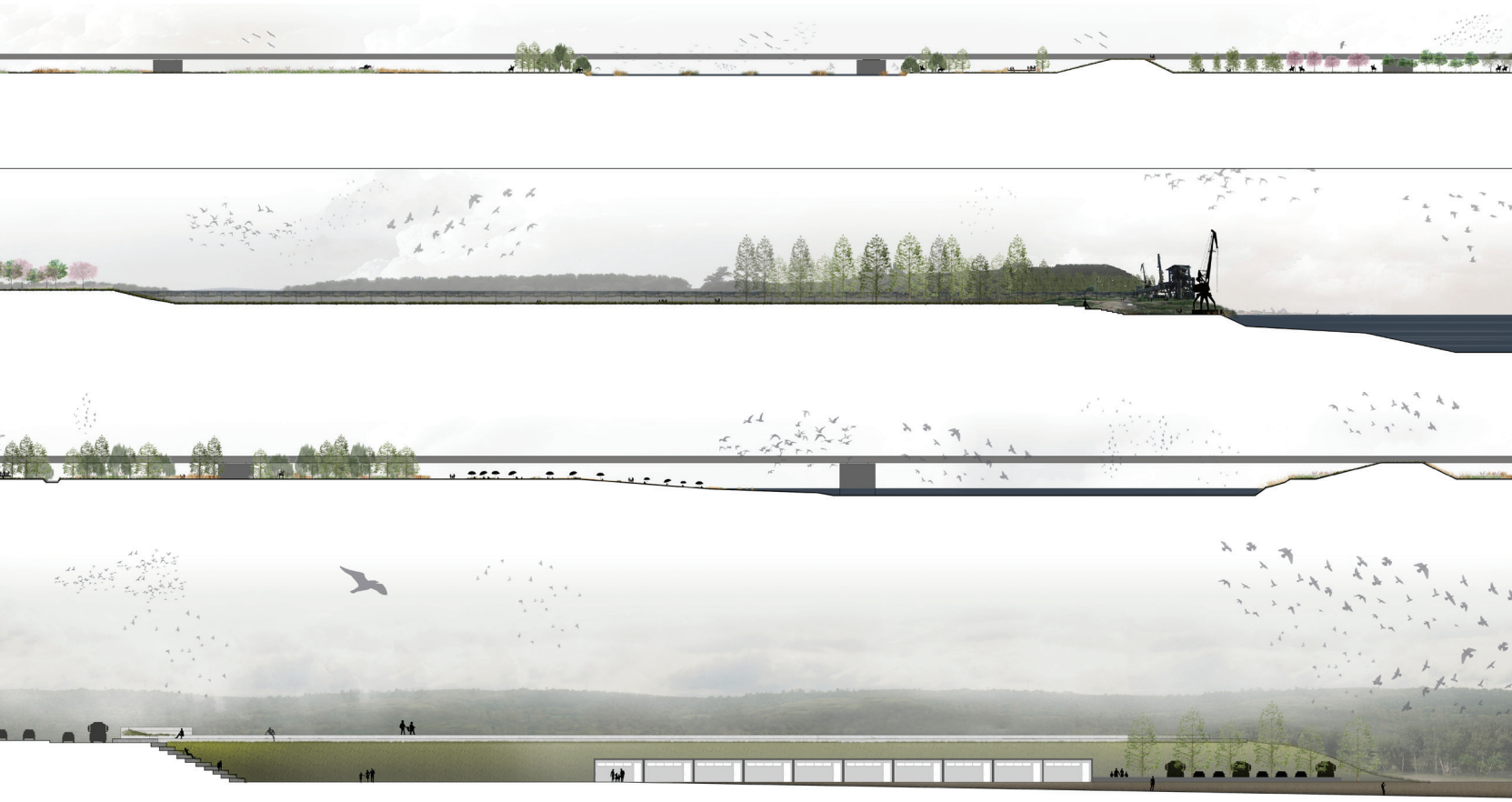
Section B B'



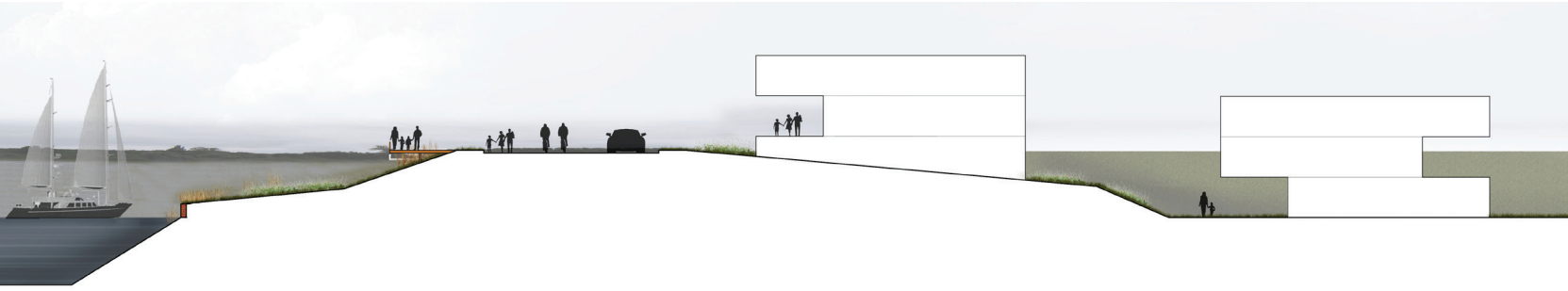
Section CC'



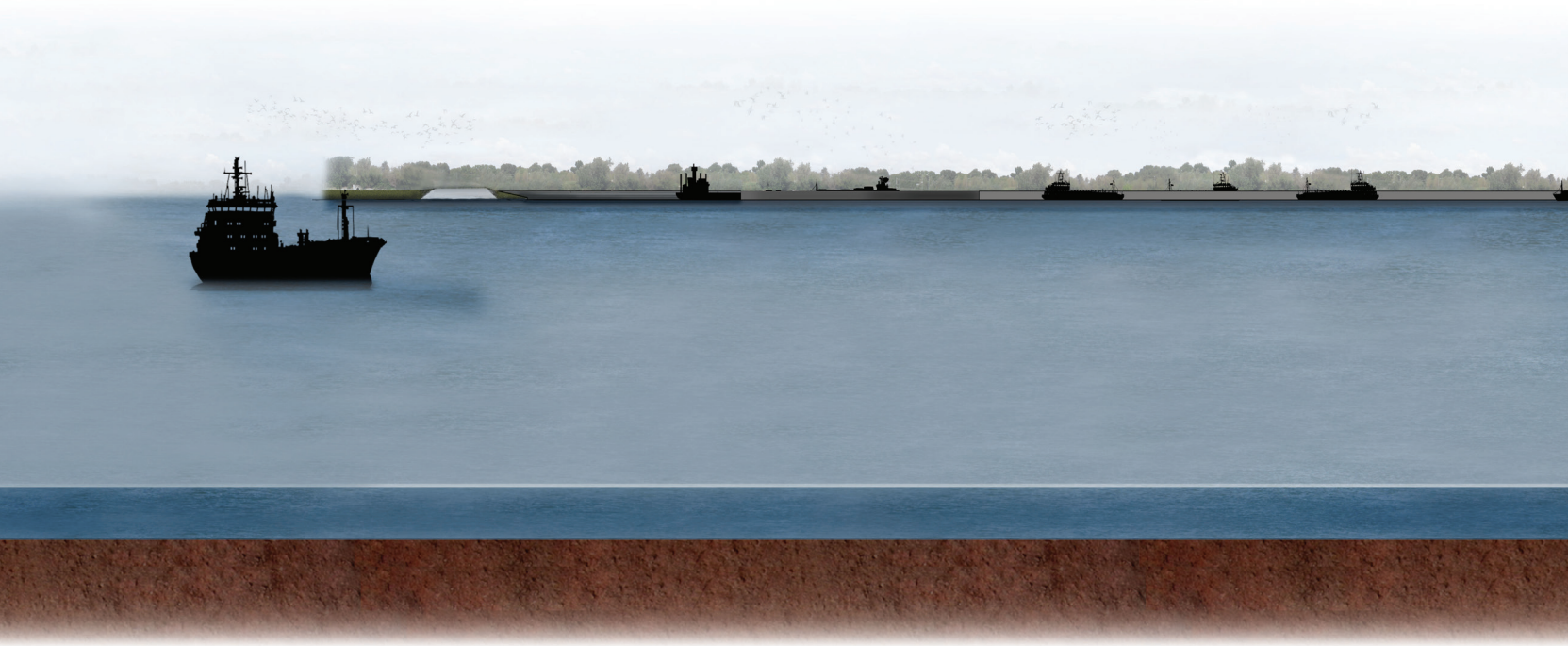
Legenda



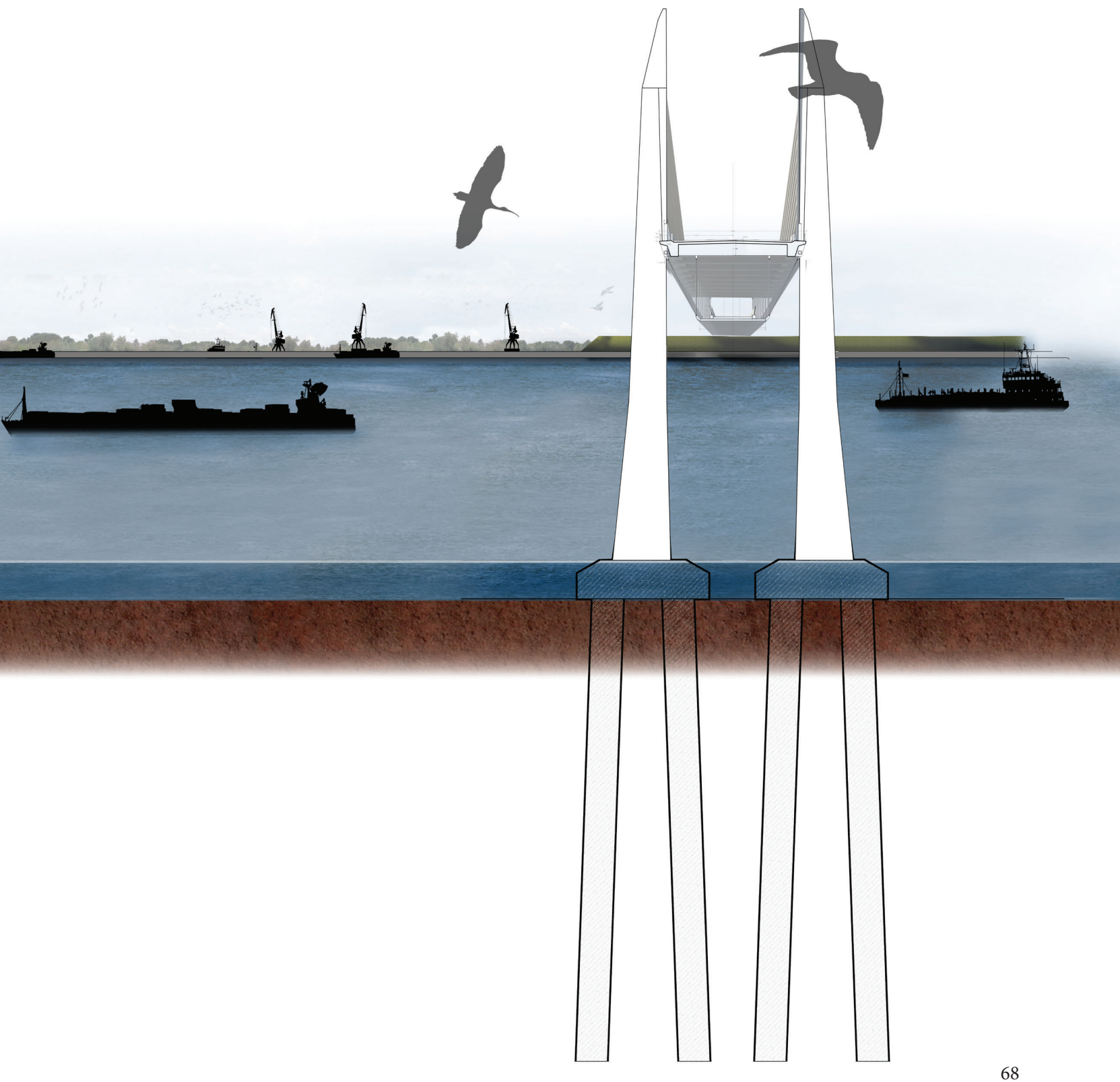
Section DD'

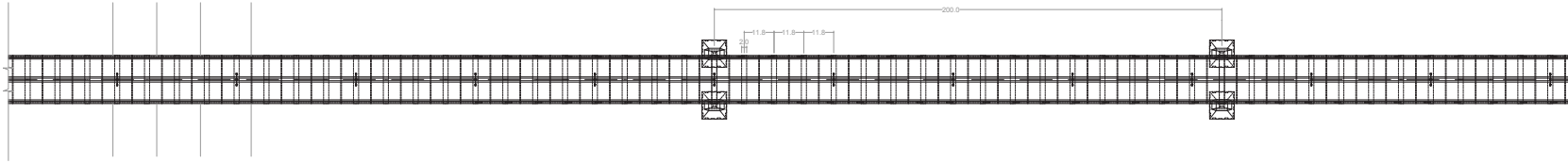


Section HH' illustrating a future vision of the expansion of the city behind the new north dike

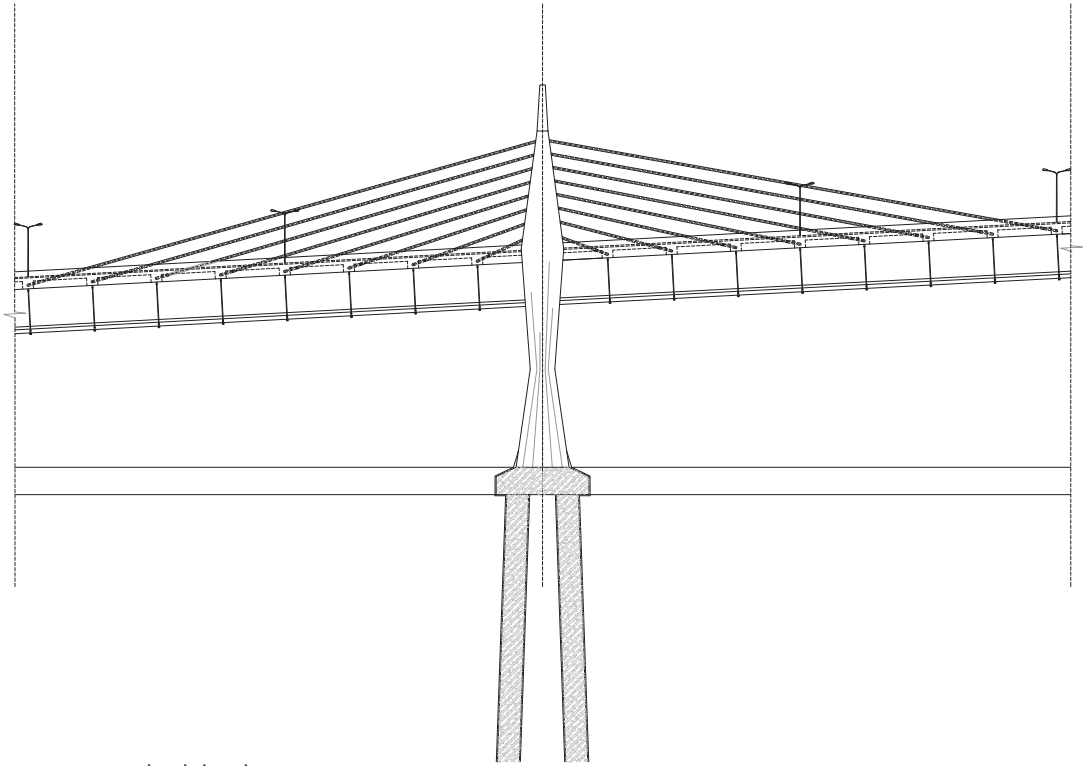


Section EE'

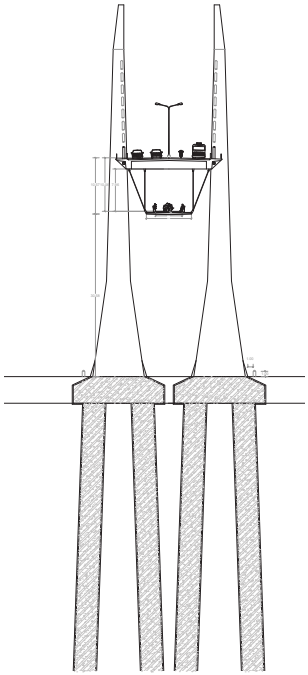




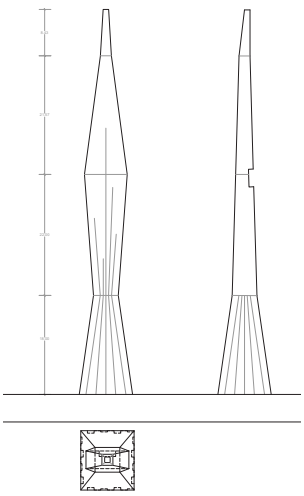
Top plan of the highway



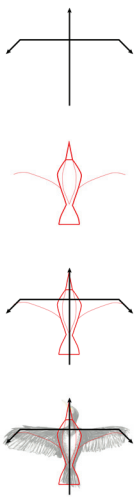
Longitudinal detail section



Cross section

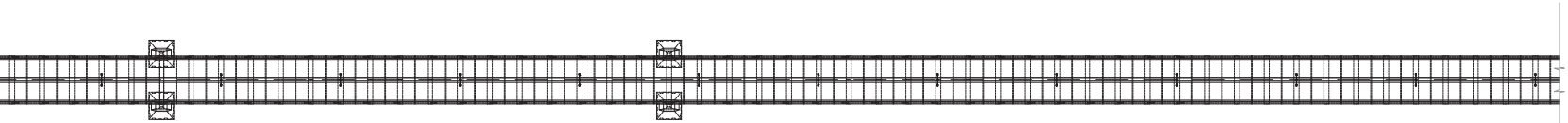


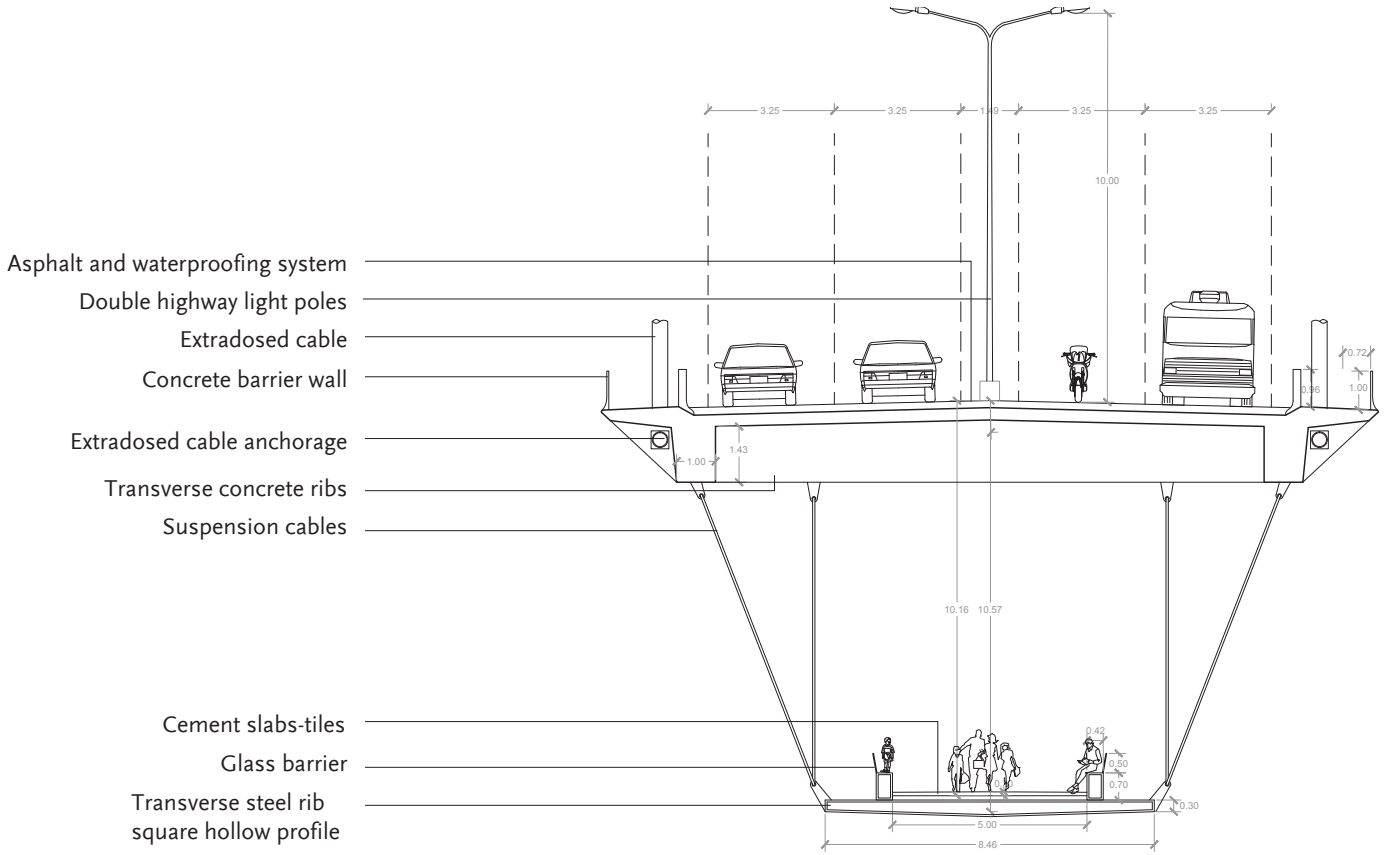
Pillar detail



Bird diagrams

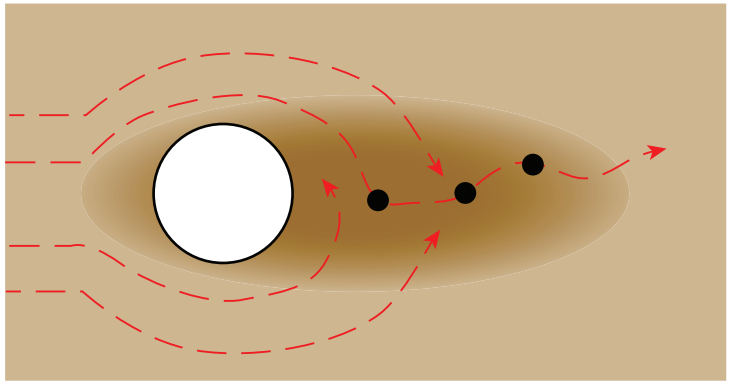
Longitudinal illustrated section



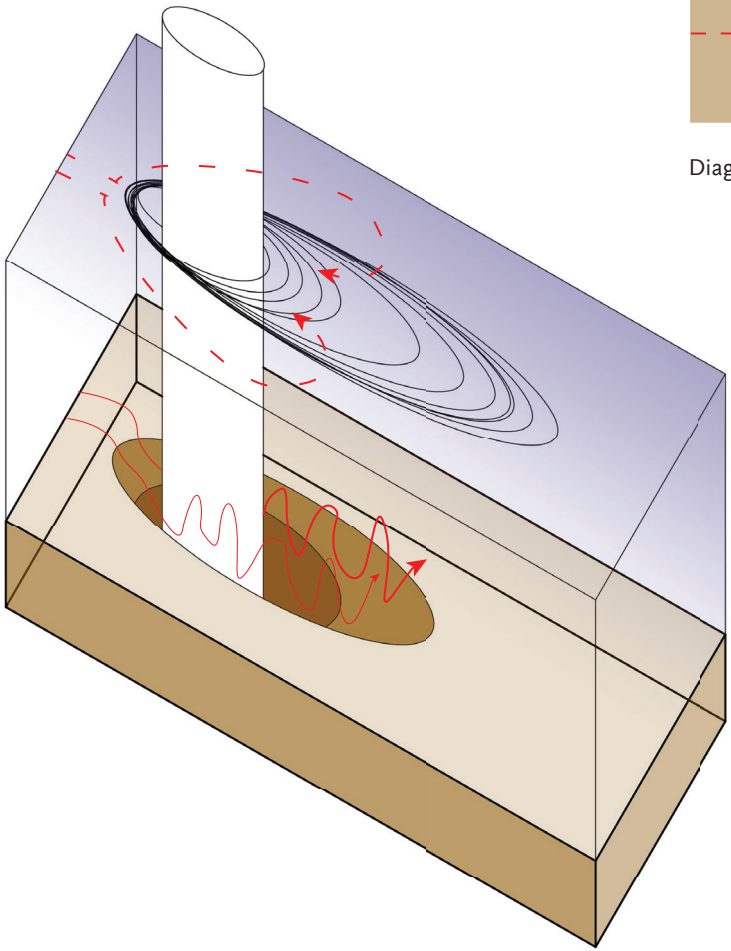

Asphalt and waterproofing system
Double highway light poles
Extradosed cable
Concrete barrier wall
Extradosed cable anchorage
Transverse concrete ribs
Suspension cables
Cement slabs-tiles
Glass barrier
Transverse steel rib
square hollow profile
3.25
3.25
1.49
3.25
3.25
10.00
0.72
0.98
1.00
1.00
1.43
10.16
10.57
0.42
0.50
0.70
0.30
5.00
8.46

Scour effect

Bridge scour is the removal of sediment such as sand and rocks around bridge abutments or piers. Scour, caused by swiftly moving water, can scoop out scour holes, compromising the integrity of a structure.



Diagrammatic top plan of the position of the pillar and the water current

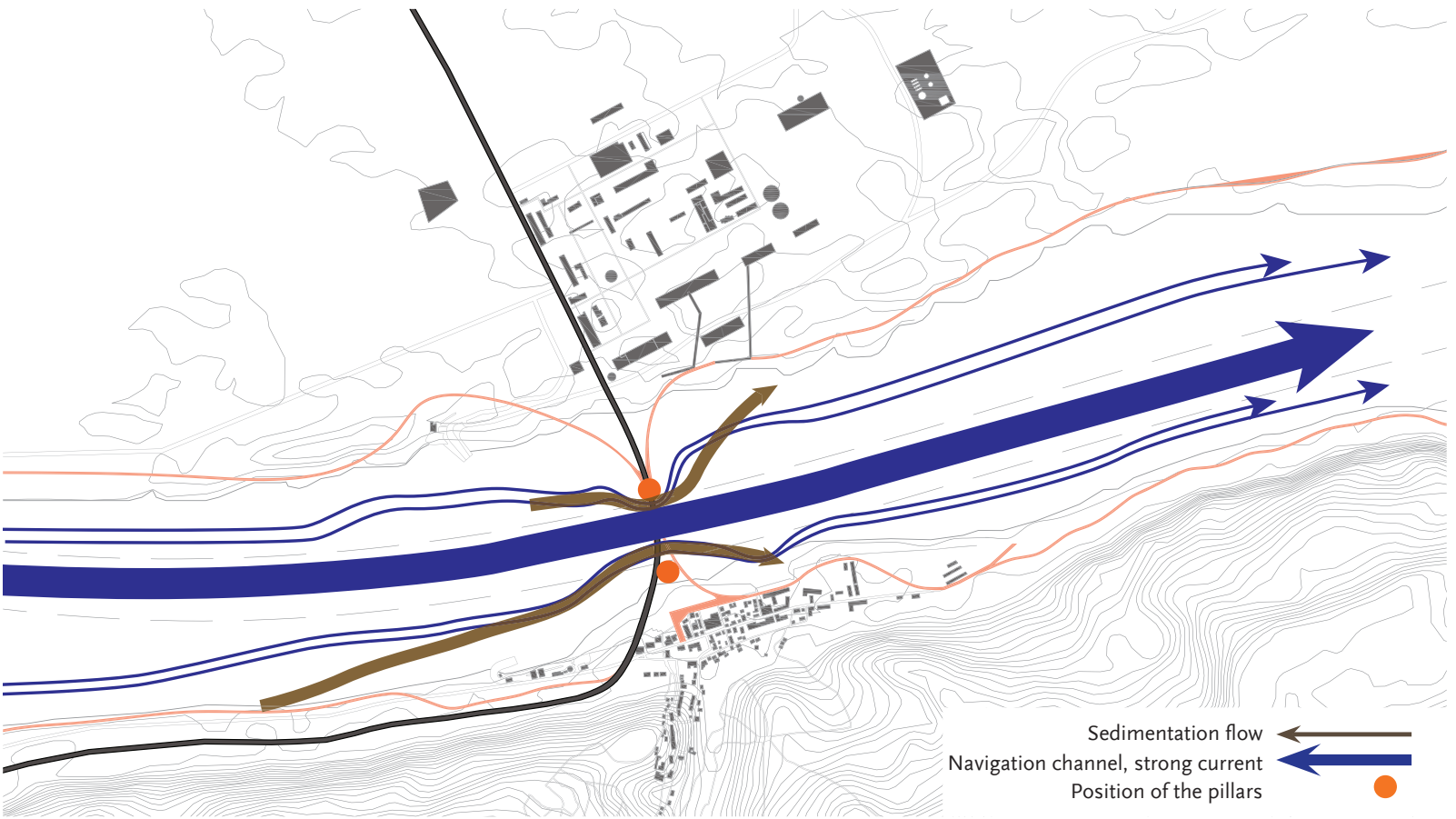


3D represenation of the water currents and the reaction of the pillar

Possisioning pillars

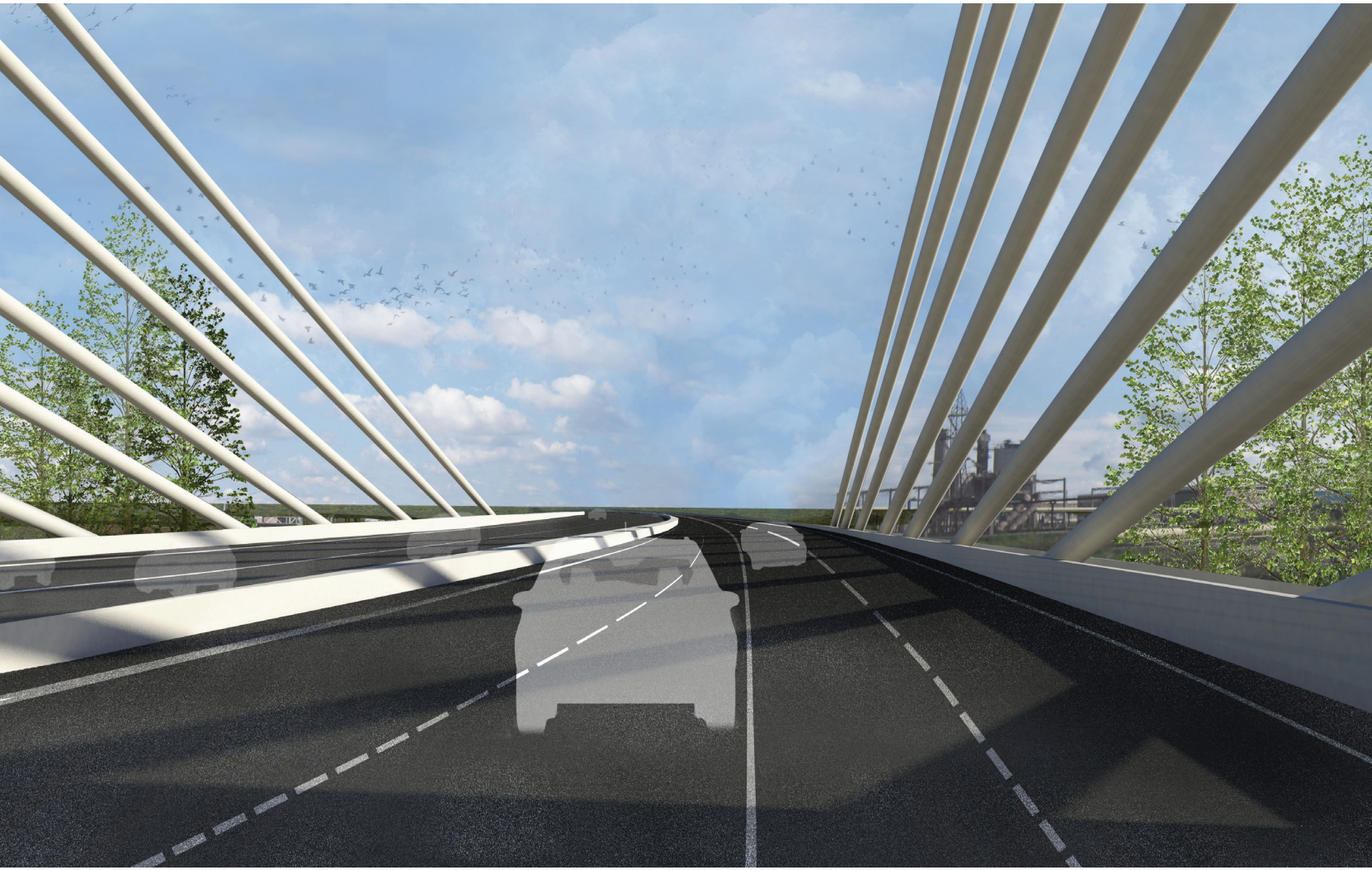
The position of the pillars is an important decision for a bridge design. Pillars should not interfere with the main canal flow in order to avoid scour effect and give space to boats. On the other hand, the position of pillars can and will manipulate the sedimentation on the river shores. For example, by positioning them in a certain way, we can achieve, after a few years, the creation of a new beach formation thanks to the current flow.

In the case of Romania and Bulgaria, the manipulation of sedimentation is important in order to re-create wetlands and flooded forests mainly on the Romanian river side where they are lacking. By placing the pillars close to the main river flow, the sedimentation will be steered towards the existing flooded forest and will enhance it. On the Bulgarian side, the sedimentation will happen on the existing island formation, re-creating wetlands and, later on, flooded forests.



Pillar's possition and sedimentation flow

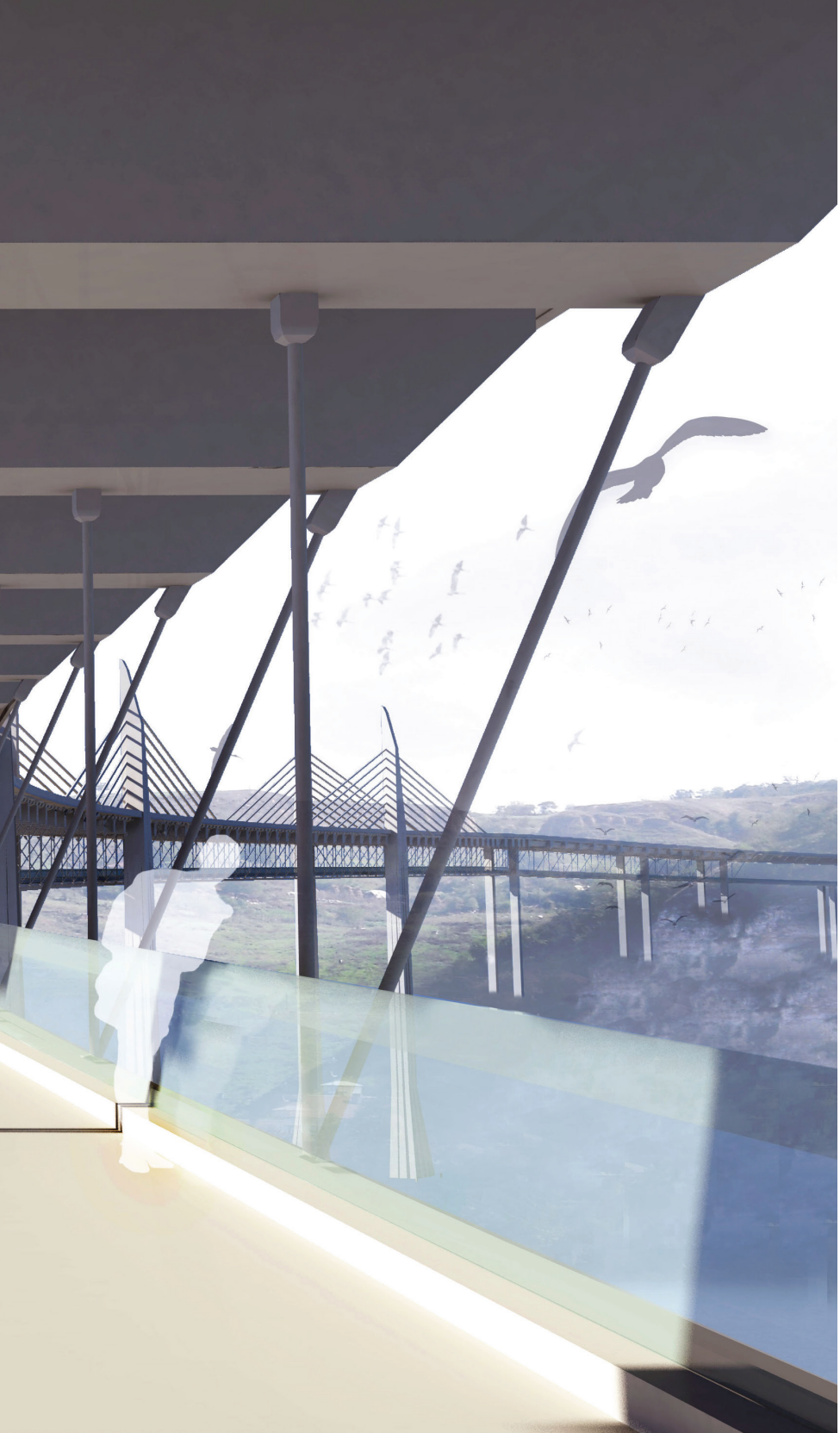
Highway exit towards Bulgaria

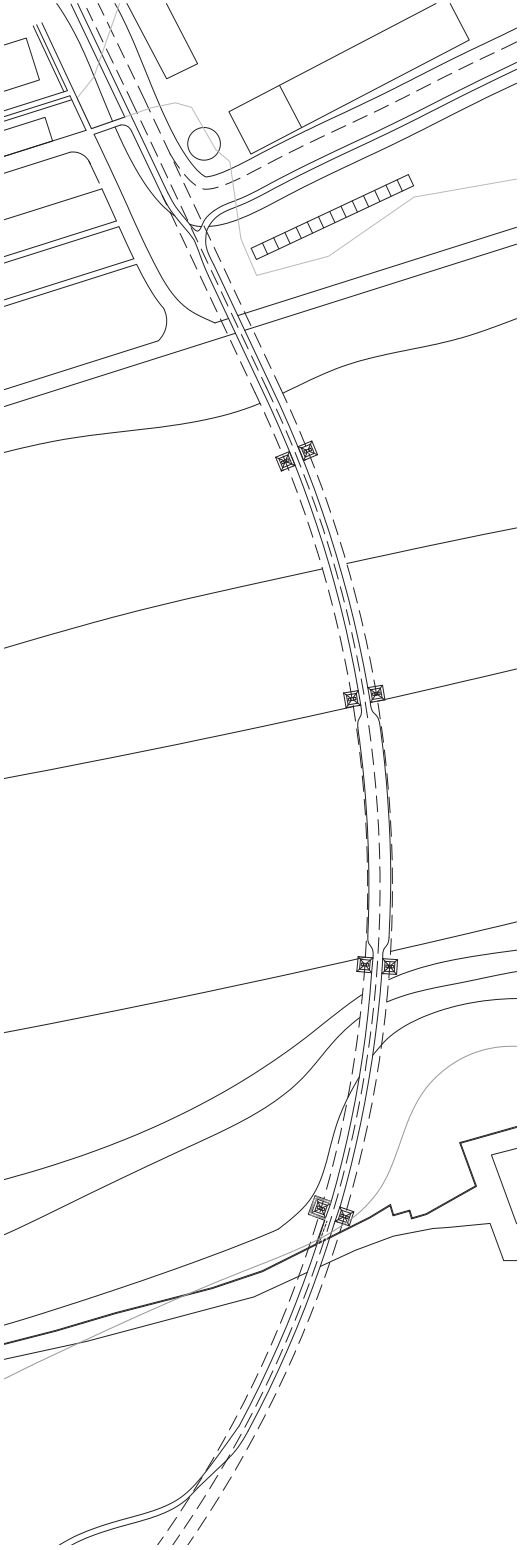


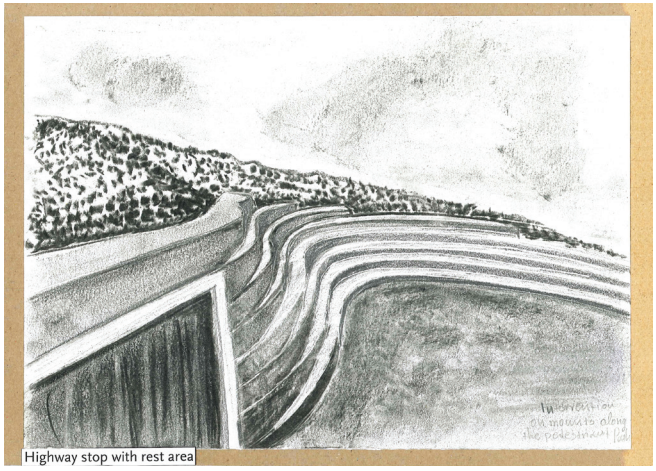
Highway exit towards Romania

Night illustration of the design

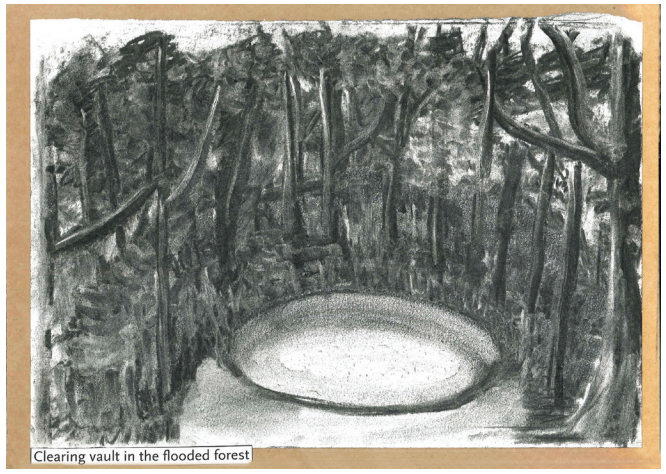
Pedestrian Bridge



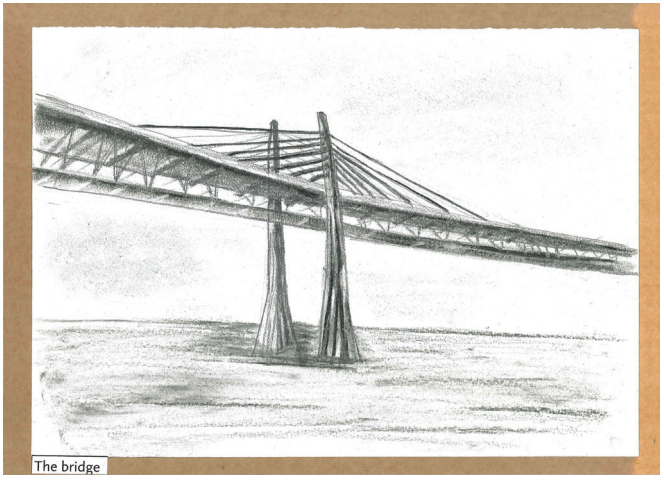




Highway stop with rest area



Clearing vault in the flooded forest



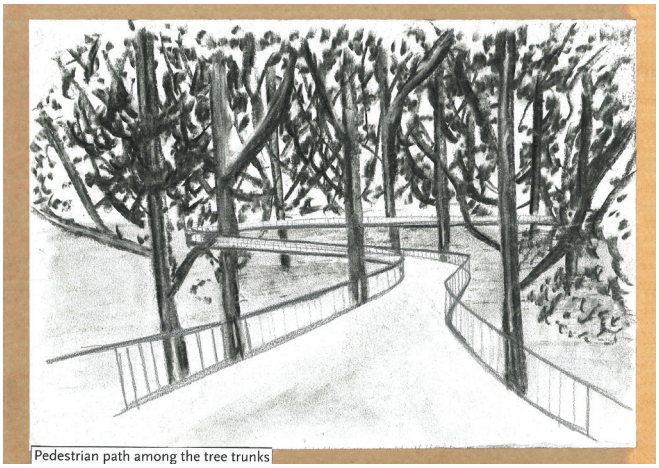
The bridge

Highway stop with rest area

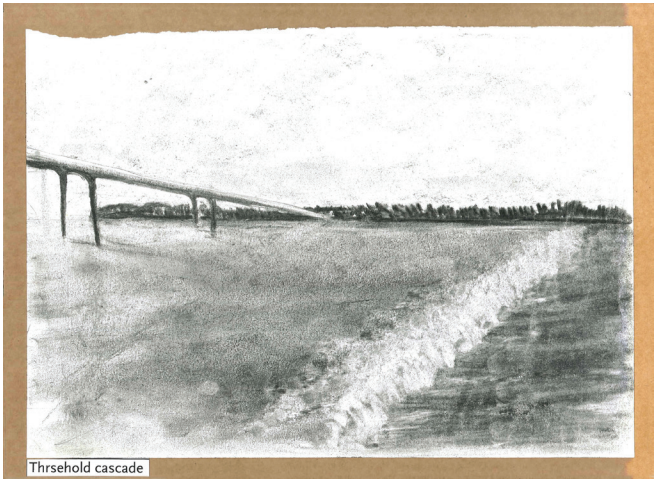
Purifying pond

On the way to the dike

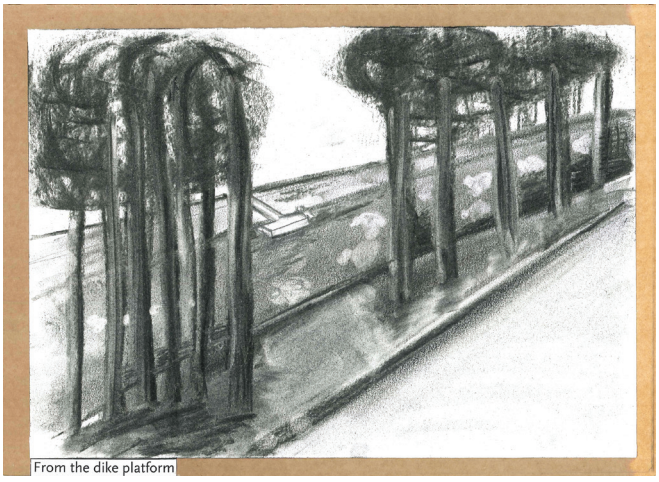
Moments



Pedestrian path among the tree trunks



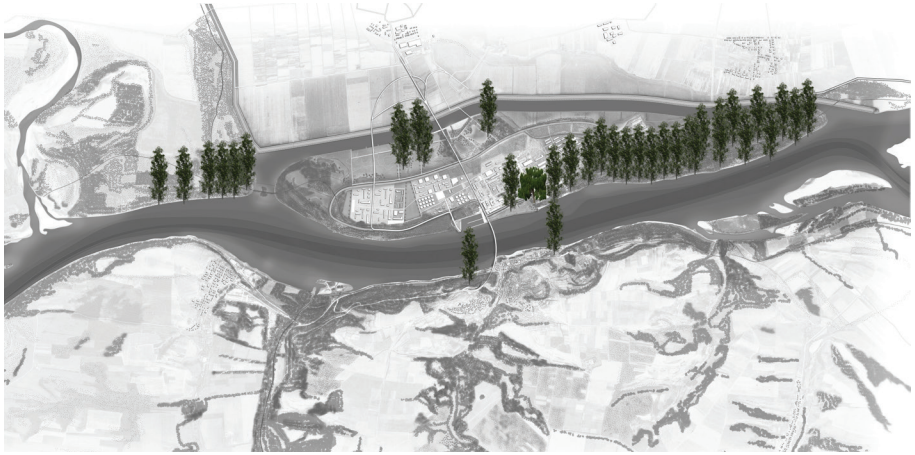
Thrsehold cascade



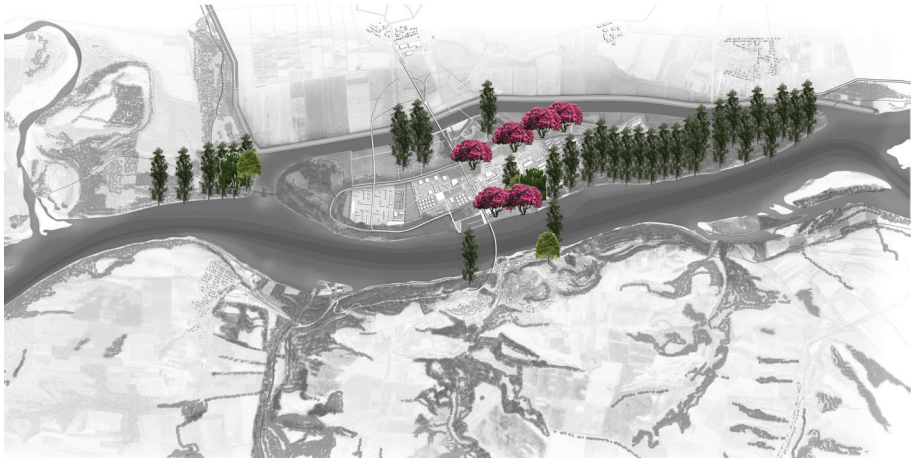
From the dike platform

Along the pedestrian paths there are many valuable moments where the beholder can stop and enjoy nature. The halts are set in places where elements of nature are strong and visible to the visitor. For example, while walking through the flooded forest, the visitor can observe the natural processes that take place in the forest. One can notice the changes of the groundfloor and the peculiar smell in the area.

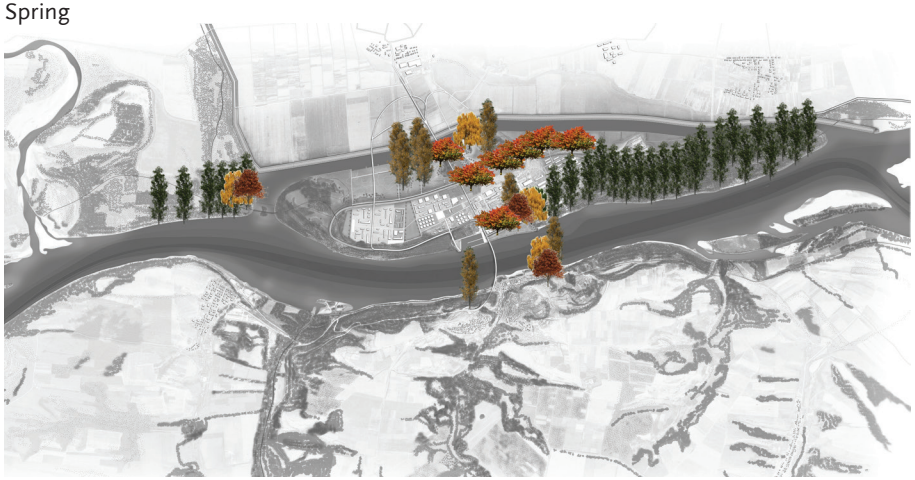
In the drawings, the atmosphere of the landscape is represented while someone is walking along the design. The view of the bridge which merges with the sky, the sound of the water cascade from the threshold and the wet smell while passing through the forest are characteristic atmospheres of the design.



Summer



Spring



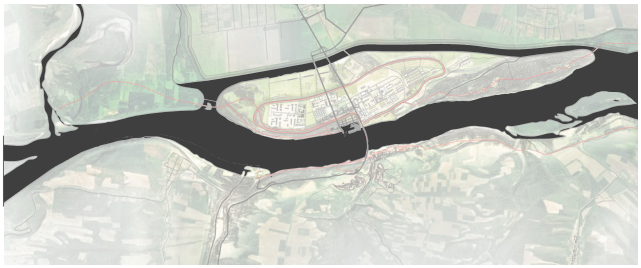
Autumn

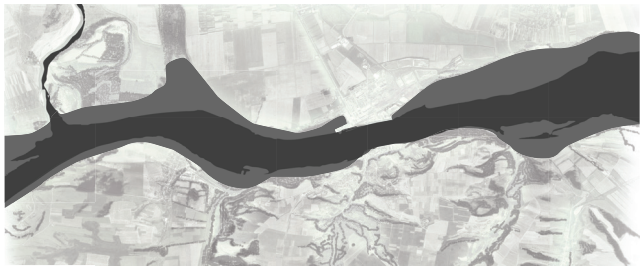
Seasons

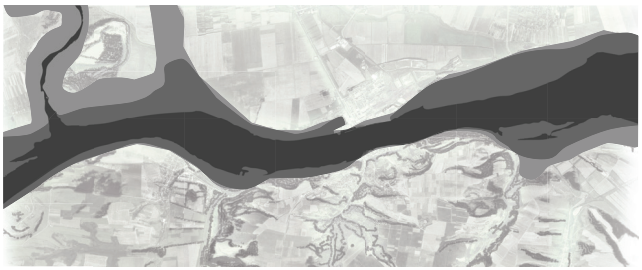
The seasonal dimension is very important for the design. The new orchards will make the space more colorful during spring and autumn. The current situation of the vegetation color scheme, is that during summer all trees have shades of green and during winter they lose their leaves. By adding orchards, different types of trees and vegetation, the area will change character along the seasons.

Placing the resting areas close to the orchards, they become visible during spring because of the lively colors of fruit trees. These areas become a destination themselves by giving a completely different atmosphere and identity next to the Danube River. A colorful resting area is unique and strange in such a river landscape which has mainly deep and light green shades.

Species	Type	Height	Diameter	Time to ultimate height	Autumn	Spring	Summer	Winter
Salix alba	deciduous	10 to 30 m	1 m	20 - 50 years				/
Populus alba	deciduous	18 m	2 m	20 - 50 years				/
Populus nigra	deciduous	30 m	1.5 m	20 - 50 years				/
Salix purpurea	deciduous shrub	1 to 3 m	2.5 to 4 m	10 - 20 years				
Salix triandra	deciduous shrub	higher than 12 m	8 m	20 - 50 years				
Ulmus laevis	deciduous	30 m	2m	21 - 50 years				/
Added trees-Orchards								
Prunus dulci (almond tree)	deciduous	4 to 8 m	4 to 8 m	10-20 years				/
Pyrus communis	deciduous	4 to 8 m	4 to 8 m	5-10 years				/
Malus domestica	deciduous	4 to 8 m	4 to 8 m	5-10 years				/







Present situation

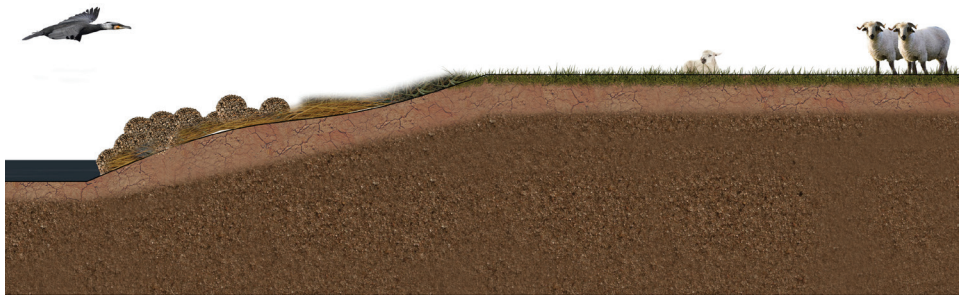
Proposed flooding event

Bypass canal

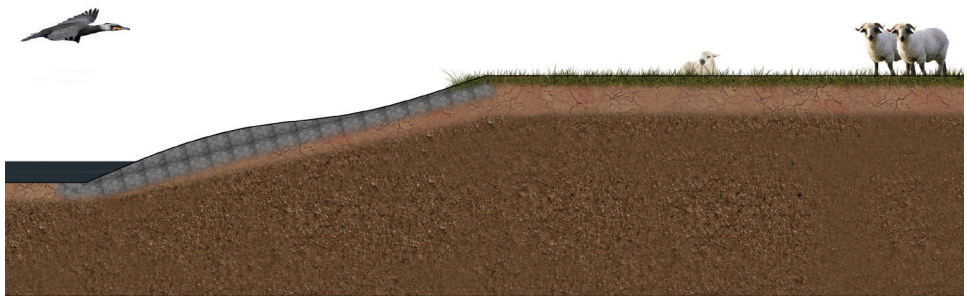
In the present situation, the dikes, positioned at the northen Romanian river side, do not allow the water to overflow. As a consequence, a bottleneck effect is created in the short passage between Nikopol and Turnu Magurelle. The river is forced to pass through a small passage of 600m and as a result it accelerates and then overflows areas.

When we compare the flooding events before and after the creation of the island we observe that the bypass canal helps to better distribute the river water in the area. The bypass canal creates better conditions for the flowing of the river and floods happen under control in the areas designed to be flooded, such as forests and wetlands. By doing so, flooding events become beneficial for the area and they do not cause disasters in agricultural fields and cities. Biodiversity, fish and bird population benefit as well. More fishes are able to pass through the area, more birds find places to breed and the aquatic plants have a better environment to grow.

Agriculture



Willow branches for the protection of the shores from erosion caused by the river flow



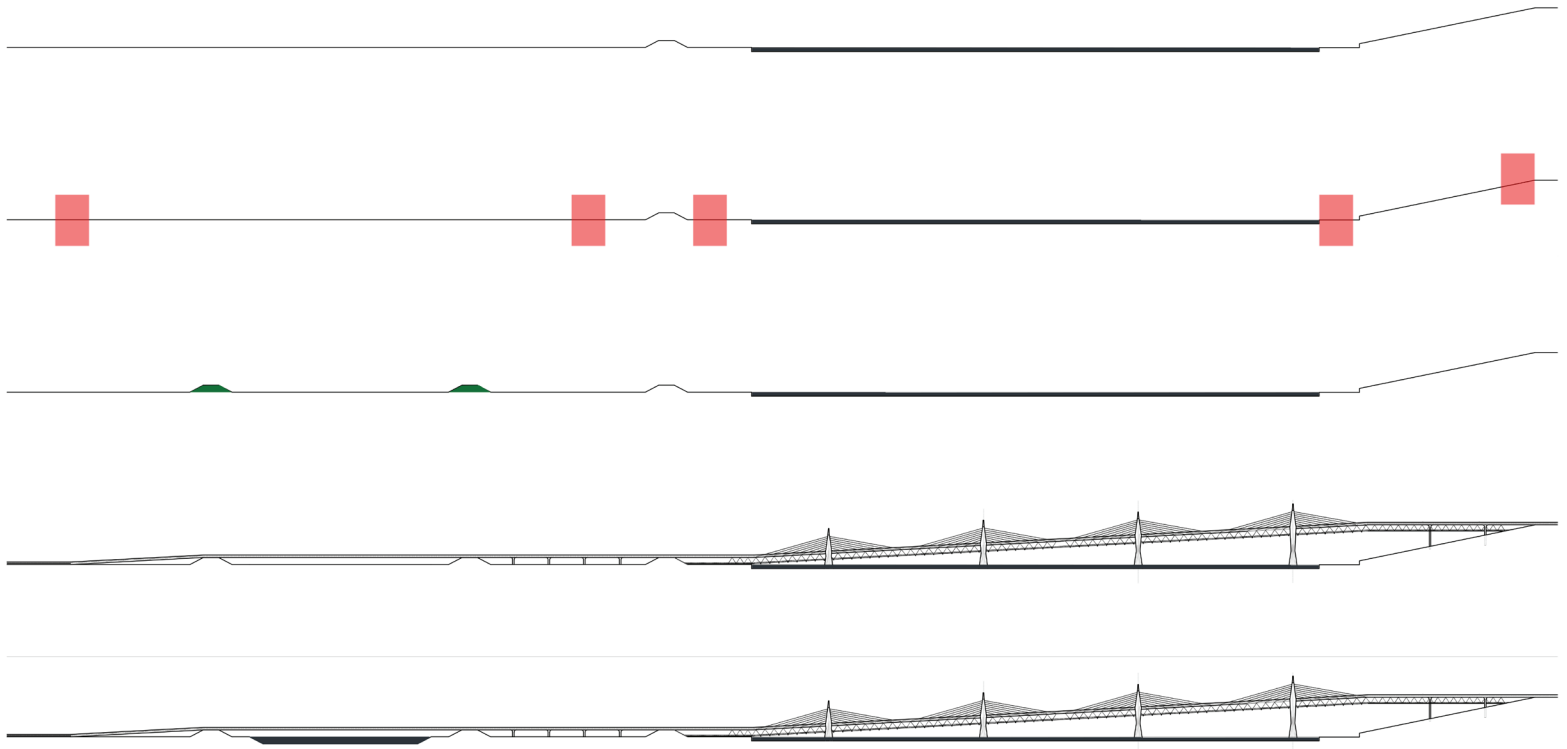
Stable ground to avoid erosion

Shore treatment

Another important aspect regarding flooding events is the treatment of the shores. There are some areas where erosion should be avoided and others that is beneficial. For example, close to flooded forests and wetlands, sedimentation is important for biodiversity and ecological succession. For that reason, the treatment of the shores nearby should must be done with materials that allow the sediments to flow.

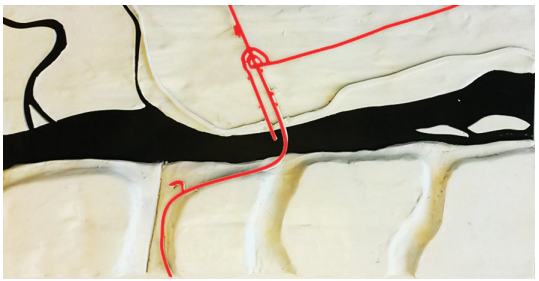
River shores close to the harbor and along the bypass canal should not allow erosion because a change in their geometry could be a threat to their well-functionning. The bypass canal should stay free from obstacles in order to let the water flow. Therefore, the shores are treated in such a way that sedimentary flows will settle on the south banks where the recreational area is. Willow branches are a good material to use as well in crucial areas where the most force from the water current will occur. The willow branches will reduce the flow and the riverbed will not change in geometry.

Timeline

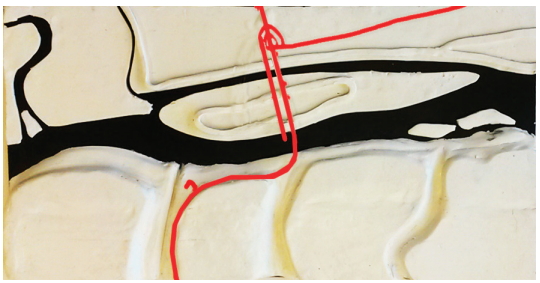


Existing situation

Investment in touristic attractions by introducing new activities restaurants, hotels etc.
Construction of the bridge foundation on the Romanian ground and the Danube River.
1 years



Construction of the bridge to facilitate a fast connection between the countries.
Tourism is already developed in the area.
5 years



Completion of the project
20 years

Design process

One last question remains for the project. Where and how do we start to realise the new design of the area?

The process of implementation of the project will focus on the self sufficiency of the area. The first implementation will be the new recreational places. The attraction of people before even the bridge is constructed, will benefit the economy of the area and make it wellknown, especially the main attractive place which is the highway stop close to the harbor. The next step will be to build the foundation of the bridge, such as the part of the dike where it lands and the pillars in the water. Following steps are the construction of the bridge itself and the rest of the infrastructure that accompanies it.

Finally, the bypass canal will be dug out and the extracted soil will be used to build the dikes on each side. The soil that is left will be used for the heightening of the surrounding area and the agricultural fields. Another important reuse of materials will be in the wooden formwork of the bridge and its pillars. The wooden paths can be constructed by reusing the formwork of the bridge. Moreover, the willow and poplar trees that will be cut in order to dig the bypass canal will be piled up to create a natural wave breaker along the shores of the island in order to avoid erosion.

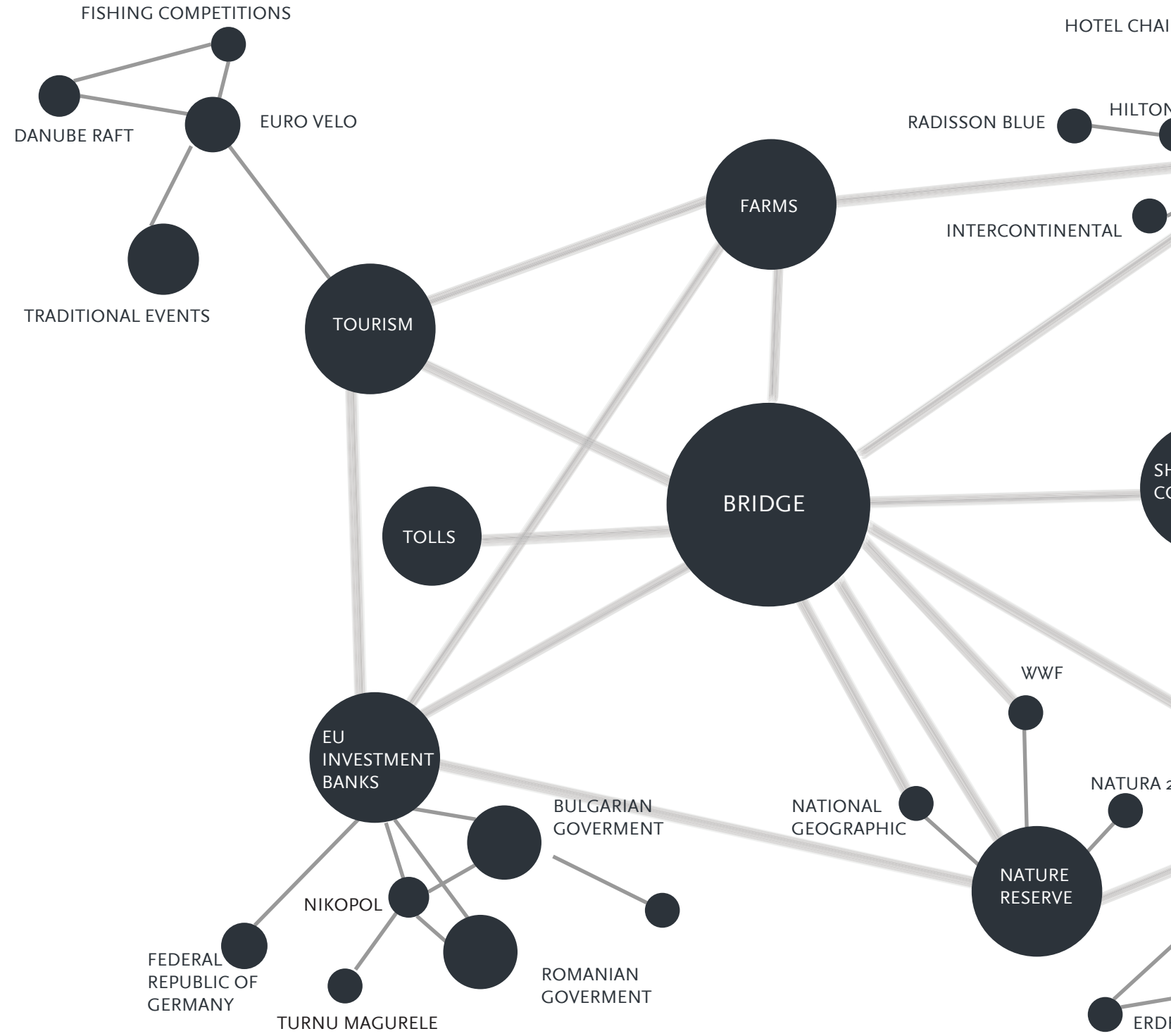
The whole process of implementation of the design is thought in such a way that there will be no unnecessary waste of materials or resources.

→ Wooden paths

→ Dike and landscape formation

→ Concrete and steel will be brought in from inland industries of both countries

→ Willow branches will be used as natural flow breakers to protect the shore from erosion


FISHING COMPETITIONS
DANUBE RAFT
EURO VELO
TRADITIONAL EVENTS
TOURISM
FARMS
HOTEL CHAI
RADISSON BLUE
HILTON
INTERCONTINENTAL
BRIDGE
TOLLS
WWF
EU
INVESTMENT
BANKS
BULGARIAN
GOVERMENT
NATIONAL
GEOGRAPHIC
NATURA 2
NATURE
RESERVE
NIKOPOL
FEDERAL
REPUBLIC OF
GERMANY
ROMANIAN
GOVERMENT
TURNU MAGURELE
ERDI

Investments

The project, in real terms, will cost a lot of money in order to be built. The money from the European funding will cover only the construction of the bridge. The rest of the project will cost, in a rough approxiamtion, 700 million Euros.

Such a large scale project will attract a lot of companies to invest. For example, the touristic activities will motivate the implementation of hotels. Farmers can also benefit from the project. By providing some hectares to the nature reserve can benefit from European funds which promote the merging of agricultural activities and nature involvement. Toll posts on the bridge, touristic attractions, sports competitions, banks, shipping companies, public administrations and nature organizations will approach the area and express their interest.

Both governments have already shown interest for such projects and they are willing to invest in the area with every possible mean. The border line area is a key element for the development of both countries.

Epilogue

Reflection

The border between Bulgaria and Romania follows the Danube River for more than 800km. Having in mind that there are only two bridges connecting the two countries, I started my investigation to form my graduation problematique. By researching the relations of the two countries and their needs, I formulated my project. My graduation project focuses on the connection between Romania and Bulgaria regarding multiple flows. Transportation, green and water infrastructures are the flows which will form a new connection for the two countries. A bridge is going to be designed and implemented nearly in the middle of their long borderline.

My main research question is to design this bridge in a way that is going to propose an international public space, uniting the two countries in a social, cultural and economic level. How can the bridge influence the urbanization and the landscape around? How can we as designers stimulate the urban flow so as to interact positively with the environment and its natural processes? These were the research questions that drove my project from the beginning. Along the way, some changes took place, regarding their importance in the project but they are still a strong part of my problematique.

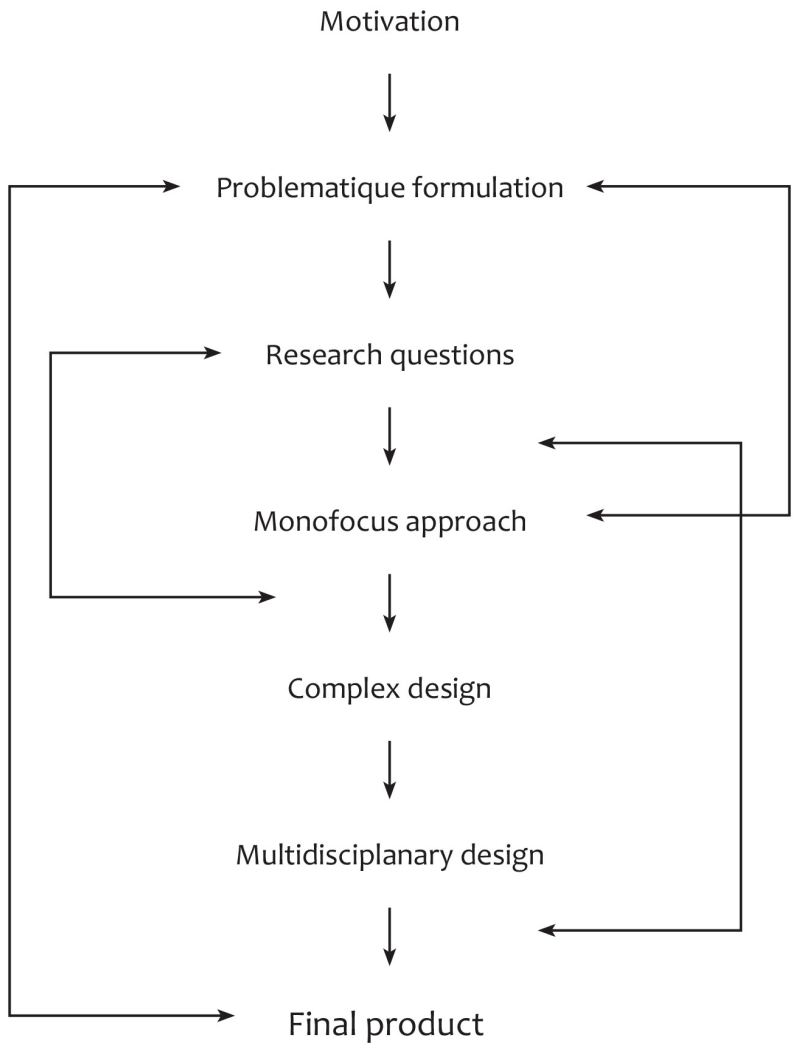
Motivation

The idea of bridging was always an interesting topic for me therefore I wanted to investigate this theme deeper during my graduation project. During the phase of research and design and by investigating into relevant articles, case studies and site visiting, I concluded that bridges are landscape infrastructures that facilitate the idea of connection through the framing of the landscape, sense of orientation, symbolism, imageability and adaptability of the design. As a consequence, they are not only products of engineering; they can also have landscape dimensions. For example, green corridors or animal bridges are two types where engineering and landscape architecture are combined.

My previous studies were in architecture where I was trained to think and act as an architect but I was feeling that something was missing from my approach. When I entered the Master of Landscape Architecture in TU Delft, I realized that landscape architecture can combine both nature and engineering which was the layer of investigation that I was missing before. Natural processes are an important aspect of every design and they should not be forgotten. One of the strongest motivations for this graduation project was to combine my architectural background with my current studies. My project intertwines architecture and landscape architecture to facilitate connection through the design of an engineering product and the manipulation of natural processes of the landscape.

Flowscapes

Bridges are closely related to flows such as traffic, people's movement and natural flows. The Flowscapes studio integrates flows in landscape planning and design. Flows are described as the movement and scapes are the territories. Both are closely related with each other. The emphasis is given on the interaction of humans with their environment and biodiversity. In the border between Romania and Bulgaria, the flows and scapes are either blended or absolutely separated from the borderline. My approach from the beginning was to preserve the uniqueness of each country but to connect the green and water infrastructure in order to reinforce it.



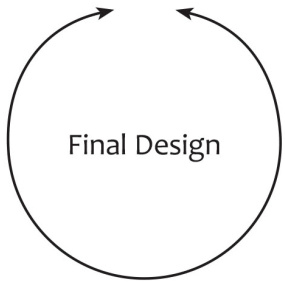


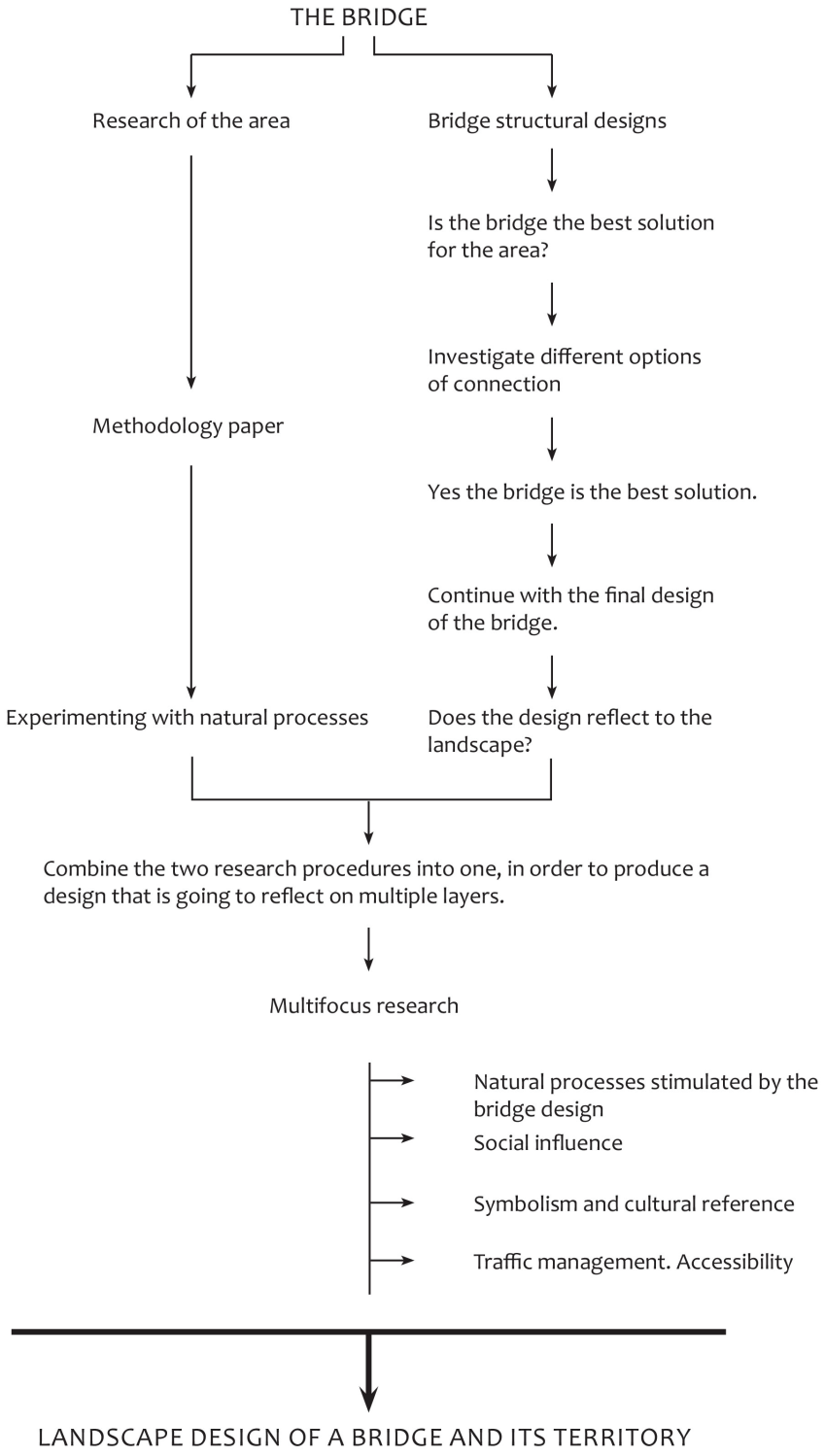
Diagram of the design process. A circulation of thoughts until the completion of the final design.

At the beginning of my research there was a doubt whether my design should focus on the construction of the bridge or generally on the notion of connection through several flows. My first approach was to focus on the construction of the bridge. Through researching and designing the bridge was proved to be the best infrastructure in order to connect these countries. Alongside, I was investigating for the changes in the landscape that a bridge will bring but I was not able to combine both in one project. What made it difficult was the amount of information for both fields. I found myself divided between an architectural and landscape project. Having a lot of information for each "project" I was not able detach myself from the projects in order to realize their connecting point. By following the obligatory courses of my Master during this confusing period, made strong decisions and combined the projects in one. That is a moment in every project where the designer needs to be determined and take fast and strong decisions that will develop the design.

The first obligatory course that I followed was Research and Methodology in Landscape Architecture which I found crucial for a successful design. By following this course I discovered that by excluding other options of connection than the bridge is not vital for the success of my design. Therefore, I broadened my horizons towards other forms of connection which do not necessarily require the structure and engineering of the bridge. This decision was taken nearly in the middle of my graduation thesis and helped me to improve the landscape layer of my design. By investigating in other types of connection, I came across valuable problematiques and notions that could reinforce my argumentation for connecting the two countries. For example, the notion of symbolism and cultural references that the bridge can offer. Romania and Bulgaria are countries with different cultures and language. Until now, they mainly communicate in English or have no interaction at all. By offering a common place of reference, they can both relate to a same thing. As a result the communication becomes easier because the bridge acts as a motive for discussion. In addition, by reading articles about bridges in the book Flowscapes , I came across interesting topics that I implemented in my project as well. For instance, the notion of framing the landscape and landing of the bridge regarding the existing territory around by looking into examples such as the Erasmus Bridge, Oresund Bridge and Golden Gate Bridge.

All these findings in the middle of my graduation thesis changed my way of thinking and designing. Analyzing and understanding bridges turned out to be a different procedure than expected. The articles and case studies that I focused on provided me with good examples to build my project problematique and recite a coherent story of my graduation project. By adding extra layers of thoughts in my story, my project became richer. My research was not monofocused anymore. An interesting experience was the Honors program as well, where I was asked to present my project. The procedure of presenting the project in short time and the effort to make an interesting presentation, were a good exercise for me to practice and to understand my project better.

Another interesting experience was the combination of landscape architecture courses with an architectural course. I followed for a quarter a bridge design course from which I acquired the knowledge needed to design my own bridge. The interaction with architecture students and the several lectures I followed were important for the development of my project.



Evolution in the design intention. From a bridge to a landscape with a bridge

It is evident that in the beginning of the course my focus was only in the bridge design. Soon enough though, and with the guidance of my mentors, I was able to work at the same time on the landscape and engineering parts of my thesis which was my goal. I believe it is quite difficult for a single person to work on both layers at the same time. The information that one is gaining from the analysis and investigations is too rich to be processed. Although, by having support and advice from my teachers and fellow students, I could process the information and implement it in my project slowly. I believe that in the future different practice fields can be more integrated with each other. Especially in a university level, students from different fields should have the opportunity to interact and collaborate. More interaction and communication among students give better project results.

Having a wide range of information, gives the opportunity for more experimentation on different ways of representing the project. As far as my design is concerned, it is focused on both engineering and landscape, therefore the drawings should depict this bipolar nature. By experimenting with different materials, the feelings and thoughts are better expressed in the drawings. Charcoal was for me a pleasant surprise which released my thoughts. The lesson that was given to me by these experimentations was to perceive my project from a different perspective. I realized that the main focus of my project is not the bridge, but the effect that engineering has on nature. How the two elements work together and create conditions for a better future.

Multidisciplinary approach

A project that deals with international connections and multiple flows tends to expand in design. In my graduation thesis, I realized that in order to be precise and accurate on my words and acts I should enlarge my design. My thesis started with a desire for a landscape bridge design. It changed into a landscape bridge design with a public space and it ended up being a landscape infrastructure that intertwines natural processes, steers the urban expansion, changes the existing landscape into a coherent one and stimulates social awareness. Personally, I am glad that an idea of a project can expand so much that it changes in its core. Landscape architecture is a field that concerns multiple layers and flows in a territory, therefore it changes constantly.

A good landscape architect needs to be ready to change the world around him. The results might not be visible instantly to the people because landscape architecture plans for the future, including the long term. For that reason, in a landscape design, all flows must be considered and calculated from the beginning. Nature changes constantly and so must the design adapt to these changes. On the other hand, since landscape architecture can influence nature, each design becomes complicated. During my research I realized that my design touches upon notions from different fields that I was not able to understand by myself. For example, the manipulation of sedimentation and the steering of the urbanization. Landscape architectural designs are multidisciplinary designs. Different fields of expertise need to collaborate in order for a design to be successful and create conditions for the future. In this project I learned that collaboration and good communication with the mentors and other experts are crucial. A strict schedule, patience and strong motivation are key elements for a successful design.

Appendix

References

Charles A. Birnbaum, A. (1994, September). Protecting Cultural Landscapes: Planning, Treatment and Management of Historic Landscapes. Retrieved from www.nps.gov: http://www.nps.gov/tps/how-to-preserve/briefs/36-cultural-landscapes.htm

Cheng, Y. (2013). Brief analysis of the application and prospect of landscape bridge design based on architecture. China: TRB2014 Annual meeting.

COWI. (n.d.). COWI. Retrieved from http://www.cowi.com.

Donald MacDonald, I. N. (2008). Golden Gate Bridge: History and Design of an Icon. San Francisco, California: Chronicle Books LLC.

Erasmus Bridge. (n.d.). Retrieved from http://www.architectuurinrotterdam.nl/building.php?buildingid=12&lang=en.

Heilmeyer, F. (n.d.). Ben van Berkel / UNStudio. Baunetz.

Lynch, K. (1960). The image of the city. Massachusetts: Joint Center for Urban Studies.

Martin Drenthen, J. K. (2009). New visions of Nature: Complexity and Authenticity. USA: Springer.

Parks, G. G. (2014). What's out there. The Cultural Landscape Foundation.

Pretty, S. P. (2013). Nature and Culture. Oxon: Routledge.

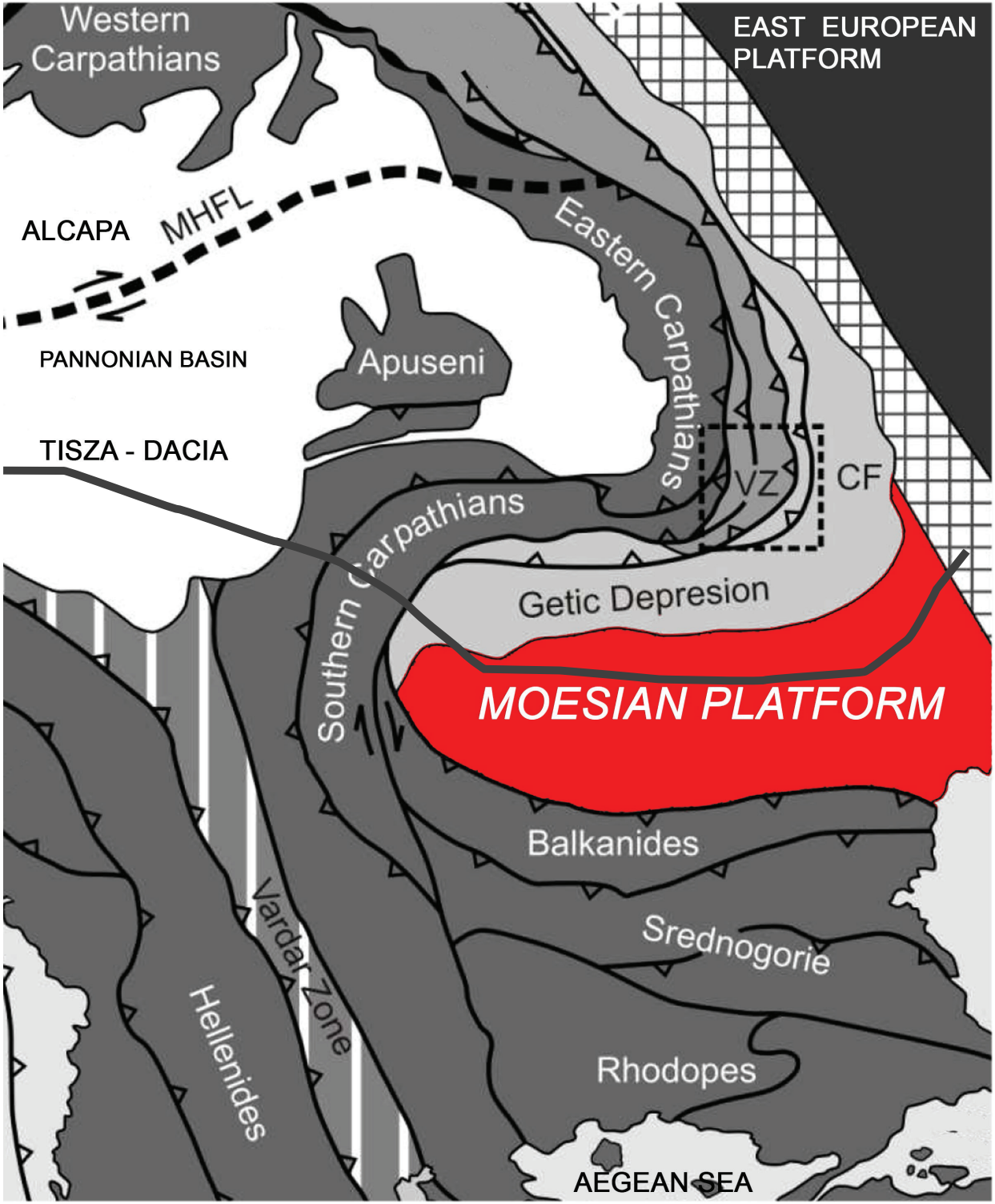
Raymond, W. (1980). Ideas of Nature, in Problems of Materialism and Culture. In W. Raymond, Ideas of

Nature, in Problems of Materialism and Culture (pp. pp67-85). Verso, London.

Sijmons, D. (March 2013). Waking up in the Anthropocene. Rotterdam: IABR.

Steffen Nijhuis, D. J. (2015). Flowscapes. Designing infrastructure as landscape. Delft: TUDelft.

UNSTUDIO. (n.d.). UNS. Retrieved from http://www.unstudio.com.



Danube River

Based on the thesis "Lithospheric structure in Central Europe:integrated geophysical modelling" by M.Sc. Grinc Michal, University of Paris- Sud XI

Moesian Platform

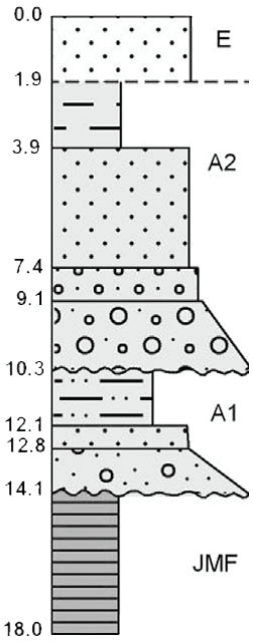
The Moesian platform forms the Alpine orogen. The sedimentary cover consists of sub horizontal Mesozoic and Cenozoic, mainly shallow marine terrigenous-carbonate and carbonate platform successions up to 7-8km thick. These platforms overlie with angular unconformity, a gently folded Paleozoic basement. The Moesian platform is a tectonic unit bordered by the Carpathians and Balkans mountains and the Black Sea Shelf. It was intensively investigated recently because it is responsible for the dangerous Romanian earthquakes in Vrancea zone (Romanian Reports in Physics, V. Raileanu, D. Tataru, B. Grecu, Vol. 64, No. 2, P. 539–554, 2012)

The cover contains:
- continental Lower Triassic followed by Middle Triassic to Norian carbonates, and Carnian to Norian marine red beds.
- terrigenous and carbonate Jurassic, the marine transgression over the deeply eroded Triassic beginning often directly with Middle Jurassic.
- Upper Jurassic – Lower Cretaceous carbonate sequences.
- Upper Cretaceous shallow-marine carbonate and terrigenous deposits, and continental or marine Palaeogene. (Transmed project 204 "Geological Trans-border Sections and Itineraries")

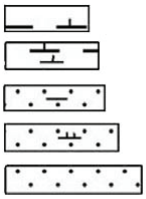
It is important to observe on this map that both the Romanian and Bulgarian sides of the Danube step on the same geological layer with the same formation. More specificly, as we will see at the following section, the Danube lies on the same floodplain in both countries and it does not form a division but on the contrary a geologic connection.

Legend

Danube Floodplain

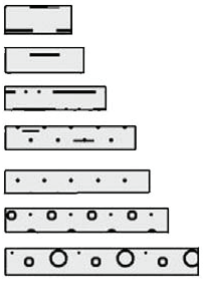


Aeolian formation



- silty clay
- clayey silt
- clayey sand
- silty sand
- sand

Danube formation

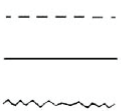


- clay
- silty clay
- sandy clay
- clayey sand
- sand
- pebble and sand
- boulder and pebble with sand

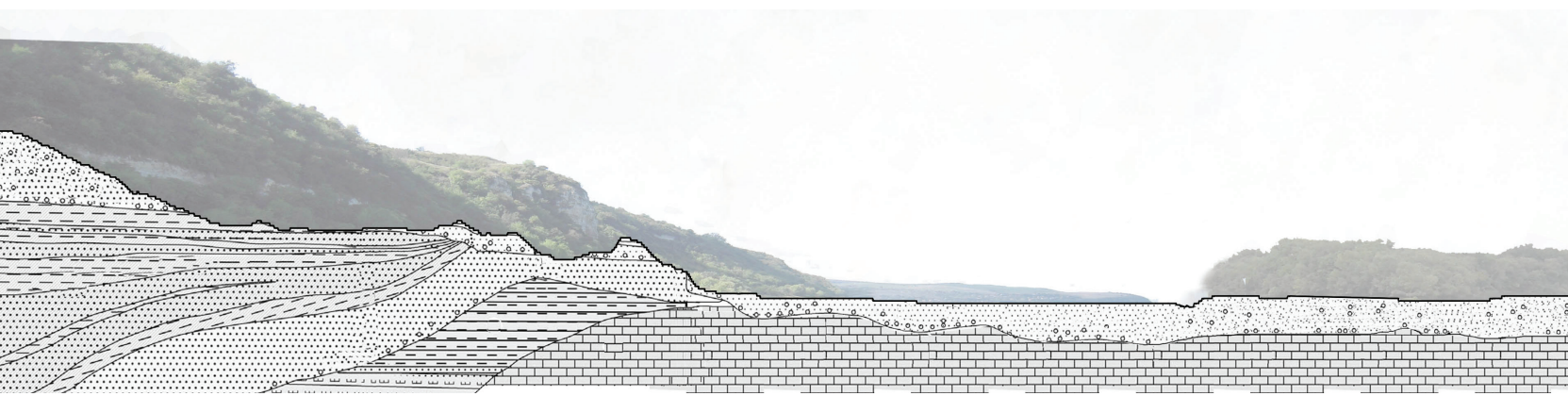
Pre-Quatermary rocks

- clay
- marly clay

Limits



- disconform
- normal
- unconform

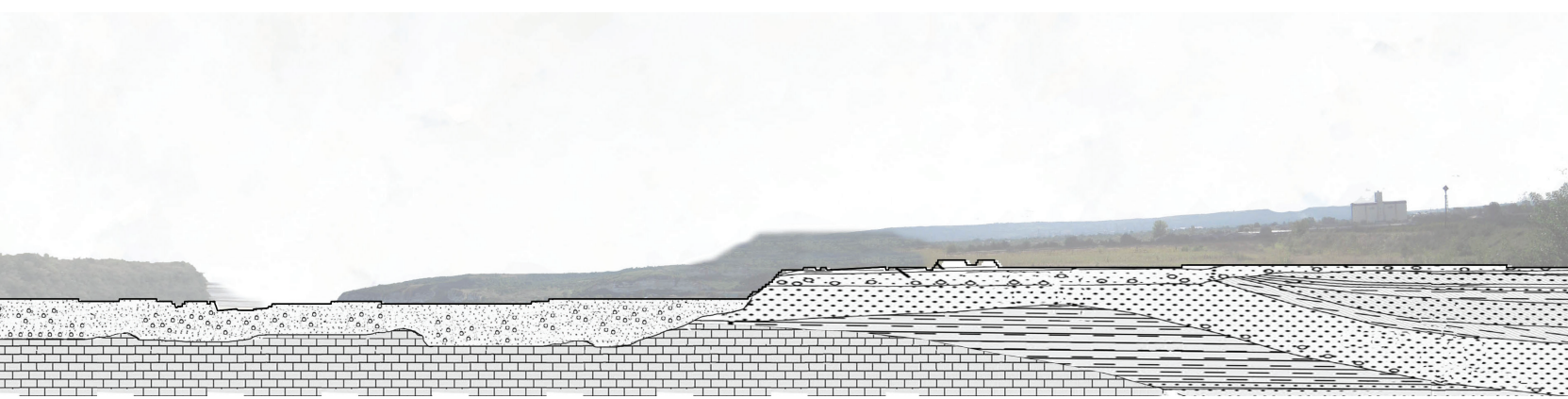


Cross section under an average water level showing the soil layers and the topography

Soil

Knowing about the geological layers of the area gives the opportunity to understand the natural processes that have already taken place. By understanding the soil types, different species of trees and plants can be proposed to improve the underground ecosystem, which is fundamental for all the above layers (for example, purification plants).

Finally, since there are a lot of agricultural fields and industries close to the project site, it is crucial to know if the soil has been contaminated and if so in which way. For example, monitoring investigations in the area of Belene Island have revealed that the water is rich in heavy metals, which is bad for the health of aquaticorganisms and also for the still water beds (marshes and wetlands). Moreover, since all the ecosystems are connected (through food chain), if the water is contaminated then fishes will die and birds will have no food anymore. As a result they will leave the area or worse event, they will die out too. Interventions are needed to prevent soil contamination to happen. It is necessary to create conditions through design, for wetland purification and preservation of the biodiversity.



Natural hardwood- sofwood flooded forests

Site photography by author

Salix alba

Populus alba

Black poplar

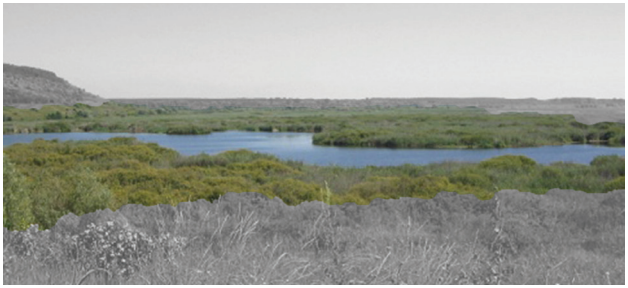
Ulmus laevis

Vitis silvestris

Periploca graeca

Leucojum aestivum

Natural inland wetlands and artificial reservoirs



Site photography by author

Salix triandra

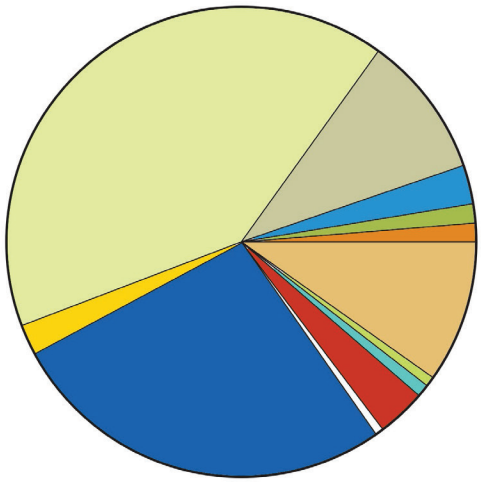
Salix purpurea

Patamogeton natans

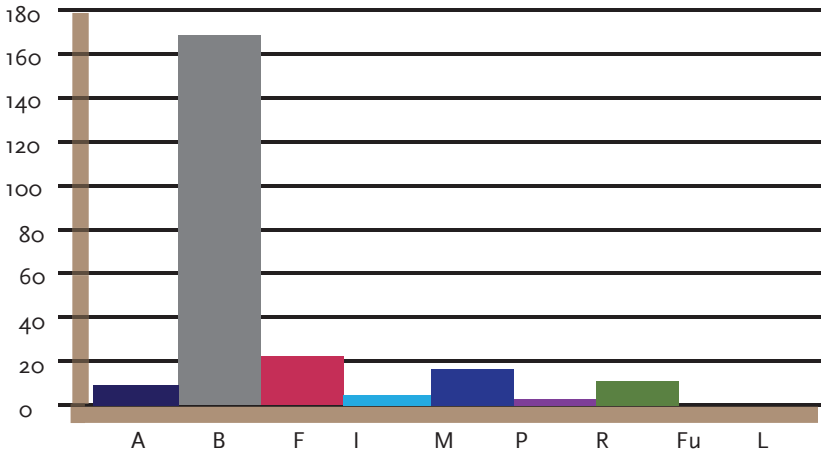
Vegetation

These species are the most frequent in an aquatic ecosystem. There have been studies about the water quality of the Danube River and it is proved that it contains high amounts of heavy metals such as copper, cadmium, lead and zinc. The Danube River is suffering from high anthropogenic pressure along its coast which results in high concentration of heavy metals in its sediments. In order to balance the nutrients of the water, more of macrophyte aquatic plant is needed. Trees with big roots, such as Salix species, help reduce the concentration of nutrients in the soil and therefore in the water. Finally, by planting more macrophyte plants in the wetlands, the ecosystem of fishes and aquatic birds will be reinforced in which fishes and birds largely feed from or around these types of vegetation.

Habitats



Protected Species



A : amphibian
B : bird
F : fish
I : invertebrate
M : mammal
P : plant
R : reptile
Fu : fungi
L : lichens

alluvial forests (Alnus glutinosa, Fraxinus excelsior)
hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
semi natural dry grassland and scrubland fucies on calcareous substrates
rivers with muddy banks
oligotrophic to mesotrophic standing waters with vegetation
sub- pannonic steppic grassland
pannonic loes steppic grassland
natural eutrophic lakes
pannonic inland dunes
pannonian woods with Quercus pubescens
pannonic salt steppes and salt marshes
moesian silver lime woods

Phalacrocorax pygmeus

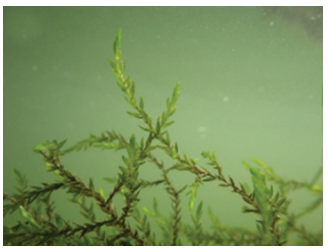
Cyprinus carpio Linnaeus

Corydoras paleatus (bottom feeder)

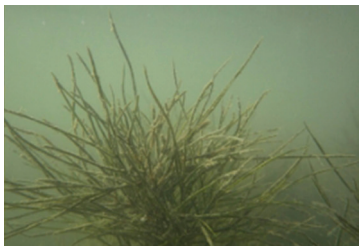
Human impact

Water ferns

Mosses



Macroalgae



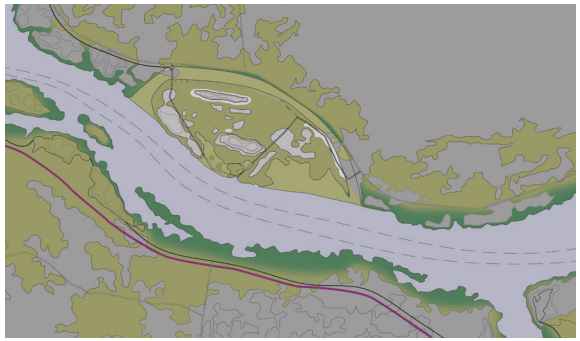
Angiosperms

Food chain

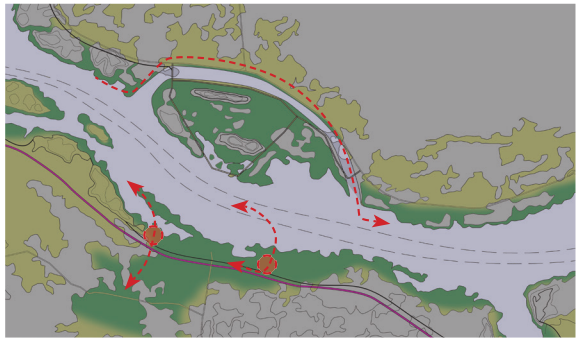
After the construction of the two dams at the beginning of the lower Danube River (Iron Gates I, II) the flow of the river declined dramatically. This caused many side effects on fish migration and the natural flooding of the Romanian and Bulgarian floodplain. Moreover, the construction of dams caused the draught of floodplains and the decline of marshes, wetlands and a lot of aquatic ecosystems mainly along the Romanian shore.

The food chain in the lower Danube region was interrupted by the construction of the dams and dikes. Less fishes choose this region to breed and spawn. In addition, many people are fishing in the area and as a result, the fish population is declining. As a consequence, native birds of the area have difficulty in finding food.

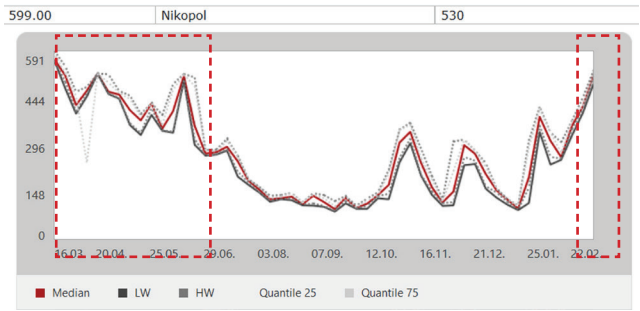
By opening the dikes in strategic locations, the ecosystems of wetlands will improve. The floodplain will flood during the spring months and will invite more fishes to find shelter for breeding and spawning. At the same time, the birds migrate from colder climates to the Romanian - Bulgarian floodplain for breeding, so the food chain is balanced. At the end of spring, the water will get warmer and lower in height which lead a lot of fishes to deeper waters, such as the Black Sea, and the offspring stays in the marshes to be more mature until the next flooding occurs.



Water level during winter_Agricultural land and marshlands are dry



Water level during spring_Agricultural land and marshlands are wet. The opening in the dike allows the water to flood the floodplain, create wetlands and reinforce the aquatic ecosystem. Meanwhile, the water used for irrigation is purified by reed beds in the riparian zone before returning to the Danube.



The chart is showing quanitative information about the water levels in the area of Nikopol (Bulgaria) for the year 2015

Topography

Existing dike

Agricultural land
cultivation of crops, corn, cereals, sunflowers

Natural Flooded forests
(Salix species, poplars, bushes, reeds)

Dike opening

Water flow