

Scenario-planning solutions for waterfront flood-prone areas

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ABSTRACT: The aim of this article is to discuss the potential of applying scenario planning to achieve resilient and future-oriented solutions for flood-prone areas. The authors have proposed additions to scenario-planning processes based on the introduction of research-by-design architectural inquiries. Examined in this article is the insight into the testing of such a modified scenario-planning methodology during two courses that accompanied researcher-stakeholder workshops organised within the H2020 project *SOS Climate Waterfront* in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT), Gdańsk, Poland. The task for the students was to propose plausible future scenarios for the flood-prone area of the Polish Hook peninsula in Gdańsk. Based on this experiment, the authors have proposed using research-by-design tools in scenario-planning practices, and they discuss the benefits of research-based learning.

Keywords: Scenario planning, scenario models, waterfront flood-prone areas, climate change, water-resilient city

INTRODUCTION

There is an urgency to develop sustainable solutions for urban areas needing to adapt to climate change. Consequently, numerous academic initiatives and research studies have focused on making cities more resilient, able to absorb excessive amounts of water and resistant to floods [1][2].

Concepts have been proposed, such as sponge city, blue-green urbanism, water urbanism or water-sensitive urban design. Despite geographical and local differences, they are all directed towards recognising the role of water in urban structures, developing effective water-retention systems, reducing grey in favour of green infrastructure, preventing flooding, enhancing biodiversity and improving the ecological quality of urban landscapes. Waterfronts are on the frontline of these efforts. Along with securing more *room for water* and designing water-adaptive public spaces, policymakers, urban planners and architects focus on developing waterfront areas as vibrant urban environments that are attractive to people [3-5].

While the above strategies are successfully integrated into many urban agendas, it is obvious that planning for a sustainable future with a perspective of 30 to 50 years entails numerous ambiguities, complexities and uncertainties, and the problem well exceeds the discipline of architecture. Besides environmental threats induced by climate change, many interdependent and not always clearly recognisable forces will shape the future of particular waterfront territories, including demographic, political, economic, social and cultural.

The question arises how to anticipate future conditions and the actions to undertake to be prepared for them. Scenario planning as a research methodology facilitates *strategising under uncertainty* to achieve such objectives [6]. In architectural education, it may effectively bond design to adaptability [7]. Moreover, as Ramirez et al show, the scenarios methodology is a form of inquiry that scholars can use to produce *interesting research* and to stimulate challenging ideas [8].

Outlined in this article are the results of an experiment on testing the scenario-planning methodology during two courses in Master's degree studies in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT), in Poland. Students were asked to develop plausible scenarios for flood-prone waterfront areas of the Polish Hook peninsula in Gdańsk, a post-industrial fragment of the historic city. The area is susceptible to inundation by the Vistula River and

Motława River waters, seawaters and a rising ground water level. Investigated in the study were two different visual scenarios for the future of waterfronts. Courses were conducted as accompanying events to the parallel researcher-stakeholder workshops organised within the H2020 RISE (Research and Innovation Staff Exchange) project, *SOS Climate Waterfront - Linking Research and Innovation on Waterfront through Technology for Excellence of Resilience to Face Climate Change* [9].

Research-focused scenario-planning with students was launched with an objective to extend the impact of the EU programme to Master's degree students and with the expectation of producing what Ramirez et al calls *interesting research* [8]. Based on this experiment, the authors propose additions to the scenario-method tools and practices, and discuss the benefits of research-based learning.

THEORETICAL FRAMEWORK

Scenario-based planning increasingly is used as a research methodology. It is based on identification of driving forces and critical uncertainties, which is a starting point for building alternative plausible scenarios for the future [10]. As Holway et al point out ...*the traditional predict-and-plan paradigm* is often inadequate to face challenges related to uncertainty and the complex contradictory driving forces that shape our future [11].

Scenario planning answers the question of how to navigate through these uncertainties. Different from other methods, it is not about probability, but causality, as Heijden explains [12]. Initially used as a method of generating long-term business strategies in corporations and organisations, it increasingly is adopted for land-planning, particularly in the United States. For land planners, it is considered *a new tool to anticipate and shape the future* [11].

Scenario planning may be of a normative or exploratory character, where the normative is based on assumptions commonly accepted, while exploratory delves into the whole range of divergent possibilities of how the future might unfold. *It is an inquiry into an unknown*, as Oliver explains [13]. After the identification of scenarios, in the next step of the process, these scenarios are shared with architects, stakeholders and politicians who subsequently define urban strategies, and then transfer them into plans and detailed projects [10].

The whole methodology of scenario planning is based on inventiveness and an open-minded attitude. Delving into this problem, van der Heijden poses the question of how one can ...*create the conditions for the true strategic creativity to emerge*, and how to achieve the moment of *reframing the problem* [12].

Many techniques and tools may be used that aim to stimulate creative thinking, such as free conversation, collaborative work on maps, brainstorming and a whole range of the Internet-enabled tools, but the issue of how to best stimulate creative thinking is still unresolved. The problem of how to trigger creativity is accompanied by the problem of how to transfer the outcomes; namely, how to effectively present the developed scenarios to a wider audience - specialists, urban planners, politicians - who will work on the further steps of the whole process.

In this article, the authors propose a new addition to the scenario-planning methodology, based on research-by-design architectural insights. Advancing initial scenarios, usually built as verbalised narratives, by architectural inquiries into the problem may provide valuable intellectual input and unorthodox visual material that may deepen the discussion on the future of urban areas. Testing this methodology with students is part of an academic strategy of assigning students to research tasks and broadening the range of research-by-design educational experiments [14][15]. It may contribute to supporting the concept of idea generation with design tools [16].

METHODS

For the purpose of the study, the method proposed by van der Heijden was chosen with the use of a 2 x 2 scenario matrix, where the identification of driving forces and two critical uncertainties represented as two axes leads to the development of four alternative scenarios, one for each of the four quadrants. The horizon line for the scenarios was specified as 30 to 50 years. Students were divided into two groups for which two different kinds of scenario-planning courses were offered, aimed at defining diverse scenario-based proposals. The first group (course 1) participated in a semester-long project supervised by Dr E. Marczak and Dr I. Burda, and the second (course 2) in a short project developed within one week and supervised by Visiting Professor Pedro Ressano Garcia.

The first author of this article gave the outline of the whole experiment. While the outcomes of the first course were architectural projects based on discussed *what-if* scenarios, students participating in the second course were expected to transfer their scenarios into conceptual, even abstract images or collages. An international group of artists participating in the Creative Europe programme, *Memory of Water*, was involved in a stimulating discussion with the participants of the short project, supporting the students with comments and suggestions. A graphic representation of the research-by-design additions to scenario planning and the adopted methods is presented in the scheme displayed in Figure 1.

In both groups, initial discussion of scenario development was based on data provided by institutions, such as the Gdańsk Development Office and the water management company, Polish Waters, as well as by reports and research

studies. All this provided insight into the spatial, hydrological and financial factors and characteristics of the demographic tendencies, economic data, flood risks from the rivers and sea, ventilation and air quality, and water quality, including ground water and river waters. The IT system for protecting the country (ISOK) flood models for the region and the city of Gdańsk, including evaluation of flood risks, were used for the purpose of the study [17].

In the next step, students discussed their initial findings against six regional agendas: environment and climate, identity and heritage, society and culture, economy and knowledge, connectivity and mobility, transformation and innovation. The report on Urban Water Strategy for Gdańsk, where the authors analysed how water can be an added value in achieving the above-mentioned regional agendas was a helpful guide at this stage of the project [18]. Finally, all of the outcomes were presented to the broader group of academics and urban policymakers.

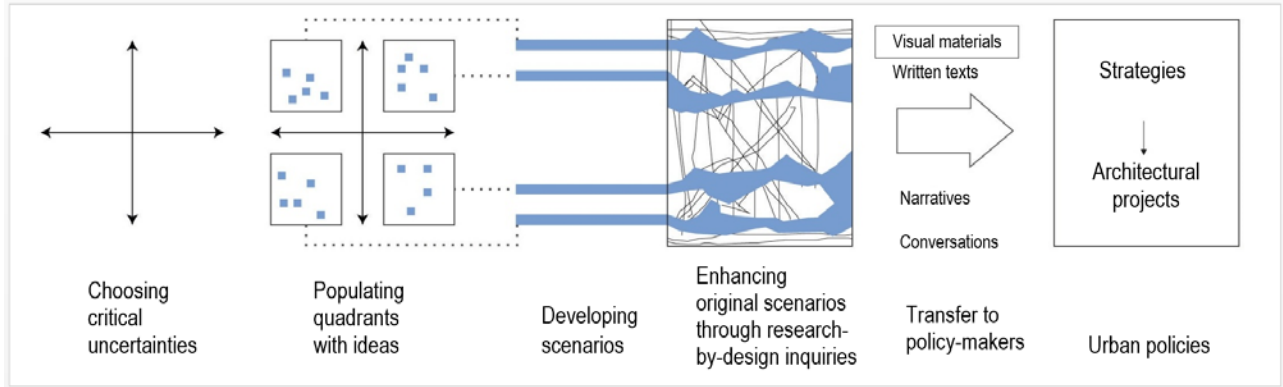


Figure 1: Scheme for research-by-design additions to scenario-planning with students.

RESULTS

In an open discussion preceded by data analysis, the participants identified multiple factors that may affect the future of the Polish Hook peninsula. One of the critical uncertainties identified by the students was population growth. In Gdańsk, the population is growing slightly, although the past decades were dominated by slow population decline. According to demographic surveys, a negative birth rate and the lack of a migration policy means Poland will lose population every year [19].

In the context of rapid urban sprawl, there is a real risk that the waterfront post-industrial areas in the city centre will remain empty. Another uncertainty was identified as a fear of living close to water with a threat of floods. Research on the social acceptance of occasional flooding is scarce; however, some studies reveal that with the general increase in the standard of living, social acceptance for even occasional flooding is very low [18]. On the other hand, infrastructural protection of coastal territory by dikes and floodgates, which might be located at a river mouth, would diminish the impact of the rising sea level.

Other identified uncertainties relate to the air quality and environmental conditions of the Vistula River Delta territory and the quality of the Baltic Sea waters [20]. Pollution from sewage and agricultural waste carried by the Vistula River results in the eutrophication of seawaters and the proliferation of algae, which leads to oxygen deficiency of the water and the widening of marine dead-zones.

Students working on the semester-long project identified the 2 x 2 matrix of uncertainties, and on the basis of adopted assumptions, generated concepts of future scenarios presented in the form of short briefs for the projects. In the next stage, they developed hypothetical applicable proposals of urban plans for the Polish Hook peninsula following one scenario path. Most students followed the assumptions that seawaters will be pushed into the mouth of the river, so the area would be susceptible to inundation, but the pressure of living close to water and cultural centres would remain very high.

Accordingly, students proposed a coherent urban environment adjustable to changing levels of water with diversified heights of embankments. Designing floodable quays and floating wharfs, and selecting areas designated for inundation, students proved that both public spaces and blue-green connections may be labile and adaptable to both high and low water. Their works pointed out that jagged or curvilinear contours of embankments might contribute to the diversity of public spaces and slow down the current of water hitting the land. Buildings might sustain different water levels due to being located at heights or be integrated with floating or amphibious structural systems.

One of the prevailing objectives was to retain continuities of public boulevards and provide passers-by with close contact to the river regardless of the water level. Facing environmental issues, students proposed urban gardens and wetland parks to control the flow of floodwater and shelter endangered species. All of the concepts were focused on transforming the Polish Hook peninsula not only into an attractive and safe place to live, but also into an inspiring environment, a territory that significantly contributes to the identity and culture of the city (Figure 2).

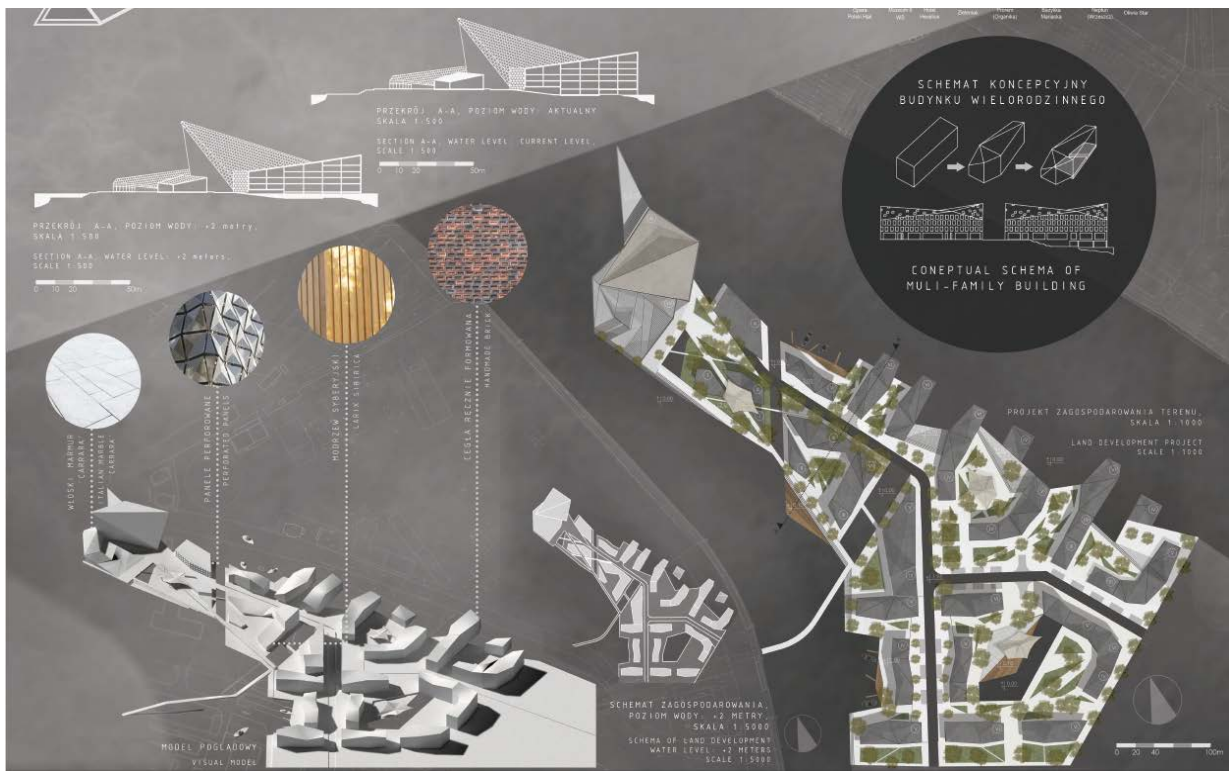


Figure 2: Axonometric view of the water-resilient Polish Hook (course 1; students: D. Zimnicka and O. Żuralska; supervisors: E. Marczak and I. Burda).

Students working on short projects presented proposals based on developed scenarios in the form of visual images and 3-D sculptural models (Figure 3). Without constraints related to the existing technologies and not focused on the direct applicability of the projects, it was a deep exploratory practice. Encouraged to cross the boundaries of disciplines and perceive the future in the context of many interdependent forces, students developed hybrid structures: architectural objects integrated with water purifying infrastructure and oxygen production, partly submerged buildings, floating ports and islands. As in the case of the first group, scenarios were built on the chosen assumptions in a deductive process, but rational thinking was integrated with creative intuition; it was an intellectually driven but also an intuitive process.

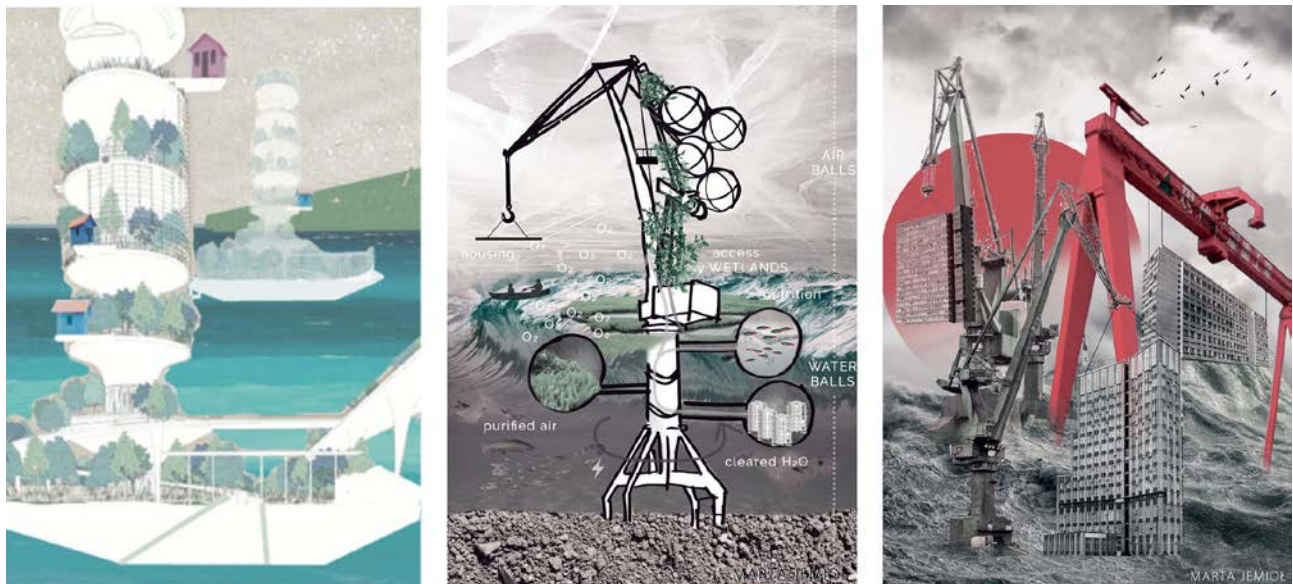


Figure 3: Exemplary collages (course 2; students: S. Kowalski, O. Mamrot and M. Jemioł; supervisor: Pedro Ressano Garcia).

The interesting outcome of the experiment was that both the scenario-based urban projects and the abstract images triggered invigorating discussions with local stakeholders, urban planners and researchers. The urban projects revealed out-of-the-box concepts presented in the form of convincing professional architectural designs. Scenarios presented in the form of creative visual images avoiding the pressure to be literal indicated the future scenario indirectly.

These most unorthodox proposals became an important inspiration that was discussed in the background of urban proposals developed in a more normative and applicable way. This twofold effect of scenario-planning courses stimulated



discussion on plausible futures and on existing municipal strategies for waterfront flood-prone areas, revealing deficiencies and the potential for corrections and additions. Both outcomes delivered valuable insights and visual material that thrived on imagination and were open to out-of-the-box solutions. The discussion unveiled that rising embankments cannot be the only path toward a sustainable future and new actions have to be launched to avoid a dead-end situation. A brief comparison between the two scenario models developed by research-by-design practice are presented in Figure 4.

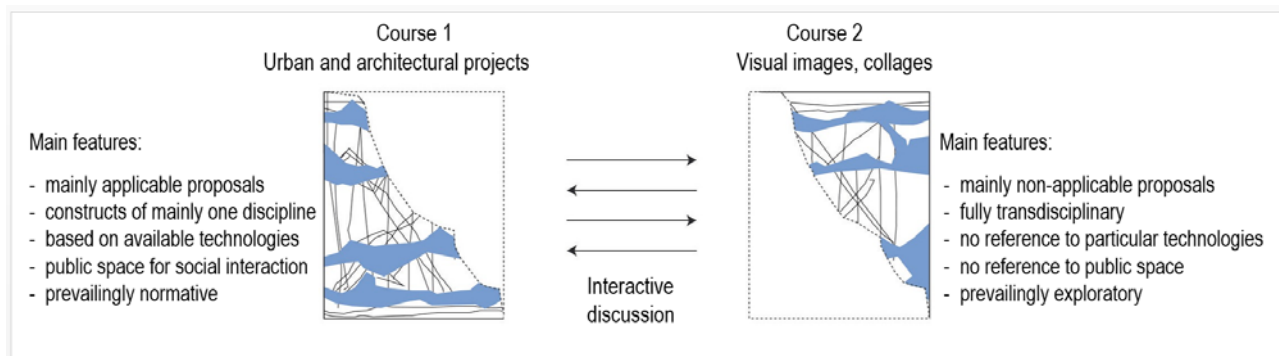


Figure 4: Comparison between two scenario models developed by research-by-design.

In the opinion of the researchers who participated in the SOS Climate Waterfront project, the numerous iterations between the first (course 1) and the second (course 2) group of the workshop outcomes eventually produced *interesting research* [8]. More precisely, it delved into the traditional boundaries between disciplines and programmes of waterfront urban areas and buildings. One of the concluding remarks of the workshop was that for a climate-resilient future, new kinds of integrated solutions presumably will be infused into architectural concepts resulting in public buildings designed as water-purifying factories; floating islands as technologically advanced power stations; and urban parks as water management facilities with constructed wetlands. Most such constructs and processes that cross the boundaries of disciplines are hardly visible today; nevertheless, they are triggering architectural imagination and indicate directions for a climate-resilient future.

CONCLUSIONS

Considering the uncertainties and numerous interrelated forces influencing urban development in the context of climate change, scenario planning seems to be the right path to follow. Based on this research, the authors propose a research-by-design addition to the scenario-method tools and practices. Moreover, it is suggested that the moment of *reframing the problem*, so fundamental in the scenario-planning process could be achieved by diversification of the forms of expression of scenario models. To be precise, the authors indicate the importance of architectural research-by-design projects and artistic visual models as valuable material providing unique insights into developed scenarios. In addition, scenario planning could be successfully integrated into architectural education curricula to inspire research-by-design.

A questionnaire was used to evaluate the results of the research-based learning and integration of students into research projects. Eighty-six percent of students declared that research-based architectural inquiry is a valuable opportunity by which to learn; 76% of the students perceived scenario planning as an interesting research-by-design practice that provided good interdisciplinary insight into the interrelated factors that shape the future of urban areas. The students appreciated the participation of city planners, politicians and stakeholders (86%). Finally, out of 45 students involved in the course, 28 integrated water-related and climate change issues into their Master diploma theses.

REFERENCES

1. Rembeza, M. and Kamrowska-Zańska, D., The *resilient city* in architectural engineering education: a joint design studio between Gdańsk and Chalmers universities of technology. *World Trans. on Engng. and Technol. Educ.*, 17, 4, 495-499 (2019).
2. Januchta-Szostak, A., Development of food prone areas in Wielkopolska region. *J. of Water and Land Develop.*, 44, 90-97 (2020).
3. Lorens, P. and Gołędzinowska, A., Shaping the competence of future spatial policymakers for small- and medium-sized towns. *World Trans. on Engng. and Technol. Educ.*, 18, 1, 34-39 (2020).
4. Burda, I. and Nyka, L., Providing public space continuities in post-industrial areas through remodelling land/water connections. *IOP Conf. Series: Materials Science and Engng.*, 245, 8, 82-37 (2017).
5. Burda, I. and Dymnicka, M., The principles of *arturbain.fr* for teaching sustainable urban design. *World Trans. on Engng. and Technol. Educ.*, 17, 4, 500-505 (2019).
6. Mariton, J., What is Scenario Planning and How to Use It, 14 July 2020, <https://www.smestrategy.net/blog/what-is-scenario-planning-and-how-to-use-it>
7. Lüle, M., Pifko, H. and Špaček, R., Adaptability and a scenario-based design methodology for architectural education. *Global J. of Engng. Educ.*, 21, 2, 97-102 (2019).



8. Ramirez, R., Mukherjee, M., Vezzoli, S. and Kramer, A.M., Scenarios as a scholarly methodology to produce *interesting research*. *Futures*, 71, 70-87 (2015).
9. Ressano Garcia, P. (Ed), *SOS Climate Waterfront*. Cascais, Manfra, Alchochete, Lisbon: Universidade Lusofina (2019).
10. Hopkins, L.D. and Zapata, M.A. (Eds), *Engaging the Future: Forecasts, Scenarios, Plans, and Projects*. Lincoln Institute of Land Policy (2007), 14 July 2020, <https://www.lincolninst.edu/publications/books/engaging-future>
11. Holway, J., Gabbe, C.J., Hebbert, F., Lally, J., Matthews, R. and Quay, R., *Opening Access to Scenario Planning Tools*. Lincoln Institute of Land Policy (2012).
12. Van Der Heijden, K., *Scenarios: the Art of Strategic Conversation*. Wiley and Sons (2005).
13. Oliver, H., *Exploratory scenario planning*. *The Commissioner* (2014).
14. Nyka, L., Cudzik, J. and Urbanowicz, K., The CDIO model in architectural education and research by design. *World Trans. on Engng. and Technol. Educ.*, 18, 2, 85-90 (2020).
15. Ryńska, E.D., Design workshops and the circular economy. *Global J. of Engng. Educ.*, 22, 1, 32-39 (2020).
16. Leahy, K., Daly, S.R., McKilligan, S. and Seifert, C.M., Supporting idea generation with design tools: nesting design heuristics within morphological analysis. *Global J. of Engng. Educ.*, 20, 3, 159-170 (2018).
17. ISOK (IT System of the Country Shield), 14 July 2020, <https://isok.gov.pl/hydroportal.html> (in Polish)
18. *Urban Water Strategy for Gdańsk*. Rotterdam: Kuiper Compagnons (2015).
19. *Demographic Outlook for the European Union 2019*, 14 July 2020, <https://www.europarl.europa.eu/RegData/etudes/>
20. Badach, J., Voordeckers, D., Nyka, L. and Van Acker, M., A framework for Air Quality Management Zones - a useful GIS-based tool for urban planning. Case studies in Antwerp and Gdańsk. *Building and Environ.*, 174, 106743 (2020).

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BIOGRAPHIES



Lucyna Nyka (PhD, DSc) is a full Professor in the Faculty of Architecture at Gdańsk University of Technology, Gdańsk, Poland. She presently holds the position of Head of the Department of Urban Architecture and Waterscapes, and since 2016 has been Dean of the Faculty of Architecture. Her research interests focus on issues concerning historical hydrographies, water-related architecture and urban landscapes. Professor Nyka is involved in several transdisciplinary research studies on urban environment and re-naturalisation of cities. She is the author, co-author and expert in many European research projects, and at present is involved in the H2020 *SOS Climate Waterfront* project focused on linking research and innovation on waterfront studies to face climate change. She is a member of the Architecture and Urbanism Committee at the Polish Academy of Sciences (PAN), one of the Vice-Presidents of the International Academic Advisory Committee of the World Institute

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