

# Hydrourban spatial development model for a resilient inner-city. The example of Gdańsk

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## Abstract

Cities that show signs of both growth and shrinkage and that nevertheless do survive, show tendencies to be resilient. Their development process can be seen as pulsative. The objective of the paper was to demonstrate the links between spatial development and Gdansk's hydrological layout—pointing out how the city spatial layout of was determined by the context of water. The results of analyses central districts, made it possible to identify three stages of hydrourban evolution: 1) Reconstruction phase (after WW2)—which led to the reinforcement of the east-west development of axis of public space, 2) Transformation phase (after 1989)—which emphasised the new north-south direction of urban development following the freeing up of the river-water system, and 3) Metamorphosis phase (initiated in 21<sup>st</sup> century)—which assumes the expansion of the hydrourban structure, while taking into account the multi-layered integration of the spatial and functional aspects of the agglomeration with flood prevention and ecological policy. The study allows to trace the relationship between the physical structure and the hydrological system which have led to the development of a rich hydrourban system configuration. The destruction of historical city centre (during WW2) and the later loss of shipyard areas, which constituted a part of the city's identity, provided space for an urban experiment. The research demonstrates changes in the perception of the role of water system in the urban structure—which can be considered a valuable tool for planners and urban designers, to be used in, meeting demands of resilient cities.

**Keywords:** Gdańsk urban development; hydrourban system; models of urban development; resilient city model

## Citation

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## 1. Introduction to the formation of the resilient model

The specificity of the spatial development of urban structures does not always indicate stable growth. The various phases of progress occur in leaps, often interweaved with periods of stagnation, sometimes including shrinkage through damage-causing processes induced by wars or natural disasters. In a broader perspective, this process can be described as pulsating, displaying interweaving periods of development or its cooling, which reflects itself in the shaping of the city model (Mironowicz, 2016). Cities whose growth is based on pulsating processes show a tendency to be resilient (Mostafavi & Doherty, 2016). Their capacity to grow back, transform and direct their growth is a remarkably interesting field of study. Identifying the phases of “pulsing” in reference to the specificity of a given urban structure can lead to determining the conditions and capacity for the formation of a resilient city.

One of the key aspects of this growth appears to be ecological policy, which is to include measures that build a stable blue-green system that is integrated with the urban structure and can give an answer how to adapt the city to the problem of climate change (Carter, 2018). This fact, in the context of projected climate change, appears to be crucial to sustaining a city's resilience (Beatley, 2016; Lemes de Oliveira, 2017; Moughtin & Shirley, 2005). Experimenting with new methods of tying the ecosystem with the urban structure leads to building a new cityscape quality (Stangel, 2013; Waldheim 2016). As a part of structural analysis, cities that have displayed strong ties between their urban layouts and water networks are a remarkable case (Nyka, 2013; Matusik, 2016), particularly when the network is built through a context associated with either a single or multiple rivers, or with numerous small waterways which can be found throughout the urban structure in which the river becomes a regional connector (Prominski, 2012). The urban studies that have been presented in the article were directed at searching for links between the shaping of the urban structure and the hydrological network of river systems. This co-dependency is considered to be among factors that are fundamental to the development of cities (Meyer 1999, Mumford 1961). Gdańsk features an urban structure in which these relationships have particularly crystallised in the inner-city and which has utilised it for its further development (Figure 1).

Figure 1. Historical panorama of Gdańsk against the background of water linkages 1650–1655



Source: Gdańsk Historical Museum. Author: Mathäus Merian.

The last eighty years were particularly dynamic period in research on resilient city spatial development models. Urban complexes of Central and Eastern Europe are an interesting field of study in this regard. It is difficult to ignore historical, political, demographic and social conditions that

have determined their spatial processes. The scale of destruction wrought on Polish cities by the Second World War was immense, with 177 of them losing over 50 % of their historical centres (Pawłowski, 1986). Cities that had been destroyed during the war experienced a relatively long period of communist dominance. The post-war rebuilding effort adopted varying schemes of reconstruction measures and has permanently altered many of them.

Gdańsk is a typical example of a city with a turbulent history (Cieślak & Biernat, 1988). Its site-specific benefits, which guarantee access to the Baltic Sea and its openness towards inland navigation—have affected its growth and determined the threats that it has faced—which have been associated with the desire to either block or dominate this "gateway to the world". Its geographical placement at the mouth of the Vistula River has allowed it to benefit from marine trade between Poland, Prussia and the entire region. Strong trading position influenced the spatial development of Gdańsk as a Hanseatic League city, with the structural patterns following the Lübeck location plan (Kostrzewska, 2013; Węclawowicz-Gyurkovich, 2016). Over the centuries, this has led to the crystallisation of a strong and significant urban centre with a remarkable urban form and outstanding architecture. The close relationship between the physical structure and the hydrological layout led to a rich hydrouurban configuration. Modifications to the layout of the city, understood as a hydrouurban model (Matusik 2016), perceived as being both core and key to the entire structure of the city, have determined the quality and, therefore, the competitiveness of the entire urban organism.

## 2. Gdańsk's hydrouurban development phases

The period after the Second World War determined the contemporary shape of Gdańsk inner-city and has impacted its future. What was the impact of the city's relationships with the water network on this period of development? The article goes in the direction of providing an overview of the spatial perspective in relation to the hydrostructure—searching for interdependencies between them. Research results have made it possible to determine three phases of urban and water development in the abovementioned period:

- the reconstruction phase (focused on inner-city)—after the Second World War;
- the transformation phase (focused on city centre)—after 1989;
- the metamorphosis phase (focused on city scale)—initiated in 21<sup>st</sup> century.

The first two phases determined the contemporary condition of the city—which was significantly weakened by war and the restructuring of its most important branch of industry—shipbuilding. The third phase is a record of Gdańsk's planning intentions, which are to reinforce its relations with the hydrological layout. This relationship with water has remained an element of the city's identity throughout all of previously mentioned phases.

### 2.1 *The reconstruction phase (after the Second World War)*

At the beginning of the 20<sup>th</sup> century Gdańsk was breaking from its fortification frames, following the Hermann Stübben Plan of 1883 (Kostrzewska, 2013; Gruszkowski, 2009). The city was ready for modern development. Hugo Althoff, who in 1929-30 presented the Great Gdańsk Plan, saw Gdańsk expanding around its inner core with ecological green corridors and zoned housing estates (Kostrzewska, 2017; Rozmarynowska, 2009). The progressive visions, due to the political situation, already before the war got abandoned. The Second World War was a moment in which the continuity of Gdańsk's development was significantly shaken. It was uncertain whether the city had a future ahead of it. Gdańsk was one of the cities that suffered the greatest deal of damage—similarly to Warsaw, Szczecin, Wrocław, Koszalin and many others, bigger and smaller towns. The centre of the historical city was buried under heaps of rubble, with elements of buildings jutting out from it

(Zachwatowicz, 1965). Maciej Nowakowski and Barbara Nowakowska (2013) mentioned that 6000 buildings were damaged to a degree of 75–100 %, while 1300 to a degree of 15–75 %. The structure of the adjacent canals of the Motława River was destroyed.

Gdańsk, because of its geo-political location that has been essential to Poland, found itself on the prestigious list of the most important city-centre complexes in which a reconstruction process was undertaken. It joined the historical centres of Warsaw, Poznań and Wrocław—each of which were being rebuilt. The reconstruction attempt was undoubtedly an expression of patriotism by Polish architects—reinforced after a short interval of interwar independence.<sup>1</sup> This tendency was rooted strong enough in Polish urban planning and architecture that we can, following Jacek Purchla (2015), describe it as a Polish *reconstructivism syndrome*. However, a comprehensive reconstruction was not possible in the post-war reality of immense destruction and immense housing needs. Many cities were left outside of mainstream measures, one example being Elbląg, located near the Vistula River just a couple dozen kilometres away. The reconstruction process, maintained in a historical spirit, was ended by the Stalinist era (Racoń-Leja, 2018; Racoń-Leja, 2019). The modernism that followed filled the empty spaces, drowning Polish cities—including Gdańsk—with its unified typology.

Gdańsk's reconstruction was not a complete process, as it only covered a fragment of the city, largely confined to the Main Town, a section of the former Old Town. This part constituted the main core of the historical city—adjacent to the Motława River channel. The reconstruction funnelled the process of development to the east-west axis (Figure 4). This direction also highlighted the importance of recreating the city's structure of public spaces. Linking with the river system also constituted an essential element, highlighting the centuries-old identity of Gdańsk and the cohesion of its development as a hydrouban model. The work covered the reconstruction of the layout of historical streets parallel to the Long Market/Long Lane and the adjacent historical monuments. The reconstruction was always associated with a process of reinterpreting and improving the former layout (Racoń-Leja, 2018; Racoń-Leja, 2019). In the case of Gdańsk, the interiors of its urban blocks were made less dense. The perpendicular enclosures of urban blocks were removed from the long structures. The architecture, maintaining a historical spirit, utilised fragments of authentic details. The character of a Hanseatic city was established by the meticulously designed attics of the buildings (Węctawowicz-Gyurkovich, 2016).

However, the most significant change was the abandonment of the mixed-use structure of the pre-war city—with its rich network of stores, services and the residents tied to them. The city was recreated as a housing district, or even *modern workers' estate* (Bugalski, 2014) with services subjected to this function—which constituted a consequence of modernist thinking in urban design. The main investor became Department of Worker Settlements. Social housing and the selective tourism-related function hindered the process of revitalisation throughout the decades that followed—the reconstructed complex became a remnant of the past instead of an actual living centre that satisfied the needs of the surrounding city. In the idea of intensifying the historical structure, in the spirit of modernism, the elements of water were becoming a factor in the modern shaping of the sparse landscape. In terms of the improvement of the hydrological system, access to the Motława River was restored. It also became the outer border of the rebuilt area (Figure 2).

The post-war spatial development of Gdańsk was also associated with the creation of large housing estates on the outskirts, like Małe Przymorze, Wielkie Przymorze, and Zaspą - typical for Polish cities in this period. The Małe and Wielkie Przymorze housing estates built from the late 1950s to the mid-1970s became the flagship project of the city's modernist urban planning. Both characteristically located to the north, within the context of the Gulf of Gdansk. Among basic urban values applied,

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<sup>1</sup> Poland regained its independence in 1918 (after 123 years). The years 1918–1939 became a period of rebuilding its national identity, as it had been previously divided into three parts.

were the sea edge and the structure of moraine hills. Three eleven-story 'wavelets' got built at the Wielkie Przymorze estate. The number of inhabitants of the longest, of 800 m, was a reference to the idea of C. Perry's neighbourhood units - officially forbidden, but used by Polish architects (Kostrzewska, 2013; Rembarz, 2009).

Figure 2. Reconstruction of the Main Town



Reconstruction of the Main Town along the east-west axis (upper left); Rebuilt complexes along Długi Rynek Street and the Mottawa River canal (upper right); The intended de-densification of the inner-city area narrowed the belts of the block structure and resulted in empty courtyards (bottom left and right). Source: photos by M. Leja and W. Matusik.

To the north of the Main City, Władysław Czerny, Witold Kuczewski and Wacław Tomaszewski developed the plan of Gdańsk (1946-47). They implemented the concept of the city's return to the Vistula, as part of a new idea of directing the axis towards the shipyard (Bugalski, 2013). This spatial aspect would come back at various stages of the city's development.

## 2.2 The transformation phase (after 1989)

The turning point of the year 1989 was a difficult period for Gdańsk—a city that had been so firmly placed in the process of the changes that led to the democratic transformation of the country. The present-day perspective of those events, which happened 30 years ago, makes it possible to take a closer look at the changes that were initiated at the time. In terms of the layout of the city's urban and hydrological structure, the axis of the city's development has changed significantly. It shifted from the east-west direction to the north-south one (Figure 4). The Mottawa River, connected with the Martwa Wisła (Dead Vistula) canal, became the axis of development. However, this is a long-term process and despite three decades of various measures, it can be concluded that we are still in the

middle of this transformation. These efforts, as well as potential areas of development, focus on the strip of the central isles in the backwater of the Motława, as well as the northern section formerly occupied by shipyards, adjacent to the Martwa Wisła River. The inner-city area clearly extends beyond the previous outline of the city's fortifications, departing from the concentric model, with a layout of public spaces oriented along the east-west axis (Figure 4). New development projects require both development potential and planning preparation for possible scenarios.

### 2.2.1 *The Central Isles*

Without a doubt, Wyspa Spichrzów and the island of Ołowianka are the most attractive element of Gdańsk's urban space. Located in the immediate vicinity of the Main Town complex, the isles have found themselves under immense pressure from developers. The area has been protected thanks to the enactment of Land Development Plans, although it was not the obvious course of action in light of the changing situation of planning control and supervision in Poland (Rada Miasta Gdańska, 1999; Rada Miasta Gdańska, 2002). References to the structure of historical inner-block parcellation and fixed building lines were pursued in the northern section—this area is a fragment of the city's historical layout and is under heritage conservation (Wojewódzki Konserwator Zabytków, 1947).

In places where there were no collisions with historical development, the parcellation followed the historical provisions of the Buhse Plan. The height of the buildings set in the plan maintained the sizes from the central area—at a level of 30–33 m. The functional programme, as outlined in the plan, assumed centre-genic functions—offices, administrative buildings and banks, as well as housing and lodging. It proposed a broad spectrum of services: commerce, gastronomy, culture, entertainment and tourism, recreation, education, science, as well as arts and crafts, including traditional ones. The plan also featured the mandatory linking of the interiors of the urban blocks through public spaces in the form of passages (Rada Miasta Gdańska, 1999).

The fragmentary character of the planning documents was their major flaw—the plans divided the area into the northern part (Rada Miasta Gdańska, 1999) and the southern one (Rada Miasta Gdańska, 2002). Over the course of the development process, the proportions of the new complex, its colour schemes and detail turned out to be extraordinarily important. The buildings are meant to have massing resembling granaries, featuring traditional materials—like plaster, brick, timber and ceramic roof tiles—a measure reinforced by the provisions of the plan (Rada Miasta Gdańska, 1999). The process of rebuilding this part can be understood as a further development of the idea of retroversion, constituted in Elbląg, Kamień Pomorski and Kołobrzeg since the 1980s—by filling in the former urban structure with contemporary albeit historicizing forms, making references to historical structures (Gyurkovich, 2019b).

The contemporary designs that are currently entering the development phase are being constantly changed. There is a public discussion concerning their planned construction taking place through online publications, for example concerning the proposals of the so-called Granaria. The concentration of hotel functions is a negative element of currently built projects. Hotel buildings with restaurant and conference infrastructure are taking over the most prestigious sites on the island. The planned supplementary housing functions and the proposal of building covered passages with gastronomic and commercial premises gives some hope of sustaining the downtown character of the area.<sup>2</sup>

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<sup>2</sup> Source: <https://www.trojmiasto.pl/wiadomosci/Nowy-wyglad-budynkow-na-Wyspie-Spichrzow-n131365.html>, Ed: Brancewicz M., published 29.01.2019 – accessed May 2019.

Figure 3. Urban redevelopment of the Central Islands



The pedestrian and bicycle bridge between the Main Town and Ołowianka Island. 2017 (upper); The northern end of Granary Island with a completed structure that evokes the connotations with the Hanseatic history of the City. 2019 (bottom); The eastern façade of Granary Island where completed investments are still neighbored by the ruins of historic structures—with a distant view to the Motława River boulevard at the Main Town. 2019 (lower). Source: photos by W. Matusik and M. Gyurkovich.

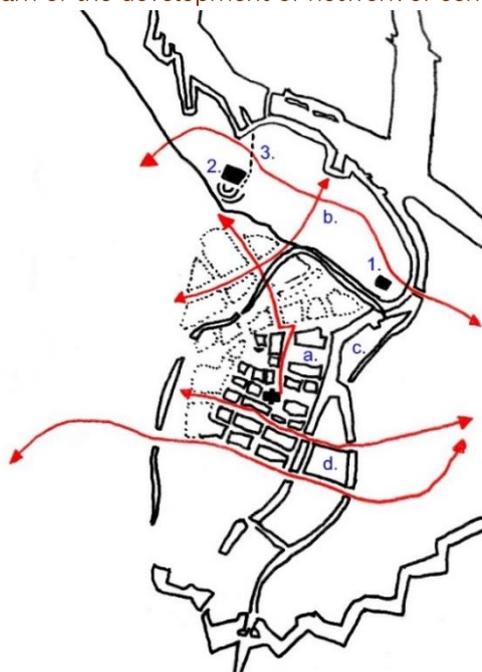
Strengthening pedestrian linkages between the central isles and the historical waterfront and the left-bank section of Gdańsk is an essential element of the area's revitalisation.

A footbridge leading to Ołowianka was built in 2017 (Figure 3), while construction of the Holy Spirit Footbridge, connecting Długie Pobrzeże with Wyspa Spichrzów (Granary Island) is currently being built.

The latter is being funded by a private developer.<sup>3</sup> Both bridges can be opened by turning one of their sections, making the Motława River navigable. There are plans to convert neighbouring bridges into drawbridges. Thanks to new development projects in the area, the river has remained a constantly active element of the city—stimulating forms of public activity in the city centre.

<sup>3</sup> The project will be financed by the Granaria company, arch. Cezary Bednarski, completed in 2018-2019. Source: <https://www.trojmiasto.pl/wiadomosci/Wkrotce-ruszy-budowa-ruchomej-kladki-przez-Motlawe-n120809.html>, Ed. Moritz K., published 5.02.2018 – accessed May 2019.

Figure 4. Diagram of the development of network of central city structures



Main City structures and buildings: a. Main Town, b. Young City, c. Ołowianka, d. Granary Island; 1. Museum of the Second World War, 2. European Solidarity Centre, 3. Path to Freedom. Source: graph by A. Matusik

### 2.2.2 *The northern areas of the former Gdańsk Shipyard*

The areas north of the Main Town formed the so-called Young City in the distant past. The Young City is an illustration of the early attempts at developing Gdańsk towards the north, in the direction of a branch of the Martwa Wisła River. Its origins date back to the Middle Ages, to 1380. In the middle of the fifteenth century, most of the buildings were dismantled in the process of fortifying Gdańsk. The area had had its development blocked until the nineteenth century—when post-military grounds became the seed for the development of the shipbuilding industry (Lipiński & Lorens, 2016). The Gdańsk Shipyard that was later built in this area became the city's most important structure of industry in the second half of the twentieth century—and not only on the economic plane, as it became a major part of the city's identity. The Shipyard was a part of not only the city's spatial structure, but also the social one—forming a strong civic structure—which would go on to transform the reality of the entire country through various freedom movements. When the Gdańsk Shipyard, along with other economic entities that cooperated with the shipbuilding industry, was closed down and later reprivatised at the turn of the 1980s and the 1990s—it meant that the city had lost an essential direction of development and a key part of its identity.

This change also brought with it significant spatial consequences—including the opening of both post-shipyard areas and the symbolic liberation of a part of the water network in the city centre. This area has become a sort of design testing area. The shipyards had previously formed a barrier, blocking the city's access to the Martwa Wisła channel. The city, located below, formed a patchwork layout of structural fragments. Areas occupied by the railway and major roads constituted additional barriers. The question as to how to connect the city and link it with the reclaimed area suitable for development has been at the back of the heads of planners, architects and developers for three successive decades. The city initiated the drafting of Land Development Plans for this area, which were prepared by the Gdańsk Development Bureau, two of which were approved in 2004 and remain in force to this day (Rada Miasta Gdańska, 2004/1; Rada Miasta Gdańska, 2004/2).

The main part of the plan for the area of the former shipyard, which is now tellingly called *Gdańsk Nowe-Miasto* (Gdańsk New City) is intended to feature dense housing developments along with accompanying services (with a floor area up to 100 m<sup>2</sup>) as well as collective housing with the exception of hotels. Commercial and public functions are also to be featured, primarily in the western section. The plan does not constrain building height in all places. It proposes a minimum building height of 12–18 m, in some zones restricting maximum height to 30–40 m.

In terms of public spaces, it assumes the establishment of a boulevard—that would have the character of a pedestrian path sequence leading northwards, the so-called Path to Freedom (Droga do Wolności). The boulevard is meant to connect buildings of cultural significance and be supplemented with greenery. It also constitutes a visual axis. The land use of waterfront areas was included in the form of a pedestrian boulevard with a bicycle path—appearing more like an edge of a downtown area rather than a green space. The character of the waterfront, with its *aquatoriums*—internal bays—is to be maintained, while all changes in this field are to be approved by the heritage conservator (Rada Miasta Gdańska, 2004/2).

The scale of the new development is a problem that still remains unsolved in land development plans. The areas of the former Gdańsk Shipyard have inspired architects to design tall buildings, creating the frames of the waterfronts or featuring references to former port cranes, while creating additional profits for developers. Because of public pressure, a portion of the area has been subjected to the procedure of being placed in the heritage sites registry. The latest recommendations of the voivodship heritage conservator Agnieszka Kowalska bring with them a constraint on maximum building height for new projects, with the limit set at 30 metres—which is meant to correspond to the height of the recently built European Solidarity Centre. High density is meant to compensate for the height of buildings—corresponding to the density of the pre-war city (although in fact it is still lower).<sup>4</sup>

Piotr Lorens has highlighted the significant potential of this area as the new centre of the entire Gdańsk agglomeration, with identity sites intended to be its essential element—sites like the Monument to the Fallen Shipyard Workers, Solidarity Square or the Path to Freedom (Lipiński & Lorens, 2016). It is difficult not to agree with this proposal—the events of the twentieth century that have been commemorated through these sites have set the history of Gdańsk on a new track. However, will the areas of the former shipyard make full use of their potential for a downtown district? The answer to this question will probably come in the years to follow. The city-generating effect will be dependent on the new functions and linkages with the historical centre to the south. The areas located to the north remain dominated by production-related and industrial forms of use (Rada Miasta Gdańska, 2004/1). These functions will block the further northward development of the city in the immediate future.

### 2.2.3 *Axis of culture - as a reinforcement of the spatial model*

During the process of the transfer of the city's development direction to the north-south axis, the introduction of attractive cultural functions has undoubtedly had a reinforcing character. The structures that have been built in recent years enrich the programme of the downtown area, creating a hybrid landscape of culture (Gyurkovich, 2019a). The new projects form a key network of the linking of the city's elements and funnelling both tourists and residents through them. They have also been linked by the axis of the river. Newly built structures in the area feature outstanding architectural

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<sup>4</sup> Source: Interview by *Gazeta Wyborcza* with the Pomeranian voivodship heritage conservator A. Kowalska from 1.02.2019, <https://www.trojmiasto.pl/wiadomosci/Wojewodzka-konserwator-zabytkow-LOT-bedzie-mniej-nowoczesny-Mlode-Miasto-nizsze-ale-gestsze-n131485.html> – accessed: May 2019.

projects—designed by leading designers and winning multiple awards. These structures also fulfil the role of an impulse for the new direction of the transformation of adjacent areas (Figure 4).

The European Solidarity Centre and the Museum of the Second World War (Figure 5, 6) constitute a sort of vanguard of the planned new centre of Gdańsk. The Gdańsk Shakespearean Theatre revitalises the areas at the edge of the historical section of the city—discovering their potential. The slightly older F. Chopin Baltic Philharmonic on Ołowianka Island has led to the revitalisation of the post-industrial complex of a power and heating plant, in addition to revealing the potential of the island itself.

Figure 5, 6. Axis of culture - European Solidarity Centre and the Museum of the Second World War



European Solidarity Centre (design by: PPW FORT / Wojciech Targowski, completed in: 2014) and the Museum of the Second World War (design by: Studio Kwadrat, completed in: 2012 – 2016). Source: photos by W. Matusik.

### 2.3 *The metamorphosis phase (initiated in 21st century)*

Despite the still-incomplete stage of the reinforcement of the north-south axis, Gdańsk extends much further in currently formulated planning strategies. These strategies are meant to rise to the contemporary challenges of urbanism and ecology—closely tied with blue and green infrastructure in this case. Civilizational development, which has drastically affected the densification of urban structures and the escalation of problems caused by said densification, requires a new approach. Gdańsk, due to the specificity of its aquatic location, is particularly exposed to natural hazards associated with the element of water, which was painfully demonstrated by the great flood that affected all of Central Europe in 2010.

The escalating threat from both sea and land waters, as well as excessive rainfall, showed the significant failure of the city-wide system. It is for this reason that the group of measures that are meant to provide an answer to these urgent problems can be described as a "metamorphosis". We use this term to describe those measures that not only deal with the threats that arise from urban considerations, but also as a pretext for the introduction of an urban structure with a new quality, one that builds a new urban landscape (Waldheim, 2016). This new quality is based on acknowledging the natural assets of the city as a good that constitutes the foundation for shaping its system of public spaces. This is how the contemporary Gdańsk Water Policy (Gdańska Polityka Wodna, GPW), formulated by Anna Fikus-Wójcik and Agnieszka Różga-Micewicz is being shaped and which has been created as a part of the operations of the Gdańsk Development Bureau (Biuro Rozwoju Gdańska). Its goal is to protect the assets associated with the city's entire water system while simultaneously

converting it into a system of public spaces that would shape a new urban model in the future. This system assumes the development of water structures, integrating spatial and functional aspects with flood prevention and ecological policy at multiple levels. In effect, it is meant to lead to the formation of a new hydrouban model, which, through a metamorphosis of the spaces that accompany the waterway and water edge system, co-creates the so-called "water strip"—the main axis of public spaces associated with water edges on the scale of the entire city (Figure 7).

The Gdańsk Water Policy assumes four layers of analysing the hydrouban model. The following aspects have been taken into consideration among them: the economic aspect, the spatial and functional aspect, the aspect of nature and wildlife and that of flood prevention. While continuing the previous processes of Gdańsk's development, in which the aspect of city life near the water is considered an element of its identity, the overarching problem to be included in the new strategy was the accessibility of the water edge. This accessibility was and remains varied, dependent on the functions that dominate each part of the city. On the other hand, it constitutes a key element of ensuring the continuity of the city in areas that are still occupied by industry and port-related functions.

The Gdańsk Water Policy is a document that is compliant with the 2030+ Gdańsk Development Strategy (Urząd Miejski w Gdańsku, 2014) that was adopted in 2014. The basis for the new hydrouban system shaped by the Gdańsk Water Policy is the strip model. The water strip has been outlined as parallel to the urban strip. In reference to previous documents, the layout has been significantly remodelled. On the scale of the agglomeration, the northward direction has been replaced with the new east-west axis of development. The two main channels illustrate the new routes of Gdańsk's development. They are both linked with perpendicular layouts, supplemented with local spaces (Figure 7). Gdańsk's Local Spaces constitute the subject of separate documents (Biuro Rozwoju Gdańska, 2017/1; Biuro Rozwoju Gdańska, 2017/2), in which particular emphasis has been placed on the possibilities of forming and developing them.

Figure 7. A strip-based concept of the city's public spaces structure set against the water strip

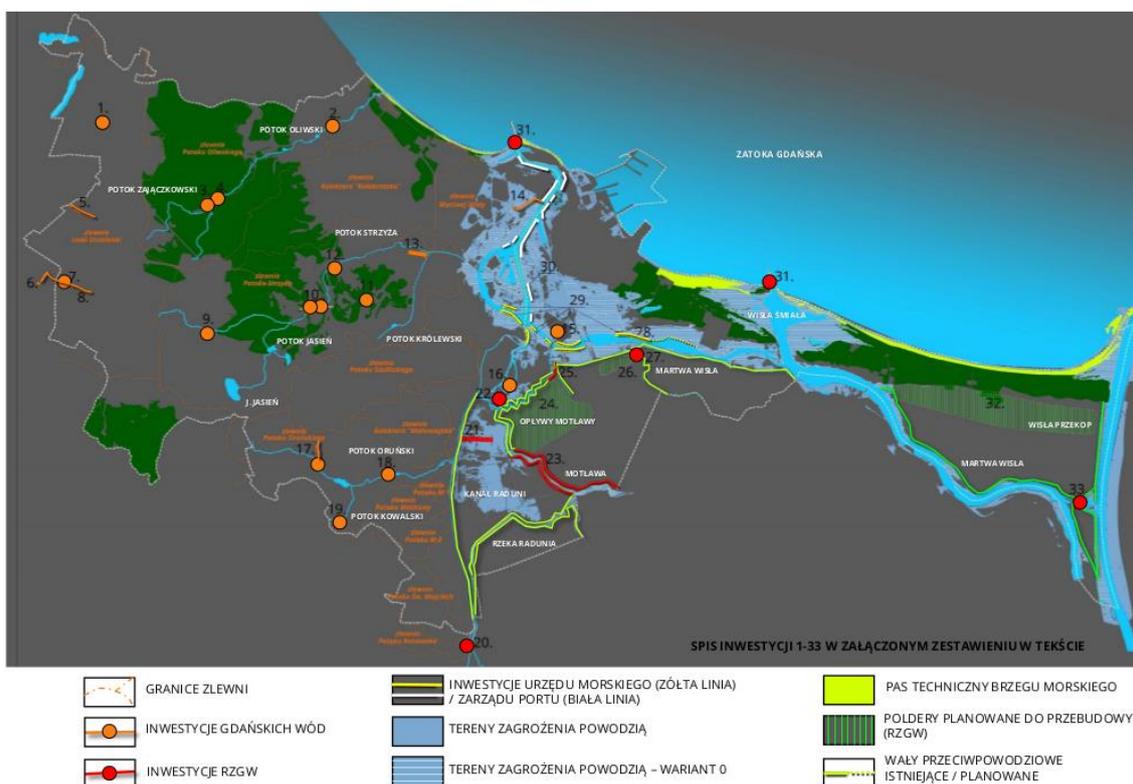


Source: Biuro Rozwoju Gdańska. (Gdańska Polityka Wodna, p: 5).

The hydrological structure taken into consideration in the city's strategy has been significantly expanded, taking into account the entirety of its waterway system. The relevant document (Biuro Rozwoju Gdańska, 2018) includes the western and eastern coastal strip covering the Bay of Gdańsk

Coast, the Vistula River basin and its channels—the Wisła Przekop, the Martwa Wisła and the Wisła Śmiała. The water edges also include the Motława and the Radunia rivers, as well as the main creeks and their tributaries: The Potok Oliwski and the Potok Zajączkowski, the Potok Strzyża along with the Potok Królewski and the Jasień, as well as the Potok Oruński and the Potok Kowalski. The entirety of the hydrological layout has been supplemented by lakes: Ossowskie, Wysockiego, Jasień and Pusty Staw lakes.

Figure 8. Gdańsk—flood prevention along with areas under the risk of flooding



Source: Biuro Rozwoju Gdańska. (Gdańska Polityka Wodna, scheme no.: 3).

### 2.3.1 The hydrouban model in the context of flood prevention and tourism-related infrastructure (according to the Gdańsk Water Policy document)

Flood protection associated with the issues of building urban drainage and retention systems, currently run by *Gdańskie Wody*, is a key factor for accomplishing the maintenance of safe and high-quality public spaces. The strategy refers to the complex problem of the threat of flooding posed by major and local waterways, as well as large-scale pluvial flooding. The significance of these threats is multiplied by the proximity of the sea.

The area under the greatest threat is undoubtedly the water edge—the public space outlined in the document. Furthermore, this space, due to its unique assets, constitutes the most attractive tourist space of Gdańsk. Flood prevention infrastructure elements have thus been integrated with the process of shaping public zones, often linked with and supplemented by tourism-related infrastructure. These measures have been concentrated on the edges of the Motława and Martwa Wisła rivers in particular (Figure 8). A concentration of tourism service projects is present primarily

along the downtown section of the Motława River and in the Coastal Strip. The linking of both elements of the flood prevention and tourism-related infrastructure strategies can be considered an innovation. It goes beyond the standard mode of thinking about waterfront public spaces.

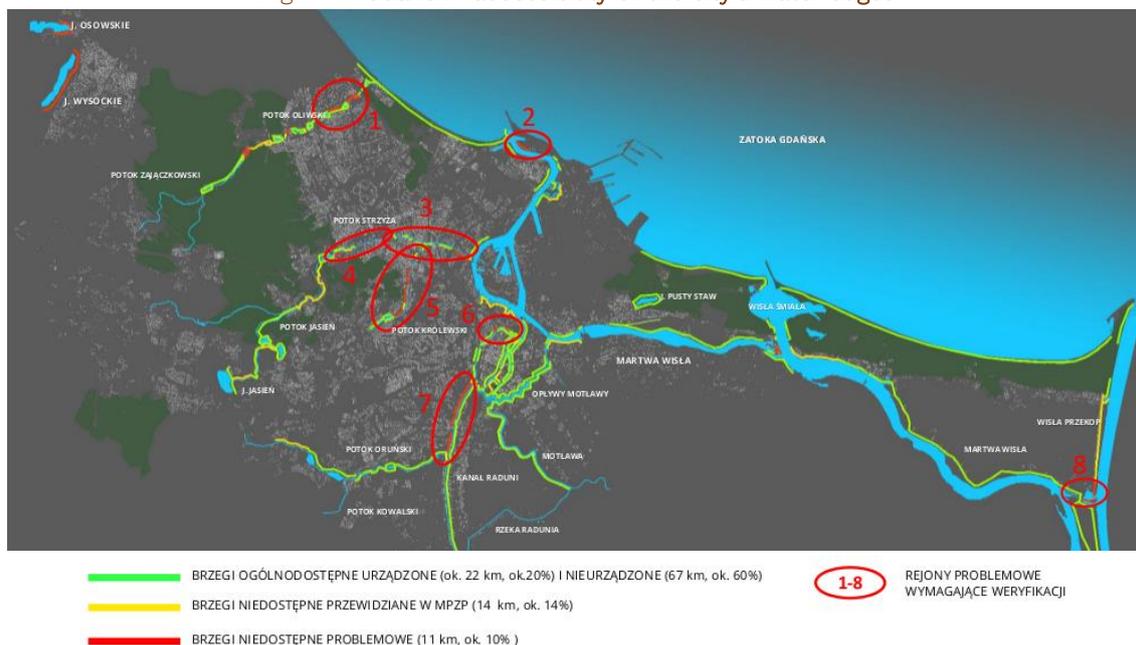
### 2.3.2 The hydrouban model in the context of the accessibility and continuity of urban space (according to the Gdańsk Water Policy document).

As mentioned above, the strategy assumes the maintenance of the cohesion and continuity of public spaces throughout the entire structure of the city as one of the key aspects of the functioning of the entire model. Internal urban barriers such as inaccessible water edges are becoming the cause of the city's fragmentation and, therefore, the lowering of the quality of life of its residents (Dudzić-Gyurkovich, 2019). A holistic approach has proven to be necessary here to determine the accessibility of water edges on the scale of the entire city, along with defining the constraints of that accessibility and any other problems. Three accessibility categories were defined on the macro scale, along with listing the approximate shore length and the percentage share in the entire length of the water edge:

- Generally accessible shores (22km—20 %) and non-landscaped shores (67 km—60 %), marked in green;
- Inaccessible shores assigned for development in the LDP (14km—14 %), marked in yellow;
- Inaccessible, problematic shores (11km—10 %), marked in red.

Furthermore, eight problematic areas were diagnosed, for which detailed analytical work will be carried out. Concerning the considerable fragmentation of the contemporary waterfront of Gdańsk, this assumption can be considered both innovative and promising. (Figure 9)

Figure 9. Gdańsk—accessibility of the city's water edges



Source: Biuro Rozwoju Gdańska. (Gdańska Polityka Wodna, scheme no.: 5).

In the detailed analysis of the downtown area (Figure 10), which also forms the heart of the city's water layout, the Authors divided waterfront types into six groups (Biuro Rozwoju Gdańska, 2018) in terms of their accessibility level and site conditions. The following have been included in the abovementioned planning analysis:

- generally accessible shores with complete pedestrian infrastructure (dark green);

- generally accessible, non-landscaped shores with incomplete infrastructure (bright green);
- landscaped shores with controlled accessibility, e.g. sports clubs, marinas (orange);
- inaccessible shores assigned for ensuring accessibility in applicable land development plans (red, dashed);
- inaccessible shores, problematic because of their ownership or technical conditions (pink, dashed);
- new projects that do not comply with the intention of land development plans (black).

The accessibility of shores, understood as edges of public space, has been linked to parameters that make it possible to introduce accompanying greenery. The model has significantly expanded the public zone of the present-day city and agglomeration—it has outlined a fully future-oriented vision, making the water system of the city a cardiovascular system of sorts, connecting that which is urban and that which is not into one fluid organism within the natural system.

Figure 10. Gdańsk—water edge accessibility analysis within the downtown area

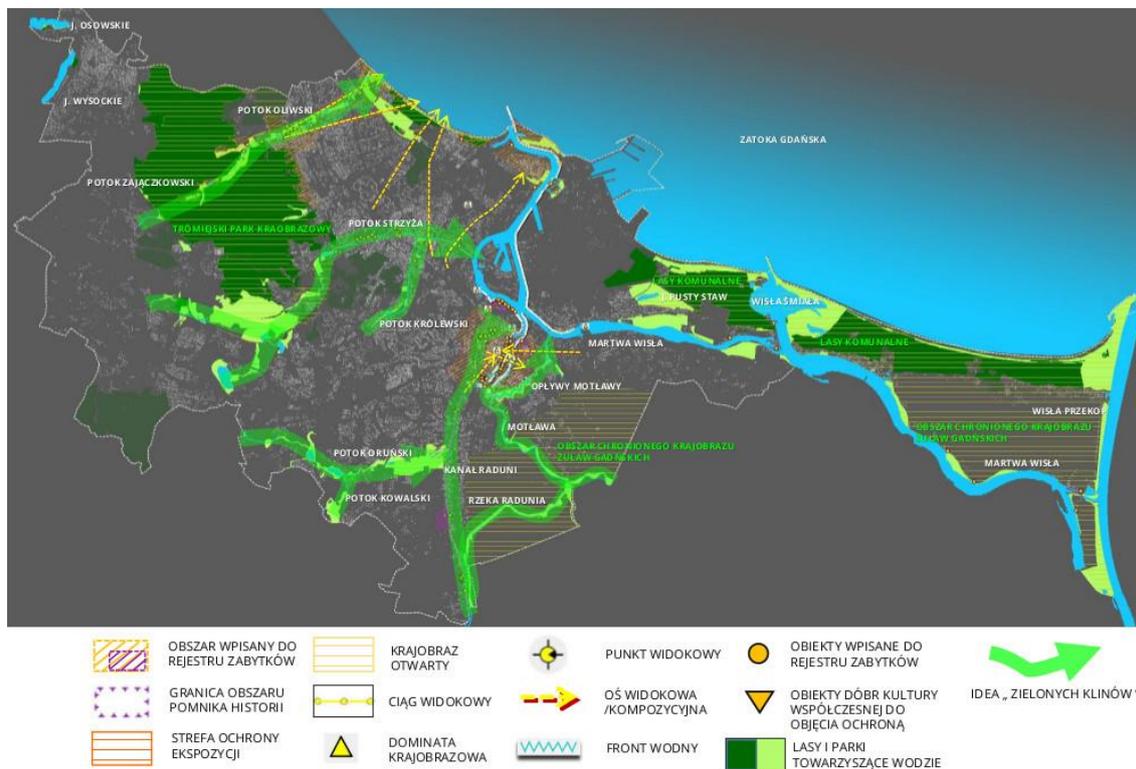


Source: Biuro Rozwoju Gdańska. (Gdańska Polityka Wodna, p.: 18).

### 2.3.3 The hydrouban model in the context of green wedges (according to the Gdańsk Water Policy document).

Thinking about the current and future stabilisation of the urban ecosystem and the protection of the quality of life within the city requires a cohesive linking of the urban organism with natural areas outside of the city. Measures of this type are undertaken by most cities that aim to improve their resilience (Sotoca & Carracedo, 2015). In the case of Gdańsk, this proposal is meant to be implemented in the form of the concept of green wedges. They have been based on the structure of creeks and small waterways. The course of the wedges naturally enables the utilisation of water valleys as natural connectors between the main water belt and the green areas that form the Tricity Landscape Park and the area outside of the city. Their continuity is ensured by various forms of greenery, such as parks, green squares, as well as an increased share of biologically active surfaces featured in projects built in these areas. The cohesion of the layout can ensure the high quality of the city's ecosystem. (Figure 11)

Figure 11. Gdańsk—the concept of green wedges in connection with the water system



Source: Biuro Rozwoju Gdańska. (Gdańska Polityka Wodna, scheme no.: 8).

#### 2.3.4 The hydrouurban model in the context of functional zones (according to the Gdańsk Water Policy document).

The managing and structuring of the development process is associated with dividing the water system into functional zones. The depth of the strip of zones was set based on pedestrian accessibility, at 500 m. Each of the zones with a dominant functional profile has been assigned appropriate measures. Five major zones have been defined (Biuro Rozwoju Gdańska, 2018) (Figure: 12):

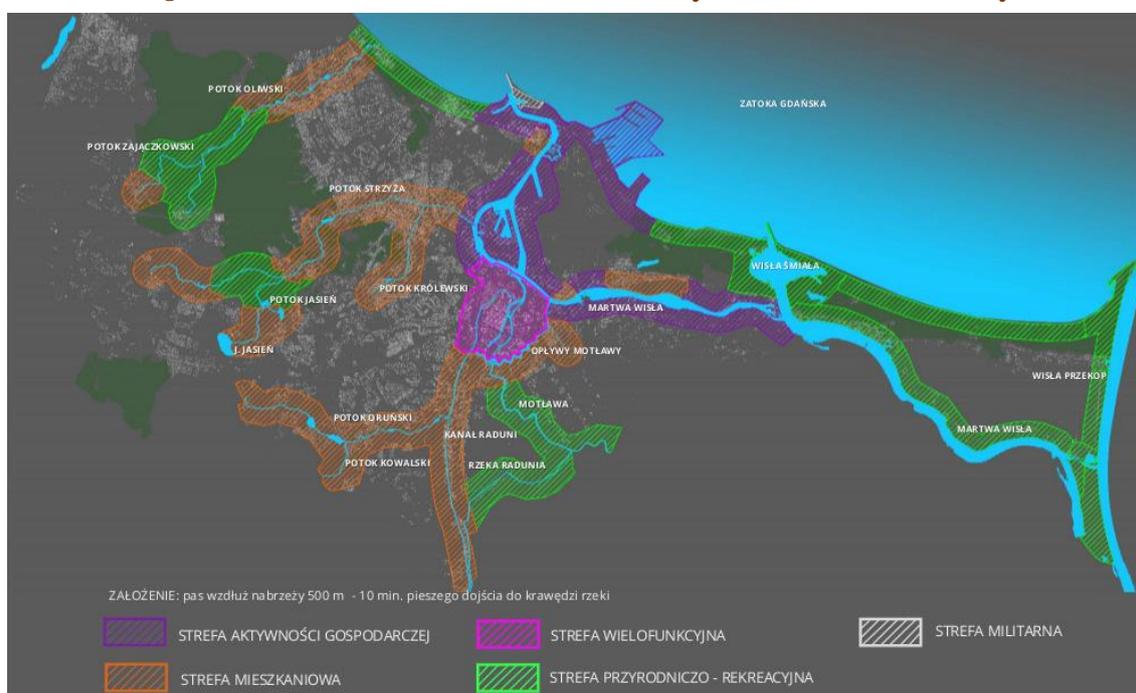
- The economic activity zone (purple)—covering a part of the Martwa Wisła waterfront, along with a section of the Young City area, as well as port and shipyard areas;
- The housing zone (brown)—the waterfronts of waterways and rivers within residential districts—both existing and planned ones;
- The mixed-use zone (pink)—the waterfronts of the strict downtown area, including those of the Motława and the Martwa Wisła rivers;
- The nature and recreation zone (green), associated with the course of waterways through areas featuring significant wildlife assets, covering the Tricity Landscape Park, the Coastal Strip and Sobieszewska Island;
- The military zone (white)—covering the military base at Westerplatte.

Each of the zones has been assigned specific development directions, determining the possibilities of their development (Biuro Rozwoju Gdańska, 2018).

- The economic activity zone reinforces port, industrial, service and tourism functions. This significantly strengthens the development of eco-friendly inner-city river-based transport, integrated with public transport.

- The housing zone assumes the further development of housing and services. It utilises waterfronts as recreational spaces in the housing zone. It also includes its significance in the system of flood prevention and wildlife protection. A particular emphasis has been placed on improving pedestrian and bicycle accessibility to the water edge here.
- The mixed-use zone assumes the development of the Central Service Belt. The belt includes the shaping of mixed-use building frontages that respect cultural and landscape heritage. The zone is planned to feature spaces of city-wide significance. In terms of transport, the development of inner-city river-based transport has been highlighted once again.
- The nature and recreation zone, on the one hand includes areas of protected natural environment and the protected ecological and landscape function of landscaped greenery, in addition to the wildlife protection of beaches and places with valuable natural asset, while on the other—it assumes the development of services associated with sports, recreation and tourism within it. The strategy assumes the improvement of pedestrian and bicycle accessibility of green areas associated with waterways within the layout.
- The military zone, whose intended use is the maintenance of the country's defensive capability.

Figure 12. Gdańsk—the functional zones of the hydrourban model of the city



Source: Biuro Rozwoju Gdańska. (Gdańska Polityka Wodna, scheme no.: 9).

The strategy binds the hydrological structure into a whole, forming the spatial network of future Gdańsk on its basis. It includes numerous elements of a sustainable city in its layout, binding water, urban, public space and housing networks, as well as those of services and production, in addition to public transport, expanded to include river-based inner-city transport. The measures meant to improve the efficiency of the multi-layered hydrourban model of the city of Gdańsk should be integrated and carried out jointly with adjacent municipalities. The model appears to perfectly lead the development of the city into the future. The maintenance of the strategy's cohesion and feasibility are the tasks that the city and its surroundings currently face.

### 3. Conclusions

Gdańsk is an immensely interesting example of a resilient city. A city that significantly enlarged its central area and which was reborn multiple times over the last century—first after the destruction of the Second World War and then after 1989, in the empty halls of the former shipyard. The city, which in the process of interweaving phases of growth and crisis, has maintained its identity—strongly associated with the Hanseatic background of the center and the water bounds.

In the search of the key elements of this process, it has set out to maintain the relationships between the hydrological and urban layouts. The city's waterways, the branches and canals of the Vistula and the Motława, have created a millennium-old city and—because of the conscious of the people who live here—have remained important to the city.

The processes presented in this article refer to the most essential featured elements of the process of shaping this hydrouban system. The results of the analysis of the three phases of development of inner-city of Gdańsk were aimed at showing the basic changes in the perception of the role of the water system in its urban structure. They followed the processes in order to meet the demands of the resilient city. The period after 1945, focusing on the reconstruction of the historical city centre and the basic river-based functions, brought the city back to its previous direction. It maintained the central core of historical Gdańsk and linked with it the new functions of post-war housing districts along the east-west axis. It facilitated the establishment of shipbuilding and industrial functions—for which the properly functioning urban organism constituted an essential form of support.

The question about the actual city centre of Gdańsk continuously remained open (Lorens, 2019). The processes of increasing market freedom opened the areas of the central islands—Wyspa Spichrzów (Granary Island) and Ołowianka—as the most desirable development areas in the city. They have, therefore, maintained the potential of the historical city centre—strengthening its linkages with it through footbridges, tourist attractions and new, attractive cultural functions. At present, development pressure is being shifted towards the area of the so-called Young City, which, supplemented with high rank public buildings and their associated public spaces (The European Solidarity Centre and the Museum of the Second World War) has become a desirable area for projects associated with high-quality housing. The control of planners has repeatedly turned out to be essential in this process—so that touristification processes and an actual urban character can remain balanced.

However, Gdańsk is a city with much greater ambitions. The year 1989 brought with it a collapse of industry and considerably shook the city's identity that had formed along with its post-war Solidarity social movement. The closing of the shipyard became a moment that demanded a search for a new direction of development and the city wanted to make use of this opportunity. This is why the pressure to form a new city centre in the area of the former Gdańsk Shipyard is so great. Work is ongoing and the city is transforming before our eyes. We will be able to see the effects of these efforts in the future, hopefully similar to some good examples from other coastal cities (Poklewski-Koziół, 2018; Zieliński, 2018), since the potential of the space is enormous. The effectiveness of the transformation is being supported by projects featured in the new axis of culture—outstanding cultural projects that symbolically accentuate the incorporation of new areas into the centre.

Meanwhile, despite the incomplete phase of the revitalisation of post-shipyard areas and the strengthening of the northern part, new proposals are being formulated in Gdańsk. They pertain to a much more distant future and are based on the broad context of the Vistula River basin, in which the future city is meant to be formed. The Gdańsk Water Policy has become their decidedly modern expression. Current activities show the strengthening of the trends enshrined in the Strategy through

a general policy of adaptation to progressive climate changes, which are becoming a pressing problem for most Polish cities (Rada Miasta Gdańska, 2019).

The future metamorphosis of the hydrouurban model of Gdańsk positions the inner-city's water system as the supreme structure-forming axis, by orienting it along the northwest–northeast direction. The axis becomes an element that balances out the so-called urban strip. Meanwhile, the strategy concerning the establishment of the so-called water strip is meant to control the development of the city in the areas adjacent to the water edge, while maintaining the dominance of the protection of natural assets. Maintaining balance in this field can guarantee that the city will maintain the capacity to regenerate while sustaining stable spatial and functional development. This broad outlook on the urban context has a chance to halt the possible processes of the cooling period in the city's "pulsating" development. The river and its network can become an actual element of both its current and future identity. What is perhaps even more important is that Gdańsk is becoming a structure that binds a human settlement with water, determining the actual resilience of the agglomeration. The article can be used by decision-makers, planners and developers to search for and discover the significance of the water environment in the process of city development. The sustainable development of both can determine the sustainability and resilience of development, as well as the future of cities and their agglomerations.

## Authorship

The scope of work was divided: Agnieszka Matusik focused on the structural relationship with the hydrological context; Kinga Racoń-Leja focused on transformations and reconstruction of urban structure; Mateusz Gyurkovich focused on structural-functional relations and Karolina Dudzic-Gyurkovich on internal urban structure and barriers.

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