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Multifunctional Riverside Buffer Parks – the Research on Nature-Urban Revitalisation of River Valleys

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This article discusses a holistic approach to the revitalisation of river valleys in urbanized areas. Research on the process of riverside urban space revitalisation in Polish towns and cities was conducted by the author within the framework of the European project REURIS and aimed to indicate multifunctional solutions and models of complex nature-urban revitalisation of river valleys.

From among 43 cities in northern Poland, which met the basic criteria, 25 projects were selected and subjected to the evaluation process using WIQUS methodology. The analysis and evaluation allowed to identify the best practices as well as the most important barriers and key factors of success of river valley regeneration projects in Polish towns.

The significance of the research follows from opportunities of gaining measurable implementation benefits in the integrated spatial planning process of urbanised areas as well as in creating riverscapes both in anthropogenic and biocoenotic aspects. The author describes the scope of the research, its main results, and conclusions in order to present the advantages and benefits of nature-urban revitalisation projects for the citizens as well as water and water-dependent ecosystems of river valleys.

The implementation of multifunctional riverside buffer parks (RBPs) appears to be the most effective and sustainable way of development of river valleys in urban environment. The paper deals with the rules of spatial arrangement of particular zones of buffer parks considering social, ecological and hydrological requirements. The implementation of buffer parks in the riparian urban areas makes it possible to significantly reduce storm water runoff and flood risk, while the multifunctional development of the parks allows to achieve a synergy effect in appealing public spaces.

Finally the author presents the application of the RBP idea in spatial arrangement of flood plains in the area of the Warta Valley in Poznan along the 'Warta' Campus of Poznan University of Technology.

Keywords: *river valleys revitalisation, riverside buffer parks, multifunctional development, riverscape, flood protection.*

1. Introduction

Degradation of river valleys in cities results from long-lasting practice of perceiving rivers mainly as sources of flood threat and as dump sites for municipal sewage. Also, lack of integrated policy connecting spatial planning and water management and a coherent strategy for managing urban river spaces contributes to the situation (REURIS 2009-2012). Reclamation of valuable waterside land in city centres, initiated in the 1970s and 1980s, involved reuse of post-industrial buildings and abandoned riverside areas (Januchta-Szostak 2011a), however, the majority of the efforts focused on the built environment.

Issues associated with the lack of, excess or poor quality of water are the hallmarks of the 21st century. These challenges require a more sensitive approach to natural environment and water resources as well as better coordination of flood protection and spatial planning.

According to experts (Majewski 2007, Kowalczak 2011), disasters resulting from extreme hydrological or meteorological events are on the rise. Such was the origin of colossal 90% of natural disasters between 1992 and 2001, compared to only 40% in the first half of the 20th century. However, the way towns and cities have developed and used land is also to blame: there are more and more inhabited areas in zones exposed to river and coastal floods which increases the risk of catastrophic events. In addition, changes in drainage basin land use, such as deforestation, building water works, draining marshlands, surface sealing, etc. have led to the intensification of floods or their appearance in previously flood-free areas (Januchta-Szostak 2011a). Other factors contributing to increased river flood risk are water control works in river valleys (narrowing of rivers with dikes, straightening meanders), as reduced riverbed length

results in higher water discharge and shorter flood time lag (Kowalczak 2007).

EU Floods Directive (2007), preceded by the strategic programmes like *Room for the Rivers Program* (2007) in the Netherlands and *Making Space for Water* (2005) in UK, has opened the gate for implementation of a more holistic approach to managing flood risks in highly urbanized areas while simultaneously allowing pro-ecological and pro-social development.

The management of urban waterside zones in Europe is currently dominated by three main trends:

1. urbanization of riverbanks and urban revitalisation of downtown waterside areas;
2. expansion of built environment on flood plains and coexistence with water (flood-proof constructions and land management that permits flood water penetration);
3. the natural regeneration (revitalisation) of river valleys and protecting riverside buffer zones from urbanisation.

Progress in pro-ecological technologies (esp. wastewater treatment and management) and improvement in social welfare in Europe gives a chance for restoring the proper functions and natural heritage of urban river valleys and their integration with urban tissue (REURIS 2009-2012).

Multifunctional riverside buffer parks (RBPs) seem to be the most sustainable and complex way of development and management of flood plains in urban environment. RBP make it possible to effectively protect natural environment, prevent urban floods and to achieve a synergy effect in appealing riparian public spaces.

However, these priorities are still insufficiently considered in spatial and urban planning in Poland (Januchta-Szostak 2010). The fact was proved by the author thanks to the research conducted within the framework of the European project REURIS on the processes of riverside urban space revitalisation. The research aimed to indicate optimal spatial solutions and models of complex nature-urban revitalisation procedures in CE countries.

2. Methods

The scope of the research conducted by the author in northern Poland encompassed 43 towns and cities located on rivers. The author selected 25 projects which met the basic criteria and aimed to revitalise urban river spaces (Fig. 2). They were then subjected to the evaluation process and finally 12 good practice examples were described. The process of selection of good practice examples was conducted in four stages:

1. Preliminary recognition and selection;
2. Classification of projects;
3. Detailed data collection and verification;
4. Evaluation of good practice examples.

For the needs of the REURIS project, special questionnaires were prepared to collect comparable data on the process and results of urban riverside spaces revitalisation in various cities (Urban Rivers… 2012). In addition to the data collected in the questionnaires, distributed among planners and authority representatives, the main sources of information include scientific literature and manuals of "best practice", local revitalisation programs, the Internet database of projects co-financed by the EU and national funds, interviews with experts (representatives of municipal and regional authorities, environmental organisations, NGOs etc) as well results of visits to places and interviewing users of riparian spaces.

The evaluation tool proposed by the author was WIQUS methodology (*Water Impact on the Quality of Urban Space*), which combined a holistic approach with the use of detailed qualitative and quantitative methods of evaluation of both direct and indirect benefits (Fig. 1, Tab. 1).

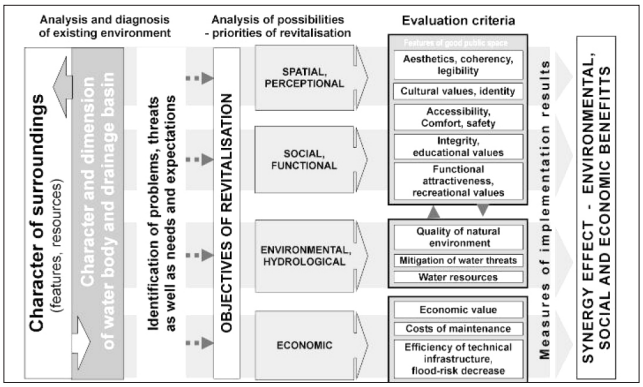

Fig. 1. *The scheme of WIQUS methodology application in the analysis and evaluation of the riverside space revitalisation projects' results (developed by the author)*

Table 1. *Detailed criteria of revitalisation projects' evaluation (Januchta-Szostak 2010)*

Main aspects	Detailed criteria:	
Spatial:	Improvement of visual quality of:	architecture
		landscape, greenery
		hydro-technical infrastructure and embankments
	Spatial integration of the river with urban fabric.	
	Harmony with the surrounding landscape	
	Emphasizing the identity of the site	
	Brownfield rehabilitation (post-industrial, post-military)	
	Modernisation and renovation of historical monuments.	
Social and functional:	Attractive and diverse public space creation	
	Accessibility to river banks	
	Continuity of by-river pedestrian and bicycle tracks	
	Experiencing the nature	
	Integration of social groups of different age and status	
	Public involvement in space management and policy making	
	Development of ecological awareness	
	Increase in public safety	
	Functional diversity	sports fields
		strolling, jogging
		cycling
		meeting points
		playgrounds
		fishing
		cultural activities
		historical heritage
		educational activities
		water tourism

Table 1 (continuation)

Main aspects	Detailed criteria:
Hydro-ecological:	Wildelife conservation
	Biological diversity
	Continuity of migration corridors
	Water quality improvement
	Providing flood protection
	Increasing the retention capacity of the landscape
	Improvement of water balance (groundwater)
	Reconstruction of historically existing watercourses
	Natural regeneration of the rivers, meandering
	Microclimate and ventilation improvement
	Water ecosystem status
Economic:	Enterprise development in the neighbourhood
	Number of new work places in the neighbourhood
	Number of new living flats in the neighbourhood
	Increase of service provision in the neighbourhood
	Benefits of better recreation for local population
	Increase of property values in the neighbourhood
	Technical infrastructure improvement
	Reduction in flood risk
	Benefits of better natural retention and groundwater balance

3. Results – best practices in revitalisation of urban river spaces in northern Poland

The diagnosis of the existing situation of urban riverside areas in northern Poland reveals that most of the analyzed cases represented a one-sided approach to the transformation of urban river valleys (Fig. 3). Only a few cities in northern Poland (e.g. Bydgoszcz, Gdansk, Torun) fully used the potential of their rivers to improve the quality of public spaces. Implemented complex strategies aimed at nature-urban revitalisation (e.g. Bydgoszcz Water Junction) were extremely rare in 2010. Riverside parks in Poland are usually fragmented and still too scattered to significantly contribute to the natural environment quality improvement (Januchta-Szostak 2010).

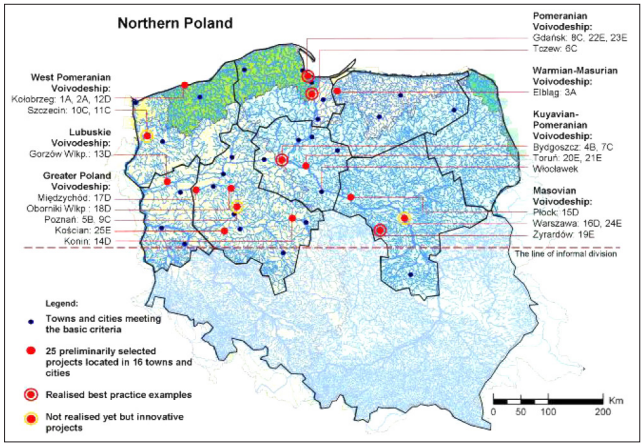

Fig. 2. *Map with locations of preliminarily selected projects and best practices in revitalisation of urban river spaces*

The evaluation of the results of the twelve implemented projects, performed on the basis of the author's WIQUS methodology revealed that the most complex and effective approach to the revitalisation process of riparian spaces was adopted in the following projects (Fig. 3): 4B – Revitalisation of Bydgoszcz Water Junction (55 points), 7C – Bydgoszcz, the Mill Island Revitalisation Project (54 points), 19E – Zyrardow, Revitalisation of Dittrich Park / the Pisia River (54 points), which also received the highest rating for hydro-ecological results of the implementations and can be qualified as RBP.

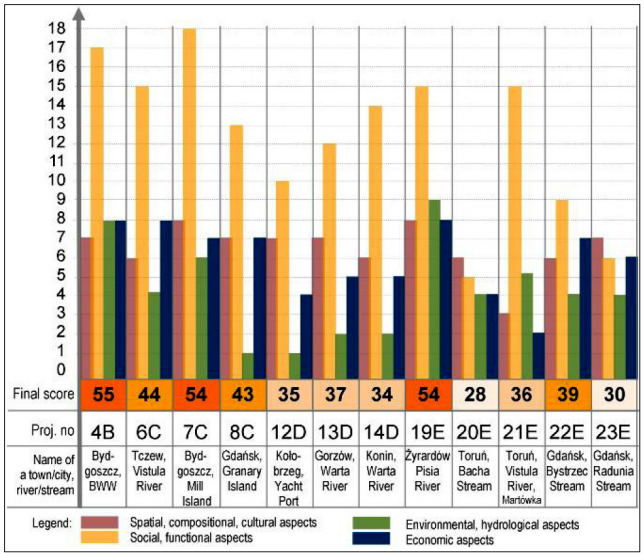

Fig. 3. *The main criteria and final scores of evaluation of the riverside space revitalisation projects (developed by the author)*

Comparative analysis of planning methods in Poland and other CE countries indicates that the implementation of new solutions, compliant with sustainable water management in urban planning and architectural design, is not exclusively dependent on high ecological awareness of the designers and decision makers. Equally important are planning, legal and economic instruments such as integrated system of spatial information, spatial planning methodology compliant with the EU directives, flood prevention strategies, natural compensation tools etc. The impact mitigation regulations and impact mitigation charge connected with the EIA can significantly contribute to revitalisation projects. However, their implementation in Poland is still insufficient.

Conclusions resulting from analysis of best practice examples as well as experiences from REURIS pilot projects made it possible to highlight the most effective actions leading to restoration of ecohydrological potential and natural regeneration of river valleys, such as:

- uncovering formerly piped watercourses (e.g. the Pleißemühlgraben mill stream in Leipzig, Bacha stream in Torun);
- restoration of riverbanks and riverbeds, as well as their natural plant and animal habitats with bio-engineering measures (e.g. renaturalisation of Sokolowka River in Lodz in the framework of SWITCH project, regeneration of the Slepiotka river in Katowice);
- increasing river valley retention capacity and waters' self-cleaning capability by lengthening

watercourse (meandering), restoring old riverbeds and wetlands (e.g. the Botic Stream in Prague, the Feuerbach valley in Stuttgart, the Biala River in Bialystok); and

- improving availability and ensuring continuity of water and tributary migration corridors and tourism routes (e.g. revitalisation of the Old Ponavka watercourse in Brno – the new blue-green axis through the city).

As a result of REURIS project the guidelines for urban river revitalisation were formulated. They can be sum up in 5 main points (Urban Rivers… 2012):

1. **Planning**: revitalisation projects should be incorporated into relevant regional and local spatial management plans and strategies. They might also serve as a compensation measures for other investments.
2. **Enhancing the ecological functionality** of watercourses as an ecosystem.
3. **Providing flood protection** – restoring retention capacity of the landscape.
4. **Increasing residential, cultural and recreational values** of urban sections of river valleys.
5. **Achieving sustainability through public involvement**.

4. Riverside buffer parks (RBPs) as nature-urban revitalisation method

The spatial expansion of cities, increasing urban density and transport needs have prompted river valley narrowing, watercourse drainage and infilling, along with additional environmental and landscape degradation. As a result, many cities currently take actions aimed at recreating the richness of the hydrographical network in order to improve environmental quality and recreational value, as well as rainwater runoff retention.

Bydgoszcz is an example of a city with a consistent "front to the river" development strategy, where the *Programme of Revitalisation and Development of Bydgoszcz Water Junction* has been implemented since 2006. Similar programmes or strategies have been undertaken in other Polish metropolises, such as Wroclaw, Gdansk, Szczecin, Krakow and Warsaw, which have invested in improved waterfront quality despite the existing flood threats. Authorities of Poznan city approved the *Development Strategy for the Warta River in Poznan* in 2012. These actions are in line with the requirements of the EU Water Framework Directive (2000) and Floods Directive (2007) that highlights the need to create space for water.

Areas located in the 100-year flood plain, that have been excluded from construction, do not need to remain neglected. The creation of riverside buffer parks that protect river valley ecosystems, retain and serve as a sink for storm water runoff while enabling recreation in inundation areas is an invaluable initiative. Apart from the important retention, microclimate and biocoenotic functions, RBPs play an equally significant role in shaping more residentially- and nature-friendly public space systems with safe access to water and attractive riverside green areas (Fig. 6). It is crucial that the method of their development should not limit flood water flow and constructions and materials used as well as small architecture elements should be solidly grounded and waterproof. The main objectives of multifunctional RBPs realisations include:

- combining the municipal greenery structures with the hydrographic system,
- protection of river valley ecosystems, securing the continuity of migration corridors,
- increasing the capacity of river valley retention,
- retaining and pre-purification of storm water runoff,
- attractive development of flood plains.

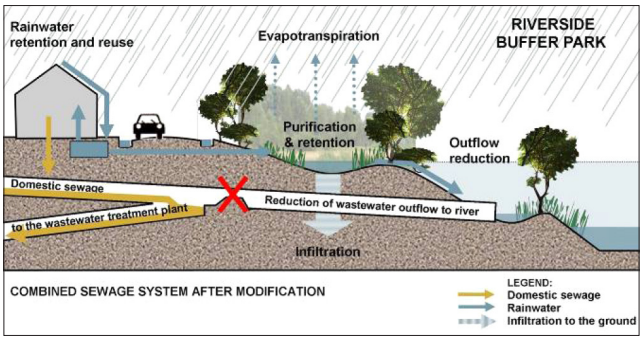

Fig. 4. *The diagram of combined sewage system with the use of riverside buffer parks (developed by the author)*

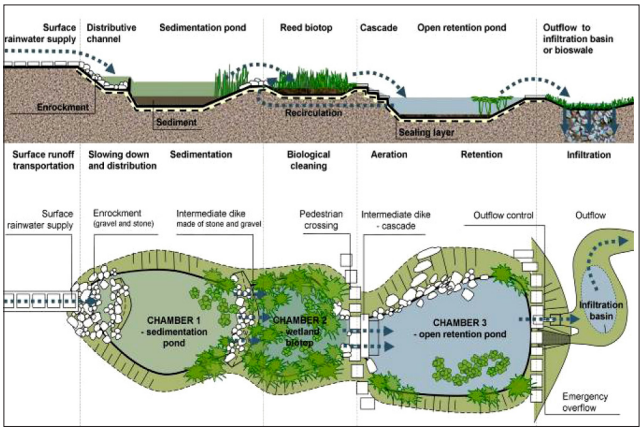

Fig. 5. *Schematic representation of a system of reservoirs for rainwater retention, infiltration and purification (developed by the author)*

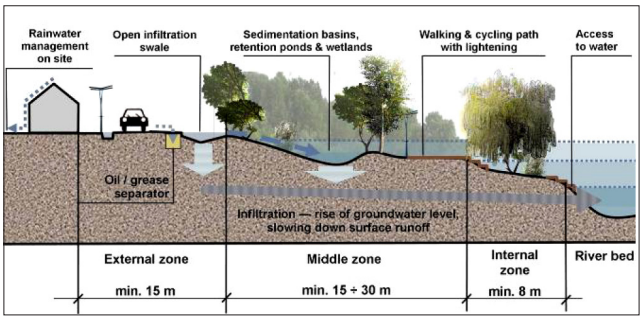

Fig. 6. *The zones of riverside buffer parks (developed by the author)*

The multifunctional RBP facilitate elimination or substantial reduction in the capacity of storm water runoff into combined sewage systems (Januchta-Szostak 2011b). Owing to the open storm water retention and purification systems (Fig. 5), they considerably enhance the quality of

Table 2. *The profiles of individual zones of riverside buffer parks in cities*

The parameters and aspects of the develop-ment	The profiles of individual zones (according to Fig. 6)			
	The external zone		The middle zone	The internal zone
	1) private (the rear of the buildings)	2) public (street, boulevard)		
The width	Min 8 m from the rear of buildings	Min 15 m from the front of the buildings	15 ÷ 30 m	Min 8 m from the watercourse bank
Ecological function	Protection of the catchment area and pre-purification		Sustaining the distance between the pollution sources and water bodies – rain-water retention and infiltration.	Protection of physical integrity of the watercourse ecosystem
Storm water runoff manage-ment	Manage-ment within the allotment area	Street-side retention-filtration bays, oil and grease separators	Cascade system of sedimentary and retention-infiltration basins; bioretention swales and infiltration basins	Protecting the banks from water erosion – gradual, slow drainage of storm water runoff
Flood protection	Total – flood plain terrace		Flood plains, sedimentary container system in the higher parts of the valley	Terrace, protecting the banks from erosion (fascine, forests etc)
Social function	Connecting private and neighbour space with the park	Public access, representative city façade	Active and passive recreation and education	Physical and visual contact with water
Use	Unlimited – the private and half-private zones	Unlimited – the approach and parking, recreational services and catering	Limited - including walking and cycling paths, playgrounds, recreational development	Limited – river bank-side paths, sustaining ecological values of the littoral zone
Vegetation type	Garden vegetation	Street trees	Varied forest and park vegetation (local species)	Bank-side forests, on-water species

the rainwater drained to the water bodies and contribute to the improvement of surface water quality (Fig. 4). They also prevent rapid flood wave in small urban streams and rivers. The approximately 30-meter buffer zone facilitates the protection of watercourses from the flow of contaminated rainwater while the forest in the zone improves its retention and infiltration capability by ten folds compared to a similar grass zone. The guidelines for the development of individual buffer park zones have been outlined in the table 2.

As long as the river hydrologic regime and the catchment area conditions allow it, it is worth undertaking natural regeneration actions where possible. Replacing concrete embankments with fascines or rock filling, lengthening watercourses by meandering, regeneration of old river beds and swamps as well as constructing lateral canals contribute to the reconstruction of ecological potential of river valleys, enhancement of their biodiversity and running water capability of self-cleaning.

5. Application of the main guidelines for urban river revitalisation (REURIS project) in the RBP concept in Poznan

A system of linear riverside parks also exists in Poznan. A distinctive arrangement of greenery wedges along the Warta River and its tributaries was developed by professors Wladyslaw Czarnecki and Adam Wodziczko during the interwar period. The Warta River constitutes an ecological axis of Wielkopolska region while the Warta Valley in Poznan is a 'spine' of the main urban greenery wedge.

The research conclusions along with the guidelines for creating RBP were used by the author in her project of flood plains development along the "Warta" Campus of Poznan University of Technology (PUT). The downtown section of the Warta Valley in Poznan, which includes the area covered by the study (Fig. 7), is currently regulated, neglected and surrounded by partially degraded post-industrial areas but it has a great cultural potential (the vicinity of the Old Town and Ostrów Tumski – an island with valuable monuments), social significance (the vicinity of vibrant city centre and big PUT Campus, housing 20 000 students) as well as recreational value (wide flood plains, the Warta waterway, Malta Lake vicinity).

The aims of the project are compatible with the strategic goals of Poznan city development and include:

Spatial aims:

- Creating representative waterfronts of Poznan and exposition of historical city panoramas along with a new, spectacular buildings of PUT (Fig. 8);
- Combining compositional and functional features of the PUT Campus and the Warta Valley.

Social and functional aims:

- Activation and attractive development of flood plains along the Warta River and the Cybina Canal;

- Creating appealing waterside public spaces – a new section of the Warta–side boulevards and "Wartostrada" – non-collision cycle path on the flood plains along the downtown section of the valley with easily accessible students, hikers and cyclists' meeting places, provided with small architecture elements;
- Development of riverside infrastructure which facilitates water sports (rowing, canoeing) as well as communication and water tourism (jetties, quays);
- Creating a dynamic system of urban park route as well as a net of pedestrian links between the Old Town, Piotrowo and Malta districts;
- Developing areas for cultural, recreational and sports activities (sport fields, amphitheatre etc.);
- Raising ecological awareness of Poznan residents (educational trail along the wetlands and the canal).

Ecohydrological aims:

- Creating a riverside buffer park with a lateral canal and wetlands used for pre-cleaning of the storm water runoff and surface water purification along with increasing the retention capacity of the river valley (Fig. 9);
- Adjusting the development to the changeable water level of the Warta River, preventing the banks from erosion with the use of bio-engineering methods and eco-friendly materials.
- Enhancement of biological diversity of the valley,

Economic aims:

- Including the river in the agglomeration and urban communication system (water trams, bridge crossings, promoting the development of alternative means of transport);
- Limiting flood risk and damages;
- Increase of the waterside area value;
- Economic activation and more effective use of the downtown waterside investment areas (catering, services).

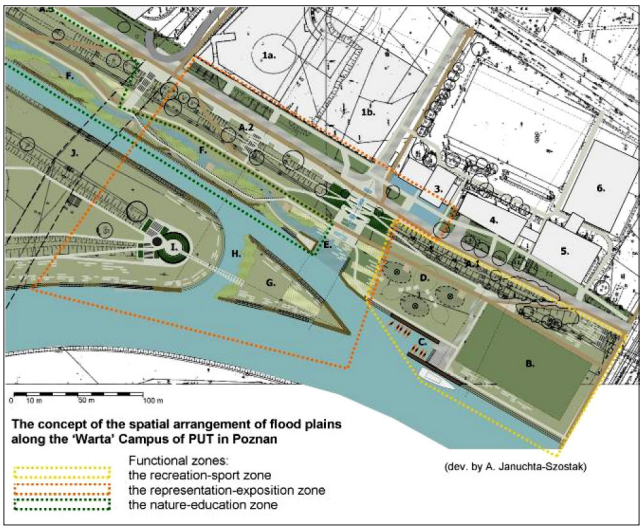

Fig. 7. *Spatial arrangement of flood plains along the 'Warta' Campus of PUT in Poznan. Legend: yellow line – the recreation-sport zone; orange line – the representation-exposition zone; green line – the nature-education zone (developed by the author)*

Fig. 8. *The view from the waterfront at the Old Gas works toward the "Warta" Campus (in the pictures: above – the present conditions, below – the project design)*

Creating the representative waterfront of Poznan is connected with the "Warta" Campus development in the way, which guarantees integrity and harmony of the Warta Valley waterside landscape and involves aesthetic arrangement of the flood plains constituting the foreground of representative buildings and panoramas. The planned development provides for the protection of the valuable greenery along with the visual connections between urban tissue and the river and the enhancement of the valley's accessibility (footbridges, stairs, ramps etc.).

The Project covers three main functional zones: 1 recreation-sport, 2 representation-exposition, 3 nature-education (Fig. 7). All of the zones will be linked with Engineers' Boulevard located over the 100-year flood level and with "Wartostrada" route on the flood plains.

In the recreation-sport zone (1) there are the following facilities provided for: a pitch – a place for mass events, sport fields (7B), a kayak marina (7C), a river tram stop (Fig. 10), people-friendly embankments (Fig. 11) and a picnic area with spots for barbecue and bonfire (7D). Slight modifications of the ground level on the flood plain route (less than 0.6cm) will allow creating shallow hollows of picnic areas and hills (Fig. 12) which will become an intriguing image of islands accessible for pedestrians and cyclists from "Wartostrada" route during mild spring swollen waters.

The keystone of the representation-exposition zone will be a water square (7E) linked to the boulevard with water cascade stairs (Fig. 13). The lower level of the square with its stone seats will constitute a kind of a water maze (Fig. 14). The layout will change along with the changing water level in the river. The accessibility of the valley will be improved by the construction of stairs and a bicycle ramp as well as Berdychowska footbridge (7J).

The nature-education zone (3) will spread from the Lecture Centre to the Cybina River estuary. The currently regulated Cybina canal bed should be partially regenerated. Additionally, the project provides for creating a lateral canal as well as marsh biotopes making it possible to clean running water and rainwater runoff (Fig. 9). A meandering canal, parallel to the Cybina (7F), will be filled with water during high waters while during low waters it will become a shallow swamp. Carved and biologically enriched

waterfront is supposed to pre-clean water, create new flora and fauna habitats as well as to diversify the landscape and educate the residents (Fig. 15). An educational trail lifted on stilts, 50 cm above the terrain surface and provided with places to sit on (floating platforms) and fishing bridges, is planned to be constructed along the bank.

The idea of the Project is to use the changeable levels and dynamics of water in order to create a spatial layout which has been illustrated by flood simulations (Fig. 16). It also takes into account collecting rainwater from sealed surfaces within the Campus and draining it with cascades on the slope across the water square to the Cybina Canal (Fig. 13).

Fig. 9. *The view of the Cybina Canal waterfront at the "Warta" Campus of PUT (in the pictures: above – the present conditions, below – the project design)*

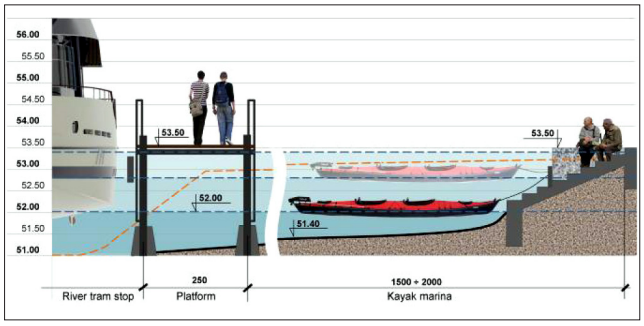

Fig. 10. *Kayak marina and river tram stop by the Warta River (developed by the author)*

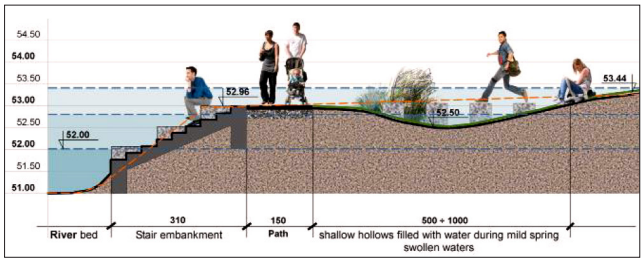

Fig. 11. *People-friendly embankments of the Warta River (developed by the author)*

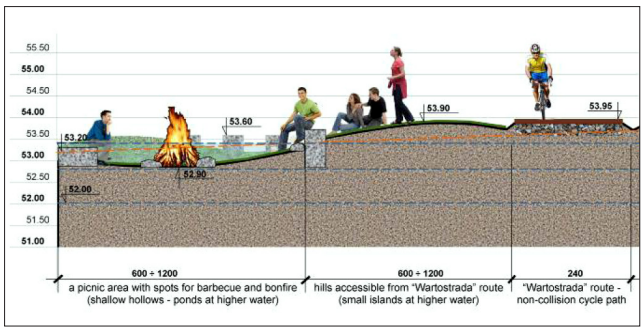

Fig. 12. *Shallow hollows of picnic areas and hills accessible from "Wartostrada" route (developed by the author)*

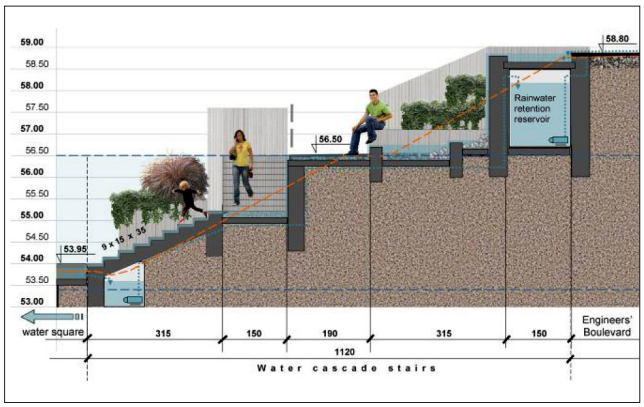

Fig. 13. *Water cascade stairs connecting water square with the Engineers' Boulevard (developed by the author)*

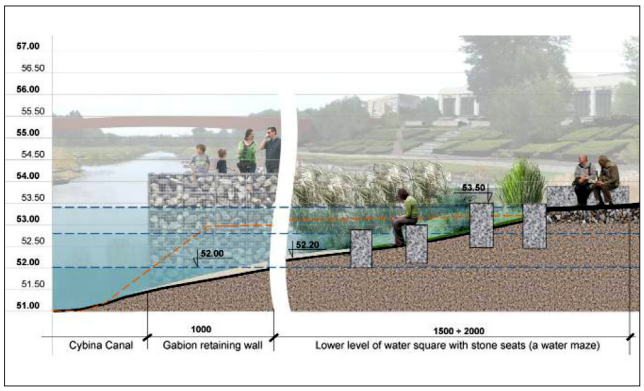

Fig. 14. *The water square with its stone seats will constitute a kind of a water maze during spring waters (developed by the author)*

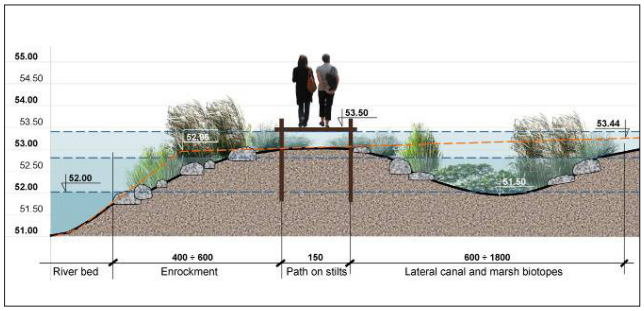

Fig. 15. *A lateral canal and marsh biotopes are supposed to pre-clean water, create new flora and fauna habitats as well as to educate visitors (developed by the author)*

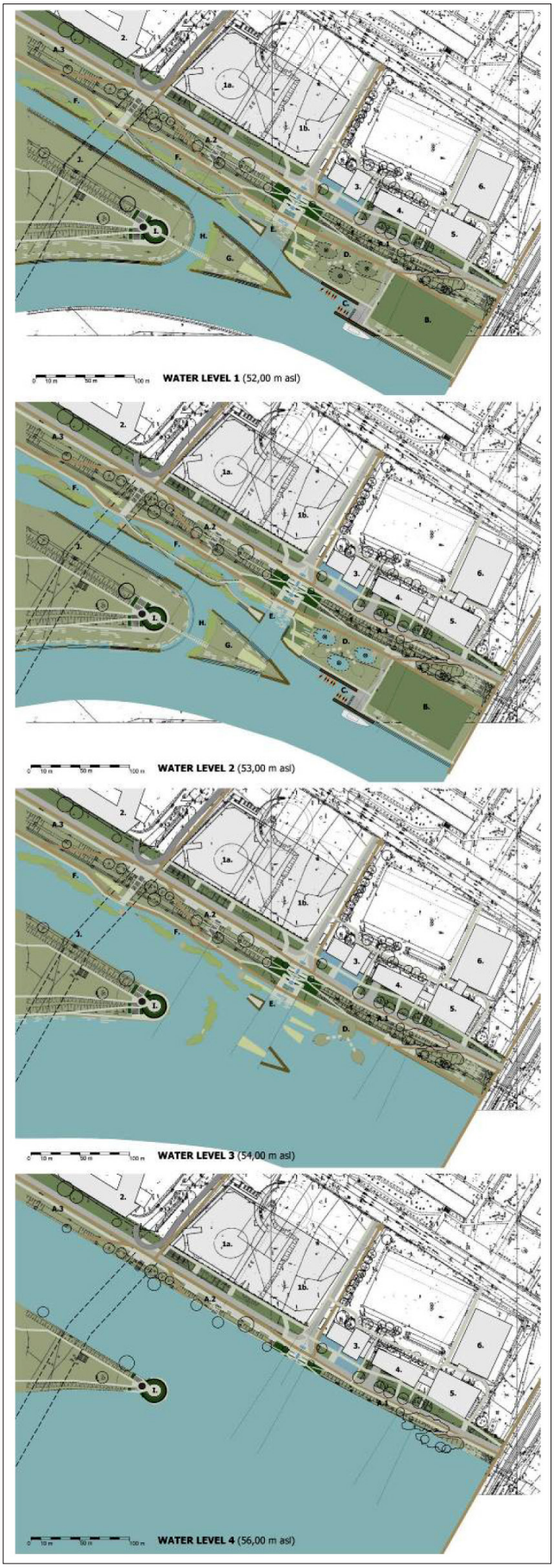

Fig. 16. *Flood plains development in the area of PUT regarding flood simulations (levels 1, 2, 3 and 4)*

6. Conclusions

Water should not be perceived only as a threat, but first and foremost as a valuable and irreplaceable resource and attractive landscape element (The Poznan Charter... 2011). The research on urban river space revitalisation processes in northern Poland allowed to indicate the benefits but also barriers to pro-ecological implementation of water body regeneration projects and sustainable development of urban waterside areas. The main obstacles to urban river space revitalisation in Poland are primarily in the planning-organizational, legislative, financial and social spheres. The most critical problems include lack of database of catchment areas, shortage of experience and methodology of preparing integrated urban-nature revitalisation projects and project management systems, legal instability, constant regulation changes as well as problems resulting from low ecological awareness and lack of local community involvement. While the key factors of success are, among others: opportunities and abilities of gaining EU funds, following good practice examples, innovative design as well as willingness and determination of the people engaged in the projects, good cooperation with designers and citizens, supported by initiating bottom-up actions (Januchta-Szostak 2010).

In the absence of publicly available databases of urban-natural revitalisation cases in Poland, and without the possibility of comparing results of transformations of riverside urban areas, this study constitutes the basis for an initial evaluation of revitalisation processes and the development and improvement of planning procedures. The methodology of the Water Impact on the Quality of Urban Space (WIQUS) can be a tool of facilitating design and decision making processes, while the set of evaluation criteria constitutes a standard of planning priorities (Januchta-Szostak 2010).

For measurable effects to be achieved in the greater metropolitan areas, systemic solutions are necessary. The use of green urban areas to retain and purify rainwater runoff and their connection to the hydrographical system provide opportunities to create a continuous system of riverside parks with environmental, retention and recreational functions. Linking these areas with a system of walking and cycling paths along urban watercourses also promotes alternative and sustainable means of transport, while the elimination of barriers between different watercourse segments allows to increase the effectiveness of riverside animal migration paths. Restoration works should be undertaken wherever possible. Actions such as substituting concrete embankments with fascine or enrockment, enabling watercourse meandering and restoration of old riverbeds and wetlands (Fig. 9) contribute to the restoration of the ecological potential of river valleys and the self-cleaning capacity of running waters.

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