SOS
Climate
Waterfront

Climate Change and Creative Solutions for Cities

Edited by:
Pedro Ressano Garcia
Lucyna Nyka
Justyna Borucka
Jakub Szczepański

GDAŃSK UNIVERSITY OF TECHNOLOGY

Funded by the European Union

MARIE CURIE ACTIONS

SOS
Climate
Waterfront

Climate Change and Creative Solutions for Cities

Edited by:
Pedro Ressano Garcia
Lucyna Nyka
Justyna Borucka
Jakub Szczepański

Gdańsk, 2021

GDAŃSK UNIVERSITY OF TECHNOLOGY

Funded by the European Union

MARIE CURIE ACTIONS

Colophon

SOS CLIMATE WATERFRONT

Grant Agreement number: 823901 — sosclimatewaterfront — H2020-MSCA-RISE-2018

MAIN COORDINATOR
Pedro Ressano Garcia

EDITORIAL BOARD
Pedro Ressano Garcia
Lucyna Nyka
Justyna Borucka
Rita Pais
Alkmini Paka
Anastasia Tzaka

EDITORS
Pedro Ressano Garcia
Lucyna Nyka
Justyna Borucka
Jakub Szczepański

Gdańsk University of Technology, Gdańsk 2021

e-book
ISBN
978-83-64333-46-0

Authorship responsiblity: the authors of the chapters are responsible for the content of the manustript

BOOK DESIGN WWW.ITEMZERO.COM

Funded by the European Union

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 823901.

MARIE CURIE ACTIONS
European Commission
Horizon 2020 European Union funding for Research & Innovation

SOS
Climate
Waterfront

PROJECT PARTNERS

Lusófona University of Humanities and Technologies, Lisbon, Portugal

Gdańsk University of Technology, Poland

Aristotle University of Thessaloniki, Greece

TOBB University of Economics and Technology, Ankara, Turkey

Sapienza University of Rome, Italy

KTH Royal Institute of Technology in Stockholm, Sweden

Intercult, Stockholm, Sweeden

The City of Gdańsk, Poland

Stichting CPO Noord-Holland – CPONH, The Netherlands

Portuguese Chamber of Commerce and Industry - ACL/CCIP

River//Cities Platform, Poland

Major Development Agency Thessaloniki (MDAT), Greece

ALPHA Consult SRL, Rome, Italy

More info:
http://sosclimatewaterfront.eu/

Funded by the European Union

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 823901.

MARIE CURIE ACTIONS

European Commission | Horizon 2020 European Union funding for Research & Innovation

Table of Contents

121

Part 2

Introduction

Creative ideas to face climate change are needed and a new way of thinking is emerging. Recent solutions can turn on the imaginary of the communities, designers and decision makers. To deal with increasing climatic disasters more parameters are to be considered. Creative solutions are challenging, demanding multidisciplinary perspectives that flourish among those imagining the future. The necessity comes from the exponential growth of demand as more regions and wider groups of people are severely affected and search for updated knowledge.

Climate changes affect regions all over the world. Rising sea levels and extreme weather events such as heavy rains, floods, fierce storms and unexpected heat waves deeply affect the quality of human life. According to the United Nations World Population Prospect, 75% of the global population will live in cities by the middle of the twenty-first century. The same report stipulates that climate change will result in a decrease in the quality of water services and living conditions in urban areas. The growing amount of impermeable surfaces results in flooding and pollution of surface waters. Urban heat islands increase energy consumption, emission of greenhouse gases and compromise human health and comfort. The lowering level of the groundwater table impairs the growth of vegetation and may cause saline intrusion into the coastal aquifers. At the same time in many coastal cities, the groundwater level is very high what results in flooding. European Commission points out, that urban areas, where 4 out of 5 Europeans now live, are exposed to heatwaves, flooding or rising sea levels, but are often ill-equipped for adapting to climate change. In such circumstances, cities should be re-thought as laboratories for innovative climate adaptation and mitigation solutions.

Laboratories of future urban environments are possible. The SOS Climate Waterfront is a H2020 interdisciplinary project that aims to bridge the gap in the understanding of how the different scales of urban and landscape planning, architectural design and technology are linked in water-related strategies and how they impact each other in the definition of preventive action plans. The project collects different disciplines to create new strategies and S.O.S. – Sustainable Open Solutions for infrastructure and urban

planning in Europe. It builds a new multidisciplinary collaboration network involving top European research institutions in architecture, urban design, regional planning and landscape architecture as well as non-academic partners: local experts, municipal representatives and cultural institutions. This collaboration allows for a better understanding of the impacts of climate change in urban waterfronts and explores them from social, environmental, educational, technological and urban design perspectives. Five European cities Stockholm, Thessaloniki, Rome, Gdansk and Lisbon are in the centre of the debate, though the network hosts experts from The Netherlands, Turkey and Canada.

During the International Conference 'Climate Change Consequences and Creative Solutions for our Cities' launched in 2019 by the H2020 SOS Climate Waterfront research group in Poland, several researchers were brought together to exchange ideas and engage in creative discussions on the topic. Authors from different countries were able to share their knowledge with other experts, critically review the present debate and, contribute with outstanding new possibilities. This book was initially conceived as an outcome of the Conference but with a time of suspense related to the outbreak of pandemics its scope became much broader. Presenting different approaches based on a variety of research areas represented by contributors it is intended to provide insights on how to integrate water management considerations into urban design and planning. It covers a broad spectrum of approaches from theoretic al concepts and their underpinning paradigms, to presentations of individual design solutions. It serves as a platform for the exchange of knowledge and experiences related to climate adaptation and mitigation questions, strategies and concepts.

The book is divided into two parts. Part One outlines the theoretical framework on the basis of experiences gained from many places in the world. Part Two covers insights into how climate change affects the cities located by Gdańsk Bay, and presents processes, strategies and concepts focused on the adaptation of urban spaces in these cities to climate change.

Part One

The paper of Claudia Mattogno, Bruno Monardo, Tullia Valeria Di Giacomo and Luna Kappler gives insight into innovative approaches in climate change-driven policies aimed at overcoming the waterfront cities' critical issues. On the background of different geographic approaches, the authors investigate the implementation of the 'River Contracts' strategy through two examples in the

Roman hydrographic basin. Dimitra Babalis explores the application of the 'Sustainable Drainage Systems' in urban waterfronts areas of great historical value posing the question of whether the urban space along the Arno River in Florence can be managed better and transformed for climate change consequences by using SuDS techniques and tools.

Anna Januchta-Szostak reaches the source of today's waterfront problems exploring eco-hydrological consequences of urbanisation of riparian areas, taking the Warta River Valley in Ponań in the centre of the study. Indicating how the retention capacity of cities has been radically limited with the urbanisation, the author presents the strategy of "coexistence with water" depicting principles of multifunctional management of floodplains and featuring building types that may adapt to changing water levels. In accordance with this way of thinking, Maxime Nadon-Roger investigates the natural and artificial morphology of the St. Lawrence Estuary and the historic land use in the Quebec City region and indicates why the adjacent shoreline post-industrial territory is particularly vulnerable to natural disasters such as flooding. The author demonstrates how a better understanding of the shoreline's operational history can guide present-day choices about where to protect, how to adapt, and what to build. Izabela Burda discusses the role of modifications of land and water boundaries on post-industrial sites and reveals how they support the shaping of places resilient to climate change. The Part One concludes with the paper by Sylwia Sietniewska and Justyna Borucka who present a study of a land-use plan for the right bank of the Vistula river in Toruń focused on adaptation of the area to flooding.

In Part Two

The River//Cities team: Agnieszka Wolodzko, Roman Sebastyanski in cooperation with Iwona Preiss and Magdalena Zakrzewska-Duda present the context of the urban regeneration planning process of the former Gdansk Shipyard area. The paper presents the methodology of a one-year-long public participatory process called "Shipyard Anew" understood as a cultural and artistic intervention focused on protecting cultural heritage and creating a new, independent social vision and strategy for the effective urban transformation of this area. Pedro Ressano Garcia discusses the effects of the engagement of graduate students and young professionals in developing place-specific design scenarios. The integration of industrial artefacts, buildings, docks, cranes, and canals were used to design future systems that mix ecologic solutions of passive

energy with vertical farms and floating platforms - all in pursuit of symbiosis and biophilia in urban ecologies. In the search for innovative visions, Garcia argues that the combination of rigor and imagination is possible experimental workshops. His paper presents a short selection of outcomes that aim to open up new discussions. Lucyna Nyka, Rui Simoes and Pedro Ressano Garcia and Joanna Rayss discuss climate-change consequences for low-lying areas of Gdańsk and present a design proposal guided by the ecosystem-based design principles and historical hydrography studies as a response to the vulnerability of waterfront heritage buildings and landscapes. Rui Simoes explores how the knowledge of the history of the place may reveal paths toward creative anti-flood solutions that contribute to urban rehabilitation and enhance the identity of historic neighbourhoods. Paweł Łukasiak argues that the construction of flood protection infrastructures like wharves or quays is often an impulse for dynamic spatial, urban, and socio-economic development of areas next to the waterfront, presenting the Granary Island example as evidence of such a process. The Part Two of the book concludes with the presentation of the two design projects. Agnieszka Nyka and Jakub Szczepański provide original insight into the problem of adaptation of historical objects in the era of climate change and convey a message that that architecture should not only be designed for people, but should also provide a framework for nature. Dominik Sędzicki and Jarosław Bąkowski present their award winning project for Gdynia Pier and provide arguments that transformation process on urban waterfronts could be perceived as opportunities for creating a new type of urban ecologies.

Most of the authors listed in Part One and Part Two share a similar sense of the present situation, though each research covers complementary approaches. The book presents a body of knowledge useful for the development of future creative solutions. It comes across several papers, references to available data, giving the evidence that urban waterfronts are facing exponential costs to adapt and mitigate damages brought by climate change. Also, the perception that the three main challenges (the urban heat island effect, floods and tides) can be fought with the same conceptual strategy: enhancing porosity of the built environment. The pores may take different shapes, they might be present in sponges or between rocks, though porosity exists in the space between things and there is a need for expansion, to enhance the capacity to absorb and to adapt, to integrate rather than to control.

The in-between space, present in the built environment, in public spaces and buildings is being transformed. To reach this goal the authors' contributions cover a wide spectrum of possibilities, addressing the role of local authorities, public and private investors and individuals that are be able to enhance resilience when integrating similar concepts. It takes different approaches, social, economic, technologic, environmental, each in its own way, aim to protect, to mitigate, to adapt to new weather patterns. Solutions and future strategies, in many cases, need the support and mobilization of civil society towards more sustainable behaviors, personal or in community network and the protection of biodiversity.

Urban porosity allows to absorb floods and tides, stabilize the temperature, to prevent the urban heat island effect, reduce energy consumption and reach a more sustainable carbon footprint. Investment in vegetation, in permeable public spaces, and its application on the facades and roofs of buildings, combined with the application of insulation, the use of rain and gray water for irrigation and the micro production of energy, are analyzed and discussed in this book. Each case is a case though the collection of ideas put together by the authors present strategies of circular economy and contributions for successful sustainable built environment.

Contributions in this volume reveal how broad and manifold the pursuit for more resilient cities is and illustrates the need for a better understanding of how climate change affects urban areas. The cooperation between academic institutions, cultural associations and local planning agencies, as project partners in the H2020 'SOS Climate Waterfront' projects has already resulted in collaborative and fruitful debate and should produce, in the longer term, a change in urban thinking and practice.

Lucyna Nyka, GdańskTech Coordinator of H2020-MSCA-RISE

Pedro Ressano Garcia, Primary Coordinator of H2020-MSCA-RISE

Part 1

FoCuS Research Centre, Sapienza University of Rome, Italy

Claudia Mattogno
Bruno Monardo
Tullia Valeria Di Giacomo
Luna Kappler

Climate Changes in Water Challenges: a "Porous" and Collaborative Design to Create New Regenerative Landscapes

Abstract

This paper aims to investigate and highlight innovative approaches in Climate Change-driven policies, aimed at overcoming the waterfront cities' critical issues. The 'River Contracts' experience, explored through two examples in the Roman hydrographic basin, is conceived to tackle the increasing vulnerability of territories, looking for a sensible attitude towards the integration of water systems, green corridors, and open spaces, with actions to be planned and shared through participatory democracy. Anticipatory adaptation looks ahead to the project scenario trying to implement policies and strategies preventing potential disasters. Creative design and conscious management embracing different spatial scales play a crucial role in enhancing the anticipatory adaptation and resilience approach. The variety of trends, contexts and spatial scales highlights that it is definitively time for fostering the 'adaptation approach', supported by mitigation strategies, with a clear twofold aim: risks to be minimised and potential opportunities to be caught.

1. Water resource management as a new approach to urban design

The following considerations are related to an EU interdisciplinary research project[1] aiming to explore the impact of Anthropocene Climate Change on European territorial and urban waterfronts domains. The main goal is to expand the realm of possibilities meant to adapt and transform urban waterfronts while also enabling them to become meaningful areas for the community.

Virtuous planning boosts public-private partnerships, incorporating adaptation strategies into planned actions through the evolution of sustainable policy tools like the 'River Contracts' born in France forty years ago and widely used across today's Europe. They should not be considered merely 'new plans' but ones representing an innovative methodology process for water management as their effectiveness is strongly based on the active participation of local actors. Supported by governments at different levels, as well as by jurisdiction ranging from the EU to local scale, they are exemplified by applications in national and transboundary territories. Special attention is devoted to the stakeholders' involvement and their role in the adaptation process to climate changes in local or regional bottom-up initiatives.

1 This paper is connected to the dissemination of the EU research project 'SOS Climate Waterfront' , Horizon 2020, Marie Sklodowska-Curie RISE, 2018-2021. The authors belong to the Focus Centre Research Unit, 'Sapienza' University of Rome.

Forming a general overview of the main methodological approaches capable of improving responses to hydrological stress, mitigating the effects of impacts and effectively optimising the management of resources towards sustainability, the structure of the text aims to outline the cultural and interpretative models emerging in Rome, Italy, through the River Contract tool to innovate water resource management strategies.

The extensive urbanisation and urban expansion have led to thousands of square kilometres of impermeable areas consisting of roads, pavements, roofs, and car parks which prevent the absorption of water into the ground, collecting it through urban drainage infrastructure and channelling it into rivers, lakes, or seas instead.

Such traditional and environmentally unconscious design methods have led to the creation of cities that are increasingly waterproof and have an ever-greater impact on the natural cycle of water. Waterproofing cities has become a recurring problem in recent years. While yesterday's challenge was to evacuate all water out of cities to limit health risks, this system now poses many other problems, particularly in terms of saturation of sanitation systems, dysfunction of wastewater treatment stations, pollution, or flood.

Faced with impending climate change and biodiversity challenges in the coming years, many stakeholders are currently reflecting on the role of water in our cities, particularly rainwater, to determine what objectives and strategies should be used and how to change the traditional practices.

The proposal is to fuel the debate with an overview of the main experiences and necessary evolutions in terms of organisation and support. Allowing water to infiltrate into the soil not only filters it but also fills the water tables and refreshes cities. Many techniques have been developed to enable natural filtration of water, including green valleys, rain gardens, and draining trenches, and many policies have been adopted both nationally and locally. Many landscapers have implemented water sensitive-projects as well, transforming hydraulic engineering works into landscaping solutions as public spaces accessible for different uses (ICI Consultants 2015, Trasporti & Cultura 2015).

More specifically, the most common approaches in different geographical areas are as follows:

– the French policy of 'permeable cities', connected with the 'green and blue frame', which provides for specific urban planning instruments (SDAGE) to reduce pollution, prevent flood risks, and anticipate the effects of climate change; (Photo 1-2)

- the ‘Sponge City’ concept initiated in China in 2014 to address urban water issues including surface water floods;
- the Sustainable Urban Drainage Systems (SUDS) approach which implies an increasingly important role of green infrastructure in the United Kingdom, minimising the outflow of surface water and flood risks in an ecological way by imitating natural water systems such as ponds, wetlands, swamps, and basins;
- the Water Sensitive Urban Design (WSUD) strategy being implemented in Australia since the 1990s, integrating engineering design with the principles of the urban water cycle to provide sustainable results for cities;
- the Low-Impact Development (LID) used in Canada and the United States to describe a land planning and engineering design approach to manage stormwater runoff as part of green infrastructure.

Findings and lessons related to different cultural strategies are proving to be useful in extracting relevant suggestions for the innovation of integrated strategies in a changing climate environment. In the Italian context, some initiatives are hindered by overlapping competencies, leading to conflicts between actors and showing a need for a cultural change to boost a new territorial vision. Above all, stakeholders find it immensely difficult to think at a basin scale; also, the administrative and sector divisions must be overcome urgently (Guerra, 2012). The main goal of this paper is to investigate and highlight innovative approaches in Climate Change-driven policies to resolve these critical issues.

This paper also addresses a key research gap present in Italy between the conceptual situation with theoretical considerations, as well as the stratifications of territory, which are to be solved through innovative tools that can enable an adaptive approach to land care. The research highlights the inner potential of integrated anticipatory planning in the city of Rome and its surroundings, where cooperation and collaborative experiences take place based on a virtuous ‘multi-actor approach’ (Klijn, Teisman, 1991).

Fig. 1-2. Lyon, Permeable City. Green and blue infrastructure, based on a landscape and environmental approach, has been at the forefront of Lyon’s permeable city strategies in recent decades. Huge redevelopment processes have transformed the banks of the Rhone River into public use spaces to manage floods without damage. (photo by Claudia Mattogno)

2. Urban challenges in a changing climate

By now, it is clear that the impact of Climate Change on cities will keep increasing in the incoming years (IPCC 2014): sea and riverfront cities with their complex hydrographic systems will be more and more vulnerable to such extreme events as heavy precipitation, leading to devastating floods and alarming sea-level rise (EEA 2012). Therefore, the emerging imperative for contemporary metropolitan and urban communities lies in the ability to develop policies, strategies, and project solutions able to prevent these impending disasters.

In the last decade, the scientific debate about the issue of 'anthropogenic Climate Change' and its effects on human settlements has been shifting towards the capabilities of public policies and integrated partnerships to rethink visions and implement virtuous, complex strategies to face the increasing threats and manage the vulnerability of contemporary regional and urban realm.

There is no doubt that the primary determinant of the location of urban settlements is related to water, coastal territories, and rivers. The origin of cities is strongly connected to river and sea waterfronts ensuring economic advancement, social development, and cultural progress for the whole human society. It is seas and rivers that have influenced the shape and distribution of cities and determined their economic destinies and social relationships. Apart from supplying essential water resources, rivers and floodways have enabled the transportation of passengers and goods, as well as access to services for various ports and water hubs.

Nonetheless, since the dawn of human settlement, the relationship between cities and their rivers has been pretty complex and can be interpreted as an everlasting competition between two different systems (Ureña 1999): on one hand, the river environment – characterised by change, diversity and the occasional flood events – on the other, the urban environment – historically homogeneous, compact, and mineral. Each city-river system is unique and riverfronts have been managed in various ways as part of urban and regional planning depending on the river environment's features; for instance, the basin hydro-morphology and flood events related to water regimes, or the urban fabric issues related to the creation of dense hubs or marginalised spaces governed by 'vicious' or 'virtuous circle' rationale (Penning-Rowsell 1997).

In the case of Europe, plans aimed at the environmental restoration and urban regeneration of riverfronts were implemented during the 1980s and 1990s, which have enabled the natural environment

to be integrated into the urban fabric. Great European capitals such as London, Paris, Amsterdam, and Lisbon, as well as other vital urban centres like Hamburg, Manchester, Rotterdam, Lyon, and Genoa, represent paradigmatic examples of the strategic regeneration of waterfront systems pursuing the synergic relationship between the open environmental space and the city pattern (Santasusagna et al. 2015). Some scholars have argued about the 'fluid city paradigm' (Carta 2016), merging knowledge and action towards an integrated and creative planning approach in which waterfront regeneration is strived for as the fundamental aspect of urban redevelopment strategies.

The emerging policies for managing urban river areas responded, firstly, to the emergence of the 'environmental movement' – in the broadest sense – and secondly, to the will to reconcile the restoration of the river ecosystem with its use by the city dwellers. Riverfront areas have gone from being perceived as neglected and 'marginalised' spaces (Panareda 2009) to ones forming part of a new model that reassesses their social, economic, and landscape value to varying degrees, enabling citizens to enjoy a city that has managed to turn around and face its river again (Ribas 2012). The introduction of these new management policies has undoubtedly been facilitated by the adoption of the Water Framework Directive and the Flood Directive in 2000 and 2007, respectively. These EU Directives and related projects implemented in the Member States contributed to the establishment and monitoring of specific targets concerning environmental quality, which the urban planners of the 21st century assumed as their main goals within attitudes and styles that emphasize, above all, the preservation and restoration of water bodies and the related regeneration of the urban realm.

Focusing on Rome's river system and the general strategy of the so-called 'River Contracts', the authors' specific goal is to investigate and highlight innovative approaches in Climate Change-driven policies, aimed at overcoming the critical problems of riverfront cities. When looking at the most advanced economies across the world, it is possible to find different cultural models through specific case studies, starting from the consolidated statement of the scientific disciplinary community about the distinction of two opposite categories of responses to extreme events: reactive or anticipatory (Repetto 2008).

Reactive adaptations occur after a 'disaster' has already taken place. They are an attempt to overcome the results of the previous inattention while reducing damage from future, similar events. Nonetheless, they are often just an over-response to an emergency

and result in neither a long-term impact nor a positive balance between the efforts undertaken and their outcomes.

On the other hand, anticipatory adaptation consists in trying to implement policies and strategies before an extreme event or any other risky situation can occur. Virtuous planning can ensure that damage (and costs) are minimised by incorporating adaptation strategies into planned actions.

As some schools of thought have highlighted (Shaw et al. 2007), creative design and conscious management of urban environment embracing different spatial scales (from single blocks to neighbourhoods, from cities to metropolitan areas and their regional context) plays a crucial role in enhancing the anticipatory adaptation and resilience of the entire urban ecosystem. The variety of trends, contexts and spatial scales bring diversity and unity through integrated-anticipatory planning. This shows that now is definitively the time for the 'adaptation approach', supported by mitigation strategies, with a clear, twofold aim: minimising risks and capitalising on potential opportunities.

3. Virtuous planning approaches: revamping River Contracts

The challenges posed by climate change for the urban water system could be addressed through the River Contracts as useful tools for the regeneration, management, and enhancement of territories characterised by the presence of water bodies. River Contracts are part of a wider set of tools that cover various categories of water bodies, including lakes, coasts, transitional waters, estuaries, and groundwater. The subject literature describes the general features and specificities of River Contracts, construed as 'the outcome of an integrated inclusive decision-making process' (Carter and Howe, 2006), which makes it possible to replace the traditional forms of water management based on top-down hierarchical relationships and overcome their strictly technical and sectorial character (Eckerberg and Joas, 2004). Based on a voluntary agreement, the River Contract involves all major players in the given river area in the process of defining and implementing a shared strategic framework (Affeltranger and Lasserre, 2003; Cannavò, 2018).

River Contracts have a homogeneous structure enabling the introduction of an incremental process of strategic objectives and levels of interaction. The process is divided into five steps and participation in it enables interconnection. River Contracts represent voluntary instruments of strategic and negotiated planning that

pursue the protection and correct management of water resources, as well as the enhancement of river territories, safeguarding against hydraulic risk and contributing to local development. As part of a shared process, a River Contract can also include smaller initiatives and become a key opportunity for the comparison between the different stakeholders and civic instances, as well as enabling the redevelopment of a river as a common good and solving the issue of overlapping competencies, which caused stagnation in the Italian water management sector.

In a European framework, these tools contribute to the pursuit of the objectives of environmental legislation, particularly those outlined in the Water Framework Directive (2000/60/EC), the Floods Directive (2007/60/EC), the Habitat Directive (1992/43/EEC), and the Marine Strategy Framework Directive (2008/56/EC). They represent a useful tool for the prevention and reduction of pollution, the sustainable use of water, the protection of the environment and aquatic ecosystems, mitigation of the effects of floods and drought, as well as enabling the coordination and consistency of the actions and interventions required for the implementation of the above directives.

River Contracts were created in France in 1981 as 'Contrat de Rivière' and were first applied in the case of the La Thur river in 1983. Due to their success, they were soon adopted in the entire country, especially for the tributaries of the Rhone. Today, more than 150 River Contracts are in effect throughout France, covering approximately 10% of its territory. In addition to the involvement of local actors, communities, and citizens, the French River Contracts have provided significant funding that affected the landscape design of the riverbanks, restoring large portions of them to enable their collective use (Plan Bleu 1998; Mattogno 2020).

Although the first national examples were implemented in Lombardy and Piedmont in the early 2000s (the first was the Olona-Bozzente-Lura, 2004), River Contracts have been formalised in Italy in 2007, starting with the National Board. They are not urban planning tools of their own, but rather are based on the existing planning tools and concern a specific river or a territorial or urban area, enabling them to contribute to integrating and reorienting local planning and improving the contents of super-ordinate planning. River Contracts refer to the already existing plans and programmes for the given river basin/sub-basin and define an Action Programme (PA) shared between all the adhering subjects who mutually

undertake to implement it by entering into an agreement, which can take various legal forms.

The Lazio Region has joined the National Charter of River Contracts (drawn up in the V National Board of River Contracts, Milan 2010), considering River Contracts to be operational tools aimed at favouring integrated and participatory strategic planning, which are instrumental to attaining good environmental quality, hydraulic safety, and health. There are currently two River Contracts in place in the metropolitan area of Rome, covering the Tiber and its main tributary – the Aniene River.

3.1 The Tiber River Contract

The Tiber Contract pertains to the northern part of the city, from the Castel Giubileo district up to the mouth of the river itself. It is a collaborative tool that makes it possible to define a shared strategy for environmental improvement and enhancement of the Tiber's urban section in the municipalities of Rome and Fiumicino. Stretching over 60 km, the area covered by the Contract concerns the section of the Tiber between the Castel Giubileo Dam (1952) and its estuary at 'Fiumara grande', as well as the Fiumicino canal. The Tiber River Contract is one of few cases in which the promoter is an association. Implemented in 2017 with the signature of the Manifesto by a group of associations named 'Agenda Tevere Onlus', the Contract now includes nearly sixty signatories, including public administration and research bodies, universities, professional associations, as well as territorial and voluntary associations. It is not an urban planning tool, but a purpose-based alliance compliant with the existing planning, which aims to resolve conflicts and overlaps. It is a 'pact of commitment' between administrations, competent bodies, experts, and the territory itself. The involvement of different stakeholders (public, private, civic) through the principles of horizontal subsidiarity (Ostrom, 2005) catalyses the efforts to redevelop the river as a common good, activating a process of re-appropriation by the community and rebuilding the relationship between the river and the city.

The critical situation of the Tiber River area is a result of different issues that must be addressed, including hydrogeological risk, land use, occupation of floodplains, overlapping of competencies, as well as uncoordinated and punctual interventions. Some sections of the Tiber drainage basin are subject to serious hydraulic risk and show evidence of erosion of the banks. In some areas, the unique flora and fauna ecosystem and the wooded areas of the Tiber are either inaccessible or are abandoned and in decay. The river basin is a complex

hydro system, however in this case, the water quality is compromised by wastewater from the area municipalities. From a socio-economic perspective, the effects of anthropogenic activities occurring in the sub-basins manifest themselves within the environmental corridors, and therefore, in the floodable areas. This particularly concerns the phenomenon of hydraulic risk, waterproofing, and soil consumption. The land use in the Rome area presents a picture of territories undergoing strong transformation. This includes the phenomena of settlement dispersion linked to the increasing occupation of the Agro Romano by new residential settlements, apart from the persistence of some industrial agglomerations and cultivated agricultural land. The area's numerous sites of historical-archaeological value are in decay and neglect, despite their enormous potential in terms of cultural heritage and attractiveness. The 8 km embankments whose construction began in 1876 have separated a part of the river corridor from the city, preventing proper connections.

At the same time, the public and institutional bodies responsible for managing the Tiber's riverbanks have been characterised by overlaps, stratification, and fragmentation. Their interventions have been reactive, sporadic, or solely related to emergencies. They have not adequately considered the common perspectives or the anticipatory approach, even though the planning guidelines and regulations have aimed at developing unified actions over time. Furthermore, the fragmented management has made it difficult to pursue common goals. Joint action and a shared framework are needed to make the Tiber a common good, which must be returned to citizens through participation and proactive interaction between public and private actors residing in and governing the city. Resolving the issues of social instability, legal uncertainty, fragmentation of management, abandonment, and temporary illegal occupation requires joint, decisive, and targeted action.

The River Contract capitalises on the opportunities underlying the presented critical issues, defining a strategic path of general and specific objectives, actions, interventions, responsibilities, and timing. The general aims include unifying competencies and socio-economic resources, promoting awareness, as well as strengthening the existing know-how to redevelop and enhance the banks of the Tiber through an 'open programme' that expresses a convergent and integrated plurality of projects. In this regard, 'urban enhancement' is construed as the regeneration of the Tiber as a system to make it safe, clean, accessible to all, and open to social, cultural, sporting, and entrepreneurial activities to give the polycentric Rome a more

liveable urban dimension. At the same time, urban interventions must prevent negative impacts on biodiversity and water management. Social empowerment is to be achieved by sharing knowledge through big data accessibility; the virtuous process of re-appropriation for the community can be addressed by decision-makers through the implementation of a collective interest project.

3.2 The Aniene River Contract

The second River contract concerns the Aniene River, from its sources to its confluence with the Tiber River, and intends to bring together the various existing stakeholders by calling on institutions and individuals to implement a non-sectorial but integrated vision. It is aimed at the rebirth of the Aniene Valley, which is considered a common good to be managed collectively. In the upper valley, the Aniene River Contract represents a flexible tool to unite a territory whose local communities are connected primarily by the ancient roads Tiburtina Valeria and Sublacense. Increasing the scale of this concept would make it possible to unite the mountain regions with the city of Rome. In the lower valley, however, this can enable integration with other similar initiatives for the development of territories and protection of water bodies through such initiatives as the Tiber River Contract and the Aniene Safe Project of the III Municipality of Rome. The participation process is aimed at promoting initiatives, events, and synergies between the territorial actors to contribute to the creation and implementation of shared and integrated river system management policies, particularly in terms of protecting the water resources, managing the hydraulic risk, protecting the river ecosystem, as well as safeguarding public heritage, and enhancing local development in a changing climate environment.

Fig. 3-4. Rome, the Tiber River. The banks of the Tiber were built at the end of the nineteenth century, based on the model for the Seine in Paris. The high walls were designed with the centennial flood in mind and unfortunately do not enable easy access to the river, representing a form of a barrier instead. (photo by Claudia Mattogno)

The promoter of the Aniene River Contract is the Public Authority 'Comunità Montana dell'Aniene' (Aniene Mountain Community). The entire river stretch has been analysed to identify measures to be taken in the short- (2025) and medium-term (2050) scope. All actors involved are required to show co-responsibility due to their belonging to a valuable ecosystem. This vital tool of participation-based territorial governance can activate processes of co-evolution of the territorial system and anticipatory adaptation. Additionally, it can promote bottom-up initiatives through continuous and programmatic dialogue between the different stakeholders and civic bodies, so that their voices be heard and amplified.

As an inclusive, participation-based tool, the Aniene River Contract is strongly influenced by the presence and activities of all actors involved. Furthermore, being a process with a medium-to-long time dimension, it can be influenced by institutional transformations and the loss of continuity in the dialogue with public bodies whose planning is often linked to the temporary nature of their mandate. The Water Framework Directive (2000/60/EC) abolished the Basin Authority according to the aggregations of the District Authorities, and as such, the Tiber Basin Authority – the main public administration body operating in the water resources sector – has been transformed into the District Authority of the Central Apennines, which was accompanied by a notable expansion of its territorial scope. From an organisational point of view, coordinating the numerous cross-sectoral and multilevel stakeholders, as well as the participation of private entities, remains a critical issue for the Aniene Valley. While financial support remains a challenging issue for this process, the III Municipality of Rome has commenced a virtuous initiative to address this problem. This made it possible to direct funding towards inhabitants and associations that strongly desired local intervention, effectively solving a safety issue and promoting the Aniene River through the construction of docks along the river. The primary objective was to make the area a safe and liveable space. However, from the point of view of preserving the quality and volume of the water resource, the critical issues for the Aniene Valley include water pollution in the lower course and the need for pumping to maintain the minimum vital flow in the upper course. These problems are further exacerbated by climate change and are accompanied by the developmental needs of the Aniene Valley's 31 Municipalities, as well as the presence of environmental protection constraints that reduce the possibility of carrying out new initiatives. As regards administrative issues, the low technical know-how of public officials handling the river contract and the

Fig. 5. Rome, Tiber Plaza. A public space on the quay of the Tiber between Ponte Sisto and Ponte Mazzini was created by the Special Tiber Office of Roma Capitale with Agenda Tevere Onlus and designed by AIAPP, the Italian Association of Landscape Architecture. (photo by Luna Kappler)

Fig. 6. Rome, William Kentridge's mural along the Tiber River. Triumphs and Laments is a monumental mural created by Kentridge, which was revealed on the evening of 21 April 2016, just in front of Tiberina Isle. Created with a deliberately ephemeral technique, it presents the history of Rome, which contrasts splendour and misery, glory and defeat. (photo by Claudia Mattogno)

need for territorialisation of actions pose major difficulties; nonetheless, interactive cartography may serve as a useful tool here. The main outcome will be achieving convergence between top-down strategies and bottom-up practices, as well as transforming discontinuous actions of different measures into systemic and organised development models in the various thematic areas of risk, environment, and local development.

The process of integrating and clarifying skills and duties for the Aniene River Contract will make it possible to invest in environmental protection and improve both risk management and river maintenance, including from the Sendai Framework perspective (Sendai Framework Priority 2: Strengthening disaster risk governance to manage disaster risk), and optimise funding for incremental territorial development. Strengthening disaster risk governance fosters collaboration and partnership across mechanisms and institutions for the implementation of instruments relevant to disaster risk reduction and sustainable development (UNODRR 2015). (photo 7-8-9-10)

4. Open issues: 'River contract' as a 'flood resilient' and synergic process

The Tiber and Aniene 'River Contract' policies deliver useful findings to extract relevant suggestions for innovation in terms of integrated environmental strategies and specific projects to be applied in Italy. In this case – unlike in France – this type of participatory tool seems to prove very useful in making social and institutional actors act in concert. Nonetheless, it does not seem capable of triggering, at least for the moment, actions related to a landscape redesign of space.

Virtuous rebounds can be expected for the 'Eternal City', even though it is still struggling with its planning paths. River Contracts are viewed as a way to address the increasing vulnerability of its territory and look for a sensible attitude towards the integration of water systems, green corridors, and open spaces to be planned and shared through participatory democracy.

The case study concerning Rome is embedded into main methodological approaches focused on what can improve the response to the territorial hydrological stress, mitigate the general and local impacts, and optimise resource management to enable sustainability and resilience. In the international scenarios, scholars and experts specify diverse cultural trends, distinguished by their focus: strategic policies, technical solutions, or their integration.

Fig. 7-8. Rome, along the Aniene River.
Famous for its Tivoli waterfalls, the Aniene is the main tributary of the Tiber, which passes through Rome in a hidden way and is almost unreachable due to dense, spontaneous vegetation that prevents any public use. (photo by Tullia Valeria Di Giacomo)

Fig. 9. Rome, Nomentano Bridge .
The Nomentano bridge over the Aniene was built using tuff and travertine in the Republican period and later, in the eighth century, was fortified with two towers. Today, is a pedestrian-only bridge, with most of its structure concealed by the spontaneous vegetation along the river. (photo by Claudia Mattogno)

Fig. 10. Rome, the Aniene River at the confluence with the Tiber.
Located in the northern part of the city, the area of confluence of the two rivers lacks adequate landscaping, which would greatly enhance its attractiveness. (photo by Tullia Valeria Di Giacomo)

Resilience is frequently associated with self-organisation and adaptive capacity, (Carpenter 2001, Low 2003, Tompkins 2004). Adaptiveness can increase resilience over time, as it is joined in acquiring the capacity to fit changing internal demands and external conditions (Gunderson 2010, Carpenter 2008). These concepts can be translated into key properties of urban resilience to floods and highlight the distinction between resistant and resilient urban areas.

That flood resistance is necessary for cities is a view widely shared by stakeholders involved in environmental and urban planning; however, the resilience theory suggests that it erodes the cities' flood resilience (Holling 1996). The flood-control

infrastructures confer the city's contrasting conditions: dry and stable, or inundated and disastrous. With huge dikes, walls, and other artificial water control systems, floods occur exclusively due to the infrastructure's failure (Tobin 1999). Cities dependent on flood-control infrastructure are highly resistant to floods but not actually resilient since they have physically adapted to the artificially introduced dry-and-stable conditions to such an extent that wet conditions are something they cannot cope with.

The 'River Contract' approach born in France about forty years ago, as well as the specific interpretation presented in the Rome case studies, highlight some relevant issues and problems rooted in the historical planning practices and still present in the regional and urban planning culture in Italy. Similarly to other Mediterranean countries, Italy is based on the 'Civil Law' juridical dimension, which differs from the Anglo-Saxon 'Common Law' model. The very concept and idea of the necessity to enter into and strengthen the 'contract' lead us back to the evolution of the intrinsic nature and role of different planning tools and their mutual relationships.

The idea of a 'contract' is intimately related to the opportunity to give sense to and implement an authentic 'strategic approach' – not a 'conventional plan', but rather a 'new alliance' among all actors involved – privileged and recessive, originally involving various and sometimes conflicting interests in the city arena. This pact, signed by public bodies with different missions, jurisdictions, and competencies, as well as by private stakeholders and non-profit entities, is the basis for implementing inclusive, shared, and virtuous projects for the whole community.

It is expected that the implementation of the new philosophy of 'River Contracts' will make it possible to prevent the reoccurrence of past mistakes, in which every institutional actor attempted to impose his political, economic, social, or environmental vision, reflecting the choices on the physical-spatial dimension through a specific plan. Between the Second World War and the early 21st century, the planning culture in Italy, and in 'Civil Law' countries in general, has had a form of a heated debate on what should be the dominant and most vital national interest. A great conflict ensued in the vast galaxy of public bodies (Ministries, Regions, Basin Authorities, Metropolitan Areas, Provinces, other inter-municipal bodies, Municipalities), which pursued the continuous promulgation of legislative measures aimed at reaffirming their primacy, undermining the hierarchies of the various territorial and urban planning tools as a result. In contrast, 'River Contracts' have recently been considered in Italy,

and notably in the case of Rome, as an innovative path for water system management. Their goal is to introduce a complex process capable of coordinating the heterogeneous visions of national, regional, and local actors, chasing synergy opportunities within different visions, plans, programs and projects. We are confident that they can also represent a suitable methodology to facilitate the renaturalisation of the river landscape and its extended use.

Authors' contributions

This paper is a result of joint efforts by all authors; however, C. Mattogno wrote section 1., B. Monardo sections 2. and 4., L. Kappler section 3.1, T.V. Di Giacomo section 3.2, while section 3. was authored by both L. Kappler and T.V. Di Giacomo.

References

Affeltranger B. & Lasserre F. (2003). La gestion par bassin versant: du principe écologique à la contrainte politique – le cas du Mékong. *Vertigo. Rev Sci Environ* 14 (3).

Bossard M., Feranec J. & O'ahe' J. (2000). *Corine Land Cover—Technical Guide.*

Cannavò, P. (2018). Verso il parco urbano del Tevere. *Tracce Urbane*, *4*.

Carpenter S. R. & Brock W. A. (2008). Adaptive capacity and traps. *Ecology and Society*, 13(2), 40.

Carpenter S. R., Walker B., Anderies J. M. & Abel N. (2001). From metaphor to measurement: resilience of what to what?, *Ecosystems*, 4 (8), 765-781.

Carta M. & Ronsivalle D. (2016). *The fluid city paradigm: Waterfront Regeneration as an Urban Renewal Strategy.* Dordrecht: Springer.

Carter J. & Howe J. (2006). Stakeholder participation and the Water Framework Directive: the case of the Ribble Pilo. *Local Environment 11(2)*, 217-231. https://doi.org/10.1080/13549830600558564

Eckerberg K. & Joas M. (2004). Multi-level Environmental Governance: a concept under stress?'. *Local Environment*, *9(5)*, 405-412. Doi: 10.1080/1354983042000255315

Guerra S. (2013). Disputed or Shared Territory? The Italian Experience of River Contract: New Relationship between River and its Region. *Planum – The Journal of Urbanism* , 27 (2)

Gunderson, L. H. (2010). Ecological and human community resilience in response to natural disasters. *Ecology and Society 15(2)*, 18

Holling, C. S. (1996). Engineering resilience versus ecological resilience. In P. C. Schulze (ed) *Engineering within ecological constraints.* Washington D.C.: National Academy Press, 31-43

ICI Consultants (2015). *Ville permeable/ Sponge cit. ICI* Interface, Paris.

Klijn E.H. & Teisman G.R. (1991). Effective Policy Making in a Multi-Actor Setting: Networks and Steering. In: in 't Veld R.J., Schaap L., Termeer C.J.A.M. & van Twist M.J.W. (eds) *Autopoiesis and Configuration Theory: New Approaches to Societal Steering.* Springer: Dordrecht.

Liao, K. (2012). A theory on urban resilience to floods. A basis for alternative planning practices. *Ecology and Society*, 17 (4), 48.

Low, B., Ostrom, E., Simon, C. & Wilson, J. (2003). Redundancy and diversity: do they influence optimal management? In: F. Berkes, J. Colding & C. Folke. *Navigating social–ecological systems: building resilience for complexity and change*. Cambridge, UK: Cambridge University Press 83-114.

Mattogno, C. (2020). "L'identità di Lione disegnata dall'acqua", EcoWebTown. *Journal of Sustainable Design*, 21.

Ostrom, E. (2005). Unlocking Public Entrepreneurship and Public Economies, Working Paper, World Institute for Development Economic Research (UNU-WIDER), DP2005/01..

Panareda, J. M. (2009). Evolución en la percepción del paisaje de ribera. *Boletín de la Asociación de Geógrafos Españoles*, 51, 305–324.

Penning-Rowsell, E. C. (1997). Rius i ciutats: amenaces i potencialitats. In Ribas A. & Saurí D. (eds.) *Ciutat i riu: l'aigua en l'organització de l'espai urbà*, Documents d'Anàlisi Geogràfica, Bellaterra, 3–34.

Plan Bleu (1998). *Orientations d'aménagement des berges du Rhône et de la Saône.* Communauté Urbaine de Lyon.

Repetto R. (2008), *The climate crisis and the adaptation myth*, *Working Paper 13*. New Haven: Yale School of Forestry and Environmental Studies.

Ribas, A. (2012). Tornar a viure de cara al riu. *Revista de Girona*, 270, 60-65.

Santasusagna A. & Tort Donada J. (2015). Urban planning in riverfront areas. *Miscellanea Geographica*, 19 (3), 14-21.

Shaw R., Colley M. & Connell R. (2007). *Climate change adaptation by design: a guide for sustainable communities*. London: TCPA.

Taleb, N., (eds.) (2013). *Antifragile. Prosperare nel disordine.* Milan: Il Saggiatore.

Tobin, G. A., (1999). Sustainability and community resilience: the holy grail of hazards planning? *Environmental Hazards*, 1, 13-25.

Tompkins, E. L., and Adger W. N., (2004), Does adaptive management of natural resources enhance resilience to climate change? *Ecology and Society*, 9 (2), 10.

(2015) Ingegneria e paesaggio. Progetti integrati per il territorio. *Trasporti & Cultura*, 42-43.

Ureña, J. M., (1999). Ordenación de las áreas fluviales en las ciudades: un enfoque metodológico. *Revista de Obras Públicas*, 46, 4–15.

UNODRR (2015). *Sendai Framework For Disaster Risk Reduction 2015 - 2030.* Sendai: United Nations.

Claudia Mattogno
Full Professor Urban Planning, Dipartimento di Ingegneria Civile Edile e Ambientale (DICEA) Facoltà di Ingegneria Civile e Industriale, Sapienza Università di Roma (Department of Civil, Constructional and Environmental Engineering, Sapienza University of Rome), via Eudossiana, 18 - 00184 Rome, Italy. FoCuS Research Centre, Sapienza University of Rome, Italy

Bruno Monardo
Associate Professor Urban and Regional Planning, Dipartimento di Pianificazione, Design, Tecnologia dell'Architettura (PDTA). Facoltà di Architettura, Sapienza Università di Roma (Department of Planning, Design, Architecture Technology, Sapienza University of Rome) Via Flaminia 72, 00196 - Rome, Italy. Focus Research Centre, Sapienza University of Rome, Italy

Tullia Valeria Di Giacomo
PhD, Lecturer, Postdoctoral Research Fellow in Urban and Regional Planning, Dipartimento di Ingegneria Civile Edile e Ambientale (DICEA) Facoltà di Ingegneria Civile e Industriale, Sapienza Università di Roma (Department of Civil, Constructional and Environmental Engineering, Sapienza University of Rome), via Eudossiana, 18 - 00184 Roma, Italy. Focus Research Centre, Rome, Italy. Sapienza University of Rome, Italy

Luna Kappler
PhD, Postdoctoral Research Fellow in LUISS University of Rome. Viale Pola 12, 00198 Roma, Italia. Focus Research Centre, Rome, Italy. Sapienza University of Rome, Italy

Dimitra Babalis
University of Florence, Italy

Fostering Sustainable Drainage Systems (SuDS)

Along Waterfronts for Climate Change Adaptation and Urban Quality

Abstract

In the last decades, flooding risks have created a serious problem for people protection and the environment. In fact, climate change projections show that heavy rainfall and flooding have become more frequent mostly due to high urban densities and impermeable surfaces such as buildings, car parks, roads that prevent the infiltration of water into the ground. Accordingly, there is a need for protecting major urban areas against climate change and stormwater management must be considered a great urban challenge.

This contribution explores some implications of a 'Sustainable Drainage Systems' (SuDS) in urban areas, especially along waterfronts of great historical value. It discusses the forms and configurations that must be provided in order to obtain urban spatiality, temporality and quality. It also stresses a specific way to experience historic environment through a strategic way of using specific waterfront sites that could be transformed into 'places' enacting forms of re-appropriation and contribution to make safer places. More precisely, this paper focuses on redefining the ways that urban space along the Arno River in Florence can be managed better and transformed for climate change adaptation by using SuDS techniques within a wider urban regeneration.

Climate change and SuDS as an effective method of adaptation

Currently, climate change is being catalysed by the increasing number of extreme weather events and cities need to respond with appropriate actions. Urban areas at risk need to manage water surface runoff due to less permeable ground available for infiltration and less vegetation for evapotranspiration (CRIA, 2015). To be precise, during heavy rainstorms, the high percentage of impermeable ground contributes to large volumes of surface water flow while the lack of vegetation would not help to absorb the flow. On the other hand, human infrastructures and activities help to increase temperatures in urban areas. It comes down to promoting measures that help integrate strategies for climate change adaptation.

Professionals play critical roles in developing a better design in existing and new urban areas to cope with the management of the forecasted surface water runoff. Otherwise flooding, pollution and erosion problems will get worse. However, Sustainable Drainage Systems (SuDS) can play an important role with regard to the threat of climate change (Interreg, 2020).

In defining 'Sustainable drainage'(Colin et. al, 2017) as "the management of rainwater with the aim of: (a) reducing damage from flooding; (b) improving water quality; (c) protecting and improving

the environment; (d) protecting health and safety; and (e) ensuring the stability and durability of drainage systems", it is important to understand the movement of water in the natural environment to design and properly adapt sustainable drainage systems (SuDS) for flood protection and decreasing of runoff volumes (Interreg, 2020).

It is argued that terms and approaches used for sustainable drainage can vary between countries and contexts. Sustainable Drainage Systems (*SuDS)* is the most frequently used term in the UK but there are other definitions, such as *Surface Water Management Measures (SWMMs*), *Stormwater Control Measures (SCMs)*, *Low Impact Development (LID*) (Cahil, 2012), *Water Sensitive Urban Design (WSUD)*, *Green Infrastructures* and so on (Colin et. al. 2017). Moreover, the *Nature-Based Solution*, *(NBS*) term is defined as the management and sustainable use of nature to face climate change adaptation, water risk, water pollution and human health. From this point of view, SuDS are Nature-Based Solutions aiming to align man-made drainage systems with natural water processes (Somarakis et. al., 2019).

In a similar sense, 'water resilience' (CWRA, 2019) must consider the interrelationships between water and other critical urban systems. To this end, a holistic approach to building resilience needs to be considered more with regard to the capacity of cities to face water-related stresses. However, a 'water resilient city' can properly face climate change adaptation, from water-related hazards to protecting residents, visitors, and urban infrastructures (CWRA, 2019).

To this end, SuDS techniques are considered appropriate for an effective water management design and their design must ensure a multidisciplinary approach that involves not only engineering aspects, technical nature, but also support from local authorities.

In Europe, the strategies developed are mainly aimed at ensuring that sustainable transformation and climate change adaptation plans have successfully been adopted. For instance, the following good examples are considered: the *Step Klima Konkret* (Berlinbaut, 2016) in Berlin with the *Stadtentwicklungsplan Klima*; *Urban Heat Island Strategy* (Design City of Vienna, 2018) in Vienna, or sustainable development plans for the regeneration of existing urban environments in Copenhagen with the *Tåsinge plads* within the *Copenhagen Climate Resilient Neighbourhood* (City of Copenhagen, 2018). Although, capacity gaps and uncertainty among actors and local authorities with regard to the long-term maintenance, performance and effectiveness of SuDS should be considered, particularly

at the city scale. Certain types require large areas of land for their implementation. Therefore, the balance of costs and social benefits can create difficulties for planners and local authorities, especially if they are not considered in the decision-making processes.

SuDS techniques (CIRIA, 2015) can be divided into three groups:

- Control of the watersource: interventions that remove the run-off of rainwater from where it falls
- Site control: interventions that gather water directly on the site
- Control of gathering: interventions that manage the outflow of water from various sites or by a single wide-site.

SuDS design (CIRIA, 2015) should be based on the following design principles:

- *Water quantity*: SuDS provide areas to store water, slowing the flow of water, allowing water to infiltrate into the ground
- *Water quality*: SuDs can improve water quality while protecting the natural environment from pollution.
- *Amenity*: by including surface drainage in urban design, SuDS can contribute to urban quality in urban areas.
- *Biodiversity*: SuDS can create natural habitats, reservoirs and ecosystems allowing transpiration from vegetation and evaporation from surface water

Finally, it is worth emphasising the amount of SuDS benefits, which include the reduction of flood risks, improvement of runoff quality, improvement of visual amenity, improvement of ecological protection, as well as provision of social, economic, and ecological benefits.

SuDS and typologies for urban water management

Sustainable Drainage Systems (SuDS) can be designed in different urban contexts and must be well-integrated with functional spaces to create High Performance Landscapes (HPLs) (Design Trust for Public Space, 2010)

Specifically, they can be used to manage runoff within:

- The boundaries of the property, for example green roofs/Rainwater harvesting/ permeable pavements
- Public open spaces, such as green streets/tree-pits/rain gardens/ bio-retention areas/water squares
- Large-scale spaces on regional scale, such as detention ponds/ retention ponds/ wetlands (Water Research Commission (WRC), 2013).

The above-mentioned SuDS typologies (Interreg Water Resilient Cities, 2020) can be briefly described as follows:

Green roof or rooftop is a horizontal or low-inclination surface at the top of a building or buildings such as sheds, warehouses, commercial buildings etc., designed specifically for the development and maintenance of an additional roof consisting of herbaceous plant species or, more rarely, shrubs;

Rainwater Harvesting involves the temporary storage and reuse of rooftop and/or surface runoff that can reduce and delay the effects of runoff after an intense weather event, preserving the water resource and allowing for its reuse later on for non-potable purposes (e.g. for irrigation and so on);

Permeable pavements are permeable paved surfaces that enable the infiltration of rapid surface water and the recharge of groundwater, reducing the number of impermeable stone-based surfaces that can temporarily detain stormwater runoff;

Infiltration trees or tree-pits are a method of rainwater control, a green infrastructure designed to collect the flow of rainwater treated and discharged into the sewer system or underground. The structure is formed with the use of a prefabricated concrete box that is filled with soil and in which a non-invasive native tree or shrub is planted. This technology functions as a compact bio-retention system;

Rain gardens are vegetated areas of land characterized by small depressions allowing to rapidly manage overland rainwater runoff through filtration, adsorption. They can be used in green urban areas and street sides. They are designed to capture, retain and disperse urban water from the surrounding impermeable surfaces;

Infiltration basins are areas shaped to create small deep water-reservoirs for temporary water storage, accumulating and disposing surface water runoff by infiltration;

Ponds are artificial reservoirs - relatively large depressions and shallows- that gather the rainwater collected from the surrounding impermeable surfaces. They serve to capture, retain, and disperse urban surface water through appropriate hydrophilic plants as well as to carry out both sedimentation processes and degradation of organic material and pollutants;

Swales are vegetated ditches with flat and sloped sides that are used to convey stormwater. They typically remain dry with no rainfall events and serve to gather, dispose and infiltrate rainfall water collected from impermeable surfaces, slowing the runoff and enabling a minimum removal of pollutants. It is a variant of

grass-lined canals slowing down the runoff and enabling the removal of pollutants;

Wetlands are purification systems for wastewater treatment, based on aquatic-resilient plants. They help to purify water, recreating a natural environment and providing a vibrant wildlife habitat;

Filter drains are shallow trenches filled with stone/gravel, enabling temporary conveyance and filtration of surface water runoff. Filter discharges can help reduce pollutant levels during runoff by filtering fine sediments, metals, hydrocarbons and other pollutants.

Briefly, the stormwater management goal is to maximize the collection, treatment, and infiltration of urban runoff, while providing landscaping and well-being benefits.

Proposed SuDS Strategies and effectiveness of approach in Florence Riversides

Climate change projections suggest that some types of extreme events may be more frequent in the future and higher intensity of rainfall is expected to increase runoff from urban and rural land, thus increasing flooding risks, pollution and so on.

Arno Riverside has recently been considered as an Opportunity Area within the current City Regulatory Plan[2]. Some riverfront areas are planned as "Areas of Transformation"[3]. Such a great number of unplanned riverfront areas is largely due to vulnerability to flooding and drought in the River Arno area. For the City of Florence, flooding events have always been present but now this threat must be managed better. However, good regeneration proposals would transform both riversides into attractive, distinctive and safer areas for both residents and visitors.

Florence's comprehensive, strategic and integrated approach to improving riverfronts aims to protect the best remaining resources as well as increase waterfront functions and conditions throughout the city. Therefore, it includes the development of management tools to measure results, with a focus on seeking environmental and urban improvement.

Thus, strategic planning for SuDS is necessary to create a sustainable drainage network that should be connected to the

2 The 'City Regulatory Plan'/'Regolamento Urbanistico Comunale', (RUC) - LR. 01/2005. Currently, the Plan is in transition due to the new Regional Law LR. 65/2014 and the new Action Plan, the 'Piano Operativo Comunale'/ The City Action Plan is about to be approved by the City Council.

3 Within the current 'City Regulatory Plan'/'Regolamento Urbanistico Comunale',(RUC)-LR. 01/2005, the 'Transformation Areas' (ATs) are intended to preserve and regenerate some specific city sites but a very little number of riverfront sites still need to be planned.

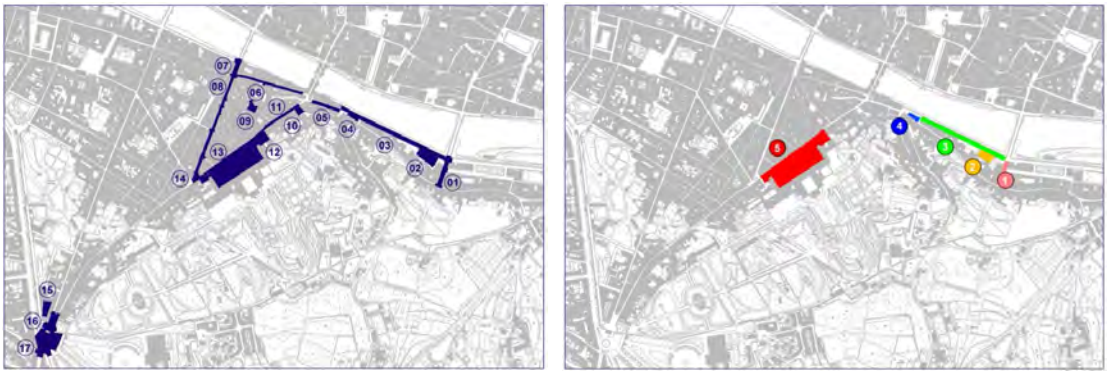
traditional city's drainage system. The proposed strategic schemes can provide information on specific spaces to ensure benefits or compliance with specific regulatory requirements. This approach should ensure effectiveness and greater flexibility in finding solutions that secure multiple communal interests. In short, combining stormwater management and waterfront regeneration can promote good design in public spaces and urbanity.

The proposed 'SuDS Strategy' is consistent with the city planning work along the Arno River and must led to the definition of several measures aimed at improving flood protection and rainwater management. For the proposed 'Action Strategy', various urban drainage techniques should be used to connect riversides to improvement projects throughout the City.

Therefore, the SuDS main benefits can be defined as follows:

- Control of the risks of rainwater flooding and pollution reaching the drains as well as freeing up the capacity of the sewers
- Improvement of the stormwater runoff that enters the city sewer system
- Climate change mitigation and improvement of air quality
- Improvement of urban environment with green strips and trees that can generate urban quality and well-being
- Improvement of mobility as well as pedestrian and cyclist safety
- Improvement of the natural environment
- Integration with wider urban regeneration
- Improvement of ecological protection
- Retrofitting of cultural heritage sites.

Developing a SuDS Strategy can help the City to evaluate current riverfront sites, measure current water risks and include them in urban water management. Considering the complexity of issues, land use planning and environmental management must be included. All the proposed scenarios assume that the Arno River can be performed to avoid future damage caused by floods. Research studies show that flooding risks combined with rainfalls are the dominant factor for the next years to come. In view of the above, it makes good sense to initiate measures that can limit rain floods in the future.



***Lungarno Torrigiani* and the proposed SuDS Network**

The present study investigates the impacts of climate change in Florence's historic Riverfront. Innovative approaches and tools will help to build better water-resilient places in this part of the City. Therefore, it is essential to provide sustainable drainage systems, at urban scale, to prevent water-related hazards, especially under intensive weather events.

The study area summarises significant proposals that have been developed to better understand how important it is to integrate SuDS intervention with planning process. At the same time, the study recognizes the importance of coordinating Local Authorities that must consider addressing water-related shocks and stresses properly.

The study is driven by the following goals and objectives:

- To identify and develop new and appropriate approaches to stormwater management technologies increasing urban quality
- To retrofit SuDS technology in historic sensitive environment options and to improve stormwater management reducing flood risks along the riverfronts.

The approach and studio proposed below are the result of both fieldwork and desk research to first understand the city's context, identify infrastructure assets and face water risks to properly manage water systems and build water resilience. In this contribution, only a part of the proposed Riverside Framework will be shown, including types of SuDS and sites:

Fig.1-2. Florence: 'Lungarno Torrigiani': The proposed SuDs Strategic Framework along the Riverside and in the wider urban context / The Proposed SuDs Plan identifying the specific riverfront sites to be transformed.

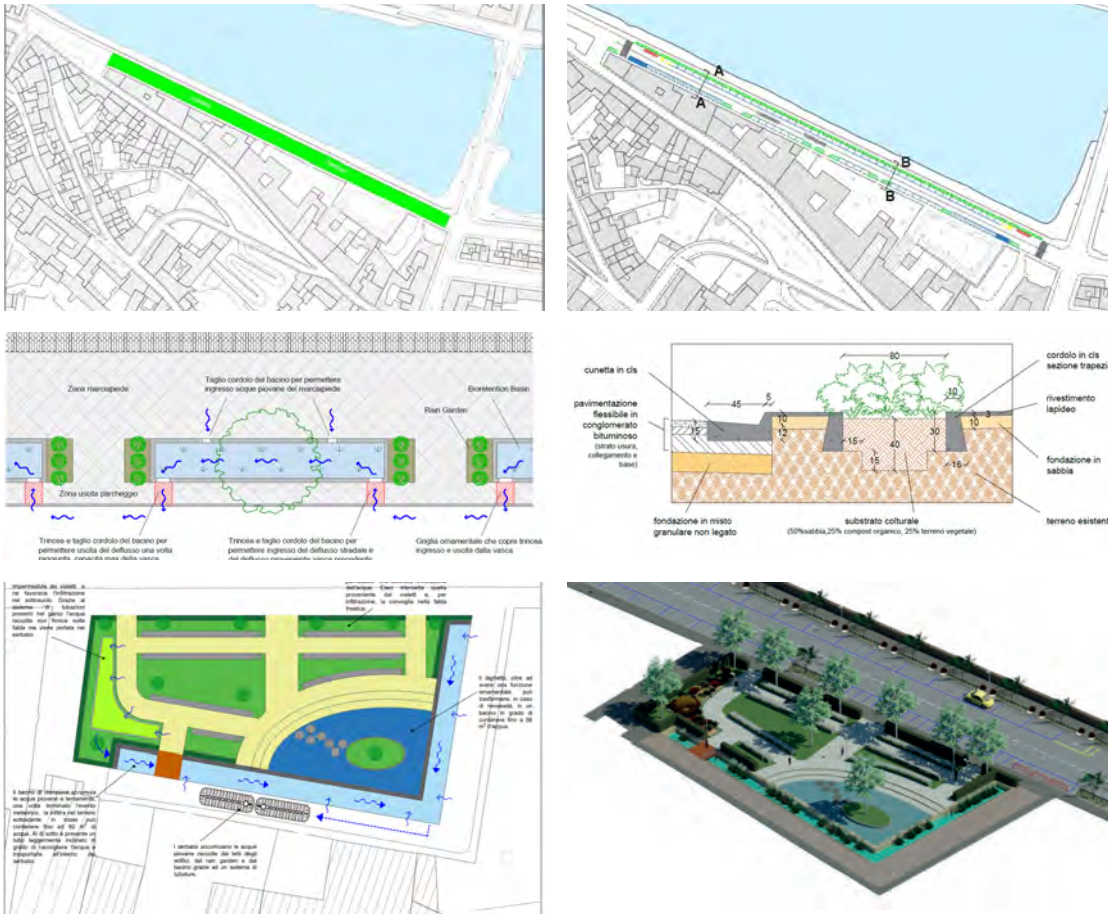
Lungarno Torrigiani – Green Street

The street is in the South bank of the Arno River and is approximately 320m long with an extraordinary view of Ponte Vecchio. Currently, the level of hydraulic hazard at the street is considered to be high and a green street intervention must be conducted to improve rainwater management using SuDS methods. The proposal promotes techniques that incorporate the benefits of the natural systems into the urban context. Planters formed by bioretention basins that can help prevent rapid flow of stormwater from roofs and parking lots are proposed on both sides of the street. In addition, rain gardens with landscape facilities that infiltrate stormwater into the ground can help to reduce surface water runoff entering the city sewers and the River.

The benefits obtained with this intervention are as follows:

- Reduction and turning of the volume of water conveyed in the sewer system
- Qualitative improvement of the road runoff that enters the sewers and the River, thus ensuring that the road as little impact on the surrounding environment as possible
- Micro-climate mitigation and improvement of air quality
- Improvement of the existing urban landscape with the addition of green strips that generate spatial and well-being benefits for citizens and visitors.
- Street re-organisation aimed at improving the vehicular flow and safety of pedestrians and cyclists.

More precisely, the north side of the road is designed with planters that effectively manage the road runoff while maintaining pedestrian circulation and street parking. Rainwater runoff flows by gravity in and out of 35 consecutive planters, formed by a central bioretention basin and two side rain gardens. Planters are designed to contain, infiltrate and clean up rainwater. On the south side, they are proposed as an extension of the sidewalk; 10 planters formed solely by bioretention basins, 8 of which are located close to parking lots. Each basin has a vegetation-covered surface that can accumulate the surface water runoff and retain it for infiltration on site. In the case of consecutive modules, when one device is filled, water flows into the next. If the rain is so heavy as to exceed the capacity of the tanks placed in series, the runoff flows into the sewer from the release of the last module.



Martin Lutero Square – Pond and rain garden

Retrofitting of the existing area with landscape facilities that infiltrate stormwater into the ground helps protect the Riverfront against high hydraulic danger. This small garden area of approximately 982 square meters, accessible from *Lungarno Torrigiani*, is well presented with some green strips.

The proposal includes interventions able to improve rainwater management and to control flooding risks with particular attention to water pollution. This approach will restore more natural riverfront functions and at the same time has the greatest potential to protect the River and provide environmental improvements. Several interventions were proposed, such as the design of a storage system of two underground tanks able to accumulate rainwater, enabling the collection of rainwater from the roofs of the surrounding buildings and its use for both the irrigation of the garden and the surrounding private green areas.

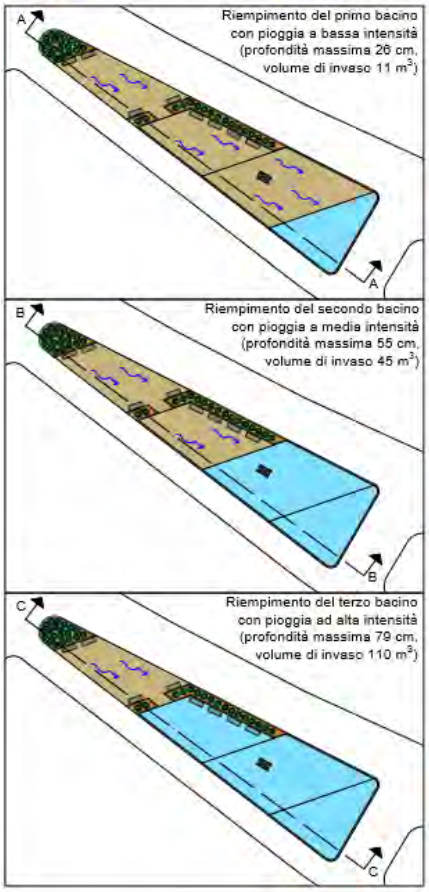
Fig. 3-8. Florence: 'Lungarno Torrigiani' Street and the proposed Rain garden – plan and detail of the rain garden. 'Piazza Martin Lutero' transformed to manage surface water runoff with rain gardens and retention basin.

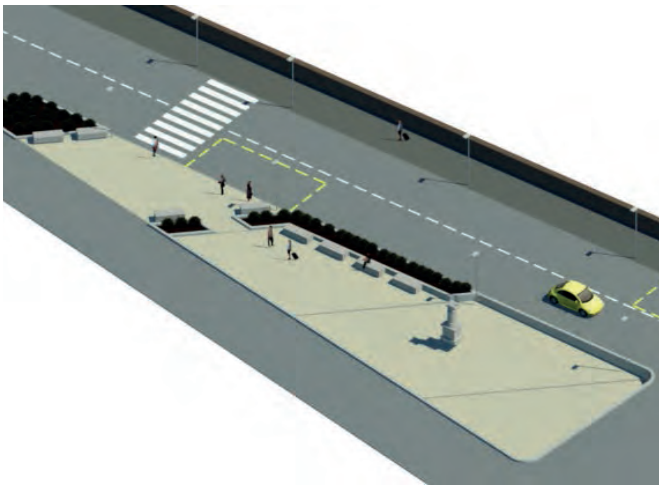
—

Fig. 9-13. Florence: 'Piazza di Santa Maria Soprarno'. Plans and sections before and after the proposed Water square. The proposed water square is divided into three basins to allow a great water retention but in slow filling.

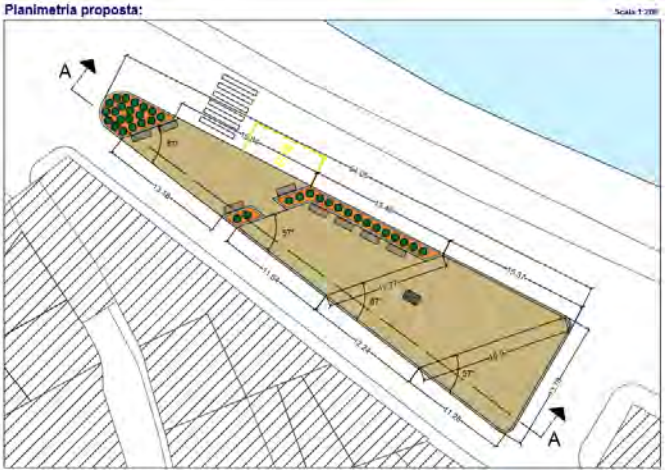
SCHEMA DI FUNZIONAMENTO:

Pianta: **Scala 1:500**

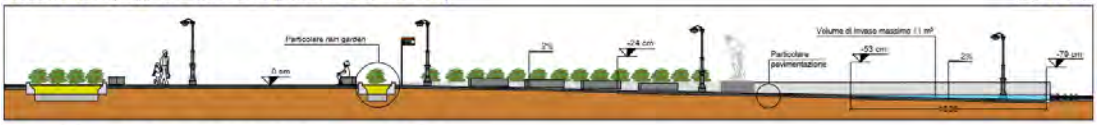




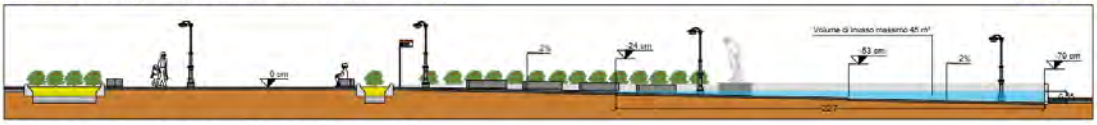
Planimetria proposta: Scala 1:200



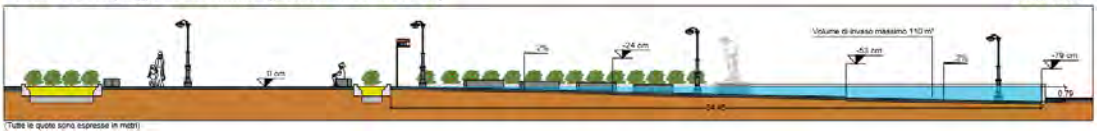
Sezione A-A con pioggia a bassa intensità (profondità massima 26 cm) **Scala 1:100**



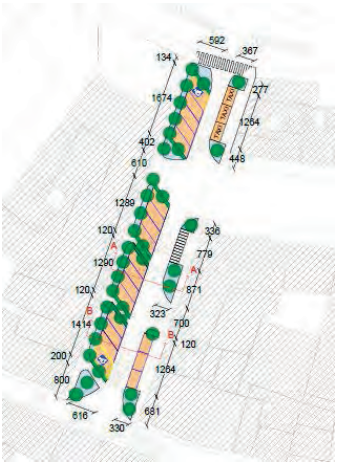
Sezione B-B con pioggia a media intensità (profondità massima 55 cm) **Scala 1:100**

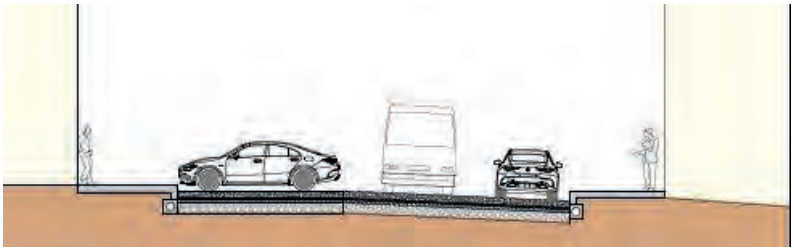


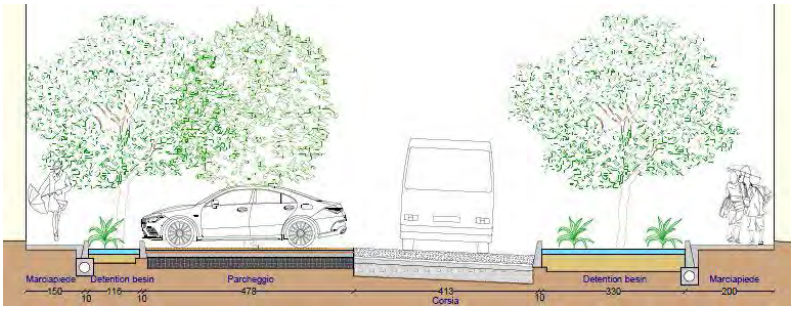
Sezione C-C con pioggia ad alta intensità (profondità massima 79 cm) **Scala 1:100**



(Tutte le quote sono espresse in metri)







The garden was designed with a view to urban quality and as an open-air water reservoir. Under normal conditions, the pond is fed by underground tanks that recover rainwater. However, in case of heavy rainfall or flooding, the pond can turn into a detention basin conserving water as a resource for non-potable purposes. The design of the rain garden was proposed with appropriate plants to reduce the amount of pollutants in wastewater collected from rainwater.

Finally, the garden is designed to recover and manage the urban surface of the surrounding buildings and open spaces with three

types of devices: (a) a piping system; (b) a system of retention and infiltration; (c) a storage system.

Piazza de' Mozzi – Rain Garden and Tree-pits

Piazza de' Mozzi is a street perpendicular to the Arno River. The level of hydraulic hazard at the street with parking lots is considered to be elevated. The main goal is to transform the street aesthetically by using SuDS techniques such as detention basins, tree-pits and permeable paving to reduce the hydraulic capacity of the sewer system and at the same time to develop urban quality. Vegetation plays a significant role in the hydrologic process through the interception, storage and absorption of rainfall, as well as through evapotranspiration. The proposal involves the addition of a number of trees and vegetation designed to absorb rainwater, shade the sidewalks and green the urban environment. The existing flooring is replaced with a permeable surface with grass for the parking lots and tree-pits, while the retention basins are placed between the tree-pits and sidewalks.

Piazza Santa Maria Soprarno – Rain Garden – Ponds and Detention Basins

The square is located close to the Arno River and the level of hydraulic risk in this place is considered high. Over the years, it has undergone many transformations, the latest in 2017 when it was redeveloped with a new flooring and two planters. The proposed stormwater actions include sustainable urban drainage and the collection of rainwater that will benefit the area. With a view to taking advantage of the slope of the square, the proposed intervention is to create a water square: an urban space entirely usable in dry periods (about 410 square meters paved) which is transformed into a water storage basin for a period of approx. 12-24 hours, mostly during rainy events. The design includes the development of three rain gardens aimed at improving the urban landscape and citizens' well-being but also at promoting urban water runoff, waterproofing the soils especially during exceptional flooding events.

In fact, the proposed water square is divided into three basins identified by three inclined floors and separated by low elevated parts to allow its gradual filling during an intensive stormwater event. With low intensity rain, the water flows freely along the sloping paved area, collecting water at the lowest elevation and filling only the first basin. With medium intensity rain, the second basin will also be filled. During periods of heavy rain, the water will cover the paved area fully, filling the third basin.

Fig.14-16. Florence: 'Piazza De'Mozzi': Plan and Section before and after the proposed SuDS intervention with permeable paving and tree-pits.

Specifically, the proposed water square with SuDS methods raises awareness and encourages climate change adaptation, (a)

reducing water pollution; (b) creating more pleasant urban landscapes; (c) providing opportunities to save water; (d) providing opportunities for studies related to the water cycle.

In conclusion

SuDS are intended to improve the quality of public space while reducing flood risks and decreasing peak flows. At the same time, they can improve the management of water flow and storage, mobility and visual connectivity, taking into account engineering design constraints. In designing SuDS, an integrated planning process taking into account people's requirements is needed to respond to constant urban changes, especially those related to climate change.

In historic environment, the design of SuDS must be flexible to preserve the historic character and cultural heritage as well as to properly investigate the ways of managing permeability, buffering and surface conveyance of storm water better.

SuDS proved to be a good solution for stormwater management, while adding aesthetical value to the areas in which they are designed. It is important to note that different types must be adapted to different sites. The cost of converting from conventional drainage systems to SuDS is high and their good performance often depends on a good maintenance of such systems, which is a matter for discussion.

For Florence's Riverside, an appropriate and integrated design should be proposed for a well-integrated system to prevent flooding risks, particularly considering the historic environment of such great value.

Note

All drawings and SuDS proposals relate to the City of Florence have been properly developed within the "Design Studio" in the framework of the Degree Course of "Technical Urbanism" (Civil Engineering Master Cource Academic Year: 2020 -2021). The Design Studio has been coordinated by

References

ARCH 503 (2008). *Portland's Green Streets, SW 12th Avenue*. https://courses.washington.edu/gehlstud/gehl-studio/wp-content/themes/gehlstudio/downloads/Autumn2008/Portland_Green_Streets.pdf, accessed 25/03/2021.

ASLA - SW 12th Avenue Green Street Project (2006). www.asla.org/awards/2006/06winners/341.html, accessed 25/03/2021.

Berlinbaut (2016). *Stadtentwicklungsplan Klima KONKRET: Klimaanpassung in der Wachsenden Stadt*. Berlin: Senatsverwaltung für Stadtentwicklung und Umwelt Kommunikation.

Cahill T.H. (2012). *Low Impact Development and Sustainable Stormwater Management*. Oxford. UK: John Wiley &Sons.

Woods Ballard, B. et al, (2015). *The SuDS Manual*. London, UK: Ciria.

Cittá di Bologna, (2018). *Linee guida sull'adozione di tecniche di drenaggio urbano sostenibile per una città più resiliente ai cambiamenti climatici.* Bologna: Cittá di Bologna.

City of Copenhagen (2018). *Copenhagen Climate Resilient Neighbourhood*. Copenhagen.

City of Portland/ Environmental Services (2006). *2005 Portland Watershed Management Plan.* Portland, USA.

City of Vienna - Environmental Protection Department (2018). *Urban Heat Island Strategy.* Vienna.

Colin, A., Booth, C.A. & Charlesworth S.M. (eds) (2017). *Sustainable Surface Water Management. A Handbook for SuDS.* Oxford, UK: John Wiley & Sons.

CWRA, (2019), *The city water resilience approach.*

Design Trust for Public Space (2010). *High Performance Landscapes Guidelines. 21 Century Parks for NY*, New York.

Fletcher T.D. et al., (2015). SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage, *Urban Water Journal*, 12:7, 525-542, DOI: 10.1080/1573062X.2014.916314.

Hoffmann J. & Paalman M. (2015). *Rainwater harvesting, a sustainable solution for urban climate adaptation?* KWR Watercycle Research Institute, The Netherlands.

INTERREG WATER RESILIENT CITIES, (2020). *Greening the Grey: A guide retrofitting sustainable drainage systems into urban areas.*

Mckenna D., Krüger, I. & Hinzmann M., (2016). *Coastal Protection and SuDS Nature-Based Solutions.* Ecologic Institute: Berlin.

Somarakis, G., Stagakis, S., & Chrysoulakis, N. (Eds.) (2019). *Think Nature. Nature-Based Solutions Handbook*. ThinkNature project funded by the EU Horizon 2020 research and innovation programme under grant agreement No. 730338. doi:10.26225/jerv-w202.

Wong, T.H.F. & Brown R.R. (2009). 2009 Water Science & Technology—WST |60.3| 2009.

Zhou, Q. (2014). A Review of Sustainable Urban Drainage Systems Considering the Climate Change and Urbanization Impacts in *Water* 2014, *6*, 976-992; doi:10.3390/w6040976.

Dimitra Babalis
Associate Professor in Urban Planning and Design, Department of Civil and Environmental Engineering, University of Florence, Via di Santa Marta 3, 50139, Florence, Italy

Anna Januchta-Szostak

Poznan University
of Technology,
Faculty
of Architecture, Poland

Eco-Hydrological Consequences of Urbanization and the Development of Riparian Areas

Abstract. Long-term historical analysis of urbanization processes revealed radical changes in the proportions of built-up, natural and water areas in urban catchments. One of the effects of these changes is increased flood hazard. The article outlines the processes of degradation of blue-green structures in European cities and the ecohydrological consequences in river valleys. Different flood risk management strategies take into account the reduction of flood hazard, exposure and vulnerability to varying degrees. The author focuses on the strategy of "coexistence with water" and presents the principles of multifunctional management of floodplains and five basic types of buildings adapted to changing water levels.

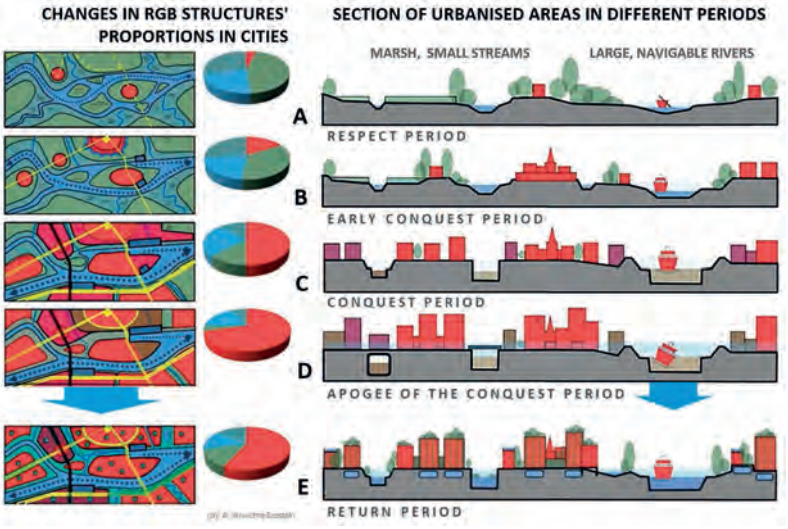
1. The historical processes of urbanization and their ecohydrological consequences

The history of urbanization was inseparably connected with the use of the environment and the transformation of catchment areas, waterfronts and rivers. The analysis of transformation processes of urban structures over a long time perspective revealed radical changes in the proportion of built-up (R – red), natural (G – green) and water (B – blue) areas in urban catchments (RGB structures - Fig. 1). In the "conquest period" which started in the era of colonialism and intensified as a result of the Industrial Revolution, large rivers were regulated, floodplains were separated by embankments and developed, the swamplands – drained, small urban watercourses – transformed into sewage collectors, vast areas of urban ground – sealed and drained while the rainfall runoff was directly discharged into sewage systems. As a result of this transformation, the retention capacity of cities has been radically limited resulting in (among others) an increased flood hazard (Januchta-Szostak, 2020). The scale of anthropogenic pressure in the 20th century changed the Earth's environment and climate, bringing us into the Anthropocene era. Today we are bearing the consequences of yesterday's mistakes in spatial decisions. Many of them are irreversible, but by implementing knowledge about the role of ecosystems and river hydromorphology, we can reduce the debt of our heirs. And this is the purpose of this article.

In the 21st century – in the face of the climate crisis and continuous growth of the urban population, the key water problems (floods, water scarcity and pollution) are escalating rapidly. Urban waterfronts are exposed to destructive floods, but the intensification of hydro-meteorological phenomena related to climate change is not their only cause. The real cause lies in the anthropogenic changes of entire catchments and the scale of environmental destruction (Fig. 1).

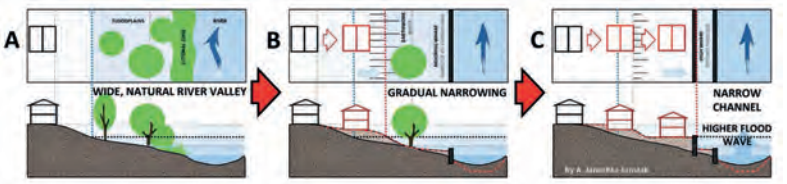
Fig. 1. A comparative profile: diagrams of changes in river valley intersection and ratio of RGB (red-green-blue) structures in the historical urbanization process (based on Januchta-Szostak, 2020, p. 203)

Fig. 2. The impact of urbanization on the shape of a river valley and the dynamic of a flood wave.
A. Natural valley; B. Gradual narrowing of the valley and strengthening of the riverbanks; C. Reduction of the valley retention capacity as a result of the elevation of the terrain or embankments.



2. Transformation of urban river valleys and floodplains

Initially, settlements were located above the floodplain level, and the wide, natural valley gave the river the possibility of meandering and self-cleaning (Fig. 2.A). The approach of buildings to riverbanks and the need for protection against erosion and floods resulted in the gradual narrowing of the valley (Fig. 2.B). The straightening of riverbeds accelerated the flow and caused even greater erosion, while concreting of wharves resulted in the destruction of the natural values of the littoral zone, including water retention and purification capacity. Dikes and embankments cut off the rivers from their floodplains. As a result of the urbanization of coastal areas and the narrowing of river valleys, the flood wave became higher, faster and more destructive (Fig. 2.C).



The strategies of return to rivers began in Europe in the 1970s with the revitalization of degraded urban waterfronts (Breen and Rickby, 1996; Bruttomesso, 2001). Raising ecological awareness and social pressure during the "green turning" of the 1970–80s led to gradual improvement in surface water quality, to which the Water Framework Directive (2000) has largely contributed. Further goals included flood risk management, river restoration, regeneration

of water resources and the environment of urban catchment areas by creating blue-green infrastructure (BGI) and sustainable urban drainage systems (SuDS) (Figures 1 and 4).

3. "Coexistence with Water" in urban riverside areas

The fundamental change in the flood risk management paradigm was reflected in the Floods Directive (2007), recognizing flooding as an unavoidable phenomenon. The focus has been shifted from flood protection to risk management, so different cities use various combinations of structural and non-structured mechanisms in relation to local conditions and levels of flood hazards. As the flood risk is a function of the flood hazard, the exposed values and their vulnerability (Kron, 2002), the reduction in flood losses can be achieved by implementing appropriate strategies (Fig. 2), such as:

A. Defensive strategy (Fig. 3.A) - flood hazard can be reduced by using measures increasing retention, both natural and artificial (retention reservoirs) and structures limiting the extent of floods, i.e. embankments, relief channels, river channel regulations etc.; that is, mainly with the help of technical flood protection infrastructure as well as increasing and protecting natural retention; this strategy is called "move the flood away from people";

B. "Retreat and Respect" strategy (Fig. 3.B), based on minimizing exposure (of buildings, objects and communities located in hazardous areas) by reducing investment in floodplains, mainly through bans or restrictions on building development, or setting special conditions for the construction of objects and by purchasing land and providing compensation; this strategy is associated with "moving people away from the water" and adapting possible development to ecohydrological conditions;

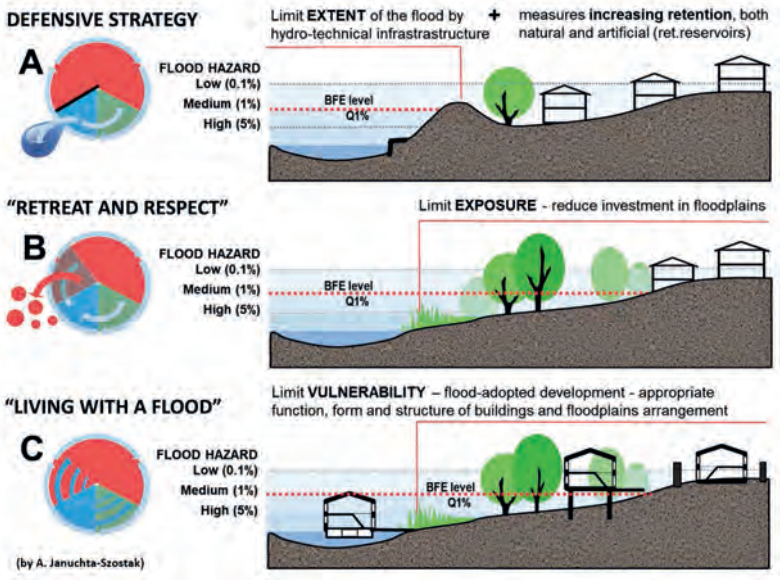
C. "Living with a flood" strategy (Fig. 3.C), aiming at limiting vulnerability (defined by the preparation of objects and people for floods) by using structural methods (e.g. protection of buildings and land development against floods) and non-structural, such as flood insurance, early warning systems and response to floods, awareness of residents and education about prevention and dealing with floods; this approach is a key element of wider "Coexistence with Water" strategy (Fig. 4).

In practice, "we manage neither to keep destructive waters away from people at all times nor keep the people away from destructive waters" (Kundzewicz et al., 2018), so "coexistence with water" seems to be the most effective strategy which combines actions aimed to limit the exposure and vulnerability and reduce sources of flood hazard (Fig. 4). Admittedly, floods constitute a hazard only when humans encroach on flood-prone areas, but in reality, it is difficult to constrain investment pressure on floodplains. In order

Fig. 3. Flood risk management strategies (Explanation: BFE level is the base, flood elevation is the computed elevation to which flood waters are anticipated to rise during the base (1% annual chance) flood event.

to increase the resilience of cities, it is crucial to strengthen the three pillars of the system: the ability to resist (e.g. through defence mechanisms), flexibility in absorbing floods and regaining efficiency (e.g. through spatial planning, disaster management and insurance), as well as seizing opportunities in the process of adaptation and transformation (Kundzewicz et al., 2018).

It is worth emphasizing that the reduction of flood losses is not the only priority in the development of urban riverside areas, although water management institutions often adopt such an assumption. Equally important is the enhancement of aquatic and water-dependent ecosystems, the preservation or restoration of migration corridors, and the recreational, commercial or residential (under high investment pressure) use of floodplains. And these functions can be performed by riverside buffer parks (RBPs – Januchta-Szostak, 2013).



The possibilities of urban development in riparian areas depend on the quality of environmental and water management in the entire catchments, as they have a direct impact on the quantity and quality of water in the receiving waterbody, i.e. the specific river or reservoir. Therefore, a "coexistence with water" strategy must include changes to land use planning, water and stormwater management, and greening entire cities (Fig. 4). Modern cities require Integrated Urban Water Management (IUWM) which is based on a catchment approach, taking into account the natural hydrological cycle and the path of water flow (a 'Source-Pathway-Receptor'

approach) because flood problems in the receivers have their causes in the lack of the retention capacity in urban catchments as well as the speed and volume of surface runoff on the path.

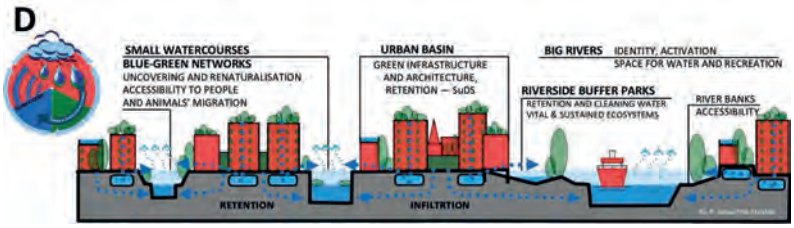


Fig. 4. "Coexistence with water". Successful implementation of this strategy requires actions in large river valleys, in the systems of tributaries and the entire urban basin (based on Januchta-Szostak, 2020, p. 207).

4. Buildings adapted to changeable water level

Leaving space for water is the best way to develop areas exposed to rapid flooding, but urbanization pressure is sometimes so strong that the only way to minimize vulnerability is to choose the right type of amphibious architecture. American and British guidelines (e.g. RIBA, 2018; NRC, 2015) for the development of flood prone areas emphasize the importance of adapting the forms, functions and structure of buildings to the peculiarity of flood hazard (including flow speeds and water depth at the 1% flood event) as well as the use of waterproof materials and installation systems resistant to water penetration. As a result of the analysis of numerous examples of amphibious architecture, five basic types of buildings (fig. 5) adapted to changeable water levels were identified (Januchta-Szostak and Karaśkiewicz, 2020), such as:

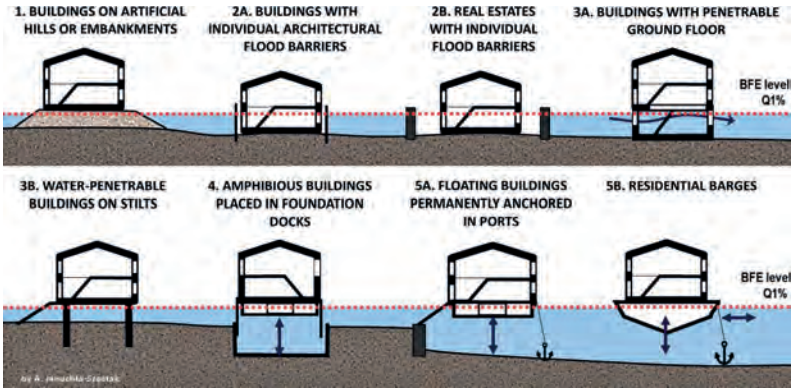
1) buildings on artificial hills or embankments;
2) buildings with individual flood barriers: 2A integrated with architecture, or 2B surrounding the plot of larger real estates;
3) water-penetrable buildings: 3A with penetrable ground floor, or 3B built on stilts/posts;
4) amphibious buildings placed in foundation docks which can rise and float during floods;
5) floating buildings: 5A permanently anchored in ports or at quays, or 5B residential barges.

A common guideline is to raise the floor level of the building's ground floor above the BFE level, considering that base flood elevation (BFE) is the computed elevation to which flood waters are anticipated to rise during the base (1% annual chance) flood event. The most suitable types of amphibious architecture for different flood risk zones should be specified in building manuals attached to the planning documents, e.g.:

—

Fig. 5. Basic types of buildings adapted to changeable water levels (based on: Januchta-Szostak and Karaśkiewicz, 2020).

- types 1 and 2B – can be located in flood-prone areas where there is no danger of the narrowing of the valley cross-section and restricting the flow of floodwaters;
- type 2 – on floodplains or embanked areas to protect the existing buildings in compact (2A) or dispersed (2B) urban structures;
- type 3 – in areas at risk of flash floods and water-retention areas (3B);
- type 4 – in areas where rising flood waters are not accompanied by high flow speeds;
- type 5 – on waterbodies (applicable only in the aquatic environment).



5. Basic guidelines to minimize ecohydrological consequences in riparian environments

Riverside areas are under constant urbanization pressure, but their development must be based on the balance of RGB structures. In terms of urban needs (R), the safety of residents, recreational values and water availability are of crucial importance. Where development is required, the specific forms and location of buildings should be considered to avoid flow disturbance and environmental damage. It is worth using an architecture adapted to changing water levels. The natural environment (G) requires the protection and restoration of the vitality of ecosystems and their self-cleaning capacity, the continuity of ecological corridors and biodiversity must be ensured. For hydrological reasons (B), it is necessary to provide space for flood flow and water retention (Floods Directive) and to improve water quality (Water Framework Directive).

References

Breen, A. & Rickby, D. (1996). *The New Waterfront. A Worldwide Urban Success Story.* New York, San Francisco, Washington D.C.: McGrow-Hill.

Bruttomesso, R. (2001). *Complexity on the urban waterfront.* In: Waterfronts in post-industrial cities. Ed. R. Marshall. London: Spon Press 39–49.

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (the so-called Water Framework Directive).

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (the so-called Floods Directive).

Januchta-Szostak, A. (2013). Multifunctional riverside buffer parks – the research on nature-urban revitalisation of river valleys. *Journal of Sustainable Architecture and Civil Engineering*, 4(5), 42–50.

Januchta-Szostak, A. (2020). *River-friendly cities.* Berlin, Bern, Bruxelles, New York, Oxford, Warszawa, Wien: Peter Lang.

Januchta-Szostak, A. & Karaśkiewicz, A. (2020). Development of flood prone areas in Wielkopolska region, *Journal Of Water And Land Development*, *44 (I–III)*, 90-97.

Kron, W. (2002). *Keynote lecture: Flood risk = hazard x expo-sure x vulnerability.* In: Flood defence '2002. Eds. B.S. Wu, Z.Y. Wang, G.Q. Wang, G.H. Huang, H.W. Fang, J.C. Huang. New York: Science Press Ltd., 82–97.

Kundzewicz, Z., Hegger, D., Matczak, P. & Driessen, P. (2018). Flood-risk reduction: Structural measures and diverse strategies. *PNAS 115/49*, 12321–12325.

NRC – National Research Council (2015). *Tying flood insurance to flood risk for low-lying structures in the floodplain.* Washington, DC: The National Academies Press.

RIBA (2018). RIBA Policy Note: *The value of flood-resilient architectural design* [online]. Royal Institute of British Architects. https://riba.app. box.com/s/j2yebl7um xdqgrhpb8jqycyl8vohspcb [Access 21.09.2019].

Anna Januchta-Szostak
Associate Professor, Faculty of Architecture, Poznan University of Technology, ul. Jacka Rychlewskiego 2, 61-131 Poznań, Poland

Laval University, Canada
Maxime Nadon-Roger

Waterfront Regeneration and Post-Industrial Shorelines in the Context of Climate Change:

A Morphological Analysis of the Situation in Quebec City

Abstract

Despite its distance from the sea, Quebec City has a maritime character by virtue of its location at the furthest point upstream to experience significant tides, which can reach more than five metres one third of the year. The natural and artificial morphology of the St. Lawrence Estuary and the historic land use in the Quebec City region make the adjacent shoreline particularly vulnerable to natural disasters such as flooding. In this context, countering urban sprawl and protecting natural environments requires a sustainable approach to redeveloping urban, industrial, and port lands. Indeed, scholars recognise the regeneration of post-industrial riparian areas as an emerging global issue associated with climate change.

Divided into three sections, this article proposes a morphological reading of this context, one that assesses how a better understanding of the shoreline's operational history can guide present-day choices about where to protect, how to adapt, and what to build. A short review introduces key concepts in the redevelopment of brownfield sites. The case study follows and provides a portrait of the geomorphological conditions in the Quebec City area, using a historical-descriptive approach. A review of the historical persistence of anthropogenic influences on the urban landscape support a morphological analysis. The vulnerability assessment of Quebec City's central waterfront district is assessed in regard to the inhabited land that will be subject to annual flooding by 2030. Finally, the paper explores whether a process of urban subtraction supported by citizen advocacy could help ensure a place for ecosystems strengthening initiatives within coastal regeneration projects. With this in mind, the modelling of a phenomenon such as annual flooding alongside a morphological analysis of the surrounding area can contribute to a better understanding of not only local issues affecting specific port cities, but also implications of those issues at a global scale.

1. Introduction

Based on current rates of urbanisation, the United Nations (2019) predicts that more than 60 percent of the world's population will live in cities by 2030, and that the figure will increase to nearly 70 percent by 2050. Meanwhile, experts expect 59 percent of cities with a population of over 500,000 to experience at least one of the following six types of natural disasters during the same period: cyclones, droughts, floods, earthquakes, landslides, and volcanic eruptions (United Nations, 2018).

The natural morphology of the St. Lawrence Estuary and the historic land use in the Quebec City region make the adjacent shoreline particularly vulnerable to such events. This is particularly true of areas that have been backfilled for industrial use and port operations. Furthermore, rising water levels will aggravate issues associated with two major inputs. First, the existing port infrastructure, including alterations to historic harbours, is reaching the end of its first useful life cycle (±50 years). Like its counterparts around the globe, the local port authority foresee therefore major new investments. Second, Quebec City metropolitan area is expected to welcome some 28,200 new households by 2036 (Ville de Québec, 2018, p. 3). In this context, countering urban sprawl and protecting natural environments requires a sustainable approach to redeveloping urban, industrial, and port lands (Nadon-Roger & Dufaux, 2020)"properties":{"formattedCitation":"(Nadon-Roger & Dufaux, 2020. Indeed, scholars recognise the regeneration of post-industrial riparian areas as an emerging global issue associated with climate change (Bardos et al., 2020).

Divided into three sections, this article proposes a morphological reading of this context, one that assesses how a better understanding of the shoreline's *storia operante* or (Muratori, 1959) 'operational history' can guide present-day choices about where to protect, how to adapt, and what to build. A short review introduces key concepts in the redevelopment of brownfield sites. The case study (i) follows and provides a portrait of the geomorphological conditions in the Quebec City area, using a historical-descriptive approach. A review of the historical persistence of anthropogenic influences on the urban landscape (ii), supported by a morphological analysis. The vulnerability assessment (iii) of Quebec City's central waterfront district is based on the probabilistic model developed by Kopp et al. (2014). Finally, the paper explores whether a process of urban subtraction supported by citizen advocacy could help ensure a place for ecosystems strengthening initiatives within coastal regeneration projects.

2. Literature Review

The existing literature shows a clear consensus on two key issues related to the redevelopment of waterfront areas. First, successful regeneration depends on the preservation of a site's maritime character (Braae & Diedrich, 2012; Crombie, 1992; Larochelle, 1997; Loures, 2015; Real, 2015). Second, cities must ensure public access to the shoreline, which is often blocked due to a site's former industrial vocation (Cenci et al., 2014; De Sousa, 2006; Merzaghi & Wyss,

2009; Tesoriere & Lecardane, 2015). More recently, Carola Hein (2016) has called on professionals and academics alike to adopt an ecosystem approach that uses 'water as a common facilitator for multiple areas within the city' (p. 423). However, a neoliberal focus on economic returns in the context of a global marketplace often prevent such efforts (Hein, 2016; Hoyle, 2010; Schubert, 2011).

In an urban context, industrial brownfield sites generally have a multi-scale relationship with the built environment. Transforming such sites involves addressing problems related to land use, decontamination, and governance. With regard to land use, various authors have reflected on urban transformations characterised by flexible and sometimes radical approaches to sustainable design (Benali, 2012; De Sousa, 2006; Tesoriere & Lecardane, 2015). Meanwhile, although studies have regularly cited diverse challenges associated with decontamination (De Sousa, 2001, 2006; Guelton, 1999), recent research has noted the long-term potential of emerging ecosystem regeneration solutions such as phytoremediation (Bardos et al., 2020). Finally, scholars interested in governance focus on relationships between various political actors. For instance, Federica Merzaghi and Malika Wyss (2009) have described how the complex process of mobilising local communities shapes urban waterfront redevelopment projects. On a related note, Patrick Le Galès (2004) underscored how 'every city has its own governance'. More recently, Jérémy Cenci et al. (2014) have emphasised the need for local actors to consistently prioritise a site's territorial resilience. These authors are therefore aligned with Dumesnil and Ouellet (2002), who previously discussed how local community involvement in brownfield redevelopment projects helps ensure the social acceptability of such initiatives.

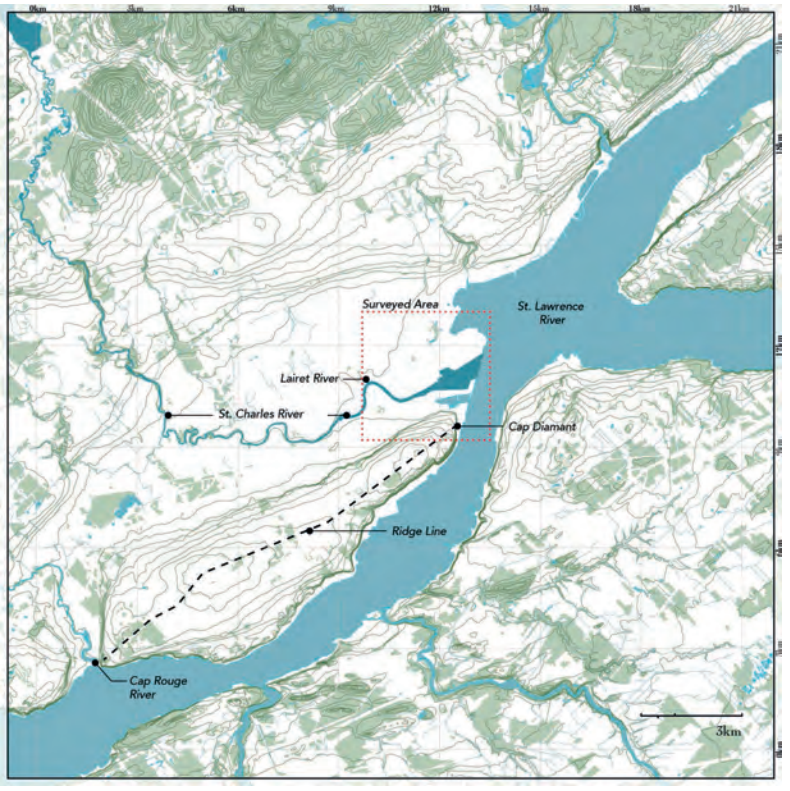
3. Case Study: Quebec City Shoreline

3.1. Historical Description

In 1608, European settlers founded Quebec City on the north shore of the St. Lawrence River, some 600 kilometres inland from the Gulf of St. Lawrence. The surrounding area, where the river narrows considerably, had first been explored by the French in 1535. Despite its distance from the sea, the city has a maritime character by virtue of its location at the furthest point upstream to experience significant tides, which can reach more than five metres 112 days a year (Government of Canada, 2021). By contrast, the port of Hamburg, located about 90 kilometres upstream from the North

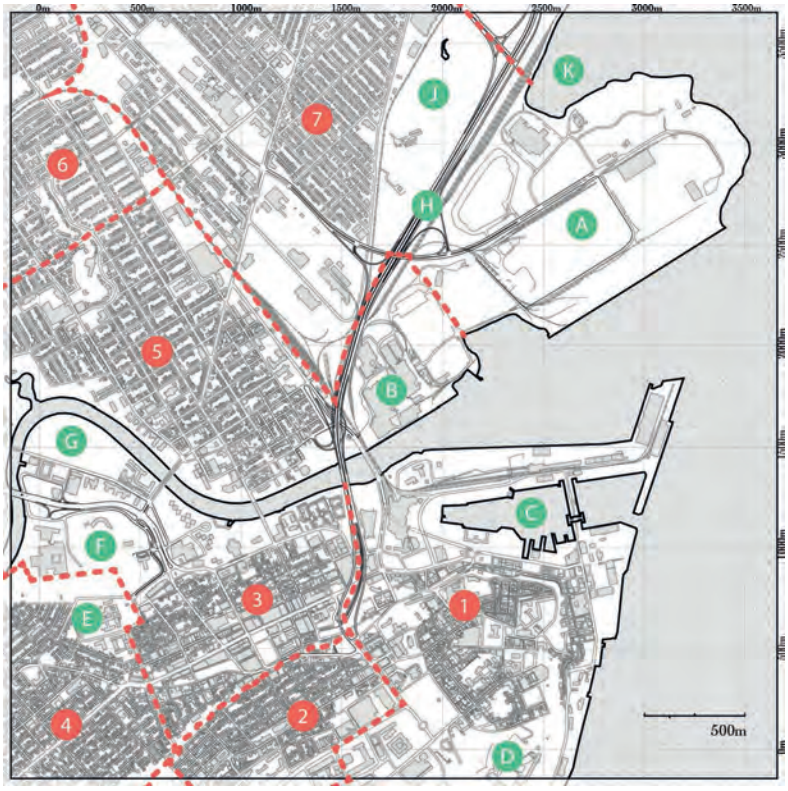
Fig. 1 The geomorphological conditions in the Quebec City area

Sea, experiences tides of four metres or more only a few days a year. Meanwhile, Nantes, located about 60 kilometres from the mouth of the Loire on France's Atlantic coast, deals with tides of up to seven metres a few days a year.

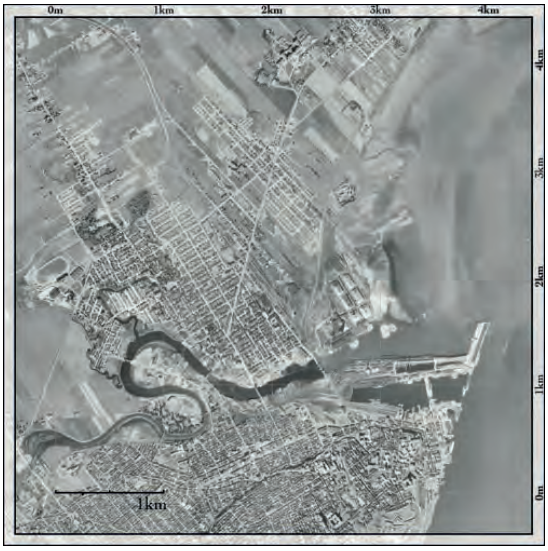


Geomorphological conditions determine a site's natural capacity for absorbing water and therefore its susceptibility to flooding. In the case of Quebec City, steep hills rise to a pair of plateaus on either side of the narrow plain that separates Cap Diamant from the Canadian Shield (Fig. 1). Following the spontaneous rules of human settlement (Caniggia & Maffei, 2000), the city's development began along the ridge that provided easy and continuous access to both the St. Lawrence and St. Charles rivers. In the 17th century, a citadel and fortified town were built at the eastern end of Cap Diamant, which rises to 100 metres above sea level. This is where Quebec City's main historic institutions – convents, seminaries, churches, government buildings – were established (Fig. 2). In the 19th century, urban development began to spread along the St. Charles River. The St. Roch and St. Sauveur neighbourhoods grew apace with the activity of the adjacent shipyards and port.

Until the early 20th century, this largely residential piece of the city's 'basic fabric' remained confined to the area between the cliff and the St. Charles River. During the same period, backfilled land was used for industrial activities at the port and for specialised structures built to support the city's role as a centre of production (Caniggia & Maffei, 2008, p. 15).



In 1865 (Fig. 3a), although numerous wharves had come to define the Quebec City waterfront, the mouth of the St. Charles River remained in its natural state with a wide shoreline. Furthermore, the river's meanders helped to naturally absorb tides that reached as far as the Hôpital-Général. The Lairet River, a tributary of the St. Charles, criss-crossed the agricultural landscape along the latter's north shore. Typical of the St. Lawrence Valley, the foreshore consisted of a type of salt mars – called a *batture* in French – that emerged at low tide and that lay below a protective cover of ice in winter.



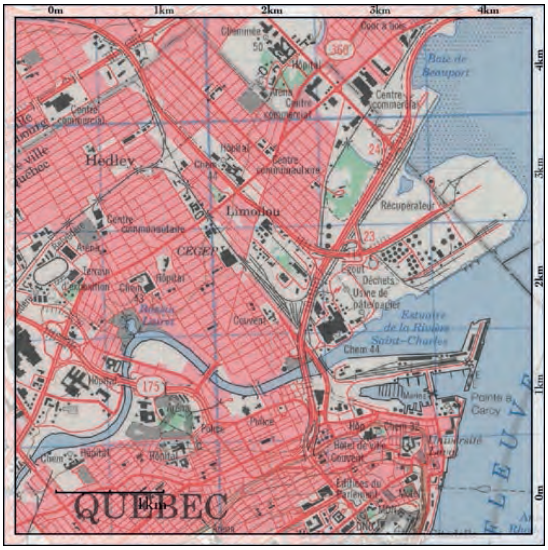
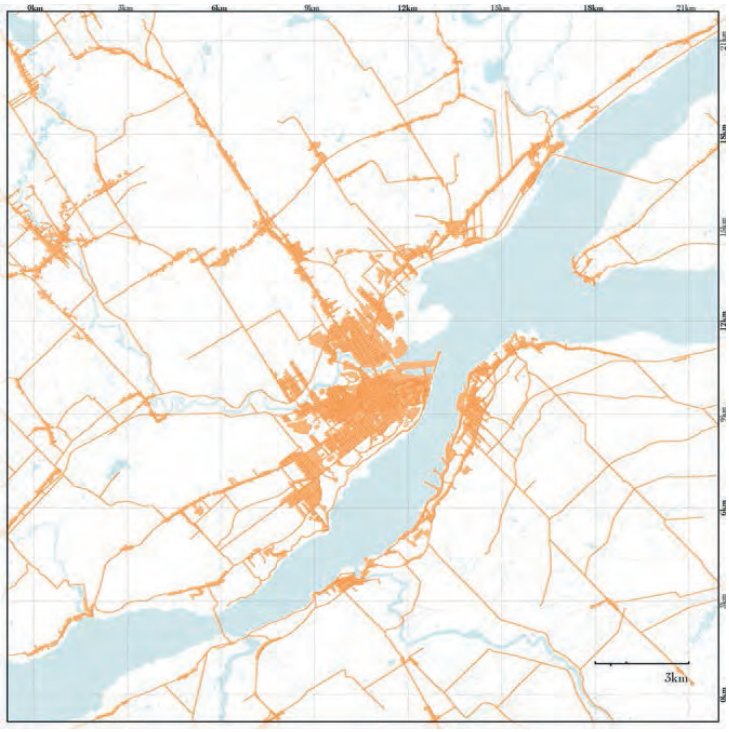
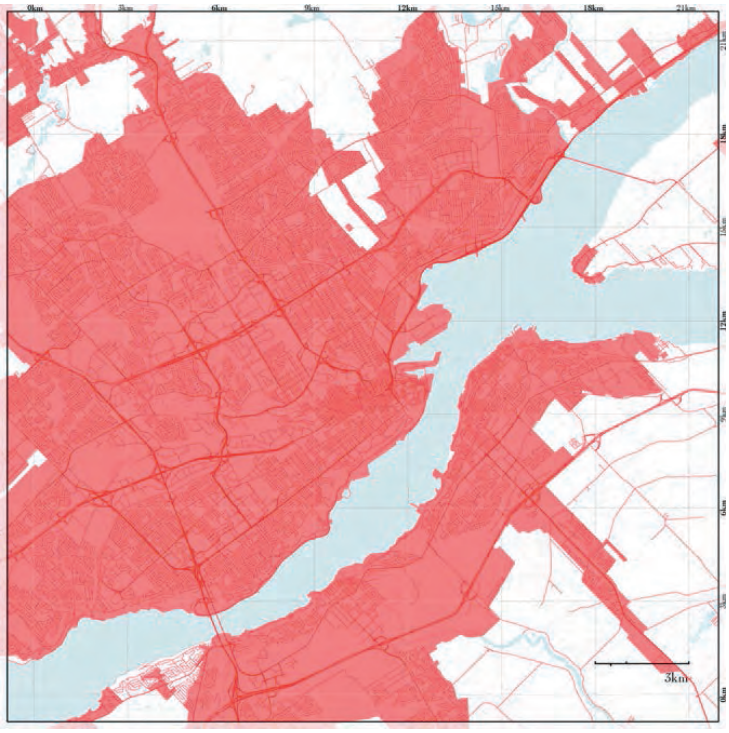


Fig. 2 Points of interest A: Port of Quebec, B: Pulp and Paper Mill, C: Louise Basin, D: Citadel of Quebec, E: Hôpital Général, F: Victoria Park, G:, H: Pointe-aux-Lièvres; H: Autoroute Dufferin-Montmorency; J: Maizerets Domain, K: Beauport Bay. Neighbourhoods: 1: Old Quebec City, 2: St. Jean Baptiste, 3: St. Roch, 4: St. Sauveur, 5: Limoilou, 6: Lairet, 7: Maizerets)

—

Fig. 3 Quebec City in 1865 (Fortifications Survey, BANQ Detail notice:P600,S4,SS2,D635), 1948 (Aerial photography, Ville de Québec. Engineering Department. Survey and Mapping Division, Archives extracted form GeoStat Centre at Laval University), and 2000(Topographic Map, BANQ Detail notice: 0002683907)


3km


3km

The construction of a pulp and paper mill at the mouth of the St. Charles River in 1928 marked the beginning of a new phase of urbanisation, one associated with growing industrialisation. Nevertheless, as late as 1948, urban development on the river's north shore remained limited to a one-kilometre radius (Fig. 3b). After 1950, alongside the increased availability and accessibility of private motor vehicles, two key factors drove significant levels of expansive growth in the Quebec City area. On the one hand, the increasing availability of suburban housing drove urban sprawl (Fig. 4). On the other hand, infilling of the St. Lawrence River near the mouth of the St. Charles supported further industrial development at the port. Granted, the Louise Basin had been dug in the late 19th century. However, anthropogenic impacts accelerated significantly after 1960, with a major expansion of the Port of Quebec (Fig. 3c).

3.2. Morphological Analysis of the Urban Fabric

During the second half of the 20th century, technological advances and growing prosperity inspired new efforts to control the urban landscape, including water management projects. In Quebec City, the banks of the St. Charles River were lined with concrete in the name of public hygiene. The meander that had encircled Victoria Park near the end of the tidal reach was cut off and filled in, dramatically altering the surrounding topography (Fig. 6). These changes allowed for the construction of the initial segment of the Autoroute Laurentienne (1956-1963). Burying a shoreline that was once submerged at high tide, this motorway links the city centre to the north and creates an urban barrier isolating the park and the surrounding lands. Meanwhile, the Lairet River was covered over, although its path remains visible in the street layout of the Limoilou District. Indeed, the originally organic and spontaneous course of these waterways, which had provided protection against spring flooding, stands in stark contrast to the grid layout applied to the surrounding neighbourhood.

Further downstream, an analysis of land use distribution shows that the lands owned by the Port of Quebec near the entrance to the St. Lawrence River were being adapted to industrial purposes (Fig. 7). This process included lining riverbanks and wharves with concrete or stone to meet international shipping standards. In addition to profoundly disrupting the natural ecosystem, this new waterfront infrastructure created a relatively low-density urban fabric. In contrast to the dense development that characterised earlier periods in the history of Quebec City, successive waves of post-war sprawl created vast wastelands associated with motorways, railways, industrial sites and suburban fringes (Fig. 8).

Fig. 4 Quebec City urbanised area in 1944 (orange) and 2020 (red).

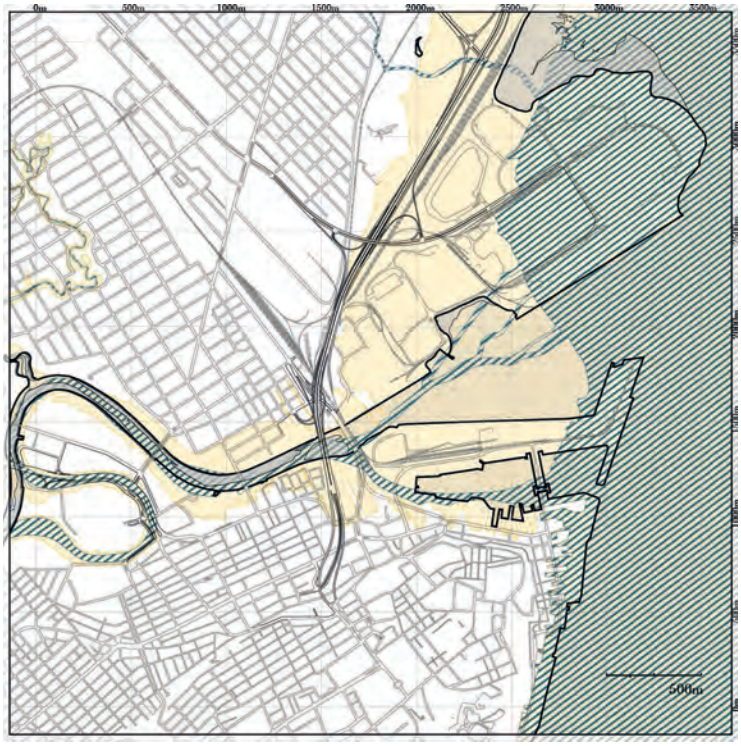


Fig. 5 Comparative view of the shoreline in 1865 (Blue: high tide; Yellow: low tide) and 2020 (Black: high tide; Gray: low tide)

Fig. 6 Anthropogenic impacts in the 1960s. Note the cut off meander on the south shore of St. Charles River and the covering over of the Lairet River to the north

—

Fig. 7 Distribution of plots in Quebec City's urban fabric, 2020 (Red: specialised plots, Yellow: basic plot, Green: green space and parks)

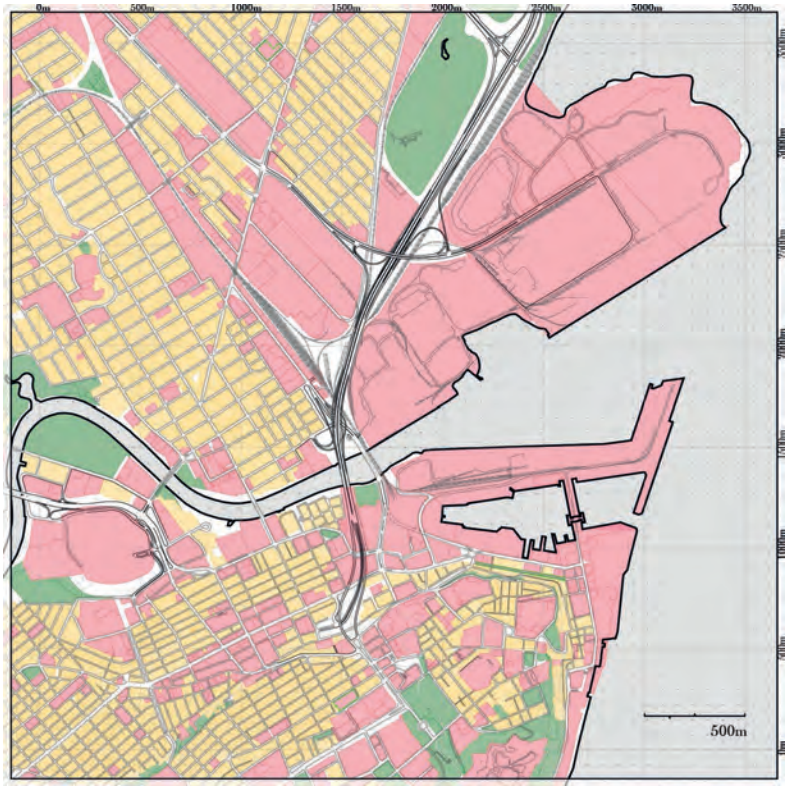
3.3. Projected Risk of Flooding in 2030

Initial projections indicate that flooding will begin to redraw worldwide coastlines by 2030, especially in areas adjacent to the ocean. And although Quebec City lies some 600 kilometres from the mouth of the St. Lawrence River, the region's natural and artificial morphology makes it vulnerable to rising sea levels. The impacts will be especially strong in the central parts of the city, between the urban core and the industrial lands surrounding the port (Fig. 9).

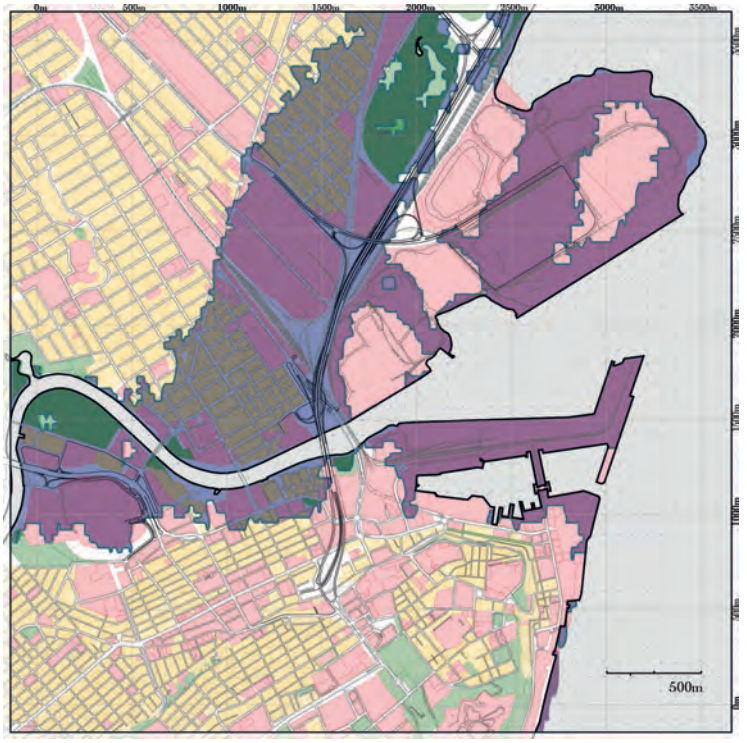
Table 1 Water surface area and ratio at low and high tide (1865 and 2020)

	Low tide area (ha)	Ratio*	High tide area (ha)	Ratio*	Foreshore area (ha)	Annual rate of change
1865	418.2	29.0%	690.3	47.8%	272.3	65.1%
2020	331.8	23.0%	360.7	25.0%	28.9	8.7%

**The ratios are in relation to the total surveyed area (1444 ha).*




2,5km


500m

Within a surveyed area of 1444 hectares (3800 m by 3800 m) (Fig. 2), the St. Lawrence and St. Charles rivers covered a total of 418.2 hectares at low tide in 1865. Based on an annual variation of 65 percent, the spring high tide line would have encompassed an area of up to 690.3 hectares. By 2020, following 155 years of urban development, the area covered by the same waterways had been reduced by 52 percent, to just 360.7 hectares at high tide. This reduction is largely due to the lining of riverbanks and wharves, as well as the removal of a shoal during the construction of the Autoroute Dufferin-Montmorency (a motorway linking the city centre to the east). Only a modest 28.9 hectares of riparian buffer strips remain in Point-aux-Lièvres Park on the Saint-Charles River and in the Maizerets neighbourhood on Beauport Bay (Fig. 5).

Table 2 Land at high risk of flooding within the surveyed area

Plot type	Quantity of affected plots	Total area (ha)	Ratio
Specialised	163	207.10	52.5%
Basic	1418	53.80	13.6%
Green space	12	13.38	3.4%
Roads, railways, and wastelands	n/a	120.53	30.5%
Total	1593	394.8	100%

The probabilistic model developed by Kopp et al. (2014) estimates the extent of land that will be subject to annual flooding by 2030, based on different climate scenarios (Climate Central, 2021). A moderate carbon scenario is considered, where the increase in global temperatures would be limited to 2 degrees Celsius by 2040, after which emissions would decline to half their current levels (this corresponds to the main target of the Paris Agreement). A scenario, within the 50th percentile of projected sea level rise, determined that 394.8 hectares of inhabited land within the surveyed area will face annual flooding by 2030. This high-risk area consists of 52.5 percent specialised fabric, 13.6 percent basic fabric and 3.4 percent green space or parks (Table 2). The remaining 30.5 percent largely consists of local roads, railways, and motorway fringes.

Fig. 8 Quebec City's urban built environment in 1944 and 2020 (Black: Built environment in 2020; Orange: Built environment in 1944)

Fig. 9 Inhabited land likely to face annual flooding (in purple), based on the probabilistic model developed by Kopp and al. (2014)

4. Discussion

The results of this analysis paint an alarming picture for Quebec City future. Changing environmental conditions could very well devastate neighbourhoods in the urban core and render the waterfront uninhabitable. Clearly, the area's natural defences will be insufficient to prevent widespread flooding by 2030 (Fig. 9). In fact, not even a restoration of the 1865 shoreline would adequately protect the central parts of the city. Furthermore, the presence of the escarpment limits options for a broader regional approach to the problems facing the lower St. Charles River Valley.

4.1. An Alternative, Citizen-Based Approach

Urban subtraction represents one possible solution. This process would involve cautiously but consciously deconstructing urban space and making the city more sustainable through the regeneration of natural landscapes and the promotion of biodiversity. For instance, re-naturalising shorelines to create new shoals and absorption zones could help establish a better ecological balance in the context of the climate crisis. Meanwhile, any new urban development must not impede the natural ability of the soil to retain water and filter pollutants through infiltration and percolation.

The Port of Quebec is currently proposing an expansion that would further encroach on the river and allow post-Panamax container ships to dock adjacent to the city centre (IAAC, 2020). Faced with the indifference of project proponents to pressing environmental issues, concerned citizens launched a community competition in February 2021. A total of 26 university students came up with nine alternative proposals for the Quebec City waterfront. The participating teams all agreed on the need for certain key measures: re-naturalising shorelines to promote biodiversity and regenerate ecosystems; providing access to the river; relying on participatory and active modes of governance; and transforming the elevated highway into an urban boulevard. Fig. 10 illustrates one of the nine proposals, which involves transforming specialised sections of the urban fabric that are at high risk of flooding into a biodiversity corridor. Based on the 'sponge city' model, these new wetlands would significantly increase urban resilience. More generally, the contest and the movement behind it provide a promising model for addressing urban problems through community action and consultation.

However, the assessment of the capacity of such efforts remains unresolved to adequately address the impending increase in the frequency and intensity of natural disasters. Future studies should

Fig. 10 Team 8 entry in the community competition of February 2021. Top: current situation (Google Earth, 2021). Bottom: Plan by Team 8, composed of Alexandra Gagnon & Maxime Nadon-Roger).

therefore seek to measure their potential impact on projected annual flooding, alongside the various scenarios forwarded by the Port of Quebec.

4.2. Limits of Local Action in Relation to Global Dynamics

Over the course of the next decades, the climate crisis will require fundamental changes at multiple scales (regional, local, household) and in multiple areas (economy, energy, transportation, resources). Furthermore, these changes will require the transformation of built environments, a process shaped by the life cycle of the existing infrastructures, standby time, abandonment, and requalification.

As Schubert (2019) explained, the technological and economic context of globalisation has profoundly altered the relationship between cities and their ports since the 1990s. Local authorities increasingly find themselves forced to adopt development parameters imposed by international markets. But alongside these global realities, planning cultures remain deeply rooted in local contexts. Brenner (1999) has discussed this paradox in terms of 'glocalization'. Indeed, the annual floods that will begin to hit Quebec City around 2030 take on a whole new dimension when viewed from a global perspective. As dire as the local outlook may be, maritime cities the world over will face similarly devastating challenges.

In light of how various authors have demonstrated the value of interventions based on the principles of sustainable design (Benali, 2012; De Sousa, 2006; Tesoriere & Lecardane, 2015), the redevelopment of vacant lands in the context of efforts to re-naturalise shorelines represents a creative solution to climate change. But to be effective, such efforts must be accompanied by measures to limit – or even eliminate – urban sprawl, monoculture farming, the destruction of wetlands, and clearcut logging; all development patterns bound to the Postwar modernisation of the Canadian society. As Tesoriere and Lecardane (2015) have pointed out, the potential for deindustrialisation to fundamentally reshape the urban landscape depends on a multi-scale and multidisciplinary approach to changing existing development practices.

In the Canadian context, complex governance structures and land abundance can make urban optimisation difficult. And although the initiative launched in Quebec City in February 2021 seems to have succeeded in addressing the disconnect between a globalised economy and local realities, Bryan Hoyle (1999) noted how community groups in port cities often lack both the resources and the expertise to address challenges associated with globalisation, even when they are sensitive to the issues at play. Given its fundamental complexity, the climate crisis presents its own set of challenges. Citizen mobilisation efforts in Quebec City therefore need to recognise

the limits of local action in relation to global dynamics. As Merzaghi and Wyss (2009) have pointed out, even when local community action inspires good practices, it struggles to comprehensively address the underlying issues.

5. Conclusion

The climate crisis is set to bring annual flooding to the central part of Quebec City, as well as to the adjacent industrial and port lands. Addressing this challenge will require a forward-looking strategy for transforming the urban landscape based on an appreciation of pre-existing forms and the value of riparian lands, biodiversity, and shoreline re-naturalisation.

The morphological reading presented in the article aimed to show how an understanding of the area's *storia operante* (Muratori, 1959) or 'operational history' can help guide present-day choices regarding what should be preserved, transformed, or built. In other words, the task is to better understand the origins of our living environments, to better assess their development, and to better plan their regeneration. With this in mind, the modelling of a phenomenon such as annual flooding alongside a morphological analysis of the surrounding area can contribute to a better understanding of not only local issues affecting specific port cities, but also implications of those issues at a global scale. The aim must be to recognise and break down the components of the problem in order to recognise its origins and work toward comprehensive solutions.

Acknowledgments

The author gratefully acknowledges the kind assistance of various individuals and organisations. The research on which this article is based was supported by the Social Sciences and Humanities Research Council of Canada. The Centre interuniversitaire d'études québécoises (CIEQ) provided assistance with the writing process. Special thanks to François Dufaux and Pedro Ressano Garcia for their helpful collaboration.

References

Bardos, P., Spencer, K. L., Ward, R. D., Maco, B. H., & Cundy, A. B. (2020). Integrated and Sustainable Management of Post-industrial Coasts. *Frontiers in Environmental Science*, *8*, 86. https://doi.org/10.3389/fenvs.2020.00086

Benali, K. (2012). La reconversion des friches industrielles en quartiers durables: Aperçu théorique. *Cahiers de géographie du Québec*, *56*(158), 297–312. https://doi.org/10.7202/1014548ar

Braae, E., & Diedrich, L. (2012). Site specificity in contemporary large-scale harbour transformation projects. *Journal of Landscape Architecture*, *7*(1), 20–33. https://doi.org/10.1080/18626033.2012.693778

Brenner, N. (1999). Globalisation as Reterritorialisation: The Re-scaling of Urban Governance in the European Union. *Urban Studies*, *36*(3), 431–451. https://doi.org/10.1080/0042098993466

Caniggia, G., & Maffei, G. L. (2000). *Composition architecturale et typologie du bâti* (P. Larochelle, Trans.; 2e éd. éd. or. en italien 1979). École d'architecture, Université Laval.

Caniggia, G., & Maffei, G. L. (2008). *Composizione architettonica e tipologia edilizia*. Marsilio ; Alinea.

Cenci, J., Pouleur, J.-A., & Becue, V. (2014). Governance and Tools for the Post-Industrial Re-Conversion of the North-West European Mining Area: From a Contemporary Vulnerability to a Territorial Resilience. *Journal of US-China Public Administration*, *11*(2), 152–159.

Climate Central. (2021). *Maps & Tools | Surging Seas: Sea level rise analysis*. https://sealevel.climatecentral.org/maps/

Crombie, D. (1992). *Régénération: Le secteur riverain de Toronto et la ville durable : rapport final*. Commission royal[e] sur l'avenir du secteur riverain de Toronto. https://epe.lac-bac.gc.ca/100/200/301/pco-bcp/commissions-ef/crombie1992-fra/crombie1992-fra.htm

De Sousa, C. A. (2001). Contaminated sites: The Canadian situation in an international context. *Journal of Environmental Management*, *62*(2), 131–154. https://doi.org/10.1006/jema.2001.0431

De Sousa, C. A. (2006). Unearthing the benefits of brownfield to green space projects: An examination of project use and quality of life impacts. *Local Environment*, *11*(5), 577–600. https://doi.org/10.1080/13549830600853510

Dumesnil, F., & Ouellet, C. (2002). La réhabilitation des friches industrielles: Un pas vers la ville viable? *VertigO*, *Volume 3 Numéro 2*. https://doi.org/10.4000/vertigo.3812

Government of Canada. (2021). *2021 Tide Tables*. Minister of Fisheries and Oceans. https://www.tides.gc.ca/fra/donnees/predictions/2021

Guelton, S. (1999). Les enjeux financiers de la dépollution des anciens sites industriels. *Revue de géographie de Lyon*, *74*(3), 233–241. https://doi.org/10.3406/geoca.1999.4965

Hein, C. (2016). Port cities and urban waterfronts: How localized planning ignores water as a connector. *WIREs Water*, *3*(3), 419–438. https://doi.org/10.1002/wat2.1141

Hoyle, B. (1999). Scale and sustainability: The role of community groups in Canadian port-city waterfront change. *Journal of Transport Geography*, *7*(1), 65–78. https://doi.org/10.1016/S0966-6923(98)00030-1

Hoyle, B. (2010). Global and Local Change on the Port-City Waterfront. *Geographical Review*, *90*(3), 395–417. https://doi.org/10.1111/j.1931-0846.2000.tb00344.x

IAAC. (2020). *Laurentia Project—Port of Quebec Deep-Water Wharf—Beauport Sector* (p. 298) [Draft environmental assessment report]. Canadian Environmental Assessment Agency.

Kopp, R. E., Horton, R. M., Little, C. M., Mitrovica, J. X., Oppenheimer, M., Rasmussen, D. J., Strauss, B. H., & Tebaldi, C. (2014). Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. *Earth's Future*, *2*(8), 383–406. https://doi.org/10.1002/2014EF000239

Larochelle, P. (1997). Morphologie urbaine et aménagement des espaces riverains. In Thierry. Baudouin, Michèle. Collin, & Claude. Prélorenzo, *Urbanité des cités portuaires* (pp. 289–300). Harmattan; WorldCat.org. http://catalogue.bnf.fr/ark:/12148/cb36698747m

Le Galès, P. (2004). A chaque ville sa gouvernance. *Sciences Humaines. Hors Série*, *44*, 34–39.

Loures, L. (2015). Post-industrial landscapes as drivers for urban redevelopment: Public versus expert perspectives towards the benefits and barriers of the reuse of post-industrial sites in urban areas. *Habitat International*, *45*, 72–81. https://doi.org/10.1016/j.habitatint.2014.06.028

Merzaghi, F., & Wyss, M. (2009). Comment une friche ferroviaire se transforme en quartier durable: Le quartier Écoparc à Neuchatel en Suisse. *VertigO*, *Volume 9 Numéro 2*. https://doi.org/10.4000/vertigo.8757

Muratori, S. (1959). *Studi per una operante storia urbana di Venezia*. Istituto poligrafico dello Stato.

Nadon-Roger, M., & Dufaux, F. (2020). Waterfront Brownfields: The Challenges of Quebec City's Industrial and Harbour Regeneration. *PORTUSplus*, *10*. https://portusplus.org/index.php/pp/article/view/205

Real, E. (2015). Reconversions. L'architecture industrielle réinventée. *In Situ: Revue Des Patrimoines*, *[En ligne]*(26), 72. https://doi.org/10.4000/insitu.11745

Schubert, D. (2011). Seaport cities: Phases of spatial restructuring and types and dimensions of redevelopment. In Carola. Hein (Ed.), *Port cities: Dynamic landscapes and global networks* (pp. 54–69). Routledge; WorldCat.org.

Schubert, D. (2019). Ports and urban waterfronts. In C. Hein (Ed.), *The Routledge Handbook of Planning History* (pp. 338–349). Routledge, Taylor & Francis Group.

Tesoriere, Z., & Lecardane, R. (2015). L'urbanité de l'héritage industriel: La reconversion du viaduc de la High Line à New York. *In Situ*, *26*. https://doi.org/10.4000/insitu.11835

United Nations. (2018). *The World's Cities in 2018: Data Booklet* ((ST/ESA/SER.A/417)). Department of Economic and Social Affairs, Population Division.

United Nations. (2019). *World urbanization prospects: The 2018 revision* ((ST/ESA/SER.A/420)). Department of Economic and Social Affairs, Population Division.

Ville de Québec. (2018). *Portrait de l'habitation à Québec* (p. 66).

Maxime Nadon-Roger
M.Arch. and candidate of the Master of Science Degree in Architecture (M.Sc.) in School of Architecture, École d'architecture Université Laval (Laval University) Édifice du Vieux-Séminaire de Québec 1, côte de la Fabrique, bureau 3210, Québec, Canada

Gdańsk University of Technology, Poland
Izabela Burda

New Shapes of Land and Water Boundaries within Post-Industrial Sites for a Better Response to Climate Change

Abstract

The article discusses the role of modifications of land and water boundaries within post-industrial sites. It can be seen that changing the water plans and the forms of their borders is being increasingly frequently inscribed into development strategies for abandoned areas of water-related urban structures. The transformations made in recent decades very often concern the conversions of post-industrial sites. Many changes are being applied to former factories, ports, shipyards and warehouses. Research indicates that establishing new land-water connections in these conversion processes is crucial. More often, those ongoing transitions change the structures of the waterfronts and result in plans that define new boundaries between the land and water. In these sites, water is introduced into land surfaces and new land is created on existing water bodies. Such an approach can be considered as highly beneficial in achieving the expected effects of post-industrial site conversions. It is perceived as an ideal opportunity to enhance the relationship of the city structure and the water. At the same time, the transformations provide the potential to achieve high quality architectural and landscape solutions as well as space quality in both social and cost-effective terms. The application of this approach can also be helpful in better adapting urban spaces to climate change events and the risks posed by uncontrolled flowing waters and excessive rainfall.

1. Introduction

The last decades of the 20th century and the beginning of the 21st century were a time of dynamic functional and spatial transformations of many urban structures. The spectacular transformations of post-industrial waterfront areas became characteristic of this period. They gave a new, significant meaning not only to the architectural and urban complexes that underwent transformation, but also to the spaces of entire cities or regions. It can be noticed that, among various factors, the uniqueness of these "reclaimed" places was determined by their history (Braae, Diedrich, 2012). The preserved objects were helpful in creating the unique character of these spaces. However, the transformations of abandoned sites carried out in the last decade bring attention to the increasing practice of freely modifying the lines of the boundary between land and water.

Such operations are important to improve the continuity of public space linkages of isolated areas and their effective connection to the existing urban structure. Providing pedestrian routes along the water or with an opening to new bodies of water increases

their attractiveness (Burda, Nyka, 2017). In many cities, due to the introduction of new canals, the transformed spaces achieved special architectural value, gaining the opportunity to locate buildings in relation with the water. Shoreline extensions, although they are expensive projects, also bring economic benefits (Ebrahimabadi, 2015). In the face of the climate crisis, however, it is worth asking the most important question of whether modifying the plans of water bodies and shaping their new outlines favours the creation of a high-quality environment with high ecological and landscape values (Bardos, Spencer, Ward, Maco, Cundy, 2020). The discussion is needed to answer the question: Would such an approach help to better prepare the urban spaces for events related to climate change and the risks posed by the lack of control over flowing water and excess rainfall?

2. Research method

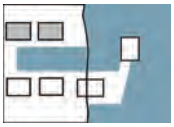
In order to analyse the ways in which modifications of the forms of land and water connections are inscribed into European brownfield redevelopment projects, 108 representative cases of such operations were identified. In examining the selected cases, the following criteria were taken into account: size of the area, location in the city structure – distance from the centre, the existing form of the connection between theland and water, as well as the mode and extent of intervention in the form of the border between the land and water. On this background, the basic main models for the transformations of the land-water interface have been established (Burda, 2016). Importantly, cases of transformations within sites located in urban centres and away from the city centres were analysed. The ways in which the land-water boundary line is transformed were compared depending on the relationship of the areas being transformed to existing water systems, the size of those areas, and the scale of the operations being carried out.

3. Forms and methods of modelling the land-water boundaries

When analysing the conversions of post-industrial areas, different models of land-water interface transformations can be highlighted. Their identification is possible because of the varied ways in which the quayside form has been modified – both in plan and in cross-section. On the basis of the research, four main types of modifications of land and water connections are possible to identify. The intermediate type, indicated as the fifth, is often used to accompany the forms listed as the main ones (Table 1). It should be emphasised

that while in the earlier phase of implementation of the transformations of post-industrial sites, in the years 1970–1990, interferences with the structure of the existing land-water connections were limited to a small extent, in recent decades an increasing degree of interventions has been applied to the design of such projects. Furthermore, it also happens that several types of modifications have been used simultaneously.

Table 1 Overview of the highlighted land-water boundaries transformation models

N.	TRANSFORMATION MODEL	DESCRIPTION	REMARKS
I		Method of reshaping the quayside with maintenance of the existing water area plan	■ there are modifications in the scope of introducing structural reinforcements and new material solutions; ■ period of application: 1970s – until now;
II		Modification of embankments using the existing land-water boundary line along with the implementation of different structures on the land-water edge and floating objects	■ there are modifications in the scope of introducing structural reinforcements and new material solutions, which result in obtaining new forms of quay cross-sections; ■ period of application: 1990s – until now;
III		Modification of embankments using the existing land-water boundary line along with the introduction of water into the land area	■ implementation period: from the beginning of the 21st century;
IV		Shaping the new contour of the land-water boundary using the introduction of new surfaces of water bodies and land areas	■ period of application: from the end of the first decade of the 21st century;
V		Point-occurring elements with the presence of water as a form of continuation of the water area on the land surface	■ river islands or floating objects can be considered a negative of such a phenomenon; ■ it is also associated with other types of transformations; ■ period of application: 1980s – until now

Owing to the research carried out and the identification of groups of cases differing in the degree of interference with the form of the water body boundary, it is possible to determine the dependence of the modes of intervention on specific conditions. The most important are the location within the city structure, the relationship to existing water systems, the size of the areas to be transformed and the scale of the operations. The existing investment in the post-industrial area and development of the neighbourhood zone

are also important determinants (Hein, 2016). These conditions determine the selection of the elements of the functional program created for post-industrial areas, and thus the method of shaping the land-water boundaries.

4. Results

Location within the city structure as an important factor

It is worth noting that a large group of post-industrial complexes which have been transformed are located in the immediate or close proximity of city-centre areas. The research shows that if the land to be converted is in the central city zone, it finally becomes an integral part of the city centre. Such a location is an advantage which very often distinguishes post-industrial areas among currently available development sites. In such areas, a high intensity of pedestrian circulation, diverted from existing urban centres, is assumed and various functions are introduced simultaneously. Due to the high intensity of development within inner-city areas and because of the small size of the post-industrial parcel or other conditions, there are cases where the possibility of modifying the outline of the water areas is rather limited. Their regeneration usually consists of changing the cross-section of the quayside so that access to the water is more convenient, and placing additional attractions on the water in the form of pedestrian bridges or floating objects is possible. At that time, numerous pedestrian paths aimed at accessing the water and the most attractive boulevards associated with them are being created. This is what happened in Gdańsk, where the original plan to create the canal in the post-industrial area of Brabank was rejected due to the preservation of the city's landscape.

However, on larger brownfield sites adjacent to city centre areas, modification of the quayside line is a very common practice. This is evidenced by the conversion of the Bjørvika area in Oslo, where an important part of the project was the modification of the water system and the boundary between the land and water, which was extended as a result of the transformation. An even more diversified form was used at Nordhavn in Copenhagen, where new canals introduced into the land area, new land areas on the water, as well as floating objects were designed. The creativity of shaping the connections between the land and water reached the highest level of interference in this case. In both cases, changes have also been made to the cross-sections of the boundaries, or forms of descent into the water, replacing sections of straight edges that maintain one level of

the quays with more varied solutions such as sloping planes or steps descending into the water.

As the analyses suggest, the further the area is from the city centre, the easier it is to model new canal lines, create water bodies or restore wetlands. The location of the transformation area away from the city centre zone is usually associated with a lower assumed intensity of use compared to the intensity of use of the city centre areas. It is therefore characteristic of most post-industrial areas located on the peripheries of cities that they are extensively developed and that mostly natural wharves are designed there. There is more flexibility in the reshaping of water area plans. They are treated primarily as places for recreation and leisure; efforts are also focussed on enhancing ecological and landscape value.

Such a strategy was used by the authors of the project for the conversion of the former airport serving Oslo, located on the Fornebu Peninsula. This idea of converting 340 hectares to create a part of the city was developed by Helin + Siitonen Architects. In the central part of the area, architects Bjørbekk & Lindheim, in collaboration with Atelier Dreiseitl, designed the 47-hectare Nansen Park, which culminates in a naturally formed large body of water. The only reminder of the former function of the site is the preserved air traffic control tower, which has become an accent element at the entrance to the park. The watercourses crossing the site, supplying the centrally located reservoir, relate to the linearity of the take-off runway. A pond that covers an area of 6500 m², flowing streams and a small waterfall, as well as the different forms of boundaries between land and water that have been implemented, in addition to their important functional role, make this part of the area very attractive.

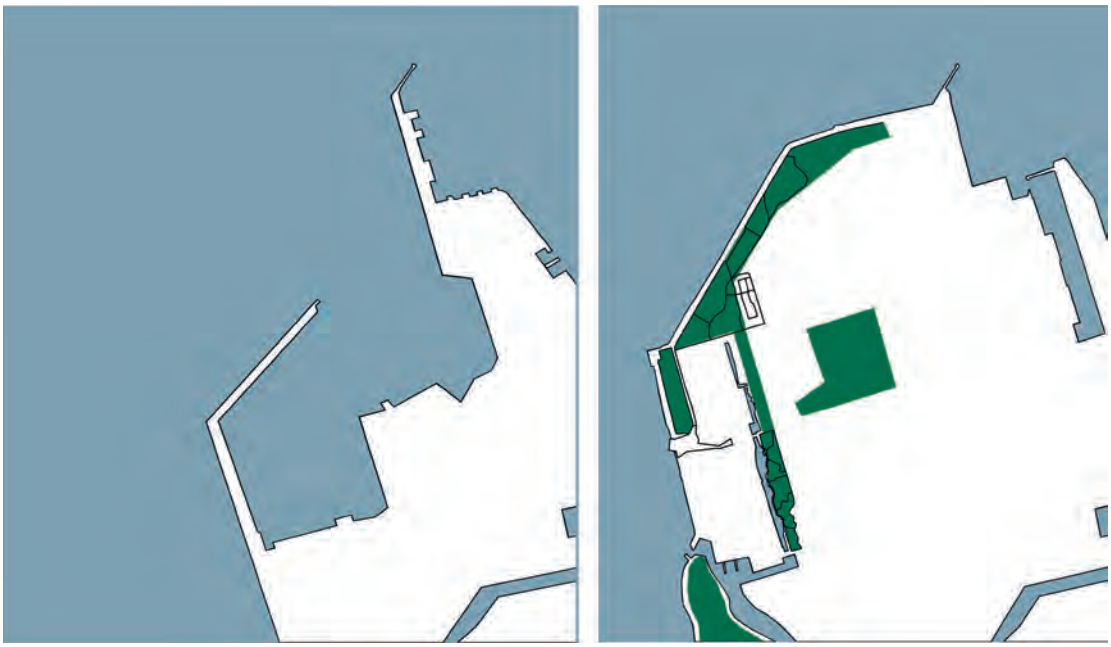
Conditions for creating eco-districts

Proper management of rainwater resources is a very important factor in the processes of introducing new functions and new water outlines to post-industrial sites (Völker, Matros, Claßen, 2016). Identifying ways to reuse it is an important element of the strategies developed for most of the projects completed in the last decade. Controlling the flow of rainwater and developing a system to regulate its level is an intervention to improve the quality of the environment, increase the attractiveness of space and ensure the safety of users (Januchta-Szostak, 2011). The introduction of new water bodies makes it possible to accumulate retention water in surface reservoir systems. As such, it can be used to power various

Fig. 1. Malmo Bo01. Comparative view of the transformed structure in 1940 and 2015 (Blue: water; White: land; Green: green areas)

water installations and even, under favourable conditions, be used as an ecological energy source.

Taking these solutions into account when planning the transformation of post-industrial areas has become one of the elements that determine the functioning of eco-districts. This term has come to mean complexes integrating the requirements of sustainable development, especially with regard to environmental protection, energy consumption and social living conditions. Model examples of eco-districts include the Bo01 complex in Malmo, Stockholm's Hammarby Sjöstad (Bo02) and Greenwich Millennium Village in London. In each case, new water plans have been introduced as important elements of nature's network, as extensions of the existing green-blue networks and as key elements of rainwater management.



For the Bo01 area, a specific strategy has been created to shape the new canals that cross the project area and the associated nature networks (Fig.1). As a result of conscious planning, water and greenery are present in the whole district. In order to fulfill one of the city's stated aims of increasing biodiversity, the green and blue networks have been extended with a rational use of the land. The numerous and varied park greenery already existing in the city and the greenery sequences accompanying the streets and squares have their continuation in the structure of the transformed area. All main routes lead towards the land-water boundary. Rainwater from

the entire area flows into canals, ponds and fountains or is directly discharged through canals connected to the Sound. Before they reach it, they are biologically treated. The waterfalls on the ponds and the various elements for buffering and purifying the water are the result of the topography of the area. They have been designed to reflect the natural course of the water.

Among the eco-districts is also the Greenwich Millennium Village in London (Fig. 2). Appropriately designed new water systems have contributed to achieving and maintaining the balance of the ecosystem in this area (Gledhill, James, 2008). It is also worth noting how important the activity of biological systems that maintain water purity is in these cases. The ecological aspect of the creation of these structures also manifests itself in the use of environmentally friendly building materials and elements of urban furnishings, in the construction of buildings and land development. The permeability of the land surface and the diversification and naturalisation of the wharf forms have a significant influence on their functionality. It can be seen here what an advantage sustainable drainage systems with surface runoff have over traditionally formed systems with underground runoff (Hinman, 2005). These are formed by streams, basins and retention ponds, which play an important role in the effective functioning of the flood protection system.

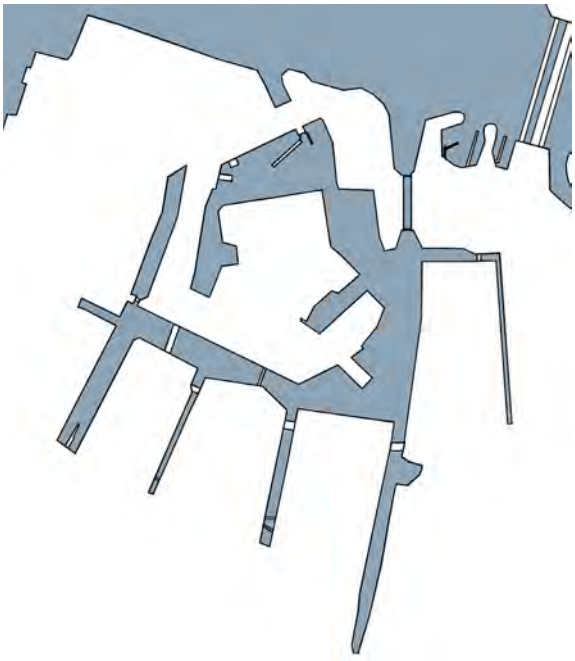
Fig. 2 Greenwich Millennium Village: Comparative view of the transformed structure in 1980 and 2015(Blue: water; White: land; Green: green areas)

—

Figure 3 Hammarby Sjostad Bo02, Stockholm: Public spaces with presence of water – solutions resulting in more complete integration of rainwater retention systems with the water system; photo: Izabela M. Burda

Similarly, at Hammarby Sjostad in Stockholm, in addition to the implementation of new canals, a well-developed and perfectly functioning rainwater and snowmelt management system has been introduced. Rainwater is discharged into the ponds via above-ground gutter forms. The drainage systems are diversified with waterfalls and various elements for water buffering and purification.

Taking advantage of the topography, entire systems are specifically designed to naturally allow water to flow to the central canal. This not only reduces the pressure on the city's purification system, but accounts for the natural and environmental values of the converted area. Through efficient use of the area, it has thus not only been possible to exclude the threat of an imbalance in the ecosystem, but to improve its condition by creating suitable living conditions for many species of flora and fauna. The solutions applied, combined with the materials used to arrange the site, have made it possible to create functional places for residents to integrate among water and greenery (Fig. 3).



Establishing continuity of the ecological system on a much larger scale was the aim of the Hamburg IBA in the Wilhelmsburg district, where new water area plans were also introduced. In formulating a strategy for the conversion of the area, the key issue was to achieve an ecological balance. The district's new image is based on strengthening its relationship with water. To fulfil this aim, the 'Make Water Visible' vision was developed to be realised by 2030. The transformation of Harburg's inland harbour with the creation of a new canal system with a total length of 2.7 km has become an important element of the project (Fig. 4). Reservoirs and watercourses are to be created here by 2030, complementing the existing system. Sustainable water management will ensure the highest environmental quality. Water surfaces will be connected ecosystems. Therefore, full control of water pollution factors and sustainable flood protection will be necessary. As the authors of the strategy emphasise, the most important thing for its implementation is to strengthen the role of water as an integral part of the city and also of the landscape. The new image of the Wilhelmsburg district will thus be achieved by improving the water quality and the long-term flood protection strategy.

New water outlines with green and blue designing

Analysing the criteria of continuity of urban nature networks created in post-industrial areas, it is possible to show that in many parts, these networks overlap with the network of public spaces (Burda, Nyka,2017). It is therefore worth paying attention to the integration of ecological systems with the existing and designed system of pedestrian zones of the city. This objective has been identified as one of the aims of the transformation of areas freed from industry in, for example, Malmo and Oslo. The implementation of such strategies is a response to climate change, an attempt to reduce the formation of urban heat islands and generally a result of increasing environmental awareness. In the conceptual domain, this approach has led to a strengthening interpretation of the city as a landscape, aspirations for urban renaturalisation (Nyka, 2017) and design methods gradually adapted to these interpretations, where greenery and water play a key role in shaping the urban composition, such as water urbanism or landscape urbanism.

Figure 4 Hamburg: Transformation of Harburg's inland harbour – scheme of the development of the site before and after conversion (Blue: water; White: land; Green: green areas)

5. Discussion

It should be emphasised that due to the scale and scope of transformation projects, those involving modification of water systems may be undertaken to the full extent when the areas are not in use.

Post-industrial sites can therefore be seen as an opportunity for the city – they provide unique opportunities to achieve new, large-scale water solutions as well as landscape and ecological linkages.

Transformations of water systems and the forms of their boundaries, being a part of strategies of post-industrial site conversions, require that a number of conflicts and barriers be taken into account (Loures, 2015). In fact, they largely determine the final design solutions. These include, among others, constraints related to climate, hydrogeological characteristics, physiography, the technical condition of existing investments and the type of soil and water pollution. The way of shaping the forms of land and water connection should correspond to the prevailing climatic conditions (Eliasson, Knez, Westerberg, Thorsson, Lindberg, 2007). In the proposed solutions, special attention is paid to adapting the area to function in any atmospheric conditions occurring in the region (Winter City Edmonton, 2016). It is therefore important to take into account the changeability of the seasons and the related fluctuations in temperature, wind strength together with the intensity and type of precipitation.

Furthermore, it is important to take into account the potential risks of extreme hydrometeorological events when developing a zone adjacent to a body of water. These include the risk of flooding, which may occur, for example, during heavy rainfall or storm surges causing a sea level rise. It is therefore necessary to take these considerations into account when designing any interventions into existing water systems. Case studies show that re-shaping land-water boundaries can be helpful in mitigating the effects of these phenomena, especially when the modelling concepts are integrated with stormwater management systems.

6. Conclusion

In conclusion, it should be pointed out that the creative shaping of the land-water boundary lines is one of the key roles in the processes of transforming post-industrial areas. This trend, leading to new plans and forms of water boundaries, supports the shaping of places resilient to climate change (Dal Cin, Hooimeijer, Matos Silva, 2021). Modelling new forms of land-water connections can be an important element, increasing the effectiveness of brownfield transformation processes. The use of new water lines to improve the continuity of public spaces, landscape continuity and continuity of ecological systems with the creation of biologically active areas plays an important role in achieving the best effects of the

implemented operations. Also important is the aspect of rainwater management, ensuring flood safety and the attractiveness of the created urban structure.

It is worth emphasising, as has also been proven, that the method of modifying the land-water boundary line depends on a number of conditions and requires the barriers and conflicts specific to these operations be taken into account. This does not, however, inhibit the increasingly visible tendency to reshape water area outline plans. Rather, it indicates that the design of sites where land and water meet becomes an intervention requiring an understanding of the mechanisms of such endeavours and the acquisition of specific competencies. It requires not only creative thinking and in-depth knowledge from the architects and urban planners, but also cooperation with specialists from many disciplines, including water engineering, sociology and economics. In spite of these challenges, the efforts to creatively transform waterside areas and to find new lines for their contours are worthwhile. They point the way to better living conditions in cities, and at the same time are a form of referring to tradition – the centuries-long history of transforming the forms of shorelines to meet the new needs that emerge.

References

Bardos, P., Spencer, K. L., Ward, R. D., Maco, B. H. & Cundy, A. B. (2020). Integrated and Sustainable Management of Post-industrial Coasts. *Frontiers in Environmental Science*, *8*, 86. https://doi.org/10.3389/fenvs.2020.00086

Braae, E. & Diedrich, L. (2012). Site specificity in contemporary large-scale harbour transformation projects. *Journal of Landscape Architecture*, *7*(1), 20–33. https://doi.org/10.1080/18626033.2012.693778

Burda, I. M. (2016). Kształtowanie połączeń lądu i wody na terenach poprzemysłowych [Shaping land and water connections in post-industrial areas] [Doctoral dissertation, Technical University of Gdańsk].

Burda, I., Nyka, L. (2017). Providing Public Space Continuities in Post-Industrial Areas through Remodelling Land/Water Connections. IOP Conference Series: Materials Science and Engineering 245 (8), p. 082037

Dal Cin, F., Hooimeijer, F., Matos Silva, M. (2021). Planning the Urban Waterfront Transformation, from Infrastructures to Public Space Design in a Sea-Level Rise Scenario: The European Union Prize for Contemporary Architecture Case. Water., 13(2):218. https://doi.org/10.3390/w13020218

Ebrahimabadi, S. (2015). Outdoor Comfort in Cold Climates: Integrating Microclimate Factors in Urban Design (PhD dissertation). Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:ltu:diva-26319

Eliasson, I., Knez, I., Westerberg, U., Thorsson, S. & Lindberg, F. (2007) Climate and behaviour in a Nordic city, Landscape and Urban Planning, 82(1–2), pp. 72–84. doi:10.1016/j.landurbplan.2007.01.020

Gledhill, D. & James, P. (2008). Rethinking urban blue spaces from a landscape perspective: Species, scale and the human element. Salzburger Geographische Arbeiten, 42, 151–164.

Hein, C. (2016). Port cities and urban waterfronts: How localized planning ignores water as a connector. *WIREs Water*, *3*(3), 419–438. https://doi.org/10.1002/wat2.1141

Hinman, C. (2005). Low Impact Development: Technical Guidance Manual for Puget Sound. Olympia, WA: Puget Sound Action Team.

Januchta-Szostak, A. (2011). Woda w miejskiej przestrzeni publicznej, Wydawnictwo Politechniki Poznańskiej, Poznań.

Loures, L. (2015). Post-industrial landscapes as drivers for urban redevelopment: Public versus expert perspectives towards the benefits and barriers of the reuse of post-industrial sites in urban areas. *Habitat International*, *45*, 72–81. https://doi.org/10.1016/j.habitatint.2014.06.028

Nyka, L. (2017). From structures to landscapes – towards re-conceptualization of the urban condition. In: Couceiro da Costa et al. Eds, Architectural Research Addressing Societal Challenges. Vols 1 and 2. Taylor & Francis, pp. 509–515. DOI: 10.1201/9781315226255-78

Winter City Edmonton. (2016) Winter Design Guidelines (Edmonton City Government). Available at https://www.edmonton.ca/city_government/documents/PDF/WinterCityDesignGuidelines_draft.pdf (accessed: 9 October 2016).

Völker, S., Matros, J. & Claßen, T. (2016). Determining urban open spaces for health-related appropriations: A qualitative analysis on the significance of blue space. Environmental Earth Sciences, 75(13), 1067.

Izabela Burda
PhD, Assistant Professor, Faculty of Architecture, Gdańsk University of Technology, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland

Gdańsk University
of Technology, Poland

Sylwia Sitniewska
Justyna Borucka

Shaping the City Responding to Climate Change – Concept of Development of the Right Bank of the Vistula River in Toruń, Poland

Abstract.

The problems of cities of the 21st century are caused by anthropogenic oppression of the environment, through the growth of economic activity and continuous urbanisation, and taking away ecologically important open areas and biologically active areas. Increasingly frequent and sudden rains, strong winds, turbulence and rising world water levels are some of the consequences of climate change that have a direct impact on the functioning of cities. The article presents a study of a land-use plan for the right bank of the Vistula river in Toruń, Poland, in reference to ongoing climate change. The authors focus on the main assumption of this concept, which is to protect the area from increasing river floods expected due to strong climate change impact on Earth's water cycle and temporary river water rise. The project strategy focussed on reshaping the Vistula river bank, as well as designing a solution that would allow floodwater to enter the area in a controlled manner. The newly designed area presented in the article is an attempt at conscious urban planning as well as planning activities in harmony with nature, and shows how such an approach to city planning can face the problems of climate change and could be a possible solution for future development of the city of Toruń.

1. Water in the city in the context of climate change

Water is a turbulent element, difficult to tame and necessary for life. It is a basic component of urban ecosystems, where it has a unique place as a culture-forming element and a source of life for flora and fauna. Water has always existed in urban structures as one of the elements shaping architectural compositions. Its presence conditions and emphasises the important squares and public spaces for city residents. One of the conditions for the emergence of medieval cities was access to water (Toruń, Gdańsk, Kraków, Warsaw), which is still used today for economic, transport and recreational purposes (Januchta-Szostak, 2011).

It is important to note that water is closely related to increasing the aesthetics of the landscape. As Janucha-Szostak says: "*Water is a carrier of beauty and content in the landscape, which can be received both in the sphere of sensory perception, through all of the senses, and semantically – referring to archetypes and symbols of various religions and cultural circles*" (Januchta-Szostak, 2011).

Water resources are limited, but it is not the lack of it, but rather its excess that is one of the threats posed by progressive climate change. Intensive and rapid development of the economy

and urbanisation of open areas in cities and around them in the nineteenth and twentieth centuries led to the destruction of many natural and water ecosystems, and increased the risks associated with floods. The result is a decline in the quality of life of people in cities, mainly in Europe and America, as well as global changes in the climate, the consequences of which we can observe today.

The problems of the cities of the 21st century are caused by anthropogenic environmental pressure, through the growth of economic activity and constant urbanisation, taking away ecologically important open areas and biologically active areas. Due to the development of cities, the role of agriculture has begun to decline, and land is being transferred to plant cultivation to expand infrastructure and services. Pollution and irrational use of non-renewable resources, contamination of land, water and air, noise and haze may lead to the loss of the natural environment's ability to regenerate itself. Increasingly frequent and sudden rainfall, high winds, turbulence and rising world water levels are some of the consequences of climate change that have a direct impact on the functioning of cities (Schröpfer, 2012).

What we are currently observing in cities around the world (including India, China), i.e. deterioration of health conditions, is a result of constantly increasing environmental pollution and an increase in waste generation. Taking away biologically active spaces for new buildings is a real threat to the quality of human life in the city. The outskirts of cities, where agriculture used to be a leader in the past, are also at risk, and are now being moved to factories. As we read in The New Athens Charter: "*Flooding, experienced almost everywhere in Europe, will fuel the feeling of insecurity. Even greater dangers of a rise in sea-level will affect the large concentrations of urban areas in coastal zones. Heavy storms, avalanches and landslides will add to the concerns about public protection from natural hazards.*" (European Council of Town Planners, The new charter of Athens 2003).

The data on the rise in the level of water around the world, increasing risk of flooding and other extreme weather events caused by climate change impacts on the Earth's water cycle are changing and continually updated. (Mercer, 1978; Graham, Parkinson, Chahine, 2010; IPCC, 2013, 2018; EEA 2017, 2018).

2. Subject of the study

The subject of the study is the riverside areas of the Vistula right bank in Toruń. The choice of this place was dictated by the author's participation in a competition organised by the City of Toruń

Commune and the Association of Polish Architects (SARP) – branch in Toruń. It is a floodplain with low development intensity and high design potential in terms of shaping urban areas in the era of climate change.

3. Hydrological analysis of the Vistula and water infrastructure in Toruń – potential and threats in the context of climate change

Water and hydrological conditions

The city of Toruń is located in central Poland, in the Kuyavian-Pomeranian Voivodeship, on both banks of the Vistula, which is on one side a limitation and it divides the city, and on the other hand, it diversifies the landscape and is one of the main recreation places for its inhabitants. The hydrological catchment area covering Toruń extends beyond the city's administrative borders, therefore a significant part of the water flows from outside of its area (Municipal Urban Development Office Toruń,2017).

The Vistula is the main watercourse and the hydrographic axis of Toruń.It flows through the administrative borders of the city for a length of approx. 19 km (from 726 km to 745 km of the Vistula river). The Vistula is a regulated river – that is, transformed by human activities. Most of Toruń's water reservoirs are located on the terrace floodplain, parallel to the bank of the Vistula River.

Potentials and threats in the context of climate change

Due to the integrated form of the city with the river, Toruń may be found to be a place exposed to constant flooding of a significant part of the area, assuming more extreme flooding expected due to increasing the levels of water vapour in the atmosphere, more intense rain storms, strong river thaws and temporary river water rise. This will lead to the widening of the Vistula river bed and the constant disappearance under the water surface of most of the

floodplains, with a high probability of flooding on average once every 10 years. Areas with an average probability of flooding will be flooded more frequently.

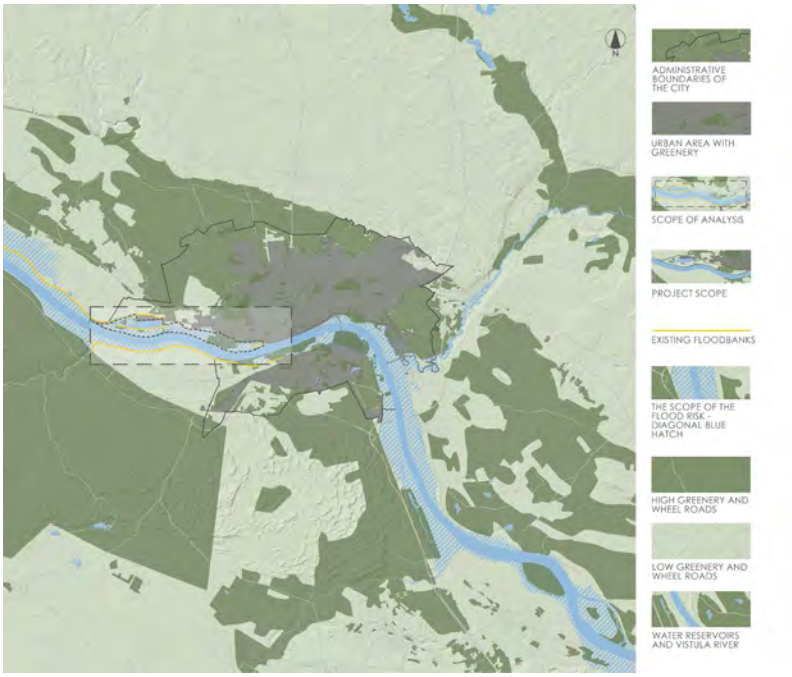
In addition, the probability of flooding of the Old Town in Toruń will increase, which may deprive a large part of the inhabitants of their homes and destroy the historical heritage of the city. The potential in this situation may lies in getting closer the water surface to the existing districts, for which access to the river was difficult. The nature of these areas can be changed for their benefit through activities that integrate the existing spaces with water. The increase in the water level in the river is a phenomenon that can be predicted, and changes planned in advance via landscaping.

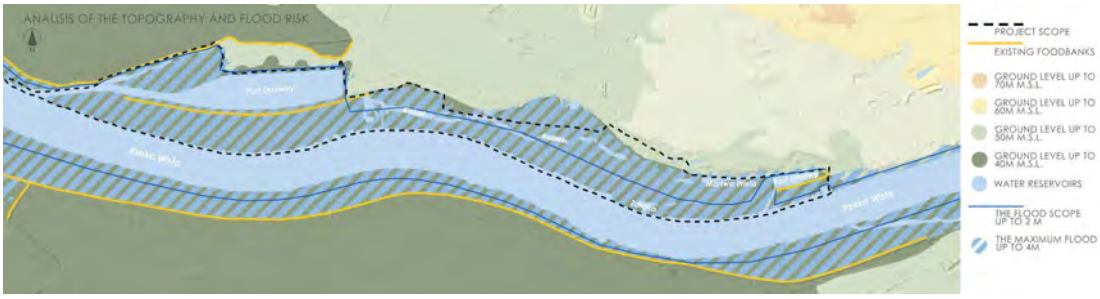
4. Urban analyses – guidelines for the conceptual design

Landform and flood risk

The area of the right-bank Vistula under development, in the area from the Toruń Harbour to the Timber Harbuor, is a flood zone. This is due to the immediate vicinity of the Vistula River and the relatively flat topography. The river's level across the entire section ranges from 38.5 m above sea level, up to 41.5 m above sea level. In most of the design area, the ground level is not higher than 40 metres above sea level. Between the Martwa Wisła reservoir – the so-called "Martówka" – and in the "Kabel"oxbow lake, there is a small area with a ground level of up to 50 metres above sea level (Fig. 2).Existing flood embankments are located within the development limits. One of them protects the Winter Port (Port Zimowy), while the otherprotectsthe Timber Port (Port Drzewny). The rest of the embankments are on the right side of the Vistula and to the north-west of the Timber Port. In the graphic: Analysis of the topography and flood risk (Fig. 3), the assumed scope of flooding related to the climate change impact on Earth's water cycle and inland water rise (the assumed temporary alarm water rise in the Vistula up to 2 and 4 meters (thaws, excessive rainfall, etc.)) is schematically marked.

Fig. 1. Scope of the site development / Competition for development of the Vistula river bank in areas located from the Toruń Harbour to the Wood Port.



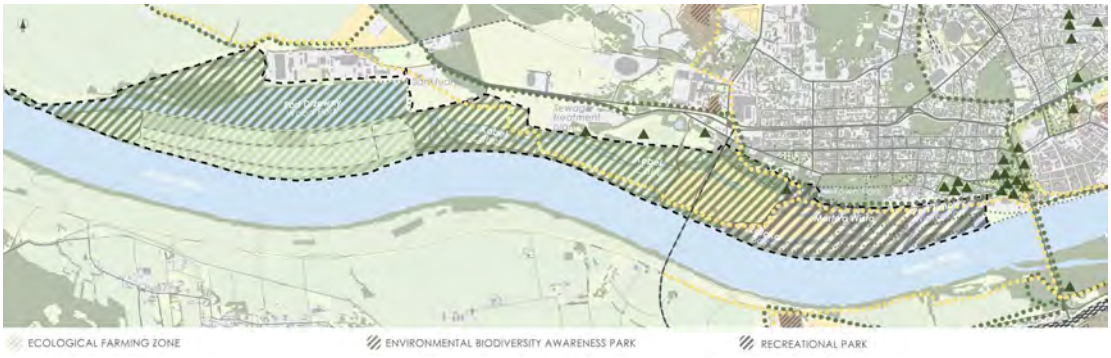


5. Vision of land development

Currently, the area of the right bank of the Vistula is clearly divided into two different utility areas: recreational and agricultural. Despite the large amount of green space, there is no greater diversity and division into smaller zones supporting different types of nature. Bearing in mind the growing problems associated with progressive climate change and the problems described above, the following division was created:

- Ecological Framing Zone – agricultural land on the peninsula by the Timber Port (Port Drzewny),
- Environmental Biodiversity Awareness Park – which includes the remaining areas of allotment gardens and the entire

"Krowieńca"area Timber Port (Port Drzewny) – a water reservoir and a fragment of the north-eastern area,
- Recreation Park – covering the area of the Toruń Harbour, the Winter Harbour, the areas surrounding the Winter Harbour, "Martówka", Błonia Wiślane, and part of the allotment gardens and the Bay.



6. Description of the urban concept

The basis of the study is a conceptual urban design development of the right bank of the Vistula in Toruń, in the area from the Toruń Harbour to the Timber Port, in the context of shaping the city space in the face of the ongoing climate change. The main assumption of the project is protection against the gradual flooding of the area and the creation of a space of various character. The design activities are related to the shaping of the new bank of the Vistula River, as well as the partial introduction of floodwater to the area. For this purpose, the project used hydrotechnical devices such as a flood embankment, locks, dams and drainage weirs.

Design objectives

The land development project is based on three design objectives:

1. Protection against excessive flooding of the area
2. Diversification of the nature of the area
3. Sustainable, biodiverse environment

Fig. 2. Flood hazard map

Fig. 3. Analysis of the topography and flood risk

—

Fig. 4. Vision of land development

Protection against excessive flooding of the area

Bearing in mind the adopted problem of the increasing risk of climate-related extremes around the world, the main design activity is to protect the area from flooding. This is done with the help of flood embankments, the additional function of which is to create a new quay in the event of a continuous flooding. (the alarm temporal river water level rise by 4 meters) in the future. The embankments were

located so that the rising water can enter part of the area of the current quay, and to keep as much of the dry land surface as possible. The flood embankments are designed along the route from the Toruń Harbour to the Winter Harbour Lock and from the Winter Harbour to the last lock, located in the canal flowing into the Timber Port.

The gradual formation of wetlands is planned on the eastern side, in the area by the Winter Harbour. The existing flood embankment was used for this treatment. The embankment is located on the southern shore of the Winter Harbour. The project provides for raising and expanding the embankment from the Toruń Harbour and the inflow canal to the Winter Harbour. Flisak Park was established in this area. There are three types of paths in the park: on dykes, on stilts, and amphibious paths that rise with the water level.

In the inflow canal to the Winter Port, a lock has been designed to protect the Port against flooding. Thanks to this, the appearance of the Port after the water in the river rises will not change and will allow the free flow of floating objects. Maintaining the current water level in the port, and thus the appearance of the Winter Port, was crucial – the port is a protected conservation object. The lock also serves as a bridge for pedestrians. This solution contributes to the continuity of pedestrian traffic. One of the needs listed in the needs study is the creation of a Winter Harbour Museum. Taking into account the opinions of the conservators of the monument, the museum was designed on the western shore of the Winter Harbour in the form of an extension of the flood embankment. The entrance to the building is from Błonia Wiślane and "Martówka".

The next break of the embankment takes place in the area of the Bay, where the canoe marina is located with the service building built into the embankment. The location of the lock is deliberate. The "Kabel" oxbow lake, which currently consists of several smaller water reservoirs, has been extended so as to connect it with the Vistula River and enable free movement on it, including canoes. The cable has also become a water storage tank. Thanks to the use of smaller embankments, which mark the watercourse bed, it is possible to store water from excessive rainfall or from the Vistula River. Locks and a dam are used to regulate the water level in the "Kabel".

In the agricultural areas, an irrigation system has been designed with water from the river, as well as with water collected in the retention reservoir, near the fields.

The regulation of water in the drainage ditches takes place through drainage weirs installed in the flood embankment. Such an

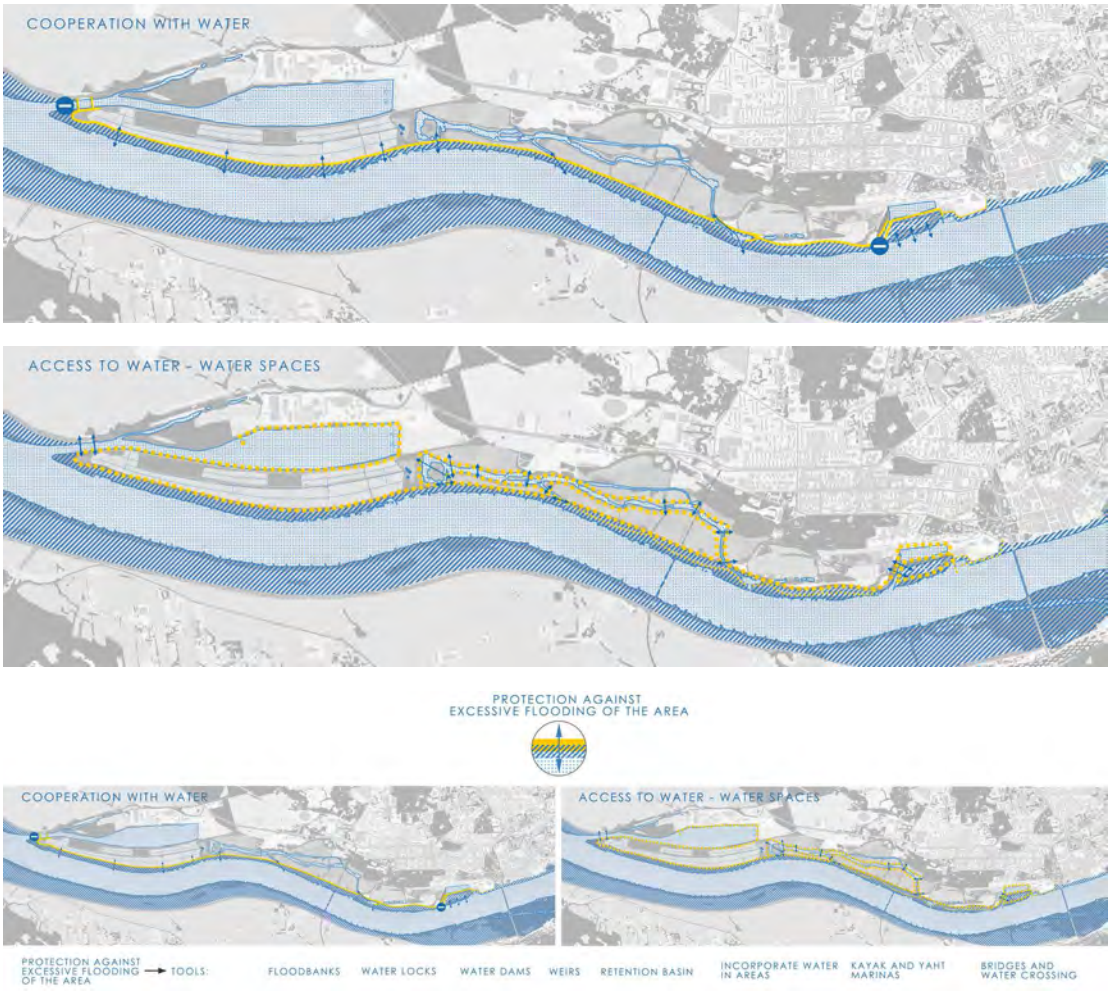
Fig. 5. Cooperation with water – Adopting water

Fig.6. Access to water – Water spaces

Fig.7. Protection against excessive flooding – tools

irrigation system is a way to counteract the effects of agricultural droughts. In the inflow canal to the Timber Port, similarly to the Winter Port, there is a lock, next to which a fish ladder has been designed. The use of a sluice will protect the buildings on the shore of the port, and the fish pass will allow the fish to freely move in.

Schemes of space functioning:



Diversification of the nature of the area

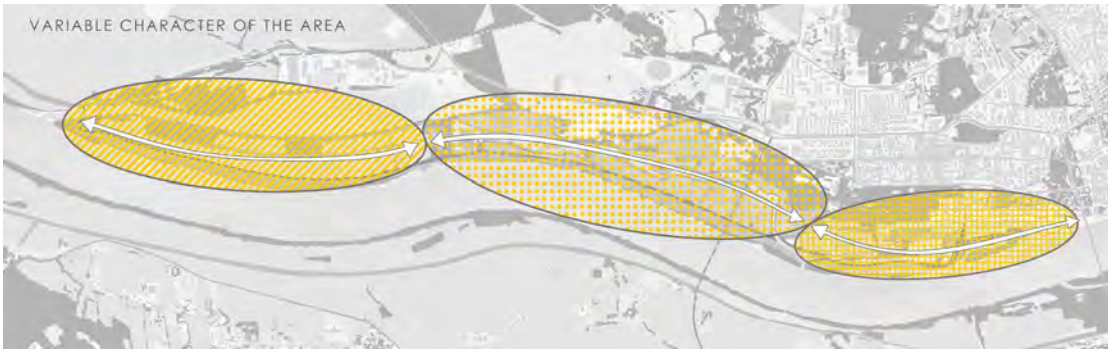
When summarising the field research, differences in the appearance of the existing landscape and the accessibility of pedestrians were noticed. Among other things, this observation became inspiration for the thematic division of the area into: Recreation Park, Environmental Biodiversity Awareness Park, and Ecological

Farming zone. The first of these parts is definitely characterised by the highest intensity of service points and attractors. There is a museum of the Winter Harbour here with the Harbour, Przystań Toruń and Kayakowa, barbecue areas, a cafe, playgrounds and allotment gardens. Access to this area is by far the most convenient and the fastest, due to the proximity of residential buildings and the existing public transport stops.

The Environmental Biodiversity Awareness Park is an extension of the ecological corridor. Agricultural land transformed into a park – "Krowieniec" – and allotment gardens, are to serve the purpose of acquiring knowledge about flora and fauna from the moment of park's construction to its use. A proposal for the city's inhabitants is to participate in the co-creation of this project by actively planting trees, and the organisation of the project on the part of the city. Here, you will find observation points, flower and grass meadows, young forests, as well as footpaths in the form of paths on the embankments, bridges connecting the banks of the "Kabel", platforms leading to observation towers and technical roads.

The final area, Ecological Farming, refers to the natural ways of cultivating the land. The presence of agricultural land, which is cultivated with modern methods, is associated with the farmer's need to manage large areas of land, and may contribute to the destruction of the landscape and soil consumption. The above areas are connected with each other by a network of pedestrian paths and bicycle routes, as well as a network of public spaces, which include, among others, meeting places, observation points and recreational areas.

Schemes of functions of the space:



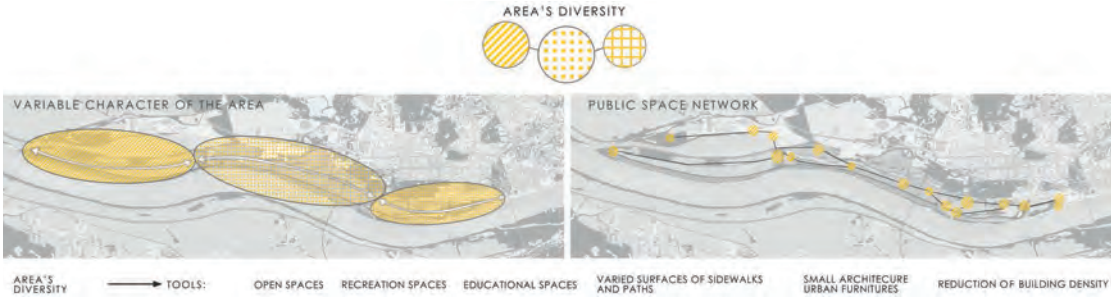


Fig. 8. The changing nature of the area

—

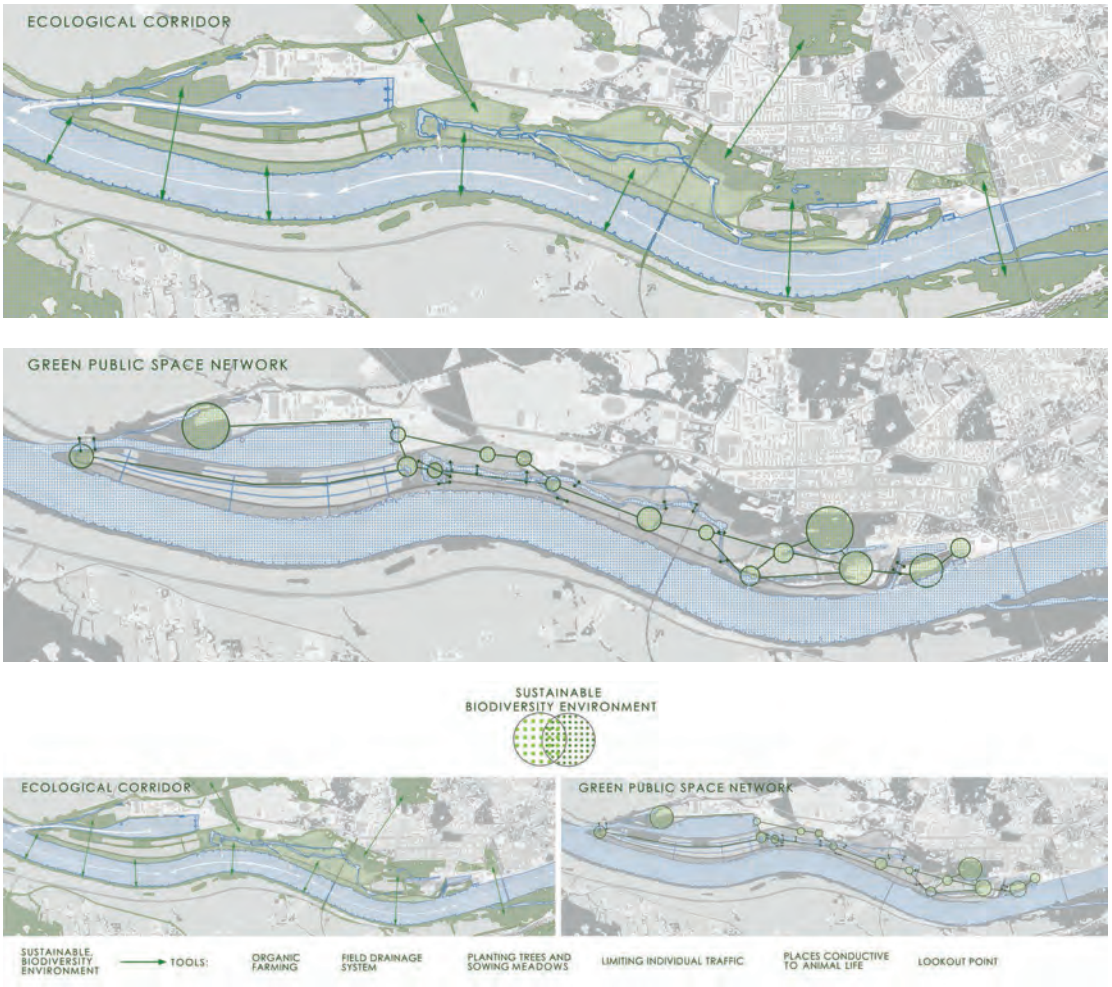
Fig. 9. Networks of public spaces

Fig. 10. Area's diversity – tools

A sustainable, biodiverse environment

Meeting the contemporary needs of society will be achieved through landscaping in line with the idea of sustainable development, which will also provide opportunities for demand development for future generations. Designing biodiverse and ecologically active recreational areas is an activity that fosters this idea. Thanks to the enlargement of ecological corridors, we are working towards the reconstruction of biologically active areas and the migration of animals. For residents, this means access to a clean environment and new walking and educational places. Shaping biodiverse park space will increase the population of wild animals, which are invaluable to biological processes, and will also contribute to cleaning the air in the city.

Schemes of functions of the space:



Relationship with the existing transportation system

The designed recreational area has limited, circular traffic. Individual transportation takes place largely to the car parking points. These roads are paved. The technical access is extended to allow maintenance construction and hydrotechnical facilities. Transportation routed to private land and leased land, such as farmland, is left preserved. There is no additional transportation in the area under urban development. The whole area is accessible to pedestrians and cyclists thanks to the network interconnected paths and cycle paths. All pedestrian and bicycle paths have been designed with good water absorption into the ground. Various paths are made of hardened sand, protected wood or flat stones.

Fig. 11. Ecological corridors

Fig. 12. Network of green public spaces

Fig. 13. Sustainable biodiversity environment – tools

—

Fig. 14. Designed roads and connections with the city

Fig. 15. Water reservoirs and hydrotechnical structures

Hydrotechnical solutions

The hydrotechnical devices used in the project are: levees, water locks, water dams, retention reservoirs. The designed flood embankment performs the basic function – protection of areas during a flood. When the water level rises, the embankment will also function as a river bed. Its construction must be preceded by a construction design and soil permeability calculations. The designed flood embankment has a trapezoidal cross-section. From the outside, it is covered with grass or vegetation found in the Toruń region. Its structure will include a water-impermeable layer – that is, a tight core located in the middle of the cross-section.

The locks on the site are to maintain a constant water level in the Winter Port and in the Timber Port, and to enable the influx of floating objects into the port area. This solution is possible thanks to the use of lock chamber. They can be operated from control towers located at these facilities.

Greenery proposal

Planting trees and sowing meadows and grasses is a planned method of changing the nature of the site, but also of increasing biodiversity among the fauna. The choice of tree species has been adapted to the quality of the stagnant soil and environmental conditions.

7. Masterplan – presentation of the concept

The planned development of the area of the right bank of the Vistula River assumes a two-stage rise in the water level, caused by the effects of climate change.

Current water level in the river

The design assumption is to adapt the land development to the situation in which the water level in the Vistula is gradually increasing. Such a situation will occur over time, hence it is important to introduce new hydrotechnical infrastructure before the effects of the climate changes occur. In the meantime, the water level in the river will remain unchanged or increase due to seasonal floods related to snow melting in the south of the country. There is also a third option – the water level in the Vistula will decrease as a result of the air temperature rise in summer. The proposed concept assumes the possibility of all of the above-mentioned circumstances. The designed flood embankments are walking and cycling routes. They can be used all year round, regardless of the climatic circumstances. Active and passive observation of areas from a higher perspective allows you to look at areas in a different way.

The locks, apart from fulfilling their basic function, constitute a bridge crossing over the water, and a small flood embankment brings the viewer closer to the Vistula river in places currently inaccessible to pedestrians. The “Kabel” water reservoir, whose widened bed collects water during periods of drought, is important in the context of changes in the water level. Thanks to the locks on the large flood embankment, with the elevated water table, the water reservoir is controlled against flooding of biologically active areas. The irrigation system will keep the Organic Farming areas in a good state of irrigation.

Stage 1 – Temporary rise in the water level

The temporary rise of the Vistula level by 2 metres will result in a extreme flooding of the area to the foot of the designed flood embankments. Built-in hydrotechnical devices will prevent the river

from reaching the existing ports – the Winter Port and the Wood Port – and will allow their continued use in an unchanged form. The locks will extend the time of entry of floating objects into the port, which may be considered a disruption, while their shoulder would result in the gradual flooding of the port infrastructure with water, as well as the development around the ports. Next to the Recreation Park zone and partly the Environmental Biodiversity Awareness Park, the water will reach the designed smaller flood embankment. When the water level in the river rises even more, for example during the seasonal flooding of the river, it will become the foundation of the amphibious path located on it. In the described situation, the waters of the Vistula River will also reach the dry areas that make up the Bay on the Vistula River. Their flooding will widen the bay, which has been secured with breakwaters. The green areas surrounding the Winter Port, as well as the Toruń Harbour, will be gradually flooded. Protection of the square by the marina with a flood-prevention embankment, it will not allow water to enter this area.

The extended the "Kabel"oxbow lake and agricultural land at the Timber Port will not be flooded. Hydrotechnical devices built into the embankment, such as locks, dams and weirs, located next to them, will allow for a controlled 'admission' of water to these areas. Collecting rainwater in water reservoirs, especially in the summertime, is necessary to maintain good irrigation of farmlands, and to create a favourable microclimate that is friendly to people and animals.

Stage 2 – Alarm temporary rise in the water level

The water level in the Vistula will temporary increase by 4 metres compared to the present level. It will reach all of the hydrotechnical devices, which will become the border of the riverbank. Their structure will constantly protect the right bank of the Vistula against flooding. The Winter Harbour and the Timber Harbour, similarly to the first stage of flooding, will not change their function thanks to the locks. Their use will not change in relation to the above description. The areas accompanying them will not be flooded. A small flood embankment will eventually become the foundation of an amphibious path connected to a large flood embankment. It will become an attractive walking path, surrounded by riparian vegetation. Thanks to the method of its construction, it will float on the water, adjusting to its level. Green areas at the Winter Port will become wetlands. The square in their vicinity, protected by the embankment, will not be flooded. It plays an important recreational

Fig. 16. New biologically active areas, tree plantings

role in the project – the end of the current Philadelphia Boulevard, which stretches across the width of Toruń's Old Town. The Toruń marina will continue to function as a place of water tourism. Błonia Wiślane, the area of the Environmental Biodiversity Awareness Park and the Ecological Farming zone, as in the previous sections of the description, function unchanged thanks to the hydrotechnical devices. It is worth mentioning that the presence of the existing flood embankment on the left bank of the Vistula will become crucial due to the rising water level. Thanks to it, the agglomeration located next to it will not stay flooded. The water discharge range is indicated in Fig. 18,19. It shows how important it is in the context of the Vistula River flooding. The scope of the conceptual design development does not reach the area of the Old Town. The illustration below (Fig. 19) shows that the river will reach the boundaries of this area. In the event of further consideration of the problem of the effects of climate change covering the entire agglomeration, it is worth considering how the city's development can be adapted to the risk of floods.

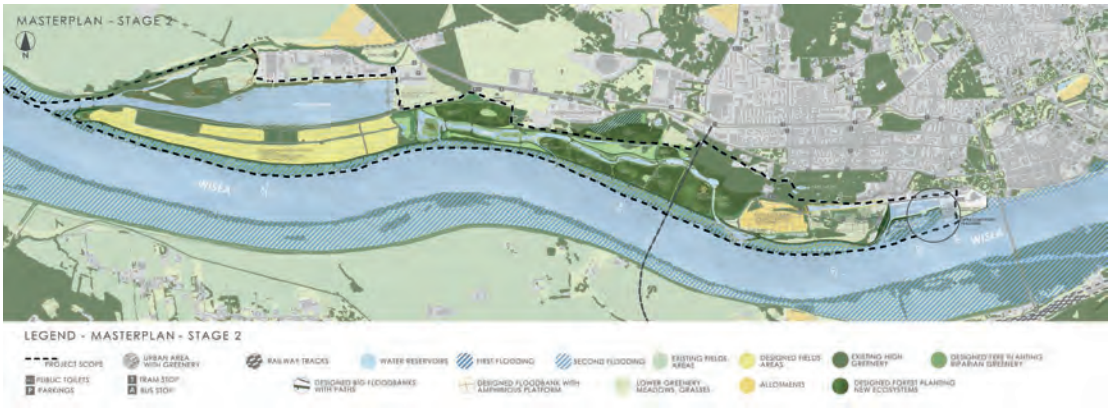


Fig. 17. Masterplan – the current water level in the river

Fig. 18. Masterplan – Stage 1 – Temporary rise in the water level

—

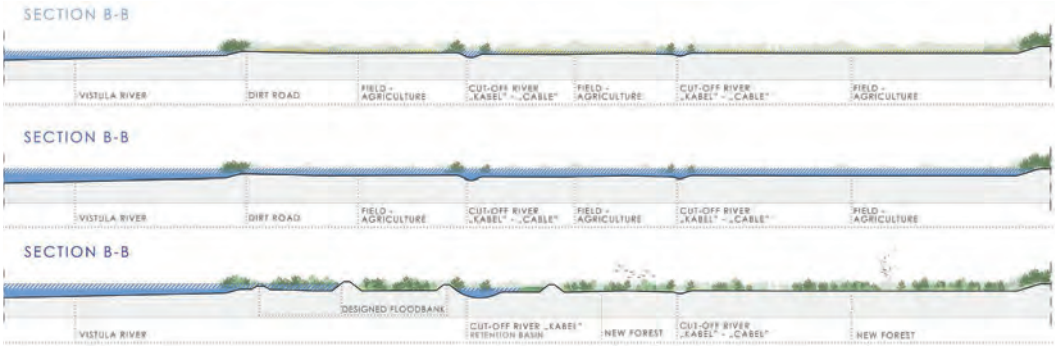
Fig. 19. Masterplan – Stage 2 – Alarm temporary rise in the water level

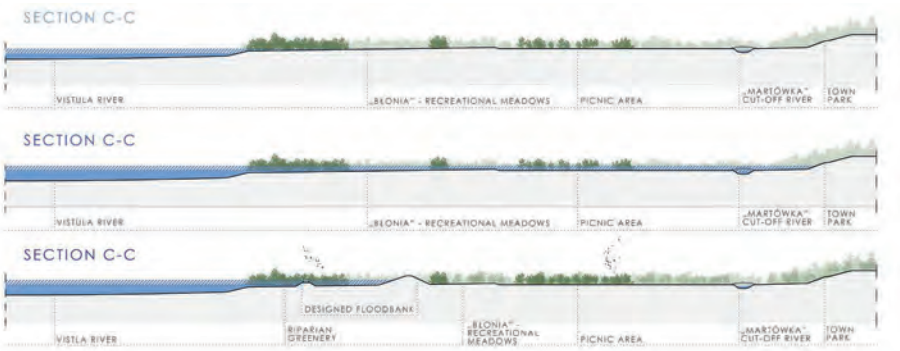
Fig. 20. Section A-A – through the area of the planned zone of the Recreation Park, currently Błonia Wiślane and the area by the Martwa Wisła – "Martówka"

Cross-sections through the terrain

The following cross-sections are a study showing the effects of raising the water table in the river in relation to the current land development and in a situation where the area gains new infrastructure.

- SECTION 1 – Shows the current situation in which the water level in the river is close to the present one. The potential extent of river flooding caused by seasonal floods and excessive rainfall is also marked.
- SECTION 2 – Current land development in the event of temporary rising in the water level, and potential flooding of the river onto the site due to periodic floods and excessive rainfall.
- SECTION 3 – Relationship of the new land development with the river after the alarm temporary rise in the water level. The blue lines marked in the cross-sections show the potential flooding of the river onto the area due to extreme periodic floods and precipitation.





Description of the concept of the development of the Toruń Harbour and accompanying area

Besides the urban development scenarios, the study covers the concept of the development of selected areas, among others the Toruń Harbour and accompanying area.

The basis for this study was the existing marina, the square, and the green area next to it. These places are located in the east of the planned urban design and constitute its entrance zone. The grounds are directly connected to Philadelphia Boulevard (Bulwar Filadejfiski), which is the main walking area of Toruń residents along the Vistula. At the western end of the boulevard, there is a water sports area, which ends with a yacht marina. In this area, there are numerous hotels, the Winter Harbour, a park connected with the Old Town, and residential buildings. The current development of the marina and accompanying areas is colourless. This haven, despite its location and recent potential modernisation, cannot be called attractive, which is also true of its surroundings –the square leading to the building serving the marina and the green area at the Winter Port are undeveloped areas. Moreover, from the perspective of the climate changes taking place, the lack of protection of the area

Fig. 21. Section B-B – through the area of the planned zone of the Environmental Biodiversity Awareness Park, now "Krowieniec" – developing a new cross-section of the "Kabel" river bed, based on: (Bojarski et al., 2005)

Fig. 22. C-C cross-section – through the area of the planned organic farming zone, currently the peninsula at Timber Port (Port Drzewny) – agricultural areas

—

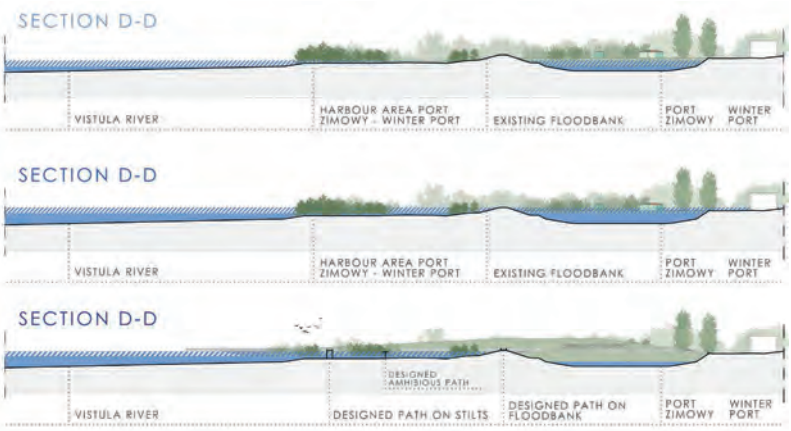
Fig. 23. Section D-D – through the Toruń Harbour and the accompanying square – in the concept of the Meeting Square

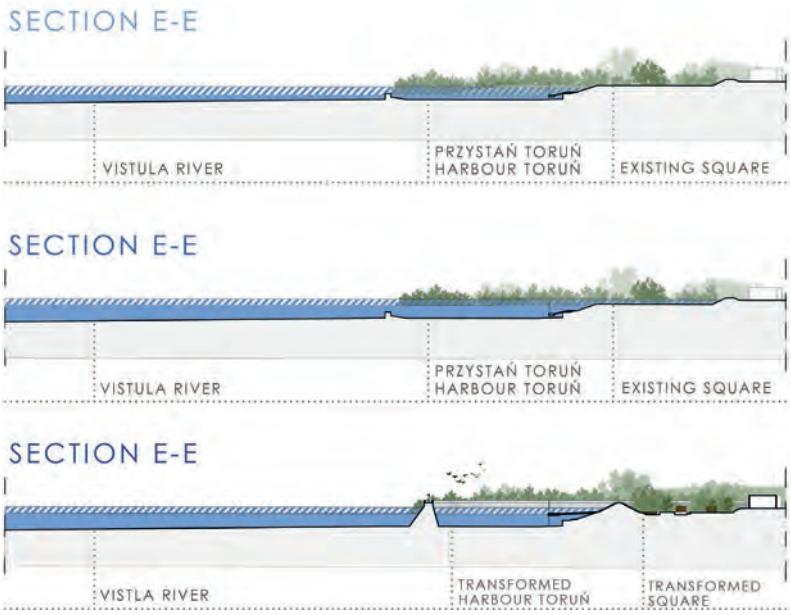
against the increase of the water level is associated with its gradual flooding.

Cross-sections through the terrain

The following cross-sections are a study showing the effects of the rising of the water table in the river in relation to the current land development, and in a situation in which the area gains new infrastructure.

- SECTION 1 – Current situation in which the water level in the river is close to the present one. The potential extent of river flooding caused by seasonal floods and excessive rainfall is also marked.
- SECTION 2 – Current land development in the event of temporary rising in the water level, and potential flooding of the river onto the site due to periodic floods and excessive rainfall,
- SECTION 3 – Relationship of the new land development with the river after the after the alarm temporary rise in the water level. The blue lines marked in the cross-sections show the additional potential flooding of the river onto the area due to extreme periodic floods and precipitation.





One of the main goals of the marina transformation and accompanying green areas, apart from improving the aesthetic value and attractiveness of the place, is to adapt it to the gradual increase of the water level in the river. The systematically flooded shore will be completely transformed. Draining water will make the marina and its surroundings disappear.

TORUŃ HARBOUR & MEETING SQUARE The new project involves the addition of a sealed flood embankment to the existing concrete slope, which will become the new shoreline and a place for recreation.

On the opposite side of the embankment, the Meeting Square has been designed. In both projects, a number of additional detailed architectural solutions have been implemented.

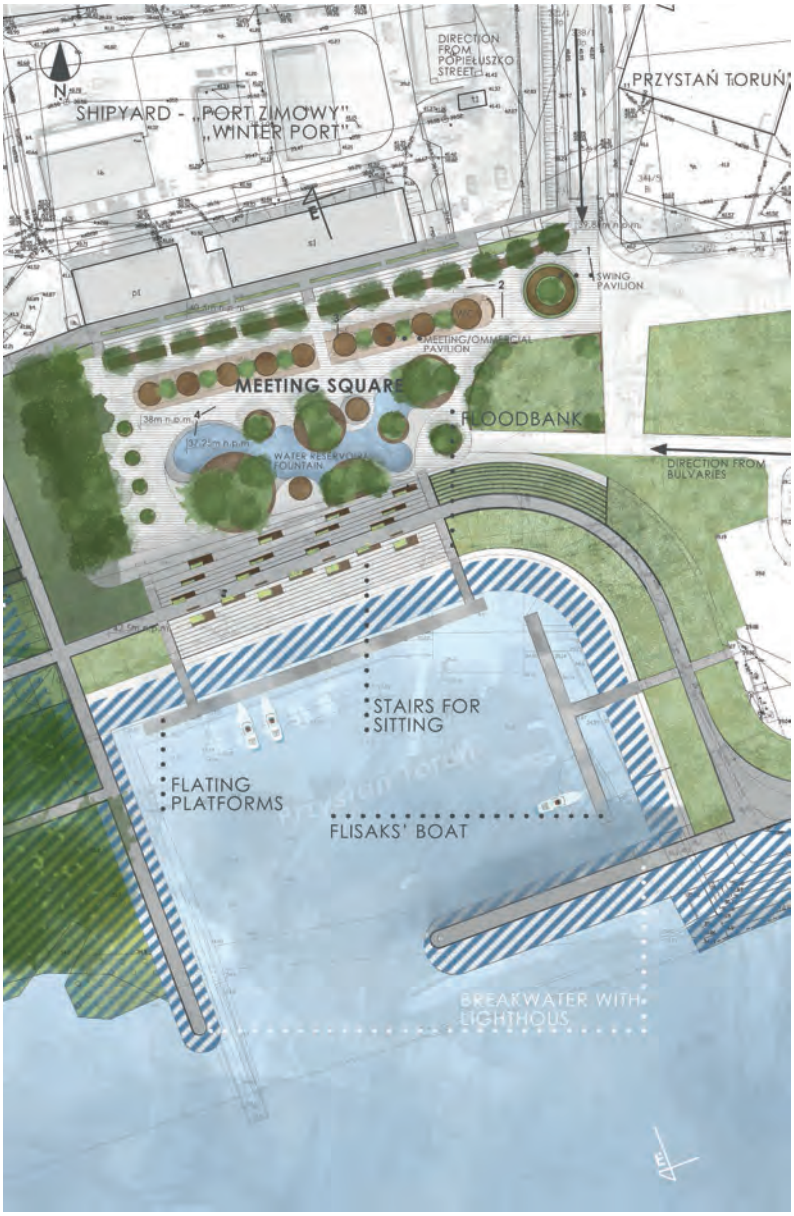
FLISAK PARK The present green areas located at the Winter Harbour and the Toruń Harbour have been renamed Flisak Park in the concept. The area is surrounded on three sides – north, east and west – by a flood embankment. The new embankments are located on the eastern and western sides of the park. It is open to the river from the south. The entire park was designed with floodwater introduced into it. The emergence of wetlands will contribute to increasing the diversity of the riverside landscape of Toruń and biodiversity among plants and animals.

The following drawings present the detailed architectural design concept (Fig.25, Fig.26).

Fig. 24. E-E section – through the Winter Harbour and the accompanying green areas – in the concept of Flisak Park

—

Fig. 25. Part of the conceptual design – Toruń Harbour (Przystań Toruń) and Meeting Square (Plac Spotkań)


N
SHIPYARD - „PORT ZIMOWY"
„WINTER PORT"
DIRECTION FROM POPIEŁUSZKO STREET
PRZYSTAŃ TORUŃ
SWING PAVILION
MEETING/COMMERCIAL PAVILION
MEETING SQUARE
FLOODBANK
WATER RESERVOIR FOUNTAIN
DIRECTION FROM BULVARIES
STAIRS FOR SITTING
FLATING PLATFORMS
FLISAKS' BOAT
BREAKWATER WITH LIGHTHOUS

Shaping the city – Solution for Toruń

The aim of the above described study was to create a land-use plan for the right bank of the Vistula River in Toruń, Poland, in the context to ongoing climate change. The main premise of the design proposal was to protect the area from the increasing river floods expected due to strong climate change impact on Earth's water cycle and temporary river water rise. The project focussed on reshaping the Vistula bank, and designing a solution that would allow floodwater to enter the area in a controlled manner. This was achieved by using water engineering systems, such as a flood embankment, locks, dams and drainage weirs. The concept assumes a division of the entire area into three zones: Recreation Park, Environmental Biodiversity Awareness Park, and Ecological Farming zone.

The site is currently partially intended for recreation and agriculture. In this study, it was assumed that recreational function is preserved in the Recreation Park zone, where it was furthermore extended and transformed. Several areas were redesigned: Toruń Harbour – a recreational venue located in the east part of the site; Meeting Square – an open, active, new public meeting space; and Flisak Park, which is expected to become a wetland area in the future. Furthermore, some parts of the agricultural area were transformed into the Environmental Biodiversity Awareness Park, which

functions as an extension of the ecological corridor of the Vistula. The main attraction of the area is the retention reservoir connected to the river, which is now an oxbow lake. A new bed for the oxbow was designed, and the park was envisioned with new, low and high greenery. The aim of these activities was to create a biodiverse environment, friendly to both people and animals. From the side of the Vistula River, the entire zone is protected by a flood embankment. The other part of the farmland was transformed into the Ecological Farming zone – an organic food production area. One of the proposed facilities is the irrigation system, which would supply the fields with water coming either from the river, or from the retention reservoir. Finally, the entire site was interconnected by pedestrian and bicycle routes, and a network of public spaces.

The newly designed area presented in the article is an attempt at conscious urban planning as well as planning activities in harmony with nature, and shows how such an approach to shaping the city can face up to the problems of climate change, and can be treated as a possible future solution for the development of Toruń.

Note

The presented studies are selected fragments of the master thesis prepared at the Faculty of Architecture of Gdańsk University of Technology in the 2020/2021 academic year (author: Sylwia Sitniewska, supervisor: Justyna Borucka).

Fig. 26. Part of the concept design – Flisak Park (Park Flisaka)

References

Blaum, J. (2017).The Paris Agreement: Climate Change, Solidarity, and Human Rights, Palgrave Macmillan [online] https://1lib.pl/book/2941481/8e8975 [Accessed: 11.10.2020].

Bojarski, A. et al.(2005). *Zasady dobrej praktyki w utrzymaniu rzek i potoków górskich*, Warszawa, Ministerstwo Środowiska, Departament Zasobów Wodnych.

EEA (2018). *Climate change and water — Warmer oceans, flooding and droughts* (europa.eu). In: EEA SIGNALS 2018 Water is life**. Europe's rivers, lakes and seas are under pressure from pollution, over-exploitation and climate change. How can we ensure a sustainable use of this vital resource?** Luxembourg: Publications Office of the European Union, 39-47. [online pdf] https://www.eea.europa.eu/publications/eea-signals-2018-water-is-life [Accessed: 30.05. 2021].

EEA (2018). *Close up — Water in the city — European Environment Agency* (europa.eu). In: EEA SIGNALS 2018 Water is life. **Europe's rivers, lakes and seas are under pressure from pollution, over-exploitation and climate change. How can we ensure a sustainable use of this vital resource?** Luxembourg: Publications Office of the European Union, 54-61. [online pdf] https://www.eea.europa.eu/publications/eea-signals-2018-water-is-life [Accessed: 30.05. 2021].

European Council of Town Planners. (2003). *The new charter of Athens 2003 : the European Council of Town Planners' vision for cities in the 21st century : Lisbon, 20 November 2003 = La nouvelle charte d'Athènes 2003* (Polish ed., Society of Polish Town Planners) (English ed. [online] http://www.itc.cnr.it/ba/re/Documenti/The%20New%20Charter%20of%20Athens%202003.htm) [Accessed: 11.10.2020].

Graham S., Parkinson C., Chahine M. (2010) The Water Cycle (nasa.gov) [online] http://earthobservatory.nasa.gov/features/Water/page1.php [Accessed: 21.10.2021].

EEA (2017) *Report 01/2017 - Climate change, its impact and vulnerability to climate change in Europe, 2016*. [online] http://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016 [accessed: 30.05. 2021].

IPCC (2013). *Climate Change 2013 The Physical Science Basis* [T.F. Stocker, Dahe Qin, G-K Plattner, M.M.B. Tignor, S.K. Allen. J. Boschung, A. Nauels, Yu Xia. V. Bex, P.M. Midgley (eds.)]. [online] https://www.ipcc.ch/site/assets/uploads/2018/03/WG1AR5_SummaryVolume_FINAL.pdf [Accessed: 15.01.2020].

IPCC (2018). *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W.Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I.Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. [online] https://www.ipcc.ch/sr15/download/ [Accessed: 15.01.2020].

Januchta-Szostak, A.(2011). *Woda w miejskiej przestrzeni publicznej, modelowe formy zagospodarowania wód opadowych i powierzchniowych*. Poznań, Wydawnictwo Politechniki Poznańskiej.
Mercer, J.H. (1978). *West Antarctic ice sheet and CO2 greenhouse effect: a threat of disaster*, Nature Publishing Group.

Municipal Urban Development Office,Toruń, (2017) *Appendix 1, Study of conditions and directions of spatial development of the city of Toruń. Part I. Diagnosis of the state and conditions for development*, [online] http://mpu-torun.pl/?page_id=887[Accessed: 30.04. 2020].

Municipal Urban Development Office,Toruń, (2017) Appendix 2, *Study of conditions and directions of spatial*

development of the city of Toruń. Part II. Directions and principles of the city's spatial development [online] http://mpu-torun.pl/?page_id=887[Accessed: 30.04. 2020].

Schröpfer, T. (2012). *Ecological Urban Architecture: Qualitative Approaches to Sustainability*, *I Materialize*, *The Practice of Sustainability by Matthias Sauerbruch*. Basel, Birkhäuser Verlag HmbH.

Sylwia Sitniewska
Master of Science Degree in Architecture (M.Sc.) Eng. in Faculty of Architecture, Gdańsk University of Technology, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland

Justyna Borucka
PhD, Assistant Professor Faculty of Architecture, Gdańsk University of Technology, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland

Part 2

'Foundation "Cultures beyond Culture, Poland	Agnieszka Wolodzko
University of the West of Scotland, United Kingdom	Roman Sebastyanski
Cooperation:	
River//Cities Platform Foundation, Sweden	Iwona Preiss
The Baltic Sea Cultural Centre in Gdansk, Poland	Magdalena Zakrzewska-Duda

Memory Of Water: Shipyard Anew. Artists-activists interventions in the former Gdansk Shipyard urban regeneration process

Abstract.

The general theme of our paper is the practice of urban regeneration aimed at sustainable improvement of built environment as well as social and economic well-being together with the overall quality of the public realm (Evans and Show, 2004). It addresses the lack of adequate and effective public dialogue and participation referred to as neoliberal hegemony of urbanization (Brenner and Theodore, 2005; Miles, 2004; Fezer, 2010; Harvey, 2012). On the other hand, we can observe artist-led cultural methodologies, seen as an independent and alternative engagement with the creative processes of urbanization through participative methods of public pedagogy integrally connected to larger social movements (Evans and Shaw, 2004; Kester 2004, Sholette, 2005, Mouffe, 2008, Lacy, 2010). Such alternative forms of critical engagement with the city are more commonly referred to as urban interventionism as a practice that reclaims urban futures from the domination of commodity and state apparatuses to present an alternative set of social relations in a re-articulation of needs and desires.

The paper presents the methodology of a one-year-long public participatory process called "Shipyard Anew" understood as such a cultural and artistic intervention. The process took place within the European "Memory of Water" project in the strategic partnership with the River//Cities network. It addressed and challenged the lack of adequate and effective public dialogue and participation within the formal-official scheme of the urban regeneration of the former shipyard post-industrial waterfront in Gdańsk, Poland (Sebastyanski in Nyka and Szczepański, 2010). The process aimed at creating (and providing) a new, independent social vision and strategy as public guidelines and recommendations for the effective urban transformation of this area. The results have been published in the form of a report entitled "Dreams to Fulfill" and distributed to all main stakeholders as well as the wide public. This dialogical process was reflected in the project's artistic interventions. The artists aimed to create a project open to the future realised through often ephemeral, transitory actions meant to initiate further debates and events rather than a finished work intended for a single presentation to the audience. We claim that with the use of specific methods and tactics, especially those led by the creatives, the public can gain a substantial voice in the local policy of urban post-industrial waterfront regeneration make this voice heard.

1. Waterfront today: former Gdansk Shipyard Area

The empirical context of this study is the urban regeneration planning process of the former Gdansk Shipyard area (in Poland) understood as sustainable improvement of built environment as well as social and economic well-being, quality of life and the overall quality of the public realm (Evans and Show, 2004). It was an example of the neoliberal hegemony of urbanization (Brenner and Theodore, 2005; Miles, 2004; Fezer, 2010; Harvey, 2012) as related to the problem of the expert-led business-driven formal planning with the exclusion of former shipbuilders and the general public. Gdansk Shipyard is a unique and important place in the world as the cradle of Solidarity – a democratic social movement founded in August 1980, based on free, open dialogue and self-government which peacefully won democratic freedom for Poland and Central Europe (Goodwyn, 1992). Paradoxically, 20 years after the birth Solidarity, half of the Shipyard's site was sold to private investment funds and so to say – turned from a democratic agora to a neoliberal market. A new business-driven land-use plan, approved in 2004 by Gdansk city authorities without public consultation, did not adequately protect heritage which led to its gradual destruction during the development of a "modern" waterfront district called the Young City (Sebastyanski in Nyka and Szczepański, 2010). Then artists started to attract public attention to this destruction and, joined later by city activists, they managed to reverse this negative process.

2. European collaboration: "Memory of Water".

At the end of 2018, the European, two-year artistic collaboration "Memory of Water" (MoW) under the Creative Europe programme was inaugurated which was devoted to social participation in the processes of protecting cultural heritage through the regeneration of the post-industrial urban waterfronts. MoW programme included 1/ open public discussions (in the form of City Labs) which were initiated and led by people of culture, art and education as well as 2/ art residencies leading to artistic interventions. The program in Gdansk, coordinated locally by the Baltic Sea Cultural Centre (BSCC), was dedicated to the waterfront areas of the former Gdansk Shipyard. Besides BSCC, partners from five other European cities participated in the project: Municipality of Levadia (Greece); Municipality of Oostende (Belgium); Ormston House, Limerick (Ireland); Fablevision, Govan (Glasgow, Scotland) and Intercult, Stockholm (Sweden), which coordinated the whole project.

3. River//Cities network: culture for waterfronts.

All the above-mentioned organizations are members of the River//Cities platform which became a strategic partner* of MoW. The River//Cities network gathers cultural, environmental and political initiatives across Europe aiming to develop their rivers and/or waterfronts as cultural spaces and/or regenerate them using cultural tools and practices. Its goals include exchanging and elaborating ideas, capacity building, facilitating European cooperation of members through joint projects and providing expert engagement. River// Cities is a non-academic partner of the *S.O.S. Waterfronts* project making as a cultural organization a dialogical connection between art in practice and research on the impact of climate changes on the transformation of waterfronts.

4. Participatory City Labs and art interventions

The methodological framework for the whole "Memory of Water" City Lab program had been provided by the city of Ostend. Along with these guidelines, the part of Gdansk program entitled "Shipyard Anew" was launched - a participatory urban laboratory of public space in which all parties interested in the process of transformation of post-shipyard areas in Gdansk could meet and freely present and discuss alternative visions of the future - without predetermined dominant vision or specific solutions. It was a shared space for innovation, experimentation and discovery of new opportunities as well as for mutual learning. It was also a place for reflection on and evaluation of the existing solutions, allowing participants to flexibly respond to changing situations and the needs of citizens and all stakeholders of the process to meet the g-local challenges of the future. According to the principal idea of the "Memory of Water" project, also in Gdansk, cultural workers, artists and educators were the initiators and leaders of the open public discussion. According to the contemporary methodology of Cultural Planning** , the participative process organized by the BSCC had engaged interested social organizations as well as representatives of state and municipal administration together with the owners of plots in the post-shipyard area and developers. The team adopted a method of public disclosure of desires to come up with our collectively imagined future of the former Gdansk Shipyard area, with respect for its great history and traditions. Another important method implemented in the project "Memory of Water" was the placement of international artists in the shipyard. It was based on a two-stage artists' residency program in Gdańsk, to which artists from Ireland, Greece, Belgium, Scotland, Sweden, and Poland were invited.

5. "Shipyard Anew": a dialogical collaborative process

The "Shipyard Anew" project was inaugurated at the end of January 2019 in an art studio within the Gdansk Shipyard. Initially, a group of 20 independent artists and people of culture presented and discussed their desires regarding the forms and methods of transforming the former areas of the Gdansk Shipyard. Within the next two weeks after the meeting, all the participants presented in writing their visions of the Shipyard's future in the form of a survey divided into six thematic categories: MEMORY; ART; WATER AND PUBLIC SPACES; PRODUCTION; GREEN AND ECOLOGY; and DIALOGUE. After collecting and editing this material, the visions and desires of all participants, grouped according to the categories adopted (and accepted) by their authors were published on the blog stoczniaodnowa.pl. They were later sent to the representatives of landowners, public administration as well as academics and cultural institutions. At the next meeting in March 2019 at the Baltic Sea Cultural Centre, the participants presented their desires and commented on the received materials. After a lively debate, all the participants were asked to send short written summaries of their presentations, and the submitted opinions were published on the blog of the project. Summaries of the main ideas in each thematic category were also presented in English, on a website available to all partners of the "Memory of Water" project, including artists preparing their interventions in the post-shipyard areas for October 2019. In the beginning of June 2019, with the Baltic Sea Cultural Centre as a host, a presentation of the current effects of work on the creation of a new, common vision of the transformation of the former Gdansk Shipyard was held, followed by a public debate. The same day, in the afternoon, there was a dialogic workshop (charrette). Discussions were organized as six round tables, for each category separately. The results of the discussion of each panel were presented (in English) to European artists staying in Gdansk at the time for a several-day residency meant to inspire their artistic interventions in October.

6. Artists as ethnographers

During their first stay in Gdańsk, the artists acted as ethnographers, researching a local specificity, past and present problems, and actual threads (Foster, 1995). The art residency program consisted, among others, of joint research walks, participation in workshops entitled „Gdansk Shipyard – mental maps workshop" conducted by social geographer, Klaudia Nowicka (University of Gdańsk). The artists broadened their knowledge thanks to a visit to the European

Solidarity Centre (ECS) and getting to know the collections there and gathering information through conversations with ECS experts. They also had an opportunity of meeting in person and listening to the stories of former employees of the Shipyard. Last, but not least, the artists were invited to a joint conference and presentation of visionary models of the Gdańsk waterfront at the Gdańsk University of Technology, organized by a partner of *the S.O.S Waterfronts* project, Department of Architecture, bridging the space between research, technology, art and visions.

7. 'Inside-in', 'Outside-in' art interventions

During their second stay, artists carried out interventions based on previously acquired knowledge and archival documents. Most of the actions were aimed at involving the local audience in the cooperation. The type of relationship between the artists and the participants of their actions were of an 'inside-in' character, as in the case of the project by a local artist, Iwona Zając, or of an 'outside-in' character - in the case of foreign artists coming to Gdansk (Hannula, 2012). Issues undertaken in the artistic projects were related to the slogans selected during public discussions. They included: a postulate of restoring biodiversity and green habitats to the area (Mary Conroy, IRL; t s Beall, US/SCT); restoring the memory of the underground Radio Solidarity (Iwona Zając, PL); warning against the temptation to remove traces of the past and a positive valorisation of the industrial landscape (Jonas Myrstrand, SE; Siegfried Vynck,

BE); and using an individual story of one of the retired shipyard workers as a message for the younger generation (Ira Brami, GR).

8. Waterfront tomorrow: "Dreams to Fulfill"

As a result of the whole dialogic and participative process, a report entitled "Dreams to Fulfil" was formulated and presented at the Baltic Sea Cultural Centre in October 2019. It was a list of 30 specific ideas about the publicly desired future of the post-Shipyard area in Gdansk, jointly developed by almost 40 active participants in debates and dialogical workshops (charrettes) and then widely disseminated. As for the artistic outcomes of the process, the artistic interventions which followed the social desires were not intended as finished works for a single presentation to the audience. Realised through ephemeral, transitory actions, they were meant rather to initiate further events and debates, thus opening this process to the future and ensuring its sustainability.

9. Arts and culture: a vital part of recovery policies.

We claim that with the use of specific methods and tactics, the public can gain a substantial voice in the local policy of regeneration of the post-industrial urban waterfront and make this voice heard. These methods contribute to the development of culture-led collaborative creative processes offering shared space for encounter and dialogic exchange among various stakeholders. The leading role of the cultural and creative sectors allowed for an open process of experimentation and visioning, resulting in many inspirations for very practical solutions. Moreover, the EU funding of international collaborations allowed the involved partners to develop a common methodology of placing arts and culture as a vital part of recovery policies in the development of European cities.

Acknowledgment(s)
The authors wish to acknowledge the support of the University of the West of Scotland as the scientific partner of the "Memory of Water" project.

Notes:
* visit memoryofwater.eu and river-cities.net for further information on our European collaborations.
** this concept has been used increasingly frequently in recent years, it is also at the core of the current *UrbCulturalPlanning* project (in which BSCC is a partner). "The idea is not just to create cultural events by making space where people can display art or other cultural events, it is rather about involving local people in the planning process of how they want their cities to be." Read more under this link: https://urbcultural.eu/urban-cultural-planning-as-a-method/

Fig. 1. SEED CHANGE, Mary Conroy (Limerick, Irland). Photo: BSCC archives.

References

Bishop, C. (2012). *Artificial Hells: Participatory Art and the Politics of Spectatorship*. London: Verso.

Bourriaud, N. (1998). *Relational Aesthetics*. Paris: Les Presses du Reel.

Brenner, N. & Theodore, N. (2005). Neoliberalism and the urban condition. *City, 9 (1)*, 101-107

Evans, G. & Shaw P. (2004). *The Contribution of Culture to Regeneration in the UK: A Review of Evidence*. London: Department for Culture Media and Sport.

Fezer, J. (2010). Design for a Post-Neoliberal City. *e-Flux Journal #* 17. Retrieved January 10, 2016 from http://www.e-flux.com/journal/design-for-a-post-neoliberal-city/

Foster, H. (1995). The artist as ethnographer? In: *The traffic in culture. Refiguring art and anthropology*, ed. G. Marcus and F. Myers, 302–309. Berkeley, LA and London: University of California Press.

Goodwyn L. (1992). *Jak to zrobiliście? Powstanie Solidarności w Polsce*. Gdansk: Krajowa Agencja Wydawnicza. 55,416, 426, 436,447 and 587.

Hannula M. (2012). *Politics, Identity and Public Space. Critical Reflections in and through the Practicies of Contemporary Art*. Utrecht: MaHKU.

Harvey, D. (2012). *Rebel Cities*. Verso Books the imprint of New Left Books.

Kester, G. H. (2004). *Conversation Pieces: Community and Communication in Modern Art*. Berkley: University of California Press.

Kester, G. H. (2011). *The One and the Many; Contemporary Collaborative Art in a Context*. London: Duke University Press.

Kwon, M. (2002). *One Place After Another: Site-specific Art and Locational Identity*. Cambridge, Mass. London: MIT Press.

Lacy, S. (2010). *Leaving Art: Writings on Performance, Politics, and Publics, 1974-2007*. Durham: Duke University Press.

Miles, M. (2004). *Urban Avant Gardes: Art, Architecture and Change.* London: Routledge

Mouffe, C. (2008). Critique as Counter-Hegemonic Intervention. transversal - eipcp multilingual web journal ISSN 1811-1696. Retrieved June 18, 2018 from http://eipcp.net/transversal/0808/mouffe/en

Sebastyanski, R. (2010). *Artistic colonization of the Gdansk shipyards.* In: Nyka L. & Szczepański J. (Eds.) Culture for revitalization – revitalization for culture. Gdansk: Laznia Contemporary Art Center, 152-174

Sholette, G. (2005). *Heart of Darkness: a journey into the dark matter of the art world.* In: Hall, J.; Becker, L. and Stimson, B. (Eds.) Visual Worlds. New York & London: Routledge, 116 -138

Thompson, N. (ed.) (2012). *Living as Form: Socially Engaged Art From 1991-2011*. New York: Creative Time Book and Cambridge: MIT Press

Agnieszka Wolodzko
PhD, Artist, curator and researcher in the field of culture studies. Foundation "Cultures beyond Culture", Al. Wojska Polskiego 33c/9, 80-268 Gdańsk Poland,

Roman Sebastyanski
Doctoral Researcher, University of the West of Scotland, United Kingdom, Paisley Campus, High Street, J217, Paisley PA1 2BE

Iwona Preiss
President of River//Cities Platform Foundation Board, CEO Intercult, Sandbacksgatan 8, Nytorgsgatan 15A, 116 22 Stockholm, Sweden,

Magdalena Zakrzewska-Duda
Local MoW coordinator, The Baltic Sea Cultural Centre in Gdansk (BSCC), 33/35 Korzenna St., 80-851 Gdansk, Poland; River//Cities Platform Foundation Board Member; Al/ Grunwaldzka 5, 80-236 Gdansk

Lusófona University, Portugal & Laval University, Canada
Pedro Ressano Garcia

Beyond Climate: Adaptation on the Waterfront

Abstract

The programs for waterfront territories facing climate change raise relevant questions concerning reclaimed land located along the water, ecological systems, local context and cultural adequacy. In vulnerable territories, new solutions are planned to enhance their present conditions. The process of regeneration seeks to develop adaptation strategies and make waterfronts more resilient. Projects at the waterfront are requested to develop innovative typologies and present new possibilities. The present situation raises important challenges for the next decades and presents a major question regarding the need to imagine a better future. There are many parameters to be considered, probably too many; therefore, it becomes hard to guess with certainty what the future could become. Engagement with graduate students and young professionals is particularly useful for the discussion. It may be shaped in a creative and intense way, with new strengths that show a commitment to the future generations, or it may be seen as a source of despair of irreversible mistakes towards a dead end.

During the workshop, participants present design proposals that raise fundamental questions about the territory at risk. They are called on to deal with times of threats, caused by climatic catastrophes and develop solutions that result in inspiration to higher dreams. The concepts of symbiosis and *biophilia* in urban ecology are taken into consideration and applied to waterfront projects. The historical constructions of the territories, the geographic conditions, and the climatic indicators have a deep influence in some proposals. Sea level rise and frequent floods drive the will to reshape and redefine the contours of the territory. The integration of infrastructure, the use of renewable energy sources, combined with green systems and urban farming empower sustainability goals. The integration of industrial artifacts, buildings, docks, cranes, and canals are used to design future systems that mix ecologic solutions of passive energy, vertical farms, and floating platforms to build a post-industrial area that is committed to capturing CO_2. The speculative design proposals for Gdansk are becoming relevant due to their capacity to combine systems that are not related, and to connect them to envision integrated mechanisms in symbiosis. Among the participants, the imminent and inevitable climatic disaster is not taken from a pessimistic perspective but as a creative engine to redefine the rules, the goals and most importantly, the dream of the next generation.

Introduction

We advocate a territorial approach to climate action and resilience by promoting place-based policy responses to accelerate efforts to mitigate climate change and to more effectively adapt to its local impacts. (…) This action will rely on systems level change and innovation such as in digitalization, big data, new global economic models, (…) (Declaration, 2020).

The statement is part of the Declaration of the World Congress of the International Society Of City And Regional Planners – ISOCARP organised in 2020. Waterfront territories are facinge new patterns of natural disasters. They are particularly vulnerable, which necessitates the search for new solutions and looking beyond the present climate conditions. Climate change brings a frequency of extreme events that affects the urban environment with floods and high tides, tropical hurricanes, droughts and the urban heat island effect. To face the present challenges, urban environments are seeking to improve their resilience, like sponges that are able to absorb without being degraded.

The effect of a sponge is smooth, the water is soaked up discreetly, the temperature dissipates and gradually returns to its initial condition. The concept of a sponge applied to the built environment requires a shift in the way urban waterfronts have been designed until recently. Sponges take and give, they are passive and active, and open a new realm of opportunities for contemporary design.

A high level of expertise and international excellency among professionals integrates our research project, thus providing the competences necessary to develop futuristic solutions for waterfronts. Sustaining new approaches requires a systematic and rigorous collection of data, the identification of patterns of evolution, and further on, creative contributions. To elaborate future scenarios, it is necessary to combine rigour and invention. Rigorous approaches do not tend to value innovative visions. Innovation presents new ideas or methods to be tested for the first time and does not strictly emerge from rigour. The question is how to find the right balance between the two. Critical thinking and skepticism take it for granted that only a tiny portion of the results will be valuable. Most of the outcomes of an experimental workshop are not useful, they are wasted, but the small part that is relevant is worth the effort and opens up new perspectives.

Methodology

This section presents the results of a short and intensive workshop hosting graduate students of master's in architecture who shared

a common interest in Gdansk's waterfront. They received rigorous data about the rise in frequency of climatic swings and its consequences. Participants were encourage to experiment, to take risks and think about solutions that explored sponge strategies. During the workshop, they had access to the present debate (Lorens, 2019) and the recent discussions. They were encouraged to invest in the potential inventiveness of future solutions based on the local cultural context (Lorens & Mironowicz, 2020). At the end of the workshop, each graduate student had to present their own design proposal that emerged from a balance (Burda & Nyka, 2016) between the scientific rigorous use of data and ecologic sensibility to produce imaginative green/blue solutions.

The European Green Deal has a strong influence among graduate students. Initially, some of the students sought to copy solutions applied elsewhere. It soon became evident that there are no blueprints, and each city has to invent its own solution. The challenges presented by the anthropogenic action on climate change demand the search for innovation, and solutions that are not repeatable, that require the interpretation of each place and the imagination of a specific design.

In order to engage in the present debate, the participants discussed among them the necessities of the public. The methodology adopted brought local knowledge, and local talent to find the best local solutions from local designers. Several authors claim the importance of linking existing public spaces and waterside areas, as argued by Nyka & Burda, referring to social benefits, and advantages of building a more comprehensive and creative city landscape (Burda & Nyka, 2017), though the means to implement these measures can be interpreted broadly.

The interpretation searched by the group of participants influenced the production of design solutions. They intended to combine a good balance between rigour and creativity, while speculating on and opening up new perspectives. Invention relies on both, and flourishes when they are in balance. In Europe, many urban waterfronts are investing in processes of regeneration to face the new challenges brought by climate change, which requires new, innovative answers as stated in the Declaration of ISOCARP.

The central question regards the inevitable process of regeneration. Where should "sponge" strategies be implemented? How may adaption and mitigation improve the resilience of waterfronts?

State of the Art

The reduction of biodiversity, unprecedented climate swings, and the raising costs of maintenance are symptoms of a planet struggling with illness. To reestablish a healthy condition, experts are working to

develop adaptation strategies that increase the resilience of the built environment. Along the lines of a wide range of authors discussing urban resilience, Ayda Eraydin defined a resilient system in terms of "its ability to absorb change and disturbance, and the persistence of systems while retaining its basic functions and structure" (Eraydin, 2013). The persistence of systems raises important challenges for the next generations. To retain basic functions, it is necessary to mitigate risks and develop means to adapt.

According to other authors writing on resilient cities, such as Vale and Campanella, finding a broader perspective will lead to understand the loss of resilience. They define resilience as "the ability to absorb change and disturbance" to the conditions of the community which in many cases is beyond climatic causes: Sometimes, social and political disasters are even self-inflicted, usually by regimes seeking drastic overhaul as a means to promote massive, rapid modernization (Vale and Campanella, 2005). To imagine a better future, projects along the waterfront are expected to integrate local constrains, develop innovative typologies, and present new possibilities.

Climate change imposes transformation. Change itself is not necessarily the problem. Transformation does not, by definition, compromise or promote resilience. It brings new challenges which can be converted into opportunities, according to Yoshiki Yamagata, Principal Researcher at the National Institute for Environmental Studies in Japan: Resilience is not a static state of a system. It is a process. A city is dynamic and is always changing. (…) Resilience is transformative, and in each transformation, tries to create a stronger, improved city" (Murakami, Maruyama, 2016). From his perspective, resilience itself can be understood as change.

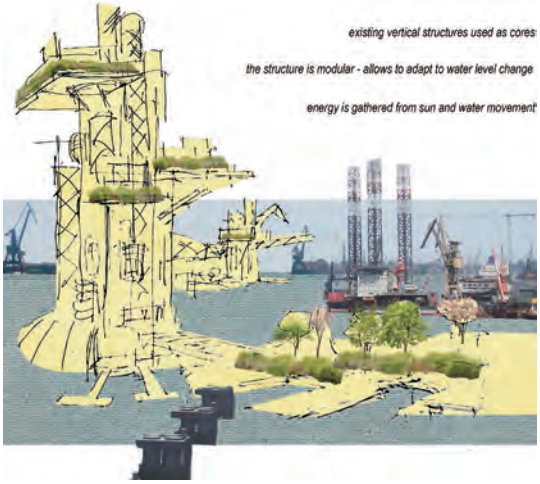
Some scientists claim that it is during the present decade that humanity will decide to balance the anthropogenic influence with natural habitats. It is uncertain whether countries will be able to slow down global CO_2 emissions and protect biodiversity, or if the human race will perish.

The participants in the workshop understood that waterfront territories can play an important role. They share the perception that the most relevant aspect is to find the most appropriate programs and answers that raise pertinent questions concerning reclaimed land located along the water, to protect ecological systems, to value local context, public health, and cultural identity.

Political decisions are required to take affirmative actions and measures that are effective regarding public health. During the pandemic lockdown, political leaders and local communities have shown

the capacity of nations to collaborate and react to protect humans. Radical measurements were taken, proving that it is possible to react positively at a global scale. Procedures of justice and scientific information are needed to be considered in order to relate all of the available parameters. Most of the parameters are increasingly difficult to guess with certainty, thought the correct combination of parameters is useful into predicting and ascertaining what the future could become. The relevance of the results presented in this section relies on the importance of thinking "out of the box" since climate change is presenting unprecedented new challenges.

Graduate students, Aneta Keller, Szymon Kowalski, Marta Jemioł, Tomasz Florczuk and Milan Grześkowiak, Ewa Siostrzonek, Katarzyna Kosińska and Agata Malankiewicz, and Anna Ginter and Magdalena Klimowicz produced the projects presented here. They were selected to illustrate a variety of strategies that share exploratory visions and should contribute to the discussion of potential solutions.



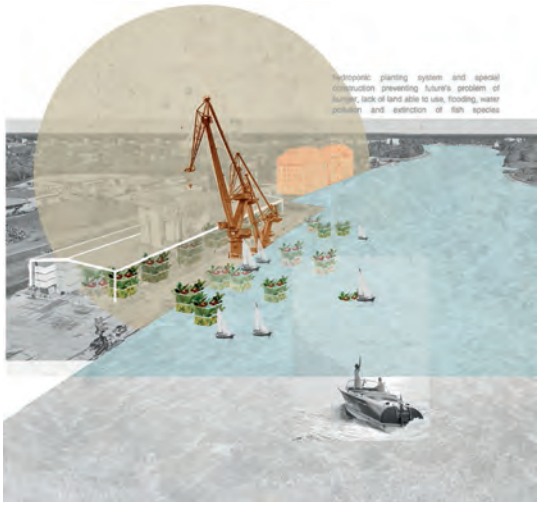


Fig. 1. Marta Jemioł – combining port infrastructures, ecologic interventions and sea-level rise.

Fig. 2. Tomasz Florczuk and Milan Grześkowiak – new structures promoting local biodiversity are implemented in amphibious areas to enhance natural systems.

—

Fig. 3-5. Aneta Keller and Ada Kowalska – hydroponic planting system, floating farming, natural water cleaning systems, three systems are combined to face the water and food shortage

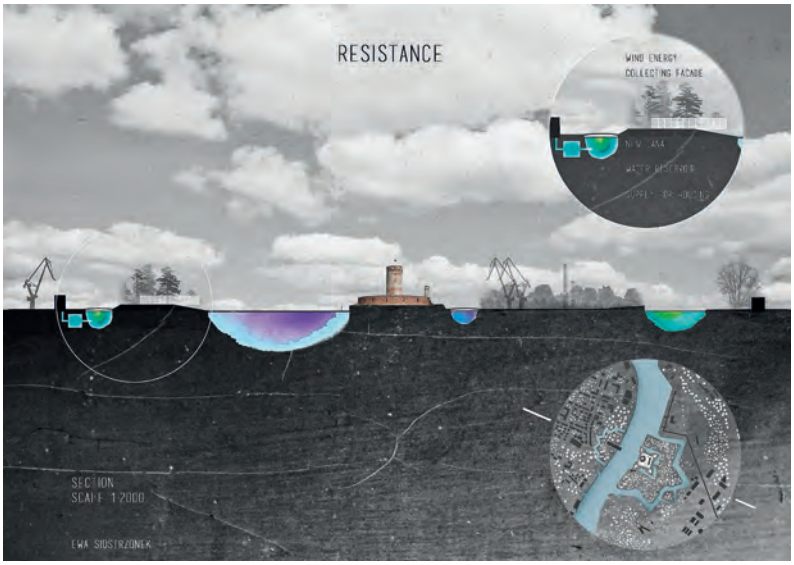
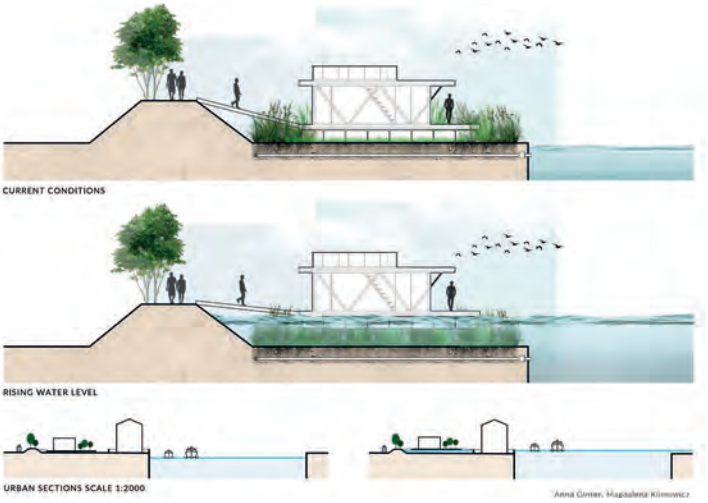


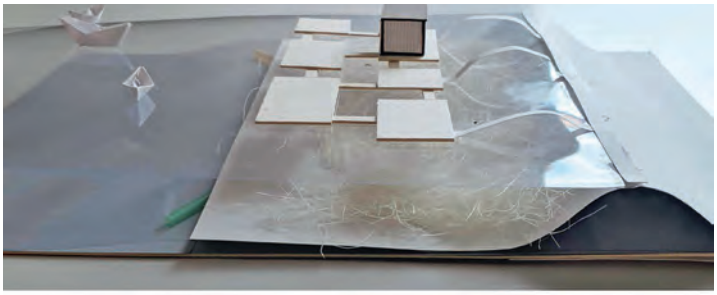
Fig. 6. Ewa Siostrzonek – new hydraulic infrastructure to prevent flooding events is designed to improve public spaces and local heritage.

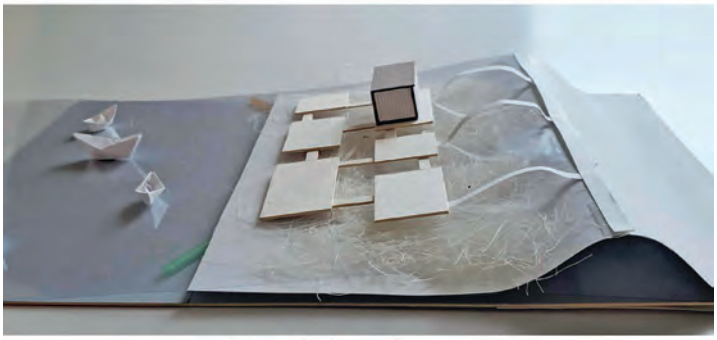
Fig. 7. Marta Jemiol – collage of different infrastructure located along the waterfront

—

Fig. 8-11. Anna Ginter and Magdalena Klimowicz – exploring strategies to enhance the sponge effect, using passive hydraulic systems and new infrastructures located along the waterfront.


CURRENT CONDITIONS
RISING WATER LEVEL
URBAN SECTIONS SCALE 1:2000






fosforite
chemicals
dye fertilizers
dangerous bacteria trash
gasoline mineral oil ???
ean water

Outcomes

The improvement of resilience includes shrinking the ecological footprint and long-term strategies. To face the present threats, research and exchange of practices stimulate new ideas that are occasionally useful in finding solutions (Ordine, 2017) that are betting in the future or in other words present the best guessing.

Planning regulations, academic perception of planning and their methods are outdated. The methodology adopted in the workshop aims to conceptualise for the future and face the present challenges. To envision the new opportunities, it is necessary to engage the next generation, namely graduate students and young professionals that contribute positively to the discussion. Their contributions may be shaped in a creative and intense way, with new strengths that show a commitment to future generations (Krenz, 2018), or it may be seen as a source of despair of irreversible mistakes towards a dead end.

The images presented above are designed for specific sites. The authors were encouraged to think "out of the box" to imagine beyond predictable scenarios and to take risks. Their design proposals address fundamental questions about the vulnerability of waterfront territories, dealing with times of threats caused by climatic catastrophes, and develop solutions that may become an inspiration to higher visions. The concepts of symbiosis and biophilia in urban ecology are transversally integrated and applied in the design.

The research, by design, takes into consideration the influence of geographic conditions, historical buildings and climatic indicators. Data related to sea level rise and frequent floods influenced the authors to redefine the contour of the line separating the land and water. Geographic data proves the necessity for new infrastructures, the use of renewable energy sources, combined with green systems and urban farming. Together, these measures empower sustainability goals. Among historical heritage, industrial artifacts, buildings, docks, cranes, and canals are used to design future systems that mix ecologic solution of passive energy, vertical farms, and floating platforms, to build a post-industrial area that is committed to capturing CO_2.

The speculative designs presented by Anna Ginter and Magdalena Klimowicz, and by Kosińska and Malanliewicz, explore alternative strategies to promote the sponge effect. The first through passive hydraulic systems, and the second through the implementation of new green infrastructures located underwater in order to absorb and filter excess water.

Fig. 12. Katarzyna Kosińska and Agata Malankiewicz – future systems to integrate vegetation that clean the water and enhance the sponge effect.

Both designs explore a new realm of possibilities that emerge from integrating natural systems into the built environment. Nature

and buildings are combined and taken as one. They work together and benefit each other. The design promotes a symbiotic approach by promoting the sponge effect. It is able to absorb extreme swings of temperature and water. The sponge is resilient, not static. It cooperates in the process of transformation while sustaining permanence. From their perspective, promoting a smooth dialogue between the natural and the built environment is able to regenerate nature.

In short, these design proposals prioritise the following aims: integrity of the city and the protection of the urban environment as a place of integration, unity, safety, and sense of belonging. They succeed in contributing to the present discussion by combining systems that are not related, and by envisioning integrated mechanisms of symbiosis.

Among the proposals, it is understandable that the eminent and inevitable climatic disaster is not taken from a pessimistic perspective. The participants acknowledged that possibility when processing the scientific data; they did not ignore the facts, though they did decide to invest in an optimistic vision based on the perception that previous generations have been able to move quickly and respond positively in times of catastrophe. Climate action is taken as a creative engine to redefine the rules, the goals and most importantly, the dreams of the next generation.

References:

Declaration, (2020) 56th World Planning Congress of the international Society of city and regional planners, https://doha2020.isocarp.org

Lorens, P. (2019), Shaping the new face of the Imperial Shipyard in Gdansk, in Przestrzen i Forma, Journal, pp 151--170

Lorens, P., Mironowicz, I. (2020). Gdańsk: a City of Solidarity and Freedom. Disp, 56, 8–21. https://doi.org/10.1080/02513625.2020.1756621

Burda, I. M., Nyka, L. (2016). Re-Shaping the Land and Water Connections and Its Role in Achieving Landscape and Ecological Systems' Continuity on the Post-Industrial Territories, Sgem 2016, Bk 4: Arts, Performing Arts, Architecture and Design Conference Proceedings, Vol II, pp. 533-538.

Burda, I. M. Nyka, L. (2017). Providing Public Space Continuities in Post-Industrial Areas through Remodelling Land/Water Connections, *IOP Conference Series: Materials Science and Engineering* DOI: 10.1088/1757-899x/245/8/082037 Part of ISSN: 1757-8981.

Eraydin, A. (2013). "Resilience Thinking" for Planning [in:] Resilience Thinking in Urban Planning, p. 28 Dordrecht, Springer

Vale L. J., Campanella T. J. (2005). "Introduction, The Cities Rise Again" [in:] The Resilient City, How Modern Cities Recover from Disaster, pp. 6–7, New York, Oxford University Press.

Murakami, Y., Maruyama, H. (Eds), (2016). "Preface" [in:] Urban Resilience, A Transformative Approach, Switzerland, Springer.

Ordine, N. (2017). The Usefulness of the Useless, New York, Paul Dry Books.

Krenz, M. (2018) „Walking on Water: Alternative Perspectives on Urban Networks" [in:] *Studia KPZK*, vol. 188, pp. 268–282.

Pedro Ressano Garcia
Associate Professor, Department of Architecture, School of Communication, Arts and Information Technologies (ECATI). Universidade Lusófona (Lusófona University), Campo Grande, 376, 1749-024 Lisbon, Portugal & Professeur Agrégé, École d'architecture (School of Architecture), Université Laval (Laval University). Édifice du Vieux-Séminaire de Québec 1, côte de la Fabrique, bureau 3210, Québec, Canada

Gdańsk University of Technology, Poland — Lucyna Nyka
Lusófona University, Portugal — Rui Simões
Lusófona University, Portugal & Laval University, Canada — Pedro Ressano Garcia
Rayss Group & Landscape Architecture Association, Poland — Joanna Rayss

Designing with Green and Blue – Climate Adaption Proposals for Lowland Areas of Gdańsk

Abstract

The paper gives insight into issues explored within the framework of the SOS Climate Waterfront workshop that took place in Gdańsk in June 2019. The aim of the study was to propose solutions that will decrease the number of flooding events and span the gap between flood prevention strategies and the provision of other benefits such as ecological, urban, cultural and social. Historical cartography enquiries and research by the design method were used to develop design concepts. The main foundation for the design concept was built on the goal of providing more room for water, particularly for stormwater and rainwater. The second aim was to create blue-green connections that would span the amorphous territory and bring various benefits, including environmental, hydrological, and social. As research studies demonstrate, historical hydrographies can be effectively explored as guiding agents in urban climate adaptation schemes. Referring to past landscapes contributes not only to the protection but also to the exposition of cultural heritage and strengthening the relations between historical buildings and urban surroundings. It conduces to questioning the land-water dichotomy in favour of proposing their alternative and more fluid boundaries making territories less vulnerable to the threats brought by climate disasters.

Introduction

Climate change engenders pressure for sustainable solutions in urban waterfront areas. Rising sea levels, heavy storms, flash floods and prolonged periods of drought demand the introduction of diverse adaptation strategies to protect both people and the built environment. Creating more water-resilient cities leads to rethinking urban territories in terms of their capacity to absorb water and give it more space. As it appears, this may be the only way to effectively respond and easily recover from certain sudden, climate-related events. (EEA, 2012; EEA, 2020). The pursuit for achieving such goals entails the introduction of different kinds of concepts from hard engineering constructions to soft, nature-based and ecosystem-based solutions.

Planning for urban resilience may pertain to the large-scale waterfront territories that undergo massive transformations, usually related to the withdrawal of industry, but also relates to smaller historical neighbourhoods (Garcia, 2021). While in the first case water management concepts could be implemented as a part of an initial overall strategy, designing for densely built urban structures poses specific challenges. Specifically, the question arises as to how

to intertwine stormwater infrastructure into an existing urban structure. Another case concerns territories that combine both of the above-mentioned characteristics, where green-blue concepts support urban patterns and may unfold into experimental water landscapes and water urbanism scenarios (De Meulder & Shanon, 2007). Regardless of the scale, there is also the dimension of the ecosystem functions of green and blue infrastructure, which is often forgotten.

In all cases, however, knowing that cities are complicated social-ecological systems (Andersson, 2021), the same group of issues emerge, such as how the water management infrastructure may balance diverse public and ecological functions while providing various ecosystem services. Can the proposed climate adaptation schemes contribute to urban and social rehabilitation and promote inclusiveness? Another important group of issues relates to the vulnerability of waterfront heritage buildings and landscapes, a concern that has recently gained very close attention (Nyka et al., 2021). In this context, the question of how the contemporary flood protection measures may contribute not only to the protection but also to the better exposition of the architectural and urban heritage in connection with the ecosystem values of these spaces gains prominence. Can historical hydrographies become a guiding agent influencing today's flood-resilient urban morphologies and flood adaptation schemes?

All of the above-mentioned issues were explored within the framework of the SOS Climate Waterfront workshop that took place in Gdańsk in June 2019. The aim of this urban resilience project was to propose solutions that will decrease the number of flooding events, now and in the coming future, and span the gap between flood prevention strategies and the provision of other benefits such as ecological, urban, cultural and social.

Study area, materials and methods

According to the various flood projections models, the city of Gdańsk is one of the most vulnerable places in Europe. It was founded on islands and wetlands at the confluence of the Motława and Vistula rivers in the estuary of the Vistula River to the Baltic Sea. On the east side, the city is encircled by geographical depressions, transformed through centuries into polders. The low-lying waterfront territory, located north of the historical city, where two districts of the city of Gdańsk, namely Letniewo and Nowy Port, seamlessly connect, has become a field laboratory for climate adaptation concepts. The study area is adjacent to the Dead Vistula River and cut by polder canals named Warzywód I and Warzywód II – watercourses flowing from

the former Lake Zaspa through the wetlands towards the Vistula River. Today, the whole area remains dry only due to the constant pumping action by the Nowy Port Pumping Station. The average water pumping height is about 1 m (from the ground ordinate, -2.0 m to -0.9 m below sea level) but sometimes even more due to an increase in the water level in the Dead Vistula River. Despite this action, the territory is under the constant threat of inundation resulting from the high level of groundwater, and is prone to riverine floods and flash floods caused by water run-off from the higher located urban territories of Gdańsk – the Warzywód canals operate as the rainwater collectors for the whole district.

From a historical perspective, it should be pointed out that most of the areas that belong today to the Nowy Port and Letnica districts in Gdańsk were covered by the waters of Gdańsk Bay even in the 16th century (Kościelak, 2021). With time, however, the sands and silts carried by the Vistula gradually led to the emergence of wetlands, swamps and peat bogs, where individual buildings were erected on small mounds called 'terps'. The plan of Nowy Port dated from 1711 shows a few isolated buildings – the first in the region. In the last decades of the 18th century, the locality of "Neufahrwasser", later known as Nowy Port, was established and very soon the main urban complex of the port settlement was built (Kościelak, 2021). Mathias Broschke played a special role in the development of Nowy Port (Szczepański, 2010). He built a sawmill, a brewery and a distillery, and was an owner of 40 houses in Nowy Port. In 1804, the distillery came into the possession of the Fischer family, was greatly expanded, and operated until 1945 when it was demolished. The residence of the Fischers, so-called Fischer House, has survived to this day. Sadly, this heritage is rather blurred today, which results from the immediate vicinity of a rich but equally problematic hydrological system.

In contrast, the area known today as Letnica has never been fully urbanised. It served mainly agricultural functions, serving primarily as meadows for grazing cattle, until the 19th century when the first industrial factories were located there, and the first residential houses began to be built. The 18th, 19th and early 20th century maps reveal that Lake Zaspa was located in the centre of this area – a reservoir of about 40 hectares with very fluid boundaries (Fig. 1). The whole area is very low-lying, only several centimetres above sea level, so the wetlands surrounding the lake were crossed by innumerable channels. During an immense flood in 1829, the Vistula overflowed the nearby Lake Zaspa. The plans to designate this territory for industrial purposes have never been fully implemented.

Fig. 1. Nowy Port and Letnica areas. Plan von Danzig: Städtischen Vermessungsamt (1933). Source: State Archives in Gdańsk

After WWII, Lake Zaspa, located in the Letnica area, was gradually covered with debris from the destroyed city of Gdańsk, starting in 1945, and later with sediments and ashes resulting from the production of energy by the Gdansk thermoelectric plant. The ashes were mixed with water at the plant and pumped through a pipeline to the lake and dumped there, a process that was only interrupted in 2011. Approximately 2 million tons were discharged, which led to the complete disappearance of the lake. At present, the landfill is partially reclaimed and completely covered with vegetation – the water basin has vanished. The area of the former Lake Zaspa is rather perceived as a hill. Today, the majority of this district of Gdańsk is an amorphous, partly industrial, partly residential territory with scattered disorganised green spaces with paradoxically low biodiversity and a significant share of the fenced area of allotment gardens inaccessible for the public. The whole territory here only remains dry only thanks to the Warzywód III Canal, and constant pumping action in several pumping stations near Marynarki Polskiej Street, and finally in the Wielopole Pumping Station, where water is discharged into the Dead Vistula River under the normal water level of the river (Fig. 2).

Both Nowy Port and Letnica underwent urban revitalisation programmes in the second decade of the 21st century. Despite this fact, the study area combines a mixture of complications. Primarily, it is a low-lying mostly post-industrial territory. It has been passed on to the present generation with major economic and social problems, growing expenses in facing natural disasters, loss of biodiversity and the need to adapt waterfront areas to climate change scenarios. The flood risk maps, constructed on the basis of the seawater level rise scenarios for the Polish IT System of the Country Protection against extraordinary threats (ISOK) show the vulnerability of waterfronts along the Vistula and Motlawa rivers. Nowadays, the most visible effects of climate-related changes include the increasingly repetitive flash floods, groundwater inundations, risks of saline water intrusion into the groundwater sources, and storm surges that push water back from the sea and threaten the safety of riverine waterfronts. What is more, despite the significant water resources in the area, the city is completely turning away from the Vistula River and existing canals. Although the study area faces significant challenges, it also presents extraordinary opportunities originating from its authenticity, the predominant feeling of being embedded in history, and strong social ties.

In response to these challenges, site analysis, studies of the historical background, geographical and natural conditions studies,

and collection of hydrological data were carried out. Historical cartography enquiries and research by the design method were used to develop alternative design scenarios. To identify the main challenges, the existing water management system was examined and confronted with the urban development plans and research studies related to the flood threats and Gdańsk Climate Adaptation Plans. In this context, the whole area of the Warzywód canals catchment and the banks of the Vistula River were analysed. The historical hydrography studies were carried on to understand the process of land-water transformations. Activities of the cultural institution Łaźnia 2: Centre for Contemporary Art were analysed to identify the potential of interaction between spatial solutions and cultural programmes implemented in Nowy Port. The goal was set to address not only the consequences of climate change, but to create conditions for the rich experience of the natural and cultural environment for the local population and visitors, and to bring the water closer to the citizens.

Blue-green landscapes

With climate change, the study area is expected to be even more prone to flooding by heavy rains and storms that push water from the sea into the river. The currently implemented strategy of raising the embankment walls and speeding up the pace of pumping out water into the river can no longer be considered sufficient, and furthermore, it appears to be socially, economically, and environmentally questionable. Thus, the main foundation for the design concept was built on a goal of providing more room for water, particularly for stormwater and rainwater. The second aim was to create blue-green connections that would span the amorphous territory and bring various benefits, including environmental, hydrological, and social. At this point, a new aspiration came to the fore, specifically to examine whether blue-green solutions could be guided by historical cartography and hydrography studies. If so, do they manage to reposition the perception of the heritage objects and structures? An equally important objective was to provide attractive public spaces with close contact with the water.

In effect, the concept involves the expansion of water-related green areas, including those leading towards the urban centre of Nowy Port, delimits the layout of a new water park with a lake in Letniewo, as well as with a Leisure and Culture Park located on the waterfront of Nowy Port (Fig. 3).

Fig. 2. Pumping levels (in decimeter scale), Warzywód III canal, (photos by Joanna Rayss)

Designing with water – reintroducing the lake

In the design concept, it is proposed to release the water of the Warzywód channels into a low-lying section of the Letnica area, in this way creating a lake with two zones – the 'wet part' – constantly filled with water, and the ready-to-fill – 'dry rush' part to achieve the retention capacity. Such diversity of habitats will also increase the local biodiversity and number of ecosystem services provided by local greenery. The proposed extensive water reservoir offers a chance to develop an alternative landscape structure for the whole territory, based on systems of floodplains and interconnected green and public spaces that may serve local neighbourhoods, accommodate water overflow and support vulnerable ecosystems.

Most of all, the lake is intended to serve as a buffer zone protecting the area from several threats of climate change. It would serve as a retention reservoir for stormwater and rainwater, and during incidents of heavy precipitation, protect the neighbourhood from flash floods. This buffer would also protect against the negative effects of the backwaters that occur during heavy storms on the Baltic Sea accompanied by eastern winds, which happens in this area up to several times a year. By maintaining the desired level of groundwater in the area, the lake would also protect the region from saltwater intrusion. In addition, ecologically rich aquatic plant communities and rushes will favour the treatment of water flowing through the Warzywód canals as well as the natural regeneration of soil degraded by industry. That is why, together with surrounding greenspace, the reservoir

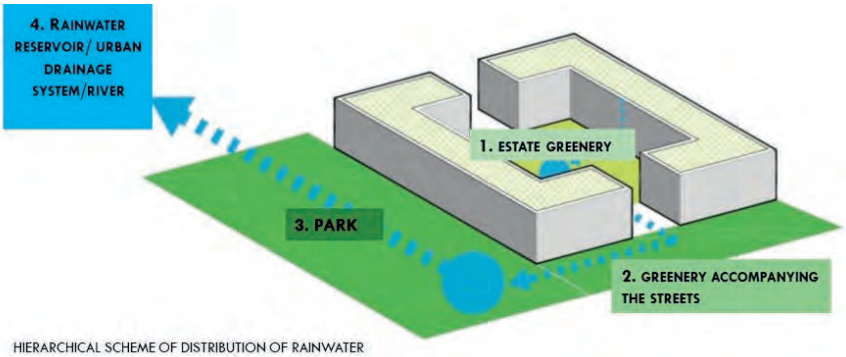
Fig. 3. Design concept for the study area, L. Nyka, R. Simoes, J. Szczepański, J. Rayss

—

Fig. 4. SURS scheme, J. Rayss

would capture and retain water, and provide environmentally based solutions such as greenery barriers to infiltrate water, and floating islands of constructed wetlands for water treatment. This complex three-stage water treatment system was proposed to adapt harvested stormwater to surface water quality requirements for beneficial use, particularly since part of the runoff flows into the lake from the nearby hill which is the former Zaspa lakebed filled with ashes from the heat and power plant. The new reservoir is also designed to become a new core for recreational activities, such as walking, biking and canoeing, and to offer diverse opportunities for the introduction of attractive urban and architectural structures.

Accordingly, in addition to the Nowy Port revitalisation plan, which proposes new housing areas next to the Vistula River in the Fischer Mansion area, our working group also foresees urban growth towards the south, around the proposed lake, with different characteristics but mostly of a residential orientation. This area is divided into three different housing programs: the east side of the lake hosts single-family houses with private gardens, some in proximity with the lakefront, however not disturbing the continuity of lakefront paths. On the west side, multifamily homes consisting mostly of four-storey buildings are located on elevated dikes that are designated in continuity with the existing urban structure. The number of floors decreases as they approach the lake. On the lakefront, groups of floating houses are proposed with access by water and by land. The whole proposed urban tissue will promote *in situ* rainwater harvesting policy, with runoff water management in a hierarchical Surface Urban Retention System (SURS – Polish SPRiM, Rayss, 2019) as shown in the scheme (Fig. 4). In the presented concept, the road that connects the city centre with Nowy Port will remain in the same place but will be surrounded by the lake waters and the number of lanes is proposed to be reduced in favour of creating bicycle paths.



HIERARCHICAL SCHEME OF DISTRIBUTION OF RAINWATER

Leisure and Culture Park

Observation on-site and examination of land use plans show that on the west bank of the Dead Vistula River, almost in front of the iconic Wisłujście Fortress, there are, in addition to the Fischer Mansion (Fig. 5), another six buildings classified as elements of interest. Together with the value of the existing remains of the old park, and its ornamental greenery (with huge and beautiful specimens of the red form of beech trees), with several characteristics for riverside riparian forest tree and shrub species such as willows, alder trees, ash trees, black poplars and reeds, they offer a sound incentive to transform this place into an area to be preserved and rehabilitated. Archive studies reveal that the Fischer Mansion appears in several promotional brochures from the Richard Fischer Brewery. To the north of the complex where the Mansion is located, there are several notable houses and residential buildings, of which a traditional wooden house stands out, which, as the research studies revealed, could be placed on the traditional construction line of this region between the 17th and 19th centuries. The area maintains the characteristics of both unquestionable authenticity and abandonment, which makes it interesting and inspiring for cultural activities.

Fig. 5. Fischer Mansion, (photo by Lucyna Nyka)

The buildings under protection located around the Fischer Mansion may well suit cultural functions. In the proposed concept, the entire park surrounding the buildings is recovered, while maintaining most of the existing plant species, especially the trees. The whole site will be dedicated to cultural activities and programmes, and provide an attractive environment for games and walks with pedestrian paths that improve the accessibility and safety of the whole

—

Fig. 6. Fig. 7. Leisure and Culture Park with a new marina. Concept development: R. Simoes, L. Nyka, J. Szczepański, drawings: R. Simoes

area (Fig. 6, Fig 7). Rainwater harvesting greenery, for example in the form of rain gardens and retention flowerbeds, is proposed to be installed by the historical buildings as the symbol of the connection of history with contemporary climate change issues. A water tank in the middle of the park, in the place where the former beer factory once existed, would remind visitors of the history of this place, and may even be a trigger for the restoration of the heritage in the form of a small craft brewery on the site.

The existing road located next to the river is transformed into a water canal and so the section of the waterfront becomes an island. In effect, the sharp line of the river embankment was rethought as an area of ecological and urban mediation. The island with the theatre scene and a floating gallery pavilion moored nearby will provide supporting space for cultural activities organised by Łaźnia 2: Centre of Contemporary Art that has been changing the image of Nowy Port since 2012. The new canals and an island with characteristic plant communities, such as riverside wickers with different species of willows, riparian forests with black and white poplar trees and hops festoons, alder forests, and reed thickets will improve the ecological quality of the space and enrich the morphology of the waterfront public spaces, provoking discussion on the land-water relation and its role in designing vivid public spaces in the context of climate change (Burda & Nyka, 2016).

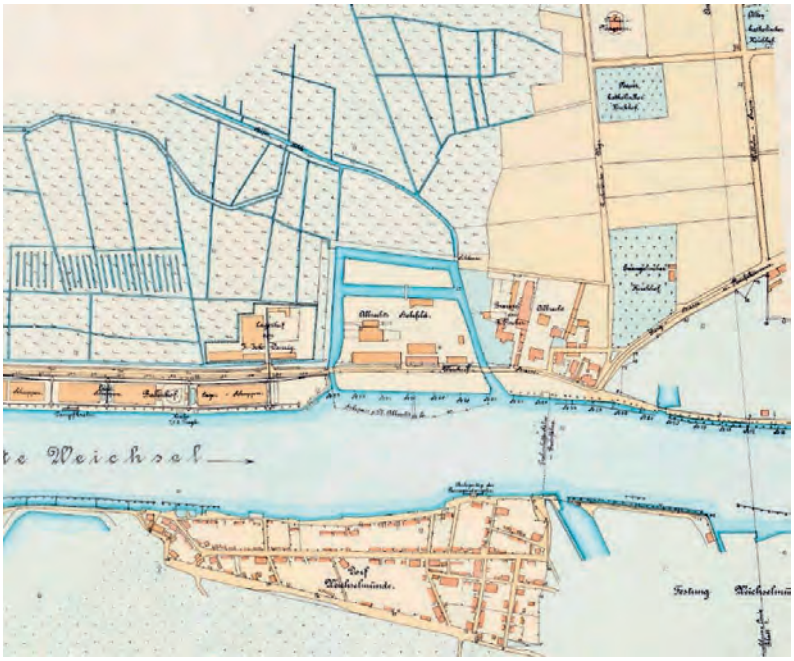
The old canals and a new marina

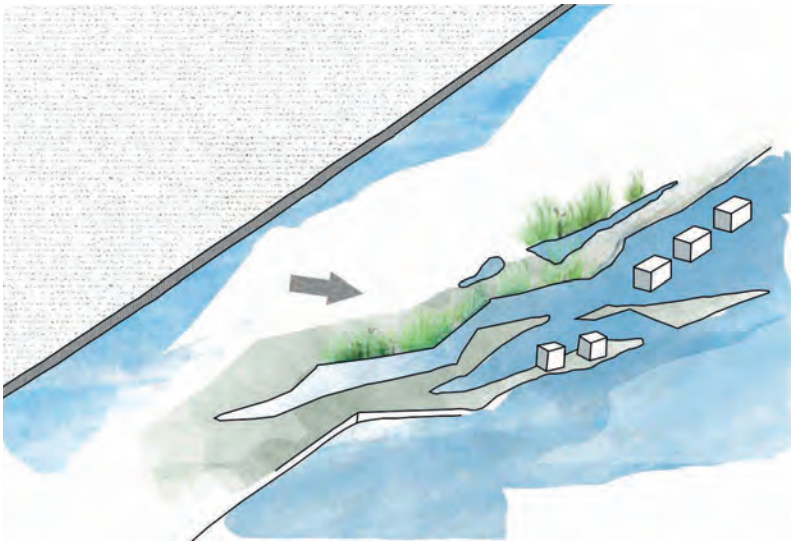
On the Dead Vistula waterfront, south of the Warzywód channel, as historical hydrography studies revealed, the natural wetlands and system of minor drainage canals and the drainage ditches were changed in the last decades of the 19th century and the whole area was transformed (Fig. 8). The natural irrigation channels gave way to access channels to port docks, and new buildings that served port functions were erected, while the minor drainage canals were filled in and moved partially underground. Today, the whole area is a large-scale concrete platform without any traces of water. The former lines of canals, visible in the plans of the beginning of the 20th century, became an inspiration for a new network of watercourses and a small marina. Smaller canals that cut through the marina park bring the *genius loci* to the place and serve as drainage system ditches, simultaneously solving contemporary problems. It is an example of ecosystem-based design with roots in the past as a tool not only for climate change adaptation and improving the quality of the environment, but also architectural and urban rehabilitation.

The proposed marina serves not only recreational purposes but also provides more room for riverine waters. In this regard, it is part of the strategy of questioning the univocal line between the river and land (Fig. 9), developed in many parts of Gdańsk as a vertical wall of the embankment, which impairs public access to the river and increases the speed of flowing waters pushed from the sea towards the city centre. The two large granary buildings next to the Vistula River will host the infrastructure necessary to support the Marina, Cultural and Leisure Park, as well as offices and apartments.

Fig. 8. Hafen Danzig-Neufahrwasser und Weichsel bis zur Mottlaumündung. Karte 2 vom Weichselmünder Festungsturm bis zum Petroleum-Lagerhof 1:2500 (1894). Source: Technische Universität Berlin Architekturmuseum

Fig. 9. The strategy of questioning the univocal line between the river and land, A. Nyka





As the research study shows, the proposed new network of canals and water basins inspired by historical cartography studies would not only make the territory more resilient and flood-proof but also significantly improve the exposition of the historical buildings.

Road access to this area is via the south, with car parking and transport points on industrial land that border the marina area to the south. The restoration of the canal-ditch system and the

construction of new marina canals for leisure activities would strengthen the connection between the existing and proposed water structures: the river, canals, and lake.

Conclusions – discussing the land-water dichotomy

The combination of green and blue infrastructures located along the waterfront is designed to accommodate extreme climate conditions and mitigate potential costs related to floods, storms and sea-level rise, with prolonged periods of drought. Questioning the land-water dichotomy and proposing their alternative and more fluid boundaries makes it reasonable to develop a new topography of the place and reshape the whole site, making it less vulnerable to the threats brought by climate disasters. As research studies demonstrate, historical hydrographies can be effectively explored as guiding agents in urban climate adaptation schemes. Referring to past landscapes contributes not only to the protection but also to the exposition of cultural heritage and strengthening the relations between historical buildings and urban surroundings. The combination of flood protection measures with ecosystem services, public space values, and the exposition of historical buildings differs from the standard land-use and flood-prevention proposals for Gdańsk, which are predominantly function-oriented. The multidisciplinary cooperation between academic institutions, experienced practitioners, cultural groups and local planning agencies, as project partners in the H2020 'SOS Climate Waterfront' projects, has already resulted in collaborative and fruitful debate and should produce, in the longer term, a change in urban thinking and practice.

References:

Ahern J, Sarel C, Niemela J. (2014). The Concept of Ecosystem Services in Adaptive Urban Planning and Design: A Framework for Supporting Innovation. *Landscape and Urban Planning*. 125:254–259. DOI: 10.1016/j.landurbplan.2014.01.020

Andersson, E., Haase, D., Anderson, P., Cortinovis, C., Goodness, J., Kendal, D., Lausch, A., McPhearson T., Sikorska, D, Wellmann, T., *(2021)*. What are the traits of a social-ecological system: towards a framework in support of urban sustainability. *npj Urban Sustain* 1, 14 (2021). https://doi.org/10.1038/s42949-020-00008-4

Andrade, A; Córdoba, R; Dave, R.; Girot, P; Herrera-F., B; Munroe, R; Oglethorpe, J; Paaby, P; Pramova, E; Watson, E; Vergar, W. (2011). *Draft Principles and Guidelines for Integrating Ecosystem-based Approaches to Adaptation in Project and Policy Design: a discussion document*. IUCN- CEM, CATIE. Turrialba, Costa Rica.

Burda I., Nyka L. (2017). Providing Public Space Continuities in Post-Industrial Areas through Remodelling Land/Water Connections. *IOP Conference Series: Materials Science and Engineering* 245 (8), pp. 082037

De Meulder B., Shannon K. (eds.) (2008). *Water Urbanisms*. Ufo 1 Urbanism Fascicles OSA. Amsterdam: SUN.

EEA Report No 2/2012 on Urban Adaptation to Climate change in Europe.

EEA Report No 1/2017 Climate change, impacts and vulnerability in Europe 2016. An indicator-based report. https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016. [accessed 01.08.2021].

Elmqvist, T., Fragkias, M., Goodness, J, Güneralp, B., Marcotullio, J., P. (2013). Stewardship of the biosphere in the urban era. In: Elmqvist T, et al. (eds.) *Urbanization, biodiversity and ecosystem services, challenges and opportunities*. USA: Springer; 2013. p. 719–747.

Kabisch, N., Korn, H., Stadler, J., Bonn, A. (eds.) (2017). Nature-based Solutions to Climate Change Adaptation in Urban Areas, Theory and Practice of Urban Sustainability Transitions. Springer. DOI 10.1007/978-3-319-56091-5_1.

Kościelak Zdzisław. Nowy Port. Gedanopedia. www.gedanopedia.pl/gdansk. Accessed 03.11.2021

Nyka L. (2019): Bridging the gap between architectural and environmental engineering education in the context of climate change. *World Transactions on Engineering and Technology Education*, *Vol.17*, *No.2*, pp. 204-209.

Nyka, L.; Szczepański, J; Borucka, J.(2021): Vulnerability of heritage waterfront areas in the city of Gdańsk: challenges, conflicts and concepts. Oslo Forum 2021 - Cultural Heritage in a Changing Climate.

https://europa.eu/new-european-bauhaus/events/independent-event-oslo-forum-2021-cultural-heritage-changing-climate_en

Rayss J. (2019) Zielona infrastruktura miasta – od skali planistycznej do ogrodu deszczowego. In: Gajewska M. et al. (eds.) System powierzchniowej retencji miejskiej w adaptacji miast do zmian klimatu – od wizji do wdrożenia. Gdańsk 2019, pp. 100-118.

Szczepański, J. (2010). Nowy Port: Matthias Broschke – od sztauera do milionera. http://ibedeker.pl/u-przyjaciol/osobowosci/nowy-port-matthias-broschke [accessed: 03.11.21]

Thu Thuy Nguyen, Huu Hao Ngo, Wenshan Guo, Xiaochang C. Wang (2020), A new model framework for sponge city implementation: Emerging challenges and future developments. *Journal of Environmental Management*, Vol. 253, 2020,

https://doi.org/10.1016/j.jenvman.2019.109689.

Xiu N, Ignatieva M, Chai Y, et al. (2017) A socio–ecological perspective of urban green networks: the Stockholm case. *Urban Ecosystems* 20(4):729–742

Lucyna Nyka
Full Professor, Faculty of Architecture, Gdańsk University of Technology,ul. Narutowicza 11/12, 80-233 Gdańsk, Poland

Rui Simões
Lecturer, Department of Architecture, School of Communication, Arts and Information Technologies (ECATI). Universidade Lusófona (Lusófona University), Campo Grande, 376, 1749-024 Lisbon, Portugal

Pedro Ressano Garcia
Associate Professor, Department of Architecture, School of Communication, Arts and Information Technologies (ECATI). Universidade Lusófona (Lusófona University), Campo Grande, 376, 1749-024 Lisbon, Portugal & Professeur Agrégé, École d'architecture (School of Architecture), Université Laval (Laval University). Édifice du Vieux-Séminaire de Québec 1, côte de la Fabrique, bureau 3210, Québec, Canada

Joanna Rayss
PhD, Landscape Architect, Rayss Group, ul. Balcerskiego 6/10, 80-299 Gdańsk, Poland & Landscape Architecture Association, ul. Warszawska 24, 31-155 Warszawa, Poland

Lusófona University, Portugal
Rui Simões

Courtyard in Dolne Miasto – Sitting on the Red Brick Wall

Abstract

Dolne Miasto's heritage is very important for the City of Gdansk. It bears witness to various periods of its history, from the 17th century fortifications, and the city's industrial zone in the 19th century, to the residential area in the 20th century. In addition, its location close to the centre and its scenic surroundings extending between the 17th century bastion line and the Nowa Motława River make it one of the parts of the city of Gdansk with the most potential for real estate investment. The problem that arises is how to conserve this urban heritage in the face of climate change that will surely affect the city of Gdansk, a city located at low levels, in some places below water level. The creation of flood zones in case of emergency may be one of the solutions found. This article intends to explore this aspect of urban rehabilitation in an experimental way.

Dolne Miasto (Lower Town)

Initially grazing land, and acquired between 1338 and 1341 by the City of Gdansk, it was donated in 1346 by the City Council to the guild of butchers of Gdańsk. Before the 17th century, Lower Town was sparsely inhabited. The urban shape of this zone evolved to its current form in the period between 1576 and 1638. The excavation of the New Motława riverbed began in 1576, and the modern fortifications of the city were completed between 1636 and 1638, to surround Gdansk with a new defence after it was threatened in the Polish-Swedish War. These fortifications that made the Lower Town part of Gdańsk were of the Dutch type with bastions combining water and earthwork structures. The Lower Town area had been covered with landfills but had not been used for years. Around 1650, Georg Tellior devises a development plan for this area, consisting of an orthogonal system of channels, along which the streets were later built. This was the origin of the urban fabric of Lower Town. The idea behind the project was to dry the land that contained a very high groundwater level; the water from the channels was pumped through windmills located in the bastions and on the outskirts of the city (Szczepański, 2008).

The main channels ran in the middle of the current streets: Łąkowa – Wróbla – Radna and Szuwarów – Jaskółcza – Jałmużnicza – Przyokopowa, and at the foot of the embankments and bastions: Królik – Niedźwiedź (now Miś) – Wyskok, and were connected by channels transversal to those along the streets: Dolna – Sempołowskiej, Śluza – Kieturakisa (collector channel, with a lock at the mouth of the Motława) and Zielona. Several bridges crossed the ditches guaranteeing access. As the land dried out, the channels

Fig. 1. Stone Sluice Mill. (photo by Rui Simões)

were gradually covered and most of them were filled in between 1869 and 1871, being replaced by an underground sewer system. This enabled the introduction of new rows of trees and a modern public transport system that connected Lower Town to the Centre, which opened in 1885. Initially, people were transported by horses, but the system was upgraded and electrified in 1900. In 1854, there were already 258 properties in Lower Town, and in 1880, the number of inhabitants exceeded 6,600. In 1914, the number of buildings increased to 499 and the number of inhabitants to 17,000 (Januszaitis 2021).

A Gdansk Residential District

At the turn of the 20th century, new houses of Fin-de-Siècle architecture were built in an eclectic style, mainly along Łąkowa Street. Among the notable buildings, the neo-Romanesque building of the secondary school (gymnasium) of 1901 stands out, on the corner of Śluza and Jałmużnicza streets, which continues with its original function, and from 1905 the building of the city baths, at the intersection of the streets Śluza and Jaskółcza, being adapted in 1992 to house the Center for Contemporary Art Łaźnia- Bathhouse (Szczepański, 2008).

Lower Town maintained its authenticity despite the war and the postwar abandonment. Unlike the centre of Gdansk, some of the buildings have not been demolished, maintaining a good architectural sample of surviving buildings from the 19th and early 20th centuries to be preserved. Also, its location close to the centre and its surroundings make it a desirable place for real estate investment. However, spatially and socially, Lower Town still belongs to the most neglected neighbourhoods in the city.

Bastions and Stone Sluice

At the end of the 16th century, the municipal authorities of Gdansk decided to erect a new set of fortifications around the city of Gdańsk in the face of the evident degradation of the medieval fortifications, changes in military technology and the increasing range of artillery. These structures around Gdańsk are one of the most extensive and significant bastion-type fortifications in northern Europe. The bastions, which are a very significant example of 17th century military architecture, are connected by curtain walls and preceded by a double moat filled with water that runs in a zigzag pattern. Cornelius van den Bosch, a Dutchman, was the architect of the project whose work was supervised by engineer Peter Jansen.

For reasons of urban expansion of the city, the bastions were gradually demolished at the end of the 19th century. Of the total fortifications built between 1622 and 1636, only five bastions, all of them in "Lower Town", remain. They are the bastions Aurochs/Maidloch, Wolf, Aussprung, Bär and Kaninchen (Buffalo, Wolf, Ledge, Bear and Rabbit). It is one of the few such Polish structures that still stands, and which is part of the historic heritage and landscape of modern Gdansk. The bastions closest to the study area are Bastion

Fig. 2. Lower Town map. Büttner, *Plan der Stadt Danzig*, 1809. Source: the State Archives in Gdansk.

—

Fig. 3. Stone Sluice. Fot. by Rui (photo by Rui Simões)

Aurochs and Bastion Wolf. The Aurochs Bastion was built between 1622–1623 and is the best preserved structure of the entire group, at the turn of the 18th century, it was expanded with the addition of a knight which was lowered for defensive reasons during the Napoleonic Wars. The Wolf Bastion, built in 1636, is also relatively well preserved. In 1792, a gunpowder storage facility was built, maintaining this configuration to this day (Dygulska 2014).

From the same period of these fortifications, Sluza Kamienna (Stone Sluice) built in the years 1619–1624, with the design of the Dutch Architects Wilhelm Jan Benning and Adrian Olbrants and with supervision of the works done by Jan Strakowski. The sluice consisted of two pairs of gates about 20 m apart from each other. Stone Sluice had a dual function to protect the city from flooding and, in case of defense, with the use of the so-called "Water Maneuver", in which the lock was closed, barring the Motława and causing it to flood the foreground around Gdańsk, hindering military attacks on the city from the south and east (Szczepański 1995; Borucka and Gatermann 2016).

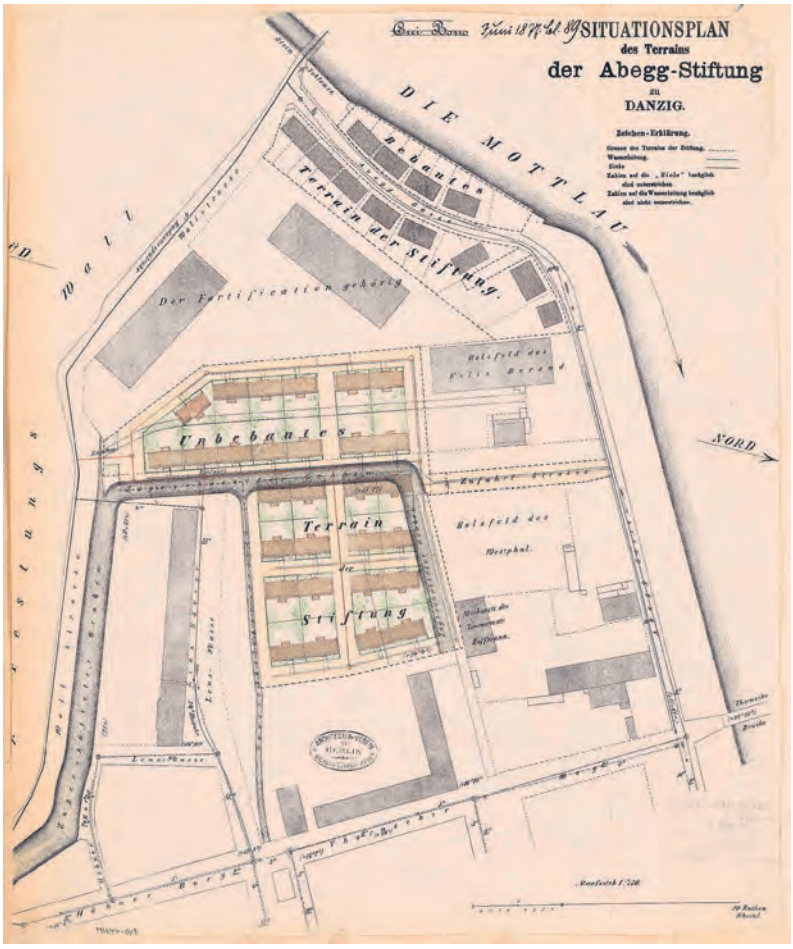
Site Analysis

The intervention site is located between Dobra and Zielona streets to the north, the Nowa Motlawa river to the west and the fortress to the south. Przyokopowa street, located on one of the main urban axes of Dolne Miasto, crosses the study area. This is the end of the urban fabric of Dolne Miasto in the south. Although it has an urban layout from the 17th century, most of the existing buildings

are from the post-WWII period, however there are still some buildings from before the First World War and between the wars. It is, moreover, the area of the city of Gdansk where this testimony is most present. This heritage is mainly expressed in brick masonry buildings, with some existing in the intervention area. The history of this place records an episode of social housing during the time of the industrial revolution, of which there are still some examples, also in brick masonry. On Dobra Street, the first residences of the Dr. Abegg Foundation in this area were built, in 1874–76, and were subsequently demolished, leaving only one of them. Another initiative of this foundation were the buildings designed for Zielona, Wierzbowa and Polna streets, the result of an 1877 project, of which only a few buildings were built on Zielona Street. A village built by the same Foundation can also be seen in the Krolic bastion, close to the intervention area. All of these buildings are examples of pre-war social housing. The name of one of the streets in the study area (Fundacyjna) commemorates this past (Załęska-Kaczko 2013-2014).

Dobra, Zielona and Przyokopowa streets form a housing block whose interior is open to the southwest, to the Nowa Motlawa River. The buildings that surround it have four or five floors and were built during the twentieth century. However, the interior of the block is also occupied by a few buildings, one of which is probably from the beginning of the 19th century. To the south of Przyokopowa street, between this and Zielona, Reduta Wilk and Dobra streets is the south zone of the project, with a lower built density, with only a few buildings on Zielona street and Fundacyjna street. The area to the west of the intervention site, next to the river and with a lower level, was quite urbanised before WWII (plague houses), but it is now a green area next to Stone Sluice, which can be flooded. The existing buildings in this area are mostly at a higher level. It was also noted that in most of the buildings in the study area, the entrance and the first floor of the dwelling is higher, between 1 m and 1.30 m higher than the level of the foundation, the majority of which is accessed by a stairway in the public space.

Fig. 4. Site plan of the Abegg Foundation site. *Situationsplan des Terrains der Abegg-Stiftung*, 1877. Source: Technische Universität Berlin Architekturmuseum. Inv. Nr. MK 44-089.



Guidelines for a Detailed Plan

Based on the analysis of the characteristics of the place and after a historical investigation, it was decided to separate the land into two zones, one with a lower elevation to the west close to the river and floodable, and the other with a higher elevation to the east in connection with the existing urban grid, both of which are filled with green structures.

The dwellings to be proposed should be inserted into the existing urban structure in plots where construction has already been carried out or by filling empty plots, always at the highest levels. The building on Dobra Street was proposed because it was felt that the block needed to be closed to the west.

Although there is already a garden in the west area, it is proposed to reinforce it, together with the creation of new green areas,

namely inside the block and in disabled parking lots, both on the low and high levels. These green areas, especially the willow garden to the west, must be provided with water channels, a memory of Georg Tellior's channels. It is also proposed to create a lake, which with the channels serves to accumulate water in situations of flooding. Parking spaces in existing garages on the surface that act as obstacles in the middle of the green spaces should be replaced by underground parking, under new buildings or under the highest level garden platform. There are pedestrian and road routes in the area that are not paved and are only recognised by the traces of their use, which must be clarified. Whenever possible, green roofs and green walls should be used in new buildings.

Detailed Plan

The main element of the Detailed Plan is the brick retaining wall, which separates the land into two zones, one with a lower level, with less construction and a larger green area, and one with a higher level, which is mainly occupied by buildings. This brick retaining

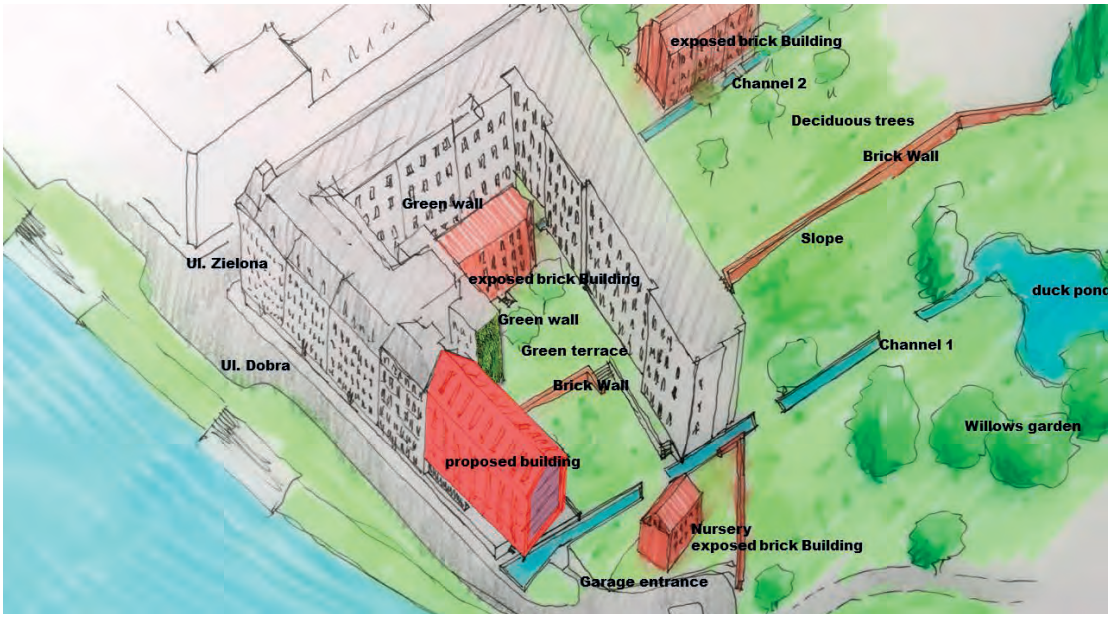
walls acts as the limit of the urban areas, and as a pier for the potentially floodable low area. The elevations of the highest platform follow the entrance levels of existing buildings, thus creating an almost flat area of access to the buildings and eliminating the exterior stairs, which sometimes work as obstacles to circulation. A brick wall is inserted in this area as a reminder of the architecture of the 19th century, the period of the greatest occupation of the place. The southern area of the intervention area must remain with low housing density, with only new buildings on Zielona Street. The two buildings to the south are accessed by a section of Fundacyjna Street, the rest of which was occupied by the new garden in the platform, as well as the car park at the end of the street. This elevated garden is characterised by being lawned and filled with deciduous trees with green coverage areas over basement parking when necessary, however it should not occupy the entire platform because of the need for permeability. The connection between the upper garden and the lower garden is made by stair and ramp access on the continuation of Przyokopowa Street. The green area of the low elevation consists of the willow garden, which must be extended to the river, keeping existing species and planting new ones. For this garden with a predominantly playful vocation, a lake to the south is also proposed, in an old play area without vegetation. In the two green spaces, water channels will be created in line with the urban grid, crossing the entire intervention area transversely.

In the north quadrant of the plane, we face a very disorganised block interior, where car access, parking and pedestrian access are mixed. This space is divided in two by a set of buildings, one of which is made of exposed brick, probably from the beginning of the 19th century, and the rest being from the 20th century, with their entrances on Dobra Street. In our plan, these buildings are maintained, but inserted in the green platform created inside the block. The courtyard formed by the brick building and the buildings on Zielona Street must be landscaped and the east façade of the brick building will have a green wall. In this courtyard, it is also proposed to continue one of the water channels that is already proposed in the southern area of the intervention. The old passage under the buildings between Przyokopowa Street and the interior of the block must be recovered to avoid the dead-end effect.

In the North-West quadrant, a housing building is proposed, which constitutes the closing of the block and concludes the entire intervention. Implanted in a difficult lot, where at the moment there are garages of precarious construction that serve the inhabitants

Fig. 5. Detailed Plan of Lower Town - Situation Plan – Pen. Felt-tip pen – Drawing by Rui Simões

of the surrounding buildings, but where there was once a single family house. The building is implanted on a platform in order to locate the housing floors at a higher level that is protected from rising water levels. This platform is on the same level as the green platform created inside the block and covers two parking floors with the necessary parking spaces for the new building created, plus the capacity of the garages on the surface. Above the parking floors, the building will have a commercial floor that is also the entrance to the dwellings. This floor, located on the roof of the basement, will only be occupied in half of its area, the rest being for circulation and terraces. It will be accessed by stairs at several points. To the east of the building, where there is a nursery in the Abegg foundation brick building, the entire area has been redesigned, with more efficient circulation routes, with green arrangements and with the continuation of the water channel that begins in the willow garden. The path that connects this area to Sluza Kamienna must be re-paved.



Conclusion

The plan's main strengths are the understanding of the historical evolution of this place, its urban and social specificities and its coordination with the geographical characteristics of the place, namely the climate and topography, and of course the expected effects of climate change. The preservation of this site involved the recreation of historic water channels and the creation of new water systems

and new green structures, with green being the best transition between the built areas and the "waterfront". With the creation of green platforms, contained by red brick walls, the intention is to protect urban areas from rising water levels, respecting the Historical Heritage of this place and continuing its housing vocation, but improving the conditions of environmental well-being and increasing its quality. The proposals for urban design and architecture foresee the effects of climate change, minimising them and making this area of the city a model of more sustainable urban development.

Fig. 6. Detailed plan of the southern part of the Lower Town. Axonometric view. Pen, felt-tip pen. Drawing by Rui Simões

References

Borucka, J. and Gatermann, H. (2016). *Architekturführer Danzig: Gdansk Sopot Gdynia*. Berlin: Dom Publishers (in German)

Dygulska, B. (2014). *The Lower Town bastion complex – the* Żubr, *Wilk*, *Wyskok*, *Miś and Królik bastions*. Accesed April 11 2021 https://zabytek.pl/en/obiekty)

Januszaitis, A. (2021). *Dolne Miasto*. Accesed April 11 2021 https://www.gedanopedia.pl/gdansk/?title=DOLNE_MIASTO (in Polish)

Szczepański, J. (1995). *Stone Sluice Mill in Gdańsk*. In: Preservation of the Industrial Heritage – Gdańsk Outlook II, Final Report, English Edition. Gdańsk: Politechnika Gdańska 69–75

Szczepański, J. (2008). *The Lower Town and its Bathhouse*. In: Leszkowicz P. (Ed.), Laznia – the Bathhouse. Architecture, Art. and History. Gdańsk: Centrum Sztuki Współczesnej Łaźnia 60-75

Załęska-Kaczko, J. (2013-2014). Fundacja mieszkań robotniczych w Gdańsku – dzieło rodu Abeggów [Founding the workers' housing in Gdansk - completed by the Abbeg family]. *Rocznik Gdański*, T. LXXIII–LXXIV, 177-194 (in Polish)

Rui Simões
Lecturer, Department of Architecture, School of Communication, Arts and Information Technologies (ECATI). Universidade Lusófona (Lusófona University), Campo Grande, 376, 1749-024 Lisbon, Portugal

Municipality
of Gdańsk, Poland

Paweł Łukasiak

The Impact of Constructing New Anti-Flood Infrastructure on the Architectural Development of Adjacent Areas

,

Having an extensive water system in a city requires decision-makers to take a comprehensive and responsible approach to it, especially with the number of climatic anomalies increasing year after year. However, the construction of flood protection infrastructure like wharves or quays is often an impulse for dynamic spatial, urban, and socio-economic development of areas next to the waterfront. Despite being a side effect, this trend is incredibly positive and beneficial for everyone. Granary Island in Gdańsk (Poland) is no exception and 70 years after its destruction in World War II, it begins to bustle with life, as befits the heart of a city.

Introduction

Gdańsk has an extraordinarily rich and complex water system. It comprises the waters of the Baltic Sea (Gulf of Gdańsk), major rivers (Wisła, Motława and Radunia), as well as many retention reservoirs and streams. The city has always attached great importance to developing and improving the quality of public spaces serving residents and visitors alike. The main role in this regard is played by infrastructure investment projects, which include not only roads, tram lines, and utility buildings, but also wharves, quays, beach infrastructure, and broadly understood flood prevention projects. This is particularly important today due to the numerous symptoms of climate change and rising sea levels. There are over 31 km of wharves in the Gdańsk Sea Port itself (Rozkrut et al. 2020) and a lot of smaller quays along rivers and canals inside the city. These numbers certainly make it difficult to set priorities and decide which ones to rebuild first. The ultimate goal is to fulfil public duties while having a finite amount of funds at one's disposal. We must not forget that every city is a complex, living organism. Does implementation of investment projects in one place cause changes in other parts of a city? Let us take a closer look at this issue.

Granary Island – Location and a Bit of History

Granary Island has an area of 24 ha and is located in Poland, in the centre of the Downtown district in Gdańsk, between Motława and New Motława river. It used to serve as a port warehouse district in the old days. Its first industrial buildings were constructed in the 14th century, and at the beginning of the 15th century, there were already as many as 120 granaries. Due to the systematic expansions of the port's functions, by 1809 the number of these warehouses increased to 359. Unfortunately, over the years, some granaries were destroyed by fires and military operations, and not all of them were rebuilt afterwards. Only 3 survived World War II in good condition: The Blue Lamb (now owned by the Archaeological Museum of Gdańsk), Steffen (formerly housed the Zejman Sea Club) and Deo

Gloria (currently part of a hotel). Until today, 36 granaries have been rebuilt (Gdańsk Foundation 2021).

Rebuilding of the Granary Island's Waterfront

One of the most spectacular examples of the revitalisation of the city's waterfront was the construction of the quays around the northern headland of Granary Island. The works were carried out between December 2012 and June 2014. It was all possible thanks to financial support from the European Union Cohesion Fund. The project was called *"Modernisation of the Internal Entrance to the Port (of Gdańsk). Stage II – reconstruction of the waterway on the Motława River"* and was carried out under the "Infrastructure and Environment 2007-2013" Operational Programme, Priority Axis VII Environmentally Friendly Transport, Activity 7.2. Development of Sea Transport. The beneficiary and infrastructure owner is Gdańsk.

The Project Implementing Unit was the Directorate for the Development of the City of Gdańsk. The contractor was Energopol – Szczecin S.A. The project's total value was PLN 27,471,213 (including EU co-financing of PLN 23,253,805).

The scope of the investment project included reconstruction of two quays on the northern headland of Granary Island:

- quay 9 – located on the west bank of Granary Island, from the Green Bridge to the northern end of the Island. As a result of the project's implementation, a two-level promenade was created in the form of a pier, consisting of 13 sections, with a total length of 258.65 m. The main pedestrian passage was set up on a structured deck at a height of 2.5 m above the water level. There are also two lower platforms on the promenade at a height of 1.24 m above the water level, which enable mooring as well. The first one has stairs and a ramp for the disabled, while the second one has stairs on both sides. The deck's surface is made of hardwood.
- quay 10 – located on the left bank of the New Motława river from the Stągiewny Bridge to the northern end of the Island (opposite the Gdańsk yacht marina). The quay is a continuation of quay 9 and it consists of 23 sections with a total length of 325.64 m. It is a top-hat type structure anchored with micropiles. The surface of the quay's walking area is made of granite cubes.

As a part of the contract, many equipment elements – such as fenders, exit ladders, rescue equipment, protective barriers, decorative elements, and mooring bollards – were also installed along both quays, as was lighting and CCTV.

The investment project's objectives were as follows:

- increasing the competitiveness of the Port of Gdańsk in the Baltic Sea region;
- increasing the efficiency and safety of navigation along the offshore section of the Motława river, including preventing the possibility of damaged fragments of the old quay sliding into the water;
- improving access to the areas of the Main Town from the waterside, which creates the possibility for mooring small vessels;
- preventing the deterioration of quays and eliminating the risk of construction disasters.

Following the rebuilding of Granary Island's quays, the investment project won the 1st prize in the 4th Plebiscite of the Independent Awards "Tricity Wings" in 2014 in the "A New Space of the Tricity" (Wings of Tricity n.d.) category. This showed that the revitalisation of this area was a long-awaited move and one that was much appreciated after its implementation.

Development of the Surrounding Area

The reconstruction of the quays initiated many positive transformation processes on Granary Island itself. The Island's newly strengthened quays and its central location made it an extremely attractive area for potential investors. On 31 March 2015, the city entered into an agreement for "Development of the northern headland of Granary Island in Gdańsk" under a public-private partnership. The aim is to implement a project consisting in the comprehensive development of real estate on Granary Island's northern headland. To implement the project, the city chose a consortium of Multibud W. Ciurzyński and Immobel Poland. The value of the entire investment project is about PLN 400,000,000 net, while the value of public utility facilities to be constructed amounts to nearly PLN 34,000,000 net (City of Gdańsk n.d.).

The lot for the investment project has an area of about 3.0 ha, of which 1.9 ha is intended for commercial purposes and has already been sold to the private partner. Commercial facilities occupy 60,000 sq.m of the total usable space. A modern commercial, residential, and service complex is already being constructed; it will include such things as a hotel and apartment building. The public-private partnership project is scheduled to be completed by 2023.

Its scope also includes the construction of public utility facilities, i.e. vital infrastructure serving the public. This includes the construction of a road system on Granary Island, conversion of the fixed Stągiewny Bridge into a drawbridge, construction of a yacht marina south of the Stągiewny Bridge, renovation of the Długie Pobrzeże

quay, and construction of a pedestrian footbridge leading to Granary Island. The footbridge facilitates increased pedestrian communication between the Długie Pobrzeże quay at the height of the Holy Spirit Street, as well as Granary Island itself. Supported by a 100-tonne foundation measuring 57 meters in length and 4.5 meters in width, the footbridge can also rotate to enable vessels to pass (Grzenkowska 2020). The expansion of the city's yacht marina to the south will also make it possible to increase the number of mooring sites. Since the Stągiewny Bridge will be a drawbridge, vessels will be able to move freely both on the Motława River and around the Island.

Conclusions

We took a journey back in time to see whether the construction of new quays contributed to the transformation of the adjacent areas. Until 2012, Granary Island was a ruined and forgotten place. The market was not interested in investing in the Island – despite its central location – because the quays did not guarantee stability, safety, and profitability of operations. It is also well known that the reconstruction of hydrotechnical devices is an extremely expensive endeavour. In the end, although Granary Island found its investors, it was necessary to rebuild the quays first to protect the area against degradation due to fluctuating sea levels. Additionally, in August 2016, the city also completed the reconstruction of Stągiewna Street, which has been turned into a car-free promenade, and which constitutes a geographical boundary separating the northern headland of the Island from the south. Therefore, the development of Granary Island is primarily the result of an investment project initiated by the city of Gdańsk. All further developments are the result of a subsequent domino effect. The revitalisation of Granary Island situated in the very heart of the historic city of Gdańsk is a unique project of a national scale. It is currently one of the most attractive areas in Gdańsk. From there one can admire a unique view of the Długie Pobrzeże quay with the tenement houses of the Main Town and the historic Crane. The generally accessible public spaces established inside the commercial development zone of the Island, enhanced by exhibitions featuring relics from historic granaries, are also bound to play a vital role for the city's residents and visitors. The city's investment project certainly contributed to restoring the water-related way of life in Gdańsk, as well as to the social, economic, and cultural development of Gdańsk's waterfront areas. Moreover, urban and socio-economic development is not limited to the northern headland of Granary Island, as activities related to many other private investment projects are also being undertaken in the Island's southern part, as well as the Lower Town district.

References

City of Gdańsk (2021). *Development of the Granary Island's Northern Headland in Gdańsk*. Accessed May 27, 2021. https://www.gdansk.pl/ppp/zagospodarowanie-polnocnego-cypla-wyspy-spichrzow-w-gdansku,a,126249.

Gdańsk Foundation (2021). *The Granaries*. Last modified March 30, 2021. https:/www.gedanopedia.pl/gdansk/?title=SPICHLERZE.

Grzenkowska, K. (2020). *The footbridge on the Granary Island Was Officially Received by the City. Opening on Saturday!* Accessed July 31, 2020. https://www.gdansk.pl/wiadomosci/kladka-na-wyspe-spichrzow-zostala-oficjalnie-odebrana-przez-miasto-w-sobote-otwarcie,a,176386.

Rozkrut, D., Adach-Stankiewicz E., Andrzejczak E., Bielak, R., Bieniek, M. et al. (2020). *Statistical Yearbook Of Maritime Economy*. Warszawa, Szczecin: Statistics Poland. https://stat.gov.pl/en/topics/statistical-yearbooks/statistical-yearbooks/statistical-yearbook-of-maritime-economy-2020,8,13.html.

Wings of Tricity. (2021). *A New Space of Tricity*. Accessed May 27, 2021. https://www.skrzydlatrojmiasta.pl/2014/nominacja/Nabrzeza-Motlawy-st106.html.

Paweł Łukasiak
Chief Specialist, Department of Investment Projects, Municipality of Gdańsk, ul. Kartuska 5, 80-103 Gdańsk, Poland

Gdańsk University
of Technology, Poland

Agnieszka Nyka
Jakub Szczepański

Adaptation of Architectural Heritage in the Era of Climate Change

Torpedo Platform in Babie Doły

Abstract

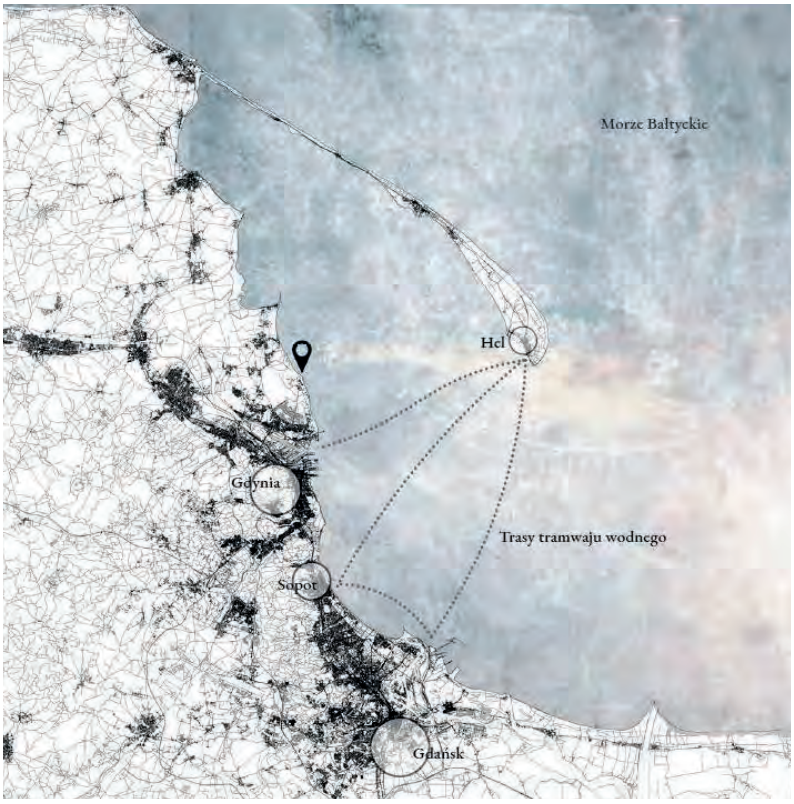
The paper provides original insight into the problem of adaptation of historical objects in the era of climate change. It conveys a message that in times of climate crisis, there is a need to go beyond an anthropocentric perspective, specifically, that architecture should not only be designed for people, but should also provide a framework for nature. As well as shaping spaces for human beings, the architect is also responsible for creating conditions for ecosystem recovery and species protection. To illustrate this problem and as a critical reflection, the stunning example of the architecture of destruction was chosen – that is, the torpedo platform in Babie Doły built during WWII on the waters of Gdańsk Bay. The presented project is a discussion on how to change this place of destruction into a place of both social and ecological regeneration, a laboratory that demonstrates, from a broader perspective, the opportunity of renaturalisation of urban areas through architecture.

Introduction: At the dusk of the Anthropocene

We live in the Anthropocene, a time when human activity on Earth is so dominant that it affects the geological structure of the globe. This leads to cataclysms and changes in ecosystems (Crutzen, 2016). We are witnessing the quality of the water deteriorating and many species of plants and animals disappearing forever. Due to the rising sea water level, cities are drowning, while scientists model predictions of changing contours of the coastlines (Vousdoukas, 2018). Climate change requires a renewed view on the issues of adaptation and conservation of historical objects (Sesana et al., 2020; Harvey & Perry, 2015). A paradigm shift is needed.
In this paper, a concept of how to develop such a new paradigm is proposed through the adaptation project of the torpedo platform complex in Babie Doły (Fig. 1). The ruins of the Babie Doły torpedo testing complex are a very strong symbol of humanity's strive for destruction. In the proposed concept, they are made a shifting point, a testing ground for reflection and new knowledge, a symbol of the need to go beyond the anthropocentric perspective. Babie Doły is presented in the project as a laboratory for renaturalisation of urban areas. The project presents a concept of a controlled revival of a space of great historical and natural value. It is designed for the future, serving as a statement that architecture should no longer be designed just for people, but it should also protect and support natural ecosystems, be created with the natural environment in mind. The torpedo platform, which once served to kill, will now become a place of natural habitat protection and revival of ecosystems.

Fig. 1. Ruins of the torpedo platform in Babie Doły

Fig. 2. Torpedo platform in the context of Gdańsk Bay


Morze Bałtyckie
Hel
Gdynia
Trasy tramwaju wodnego
Sopot
Gdańsk

Study area: Architecture of destruction

Babie Doły is a secluded and peaceful place, at once located within a metropolis and with great development potential (Fig. 2). Despite this tranquillity, the Gdańsk Bay shore has always been a key site of hostilities, and a variety of military facilities have accumulated there over the centuries (Marek & Marszałek, 2018). The torpedo platform complex in Babie Doły is a part of the military belt around the Bay (Fig. 3). In 1942, in Babie Doły, the entire logistic facility was built for the construction of torpedoes and their test

launching into the waters of Gdańsk Bay (Komorowski, 2002). The buildings, since they were abandoned in 1945, have gradually fallen into disrepair. Deconstructed by time and the elements, today they do not resemble their original form. Across the Bay, in the vicinity of Jastarnia and Jurata, there are remains of several other objects on the water, which initially served as a laboratory and measurement facilities for the main building of the torpedo platform, from which the torpedoes were launched. There are also many other remains of engineering structures and shipwrecks partially protruding above the water of Gdańsk Bay (Fig. 4).

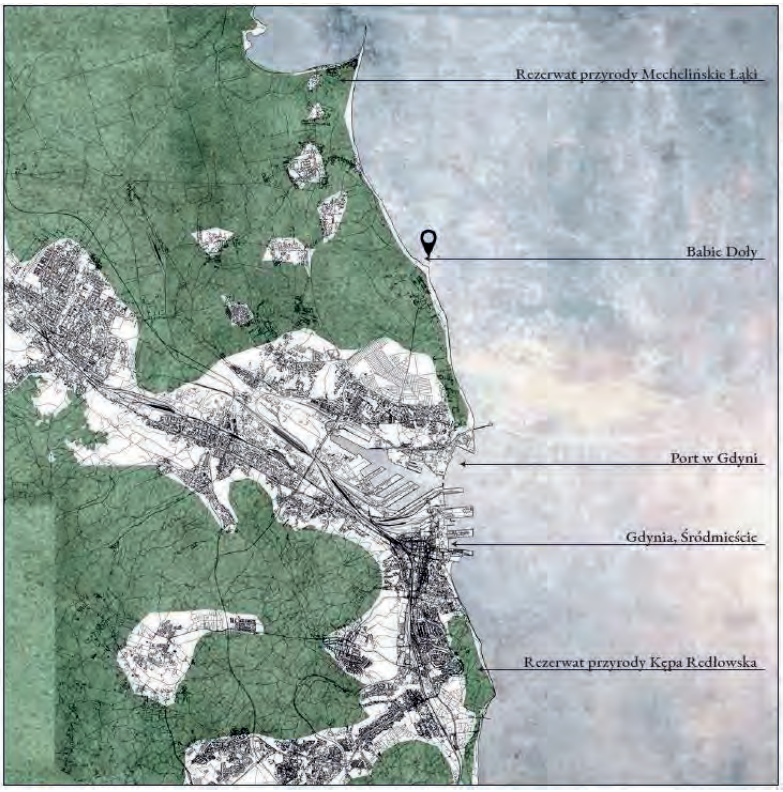


Fig. 3. Seaside fortification belt: selected military facilities of the coast of Gdańsk Bay

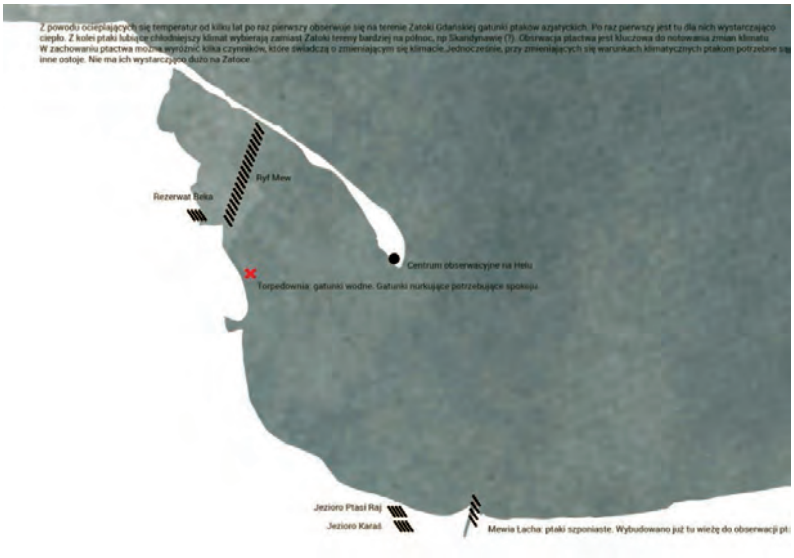
Fig. 4. Military objects and their remains in the waters of the Gulf of Gdańsk

—

Fig. 5. Landscape parks and nature reserves in the vicinity of Babie Doły

In Babie Doły, ruins of onshore logistic and production facilities of the torpedo platform are located in valuable natural areas. The torpedo platform offshore is located on bird migration routes. A 96-km-long belt located nearby along the Gdańsk Bay, stretching from Gdańsk to the east, is considered, along with Gibraltar and the Bosphorus strait, to be one of the world's most important habitats for migratory birds (Nowakowski, 2015). A few kilometres from Babie Doły, the Mechelińskie Łąki Nature Reserve was established,

which is a place of breeding protection (Fig. 5). The area of Gdańsk Bay and its coasts is a place of unique coastal plants and diverse flora and fauna. In recent years, due to the enormous pollution of the Baltic Sea and excessive human pressure, there has been a sharp decline in the biodiversity of marine plants and organisms (Owen, 2010). The adaptation proposal for the torpedo platform focusses on preserving the unique natural habitat of Babie Doły, as well as popularising the history of this place and its importance to the course of WWII (Araújo, 2011).



Methods

In order to develop the brief for the project, a number of analyses of the architectural, functional, urban, as well as historical and environmental contexts of the areas around Gdańsk Bay were carried out. Taking into consideration the strong presence of birds on the torpedo platform and in the surrounding natural reserves, consultations were carried out with an ornithologist from the Marine Station of the Institute of Oceanography of the University of Gdańsk (Fig. 6). As research shows, due to climate change, new species of birds are already appearing in the coastal zones of the Gulf. Based on Climate Central modelling, it is estimated that when the sea level rises by 0.50 m, the Mechelińskie Łąki Nature Reserve north of Babie Doły will turn into wetlands (Climate Central, 2021).

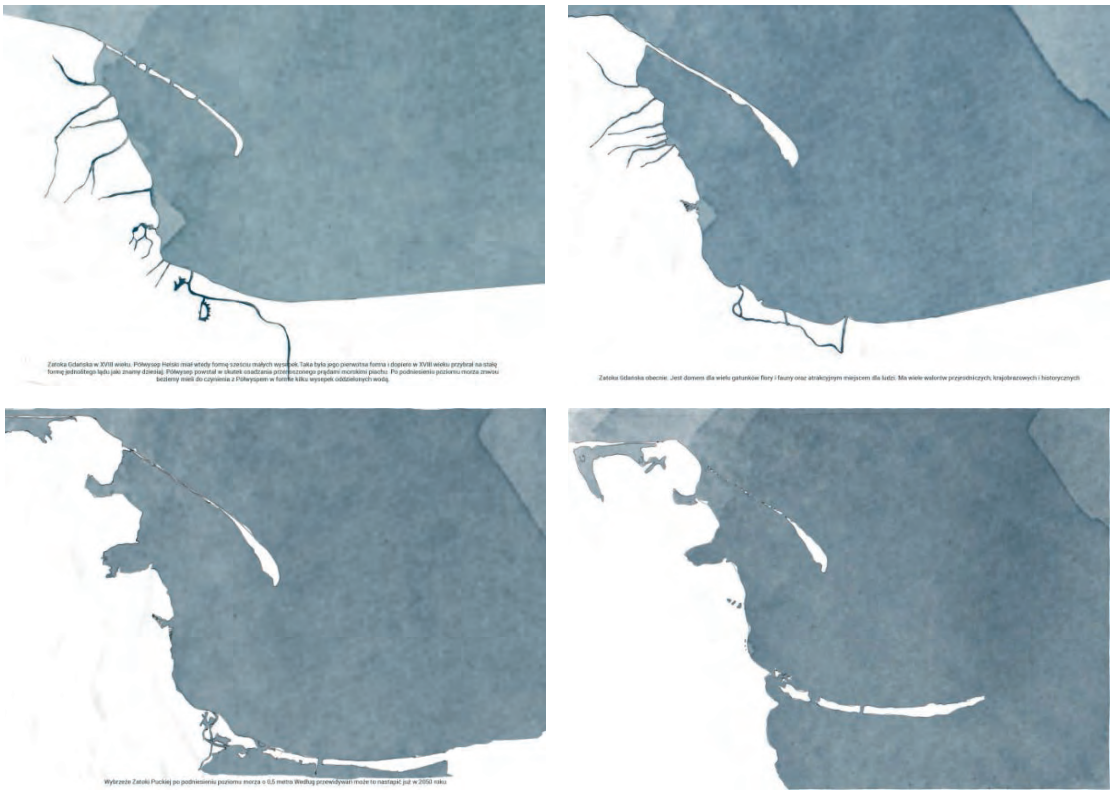
The torpedo platform has significant historical value, thus the priority was to carry out the design process in line with the principles of conservation of monuments (Szczepański, 2019). Therefore,

Fig. 6. Bird breeding areas in Gdańsk Bay and their correlation with the torpedo platform

_

Fig. 7. Dynamics of landscape changes: scenarios of rising water levels in Gdańsk Bay

the key objective of the project was to preserve its historical, architectural and functional values. In-situ visits and research by design analyses led to the conclusions that the greatest asset of the torpedo platform is the picturesque and dramatic effect induced by its ruins and location on the water. Preserving this value was in contradiction to the introduction of a new utility function there. In the proposed project, the unique atmosphere of the place is preserved, by designing the torpedo platform as a permanent ruin and keeping it cut off from the mainland. The dynamics of the passage of time will also be visible in the landscape, which will change as the water level rises (Fig. 7).



Program | Architecture not only for people

The project is a signal that architecture should not only be created for people, but should also provide a framework for nature. The objective of the functional program is thus built on two parallel goals. The first is to use architectural solutions to create conditions for the provision of natural habitats and the development of ecosystems. The second goal is to create an educational and visitor centre.

The project is divided into three zones: the torpedo platform, an adapted hall that is part of the former layout, and a newly built pavilion (Fig. 8). With the use of appropriate conservation methods, the decision was made to arrange the historic hall and the torpedo platform as permanent ruins and imbue them with new functions.

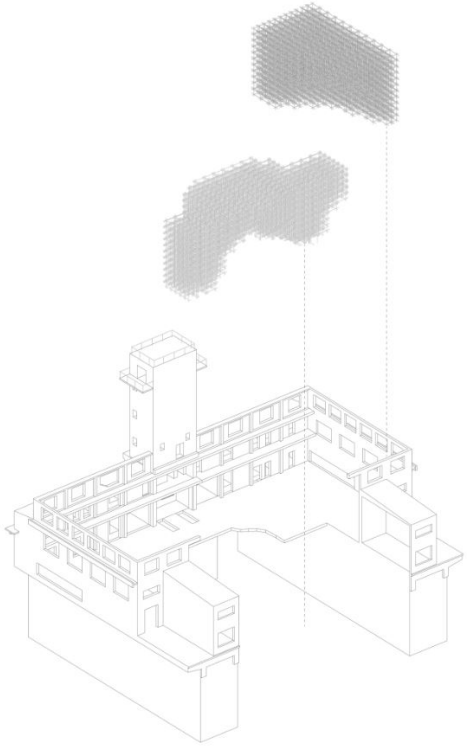


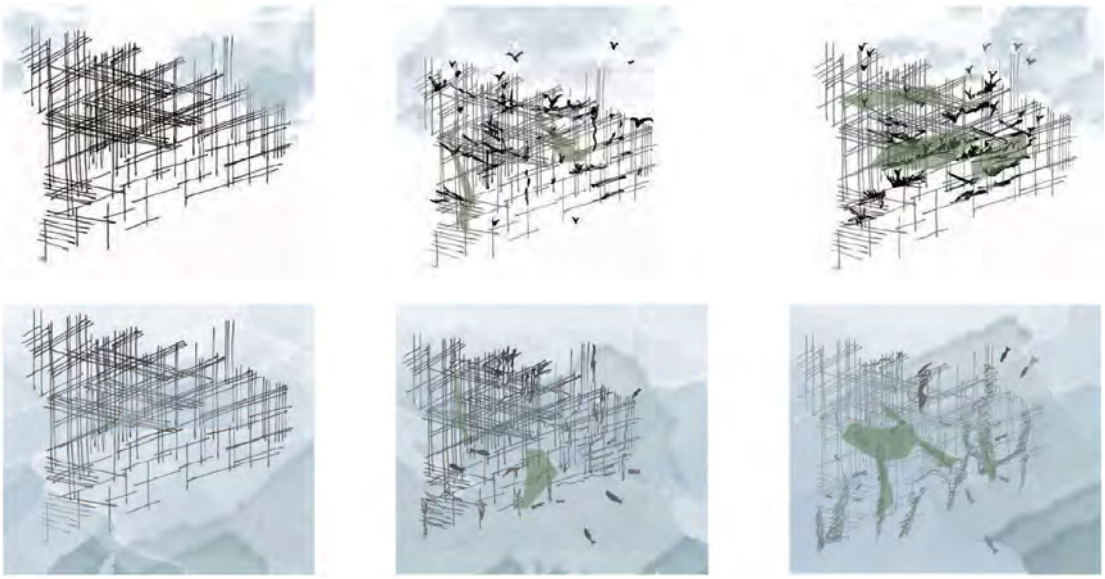
Fig. 8. Elements of the project

Fig. 9. Exploded axonometry of the installation on the torpedo platform

—

Fig. 10. Visualisation of the bird sanctuary on the torpedo platform with the new structure

The ruined torpedo platform is the most majestic form in the study area. Adaptation of this structure is crucial in preventing this historically valuable object from further deterioration, and protecting it against the negative impacts of climate change. The challenge has arisen of how to adapt it without interfering too much with its unique appearance and original tissue. Determination of the highest values of the whole setting allowed the design concept to be specified. The strongest impression in the perception of the torpedo platform is its majestic form immersed in the sea and the swarms of birds flying around it. To preserve this impression, the platform is designed as a permanent ruin and left cut-off from the mainland. It is intended for use not by humans, but by birds. This allowed for its adaptation without reducing its values. The building remained a permanent ruin, while also gaining new users. New activities at this facility are aimed at improving the living and breeding conditions of migrating birds and the reconstruction of marine ecosystems. The new function introduced into the building will still work after the sea water level rises.



A wooden structure composed of two parts was superimposed on the ruins of the torpedo platform (Fig. 9). The first one, located on the ruins, serves as a bird sanctuary providing a place of shelter and refuge for the birds. The second, located almost entirely under water, is intended for the rebirth of marine ecosystems. This new wooden structure has been designed so as not to visually distort the body of the torpedo house. It completes the form but only to the limits of the original volume of the building. It does not imitate it, nor does it try to bring back its original character. Its shape was created by generating a grid of points imitating the symbolic location of birds around the torpedo house, which was then transformed into a grid of lines from which the orthogonal structure of the grate was created. The structure was then transformed parametrically, by simulating the movements of waves and wind, which gave the structure an organic form (Fig. 10)

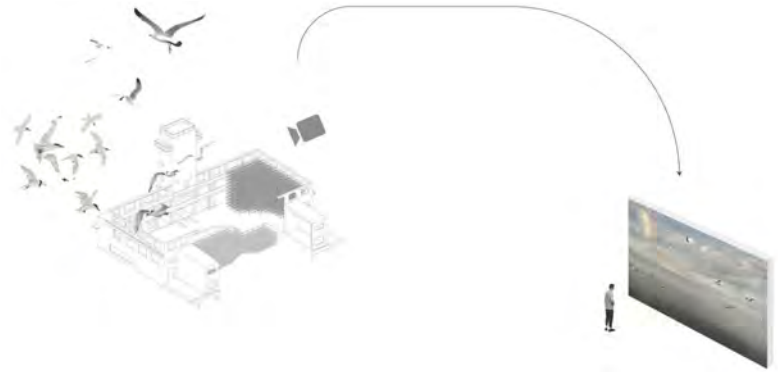
The wooden structure is made of beams made of recycled wood, either oak or exotic, characterised by high durability and resistance to weather conditions. The beams are connected to each other by means of traditional carpentry joints, without the use of additional metal joints. The structure does not exceed the outline of the original form of the building, while adding a new and organic form onto the ruin. Moreover, the wooden constructions are intended to be just grates that provide the basis for further natural transformations. With time, branches, grass and underwater ecosystems will compete it (Fig. 11).

Fig. 11. Process of organic changes of form of the structures on the torpedo platform and underwater

—

Fig. 12. Diagram of the operation of the ornithological observatory

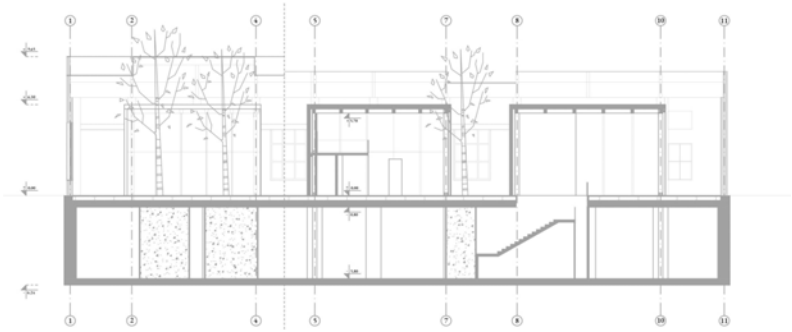
Fig. 13. In-between zone in the adapted hall, where trees and grass grow



In the early stages of the project, an ornithological laboratory area for human use was also to be included here. Consultations with an ornithologist ruled out such a possibility, leaving a stark choice: either people or birds. To not introduce human activity into a sensitive wildlife habitat, an innovative ornithological observatory was designed, in which cameras installed on the torpedo platform transmit live footage onto screens in a new exhibition centre onshore (Fig. 12)

The second object is the former torpedo assembly hall on the shore, which in the project has been adapted into an exhibition and educational centre. Searching for a common architectural language that would apply to both very different buildings, i.e. the torpedo assembly hall and the torpedo platform, the decision was made to design the assembly hall as a permanent ruin. The original shell, which is the outer walls of the building, has been preserved and left in the project, and with the use of appropriate conservation methods, protected from further destruction. Empty window cavities in the walls have not been filled in, but left as openings in the façade. The existing roof that did not hold any historical or architectural value has been

removed and replaced with a semi-translucent PTFE-coated fiberglass roof, that allows the sunlight into the building and adds a modern touch. Just as the present unique form of the torpedo platform has been created by a deconstruction through time and the elements, in the same way, the hall will be symbolically and visually deconstructed by nature by introducing trees and shrubs inside, which will protrude from the windows and the roof, connecting visually to the forest nearby.

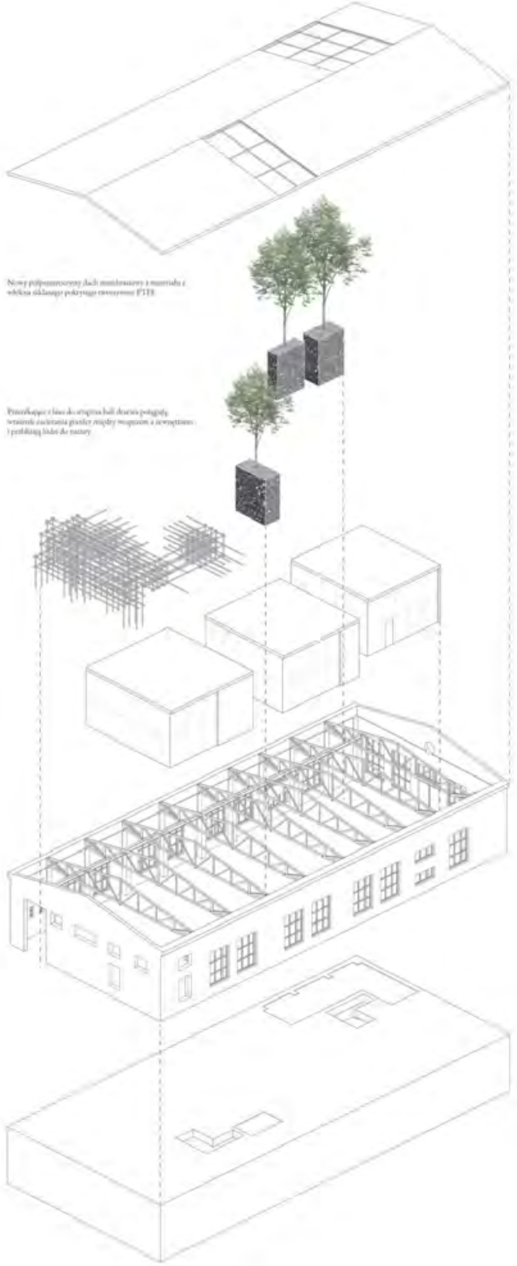


After the decision was made to keep the historical façade and introduce greenery inside the building, a new architectural object was designed inside the hall, which serves the main utility function. In this way, a very important buffer zone between the inside and the outside was created between the historic shell of the hall and the new interior facility. Trees, shrubs, grasses and mosses grow there, but it is also open to visitors. It becomes a new, interactive part of the exhibition that brings people closer to nature and popularises the topic of ecosystem protection (Fig. 13). The new facility has the form of three separate cubes on the ground floor hall, each with a different function, connected together by a large exhibition space on the underground floor (Fig. 14). When adapting the hall and designing a new cubature, it was crucial to ensure optimal use of the facility and to highlight what is the original tissue and what is the new architectural intervention (Fig. 15). This influenced the determination of the form of the designed body and the materials from which it was made. The cubic forms are built on a skeleton structure made of glued wood, with glass and in some places a concrete façade. The first cube houses the main entrance to the exhibition space on the underground floor. In the next volume, there is a buffet with a mezzanine on the second floor, which provides a beautiful panoramic view of the sea and the torpedo room through glass walls and empty windows in the hall. In the third cube there is another entrance to the exhibition space and a workshop space.

Fig. 14. Correlation between built elements and nature in the adapted hall

—

Fig. 15. Exploded axonometry of the adapted hall



The underground storey houses a large exhibition space. A new foundation tub structure tangent to the existing hall walls was created to hold the underground level. In addition to traditional exhibitions, visitors can also admire living nature in this space. This includes large screens with live footage from the torpedo platform, which will bring visitors closer to the subject of observing birds and sea life. There are also glass pots in the basement of the hall in which the trees growing on the ground floor are planted. In this way, in-depth knowledge of the processes taking place in nature is provided, bringing the wider public closer to the issues of climate change and pollution of the Baltic Sea. The more people become interested in this, the greater our chance as a society to reverse the negative changes taking place in nature. Various scenarios of passing through the hall building have been designed, from the ground floor to the underground space, and various scenarios of the penetration of nature into the hall.

Fig. 16. Temporary exhibition of military history of Babie Doły in the information pavilion

Fig. 17. New pavilion and designed paths and greenery

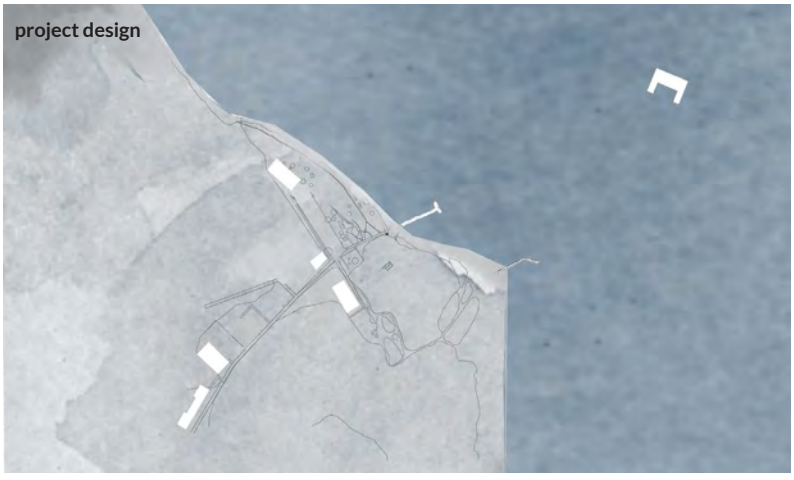
The third proposed building is a new information pavilion, which is an object that connects the entire complex. It was designed as an interpretation of the bunker architecture. Its façade is made of concrete. The aggregate used for it partially consist of fragments of ruins and demolished objects in the area. Its shape results from the topography of the area and the location at the foot of the forest, so that it does not disturb the contemplative nature of the place. The main function of the pavilion is as an information point connected to the exhibition space (Fig. 16). Just as the hall is devoted mainly to the issues of nature and ecosystems, the pavilion is designed to show the history of this place and dedicated exhibitions showing testimonies of human activities leading to destruction. There is a green roof on the pavilion, from which rainwater will be discharged to the nearby rain garden. The pavilion has been designed in a strategic place, as the first building that we come into contact with when entering the premises. Walking along the network of paths, we pass rain gardens and designed native coastal vegetation (Fig. 17).

Access to the facilities has been designed as a walking route leading us through various landscapes: plants in the dunes, a valley between hills with forests and a beach. The sightseeing route has many options. It starts along the road and slowly turns into a network of pedestrian paths that do not disturb the contemplative nature of the place. Visitors can choose to walk through the old tree hall or the new underground centre. The entire area is developed in such a way as to preserve the unique character of the place and prevent chaotic development in the future (Fig. 18). In a dialogue between buildings and the outside, the whole architecture blends with the surroundings. Apart from the new volume of the information pavilion, the existing historic volumes and topography remained almost untouched to reduce the impact on the natural scenery.

There is a clear connection between the pavilion, the hall, and other elements of Babie Doły. The entire structure is dominated by the shape of the torpedo station, not polished and not domesticated. Remains of other historical objects on the water, which were used as laboratory and measurement facilities for the main building of the torpedo platform from which the torpedoes were launched, could serve educational and recreational purposes in the future. After consulting with specialists from the Seal Centre of the Sea Station of the Institute of Oceanography of the University of Gdańsk in Hel, the decision was made to adapt selected remains of engineering structures and shipwrecks partially protruding above the water surface as platforms for seals.


2020


1942


project design

Conclusions: Towards the new paradigm

The presented project for the adaptation of the torpedo house was made with thought put into how the surroundings of the torpedo house may change in the coming years. The project examined how architecture can function in coexistence with nature and adapt to new needs on an ongoing basis, while maintaining the original buildings from WWII. The project fills an important functional niche, which is to provide refuges and breeding places for birds in Gdańsk Bay. At the same time, it was created with respect for the historical fabric. By preserving the object as a permanent ruin, the value of keeping it during the process of deconstruction has been emphasised. Babie Doły was designed as a laboratory for the renaturalisation of urban areas, and it can affect the entire metropolis and may be an attractive place to visit in the context of Gdańsk Bay. With the project, the message is conveyed that it is possible to stop the processes of planet destruction, but it is necessary to critically reflect and change the paradigm by going beyond the anthropocentric perspective, including in architectural design. The topic of linking architecture with the natural environment remains open.

Note

The master's thesis project of Agnieszka Nyka, M.Sc. Arch, "Adaptation of historical objects in the era of climate change. Torpedo platform in Babie Doły" defended at the Faculty of Architecture at the Gdańsk University of Technology, under the supervision of Prof. Jakub Szczepański and Dr. Anna Orchowska-Smolińska, received first prize in the international competition PKN ICOMOS Jan Zachwatowicz for the best diploma theses of university students dealing with the issues of protection of cultural heritage in 2021.

Fig. 18. Changes in the torpedo testing facilities layout in Babie Doły

References

Araújo, M.B., Alagador, D., Cabeza, M., Nogués-Bravo, D. & Thuiller, W. (2011). Climate change threatens European conservation areas. *Ecology letters*, 14(5), 484-492.

Climate Central. Coastal Risk Screening Tool, www.coastal.climatecentral.org [accesed 20.12.2021]

Climate change clips wings of migratory birds in Poland. Maja Czarnecka in conversation with Polish ornithologist Jaroslaw Nowakowski, https://phys.org/news/2015-10-climate-wings-migratory-birds-poland.html [accessed 12.11.2019].

Crutzen, P.J. (2016). Geology of mankind. In: Crutzen, P.J, Brauch, H.G. *Paul J. Crutzen: A Pioneer on Atmospheric Chemistry and Climate Change in the Anthropocene* (pp. 211-215). New York: Springer.

Komorowski, A. (2002). Obiekty podwodne i militaria Zatoki Gdańskiej. Toruń: Adam Marszałek.

Harvey, D. & Perry, J.A. (2015). The Future of Heritage as Climates Change. London and New York: Routledge.

Marek, A., & Marszałek, Ł. (2018). Obiekty militarne jako element krajobrazu kulturowego Półwyspu Helskiego. *Studia z Geografii Politycznej i Historycznej*, 7, 233-249.

Owen, J. (2010). World's Largest Dead Zone Suffocating Sea. *National Geographic*, 3/2010.

Sesana, E., Gagnon, A. S., Bonazza, A. & Hughes, J.J. (2020). An integrated approach for assessing the vulnerability of World Heritage Sites to climate change impacts. *Journal of Cultural Heritage*, 41, 211-224.

Szczepański, J. (2019). Sustainable monument preservation in architectural education. *World Transactions on Engineering and Technology Education*, 17, 42-47.

Vousdoukas, M. I., Mentaschi, L., Voukouvalas, E., Verlaan, M., Jevrejeva, S., Jackson, L. P. & Feyen, L. (2018). Global probabilistic projections of extreme sea levels show intensification of coastal flood hazard. *Nature Communications*, 9 (1), 1-12.

Agnieszka Nyka
Master of Science Degree in Architecture (M.Sc.) Eng. in Faculty of Architecture, Gdańsk University of Technology, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland

Jakub Szczepański
Full Professor, Faculty of Architecture, Gdańsk University of Technology, Gdańsk, Poland, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland

Gdańsk University
of Technology, Poland

Dominik Sędzicki
Jarosław Bąkowski

Pier of the Future – Investigation of Green and Blue Strategies as a Tool for Modernisation of Gdynia's Public Waterfront

Abstract:

Changing environmental conditions on cities' waterfronts present new opportunities for creating a new type of urban ecologies. Capturing these evolving dynamics in a user-friendly manner poses a methodological challenge of extending planning strategies to create more engaging space, increase biodiversity at the water's edge, reduce the heat island effect on neighbouring parcels and improve the general livability of the city's waterfront. In this paper, the authors describe the conduct of a design investigation into the relationship of the pier structure and sea domain in Gdynia, Poland. The study searches for opportunities to integrate these two territories, revealing transitional and incremental processes of potential change in the public space. This exploration aims to test the boundary between the cityscape and the water, and uncovers knowledge of forces, flows, and biological and environmental behaviours which can be used in future application of real-time solutions.

Introduction

Between global migration and rising water levels, architects need to reconfigure the relationship between public space and coastal landscapes. Cities are facing entirely new risks and elemental forces of nature. Ecology and climate change are increasingly common terms, showing the demand to specify the spatial and formal challenges faced by cities all around the world. Redefining boundaries and edges, architects have a unique opportunity to shape public awareness of these conditions through waterfront parks.

Generally, coastal cities include inhabited shorelines and large areas to enjoy the water, but comprehensive designs for this space are rare. This is especially true when it comes to post-industrial shorelines. The following chapter describes a project that proposes the redefinition of the waterfront situation in Gdynia and explores novel spatial strategies at various scales. With contemporary

landscape approaches and engaging civic amenities, this project celebrates blue and green elements while proposing new ways to experience our urban waterfronts.

Aims

The area covered by the study is located in a key location for the city of Gdynia. The main compositional axis of the project is a kind of heart of the network of connections in the central urban structure, which contributes to the enormous potential of the place. The leading design assumption for the location is the need to strengthen the identity of the place and the importance of the public space of the port area in the perception of not only city visitors, but also residents in their everyday life. An important procedure is the activation of the waterside spaces outside of the summer season and the discovery of the area in a new way, carrying many different values that represent high aesthetic, technical, functional, social, ecological and educational values.

This exploration aims at testing the boundary between the cityscape and the water, and uncovering knowledge of the forces, flows, and biological and environmental behaviours which can be used in future application of real-time solutions. A crucial objective is to improve the portside territories in Gdynia, which will provide a new focal point for port-related social and cultural activities following the example of many sites abandoned by marine industry worldwide (Roberts et al., 2021).

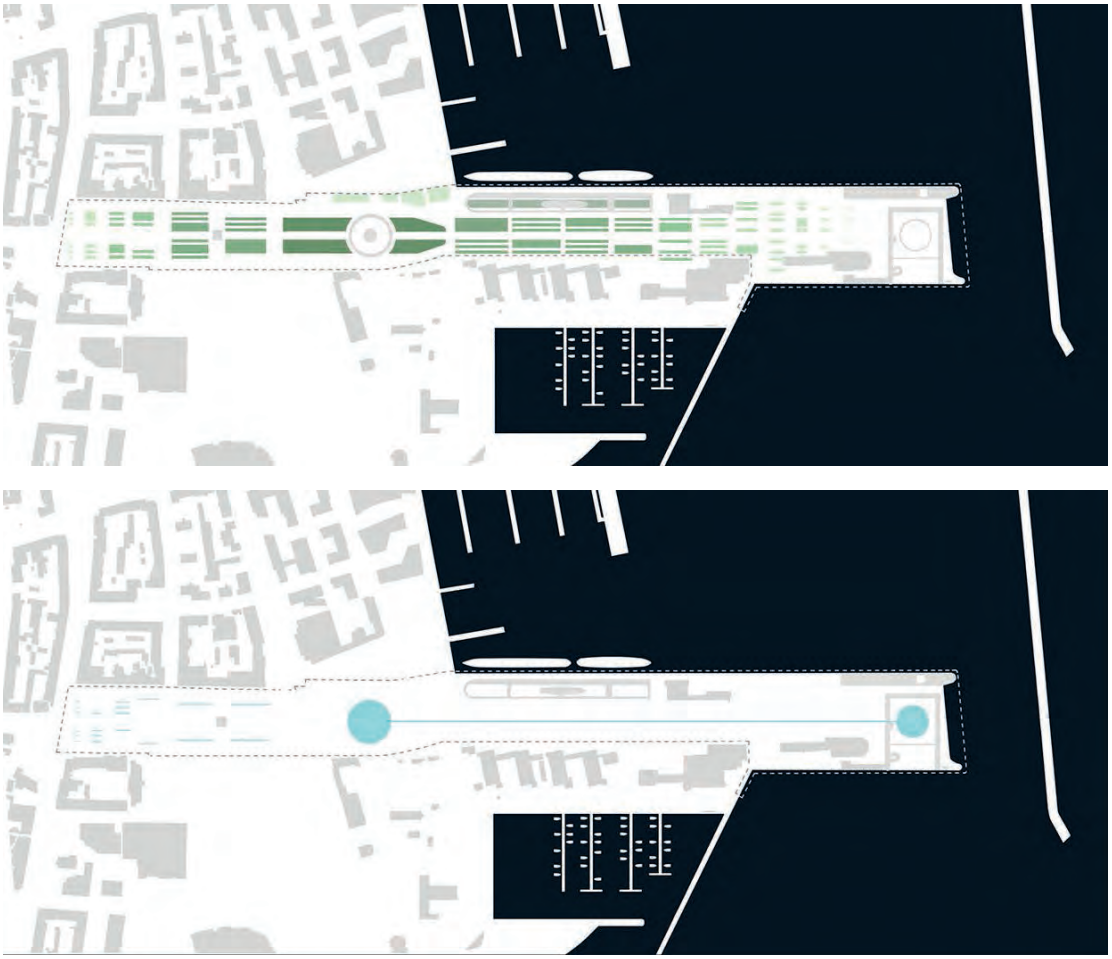
Study area

The concept is based on micro- and macro-scale actions that will ensure that the assumption is treated in a holistic manner both generally and in detail, in a way that takes care of the smallest needs of various social groups, by creating a new showcase of the city of Gdynia, and taking care of the needs of a modern city of the future that result from climate change.

The new concept assumes the preservation of important communication routes and emphasising the axes and view openings that are important for the city, as well as fitting into its context. However, in order to refresh the compositional system, a kind of spatial grid was designed. The grid superimposed on the study area gave the entire space an original character. Its simple layout is not only intended to mark the layout of paths, but it is also to be visible in the space as an enriching element, at the intersections of which sometimes important elements of spatial development may appear. Their goal is to increase the comfort and well-being of the users of this place.

Fig. 1. Plan

The determined grid also works on the principle of smaller viewing axes among dense greenery.



The inspiration for the idea was the design of the Swiss architect Bernard Tschumi for the idea of arranging the park de la Villette in Paris from 1982 (Bernard Tschumi, 2014). The project was aimed at revitalising a large area, where one facility was located on each of the thirty-five nodes. Each of the forms was slightly different, but with their red colour, they formed a coherent whole and gave a sense of place and finding oneself in such a large space. Interestingly, the objects did not have defined functions. Only the users of the park, depending on the needs, created in each of them the activity for which there was currently demand.

In Gdynia, on the other hand, the imposed urban grid will also show the intensity of the planned urban meadow and gradient saturation with greenery, creating a new quality of urban space while also giving the impression of unity and coherence of the entire space.

Water zone

In order to diversify the space in front of the newly planned Gdynia Waterfront investment, an architectural object was proposed in the form of a circle surrounding the existing city fountain, creating a kind of "water zone". From the human perspective, it looks a bit different in every place, so it may be an interesting attraction and proposition for the existing public space. The object was profiled in a way that does not interfere with the view on the main axis of the building. Its form does not interfere with the spatial composition due to the lowering of the axis, which was intended to further strengthen the importance of the historical layout.

On the other hand, in the plan, its shape is to refer to the wheels already appearing in the city space, including, for example, in the nearby Council of Europe Park, as well as to the circle connected with it by a water path in the form of a designed swimming pool / ice rink. Its colour is to be consistent with the city's characteristic white, and the water flowing out of it is to emphasise its important role in the city.

Fig. 2. Greenery

Fig. 3. Water points

—

Fig. 4. Water zone

Green dock

In the place of the existing lawn and pavilions, between Aleja Jana Pawła II and the Pomeranian Quay, a space has been designed to emphasise maritime units and provide places for their observation from various perspectives. In the above place, in order to supplement the exhibition function, it was proposed to exhibit the 47-metre-long "Sokół" submarine, which was withdrawn from service in the Kobben Navy (reference at the bottom of the the page)[1]. This is a good location to implement the project planned by the city (reference at the bottom of the page)[2], the aim of which being to display the above unit. It was "immersed" in the street as if it were submerged in water. The proposed solution works as a countermeasure to ship dismantling and raises awareness on marine sustainability (Zhou et al., 2021).

The recess in which it is located resembles the longitudinal profile of the ship. It is also an exhibition function with ramps from which you can observe the submarine from many different heights,

Fig. 5. Green dock

—

Fig. 6. Swimming Pool

1 Article describing withdrawal from service. Polska Zbrojna
2 Description of city's intention to exhibit ORP as a part of Gdynia's museum of War. Trojmiasto.pl

with the possibility of descending and viewing the object from below. The inspiration for the form of placing the submarine in this way was the historical form of the hippodrome. The basin of the area has also been widened to the sides, complementing it with a museum and exhibition function following the maritime theme. The entire green dock has been filled with various types of vegetation, which provides an additional attraction in the form of a botanical garden, and has an educational function. The green dock with the submarine seamlessly connects and merges with the recreational park designed on the south side, which spills over into a large part of the entire complex.

Swimming pool

At first glance, building a pool right beside another body of water seems a little redundant. After all, why would someone choose to swim in a pool when they have a river or ocean to enjoy? However, for people with limited mobility and younger more inexperienced swimmers, natural bodies of water can prove both daunting and dangerous. While the construction of an open-air swimming pool may be sign of urban sprawl (Salvati et al., 2015), pools not only provide a controlled, secure space for them to enjoy aquatic activities, but also provide a connection with the surrounding landscape.

In any case, building a structure along the coast or a riverbank is a complex task. The process requires a profound understanding of the topography of both the land and the body of water. The ever-changing conditions of these landscapes caused by the ocean tides and the flow of the rivers blur the boundaries between man-made and natural structures, and make designing and construction difficult.

When designing the multi-dimensional land development, it was proposed to include a part of the object recessed below the surface of the existing land and to turn it into swimming area. The proposed development and the function matched to it have been designed in a way that protects against the wind, which is the most burdensome at the end of the pier. The proposed shape is the culmination of the main compositional axis, deliberately lowered so as not to obstruct the view of the water. The composition arrangement has been inscribed in a square, which thanks to its symmetry fits very well into the straight and symmetrical character of Gdynia, and also allows for its easy and logical use.

The leading assumption of the proposed development was multi-seasonality. Therefore, a facility was proposed in the central part for urban activities, for which there is demand in Gdynia. In the summer it would be an open swimming pool and in the winter it would be an ice rink. Its form is in the shape of a circle, which corresponds with the designed water wheel at the city fountains. This space would be at the sea level, so that users of the above-mentioned attractions could use them while constantly in contact with the view of the sea and the Gdynia cliffs on the south side. These would be attractions that would attract many visitors to this place, while eliminating the problem of large open space.

The whole concept is focussed on the use of very good vantage points, which is why spaces have been designed there that will ensure even closer contact with the sea and strengthen the identity of the place. From the north, a cubature structure with a ramp leading to the viewing platform on the roof was proposed and is a continuation of the communication route from the Pomeranian Quay. Thanks to this, users will be able to move very smoothly from one attraction to the next. The elevation of the terrain in this place acts as wind protection and as a cover, and also provides a vantage point to observe the Sea Towers, the city beach and the whole new site from a higher level.

Events

Gdynia always been associated with the creative arts, which is reflected in its admission to the UNESCO Creative Cities Network[3], and the city therefore needs space for its inhabitants and visitors to enjoy events. To accommodate this, when users are not using the proposed functions of the swimming pool or ice rink, they will be able to use the multi-functional building described above to shelter

Fig. 7. Ice rink

Fig. 8. Concert space

3 List of cities in the UNESCO Creative Cities Network. UCESCO

from various weather conditions, and to use public toilets, which are in demand in this part of the city.

On the south side, however, a round, spiral descent was proposed, with its aesthetics referring to Gdynia's modernism. It serves as a pedestrian thoroughfare from the Gdynia Aquarium to the level of the swimming pool / ice rink to the public space. There are stairs, which are a place to rest, descending to the level of the water. This place could also be used as a place for temporary exhibitions for objects that may be temporarily flooded. The open air museum feature references and expands solutions undertaken in the neighbouring city of Gdańsk (Lorens et al., 2021). This proposition is to raise awareness and show the effects of the coming climate change and also to provide for a more water connected site.

There are currently two monuments in the area of the site, which have been included in the project, and special foundations have been proposed for them, thanks to which they will be an additional

form of attractions at the swimming pool / ice rink, where their original locations will not change. The entire project has the necessary facilities (reception, cloakrooms, toilets, etc.) to support the proposed functions under the surface of the existing area with direct access to the main attractions.

One of the main design priorities is the maximum saturation of the area with greenery. And recovery of the area for the municipal meadow, without losing space or the abillity to support collective and sporting events, and concerts. The design assumption was not only to enrich the entire urban fabric with numerous public spaces and attractions, but also to transform the concrete pier into a green pier, which would be the green heart of Gdynia.

The new design assumptions are to go hand in hand and in harmony with nature. As a result, most of the project area was covered with a "city meadow", which could include elements of green and blue infrastructure accompanying the entire scheme.

The connection of greenery with water is integral in this project, not only due to the location at the interface between land and sea, but also through the possibility of solutions for retention parks or rain gardens, as well as the constant relationship and contact of the user staying in the park with water.

Conclusion

The priority was to prove that there can also be space for green spaces in the city centre, and that it can become one of the most important features of the identity of a given space in a city. The main green compositional axis in Gdynia may also become a kind of showcase, which brings many educational benefits on a small and large scale. A larger one would be it serving as an example of development for other cities in a direction that is better for the environment and the future. In a smaller sphere, by educating users of the space who are using street furniture closely connected with ecological solutions.

In addition, the project assumes places for joint participatory activities and integrating common spaces in order to create a place for residents where they will be able to feel like they belong to a certain community, as well as a deep identity with their city.

A large park was proposed, where gardens may appear as a pretext for spending time together and in various activities, or a botanical garden with the possibility of conducting various types of workshops for people of all ages. Many recreational areas have been designed in wild greenery between the key attractions

Fig. 9. Aerial view

in Kościuszko Square, which will improve the well-being of its users. Visitors will have the opportunity not only to spend time actively, but also to choose from many different places to relax in this space. For this purpose, various types of multifunctional furniture or art objects interwoven with various greenery were designed to bring relief to users who are slightly affected by the weather. The vegetation itself is largely perennial, and has been selected in such a way as to create an individual scenery and a unique atmosphere at each time of the year.

References

Roberts, T.; Williams, I.; Preston, J.; Clarke, N.; Odum, M.; O'Gorman, S. Love Thy Neighbour: Social Benefits and Port-City Relationships. Sustainability 2021, 13, 13391. https://doi.org/10.3390/

Bernard Tschumi, 2014, Tschumi Parc de la Villette, Artifice Press, ISBN 10: 1908967447 / ISBN 13: 9781908967442

Zhou, Q., Du, Z., Liu, J., Liang, J., & Jiao, Y. (2021). Factors influencing green ship recycling: A conceptual framework and modeling. Journal of Cleaner Production, 322 doi:10.1016/j.jclepro.2021.129155

Salvati, L., Ridolfi, E., Zambon, I., Serra, P., & Sauri, D. (2015). Swimming pools as indicator of urban sprawl: An exploratory analysis in a mediterranean city. International Journal of Environmental Research, 9(4), 1325–1332.

Lorens, P., & Bugalski, Ł. (2021). Reshaping the gdańsk shipyard—the birthplace of the solidarity movement. the complexity of adaptive reuse in the heritage context. Sustainability (Switzerland), 13(13) doi:10.3390/su13137183

ORP „Sokół" kończy służbę, Polska Zbrojna, 08-06-2018 [accessed: 2022-01-13] (pol.) http://www.polska-zbrojna.pl/home/articleshow/25653?t=ORP-Sokol-konczy-sluzbe#

Okręt podwodny stanie się atrakcją centrum Gdyni, Trojmiasto.pl, 13-03-2018 [accessed: 2022-01-13] (pol.). https://www.trojmiasto.pl/wiadomosci/Okret-podwodny-stanie-sie-atrakcja-centrum-Gdyni-n121948.html

New cities join UNESCO's Creative Cities Network, UNESCO, 13-11-2018 [accessed: 2022-01-13] (eng.) https://en.unesco.org/news/new-cities-join-unescos-creative-cities-network

Dominik Sędzicki
Master of Science Degree in Architecture (M.Sc.) Eng., Assistant ,Faculty of Architecture, Gdańsk University of Technology, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland

Jarosław Bąkowski
PhD, Assistant Professor, Faculty of Architecture, Gdańsk University of Technology, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland

Partners


UNIVERSIDADE
LUSÓFONA


GDAŃSK UNIVERSITY
OF TECHNOLOGY


TOBB ETÜ
University of Economics & Technology


SAPIENZA
UNIVERSITÀ DI ROMA


KTH
VETENSKAP
OCH KONST


INTERCULT


GDAŃSK


Provincie
Noord-Holland


river//cities