Bridging the gap between architectural and environmental engineering education in the context of climate change

Lucyna Nyka

Gdańsk University of Technology
Gdańsk, Poland

ABSTRACT: Indicated in this article is the urgent need to adjust architectural education to the challenges triggered by climate change. Although reports on the future scenarios for cities are alarming, documents that set criteria for architectural education do not indicate competencies related to climate change adaptation and mitigation, mainly by avoiding environmental engineering considerations. An immediate answer to this problem could be specifically shaped design studios that bridge the gap between architectural and environmental engineering. Proposals developed by students prove that combining architectural concepts with environmental and water management issues contribute to the spatial, ecological and social quality of a project. However, as proposed by a few, such design studios do not contribute significantly to the overall profile of a graduate architect. This may result in a lack of specialist competencies among graduates, which could substantially inhibit a process of adaptation of cities to climate change.

INTRODUCTION

Climate changes affect regions all over the world. Rising sea level and extreme weather events, such as heavy rains, floods, fierce storms and unexpected heat waves deeply affect the quality of human life. According to the report, United Nations World Population Prospects, 75 percent of the global population will live in cities by the middle of the 21st Century [1]. In the same report it is stipulated that climate change will result in the decrease of the quality of water services and living conditions in urban areas. The growing amount of impermeable surfaces results in flooding and pollution of surface waters. Urban heat islands increase energy consumption, emission of greenhouse gases and compromise human health and comfort [2]. Lowering the level of the groundwater table impairs the growth of vegetation and may cause saline intrusion into the coastal aquifers [3]. Fresh water resources are shrinking. The European Commission (EC) points to severe consequences for Europe and indicates challenges related to a climate crisis:

> *Urban areas, where 4 out of 5 Europeans now live, are exposed to heat waves, flooding or rising sea levels, but are often ill-equipped for adapting to climate change* [4].

In such circumstances, urban areas should be re-thought as laboratories for innovative climate adaptation and mitigation. Numerous documents signed by state representatives and municipalities confirm such aspirations. Consequently, many research and development programmes are focused on climate crisis challenges. The United Nations 2030 Agenda for Sustainable Development, which is considered to be one of the strategic plans for action to fight poverty and protect the planet, among 17 goals, defines:

Goal 11: make cities and human settlements inclusive, safe, resilient and sustainable;
Goal 13: take urgent action to combat climate change and its impacts [5].

Architects and urban planners are in the middle of this process. However, the question arises: do architectural studies curricula properly address climate change challenges and are graduates prepared to participate actively in the formation of water-sensitive strategies?

ARCHITECTURAL CURRICULA AND CHALLENGES RELATED TO CLIMATE CHANGE

Architectural curricula in Europe are built with strong reference to recommendations of such organisations as the Royal Institute of British Architects (RIBA), UNESCO, the Architects' Council of Europe (ACE), numerous accreditation boards, local chambers of architects and many other institutions, committees and stakeholders [6]. Moreover, there are many discussions and controversies over the visions of the architectural professions, which influence teaching methods and topics [7]. However, the most decisive legislative document that indicates the necessary fields of knowledge and skills that a graduate should acquire in the process of architectural education is the European Directive 2005/36/EC on the recognition of professional qualifications. Unfortunately, despite the alarming tone of the UN and EC reports, this influential regulation does not refer to competencies that would enable graduates to participate efficiently in the process of enhancing the resilience of cities and making them more sustainable in a climate crisis.

Among 11 fields of knowledge and skills specified in the European Directive only a few may be seen as referring, very vaguely, to the competencies that would enable a graduate student to develop creative concepts focused on sustainability and the resilience of cities:

- *an ability to create architectural designs that satisfy both aesthetic and technical requirements;*
- *an adequate knowledge of urban design, planning and the skills involved in the planning process;*
- *an understanding of the structural design, constructional and engineering problems associated with building design;*
- *an understanding of the relationship between people and buildings, and between buildings and their environment; and of the need to relate buildings and the spaces between them to human needs and scale;*
- *an understanding of the profession of architecture and the role of the architect in society, in particular in preparing briefs that take account of social factors* [8].

That the European Directive does not refer openly to the issue of sustainability does not mean the topic is not explored in the training of architects; in fact, in a very broad sense, it dominates the architectural education debate. Some problems investigated by students may be even perceived as triggered by the climate crisis. Such considerations as the creative reuse of materials and structures [9], conservation and adaptation of architectural heritage [10] or participatory approaches to urban design [11] receive close attention by students and teachers. However, one of the most noticeable deficiencies in architectural education is a weak connection with environmental engineering and water management issues. While urban adaptation and mitigation strategies should be developed in-between these competencies and disciplines, highly intensive architectural studies curricula, built according to the European Directive 2005/36/EC, isolate future graduates from environmental issues.

The omission of any clear references to the climate crisis, and to the need to address climate changes, could be caused by the fact that present requirements concerning skills and competencies of architects were literally copied from the EU Council Directive 85/384/EEC issued in 1985 when climate crisis issues were hardly present in public debate. Another impediment in the integration of environmental engineering and water management issues into the practice of architectural education is the almost 100-year-old process of erasing water from urban spaces that began in the second half of the 19th Century and influenced 20th Century practice and education.

In many cities water was hidden, covered or canalised, which started the époque of *clean urbanism* [12], with all the consequences for the practice of teaching. Today, with many projects focused on restoration of urban rivers, conversions of waterfronts or adaptation of cities to unusual weather events, water reappears, but methods of teaching architects and urban planners do not keep pace with these changes. The problem is broader, noticed as well in hydraulic and environmental engineering education [13], and as Andre van der Beken points out, *…there is a* gap *between education, research and practice in water-related professions* [14].

The deficiency of environmental considerations in the current practice of teaching architects has been broadly investigated by Sergio Altomonte, who points out that buildings are responsible for around half of worldwide energy consumption and, he argues, that the integration of environmental and architectural design issues would boost the construction of energy-efficient buildings and thus minimise their impact on the environment [15].

Moreover, what should be noted is that the separation of architectural education from issues and technologies related to environmental engineering and water management heavily impairs the adaptation of cities to climate change and compromises the quality of urban spaces. Engineered laboratories for ecological basins, diversified systems of rainwater harvesting and retention or riparian buffers and wetlands, may be considered not only as efficient environmental infrastructure, but also can be developed into high quality urban spaces and landscapes. On the other hand, including environmental engineering issues into architectural and urban concepts may accelerate the process of adaptation to changes and result in more sustainable and creative solutions for water-sensitive cities. This explains why, even without any formal requirements, some initiatives toward such integration are undertaken in the form of international student workshops, seminars or elective design studios focused on ecological, urban and architectural challenges related to climate change [16].

THE INTEGRATED DESIGN STUDIO: BRIDGING CONCEPTS IN ARCHITECTURE, URBAN AND ENVIRONMENTAL ENGINEERING

In numerous architectural and urban projects students propose reintroducing into the cityscape former lines of canals, moats, basins or small rivers. Such decisions are often based on the analysis of urban structure that, for decades or even centuries, had been arising around water reservoirs gradually adapting to their patterns. Gdańsk, an historic city located in the Vistula River Delta, is a perfect laboratory by which to investigate the interdependence between hydraulic and urban projects in the overall concept of the city. In its history, land-water contours were frequently modified; lines of water appeared and disappeared in a process of adjusting the city to the emerging military, economic and spatial needs. Several districts are located below sea level and thus are dependent on a continuous mechanical pumping action. In the past century, many streams and small rivers were covered in the underground drainage systems, causing significant spatial and ecological disturbances. Today, the massive withdrawal of industry from the city centre reveals amorphous and fragmented spaces where water may reappear. Within the integrated design studio, students worked on a question how this reappearance might not only influence characteristics of urban structure, but also enhance ecological attributes and the climate resilience of the city.

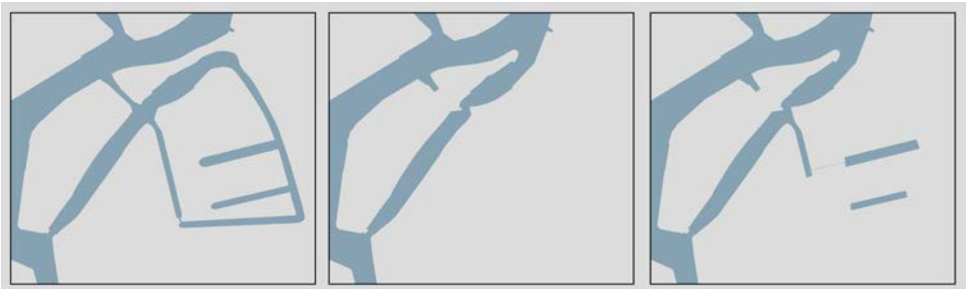

Figure 1: Changes in patterns of water: 1807, 2018 and students' proposal to restore canals as a stormwater reservoir and a blue-green core for new urban development (M. Płotka, K. Kosińska, D. Glugla, T. Sorgi).

To respond to these issues, students searched into the former lines of canals, moats, brooks and other water reservoirs, and then, creatively reinvented them, adjusting their forms to the actual urban, environmental and social context. The study was divided into several phases. In the first stage, students delved into water management and environmental engineering issues, recognising basic objectives, processes and infrastructures. In the second phase, they investigated historical maps of Gdańsk and layered them against a contemporary map, analysing dynamic processes of relocation of urban waters. In the next phase, they searched for areas where referring to the historical waterways would be beneficial, taking into consideration the morphology of urban space; the possibility of implementing climate adaptation concepts; ecological potential and socio-cultural attributes of analysed areas. Subsequently, students identified territories where the recovery of historical waterways would be feasible and beneficial for the city. Then, they developed individual concepts referring to historical water contours, but proposing necessary changes and modifications to adjust the new layout to the existing city structure, social expectation, water management issues and ecological objectives (see Figure 1).

Figure 2: Floating raft of remediation plants (A. Nyka).

Working on the integration of architectural, urban and environmental solutions for water-resilient cities, students developed original concepts. To mitigate flood risk, they proposed a diversified system for rainwater harvesting and retention reservoirs for stormwater runoff related to the lines of historical canals. By doing this, they interlinked isolated urban territories and extended pedestrian circulation paths.

Post-industrial territories appeared to be particularly interesting case studies. There, students focused on concepts that facilitate the process of changing grey into green urban infrastructure, stimulate social life and reclaim biodiversity. To meet these objectives they designed different kinds of rain gardens for natural retention, filtration systems and constructed wetlands for treating rainwater, including floating islands with retrofitted vegetation (see Figure 2).

Figure 3: Proposal for the ecological landscape of a Media Institute campus (A. Popławska).

Wherever reasonable, students proposed green roofs as an initial rain-catchment surface suggesting the use of retrieved water for irrigation (see Figure 3). New basins were proposed to mitigate ecological issues and take rainwater from the larger area, but also to serve cultural programmes and artistic projects oriented on reclaiming the sensory experience and memory of water [17][18].

As are revealed in projects, territories related to the immediate land-water boundary demand special consideration as areas of dynamic interactions between urban functional programmes, including programmes located on water, and climate adaptation solutions. This boundary, understood throughout almost the whole 20th Century as a univocal sharp line between land and water, could be re-thought nowadays as an area of ecological and urban mediation [19][20].

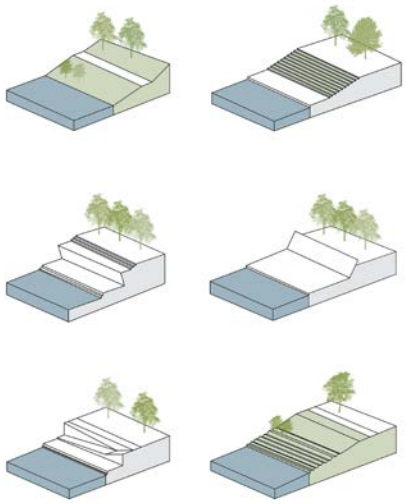

Figure 4: Typologies of riverbanks adaptable to rising sea level (S. Bobric, J. Ruela, I. Dartige).

Accordingly, students experimented on new typologies for this boundary, developing different intrusions of water into the land and, by contrast, piers of land and floating constructions that protrude into the water. New qualities of urban landscape were discussed as an effect of offering more flexible, climate-sensitive wharfs and urban riverbanks that may easily adjust to changing levels of water (see Figure 4). Consequently, in some places students soften forms and developed in-between territories with a focus on water resilience, biodiversity, quality of landscape and social inclusion (see Figure 5). For particularly vulnerable areas, students proposed different types of resistant structures located on water that would mitigate sudden hits by waves that enter the city through the Dead Vistula River.

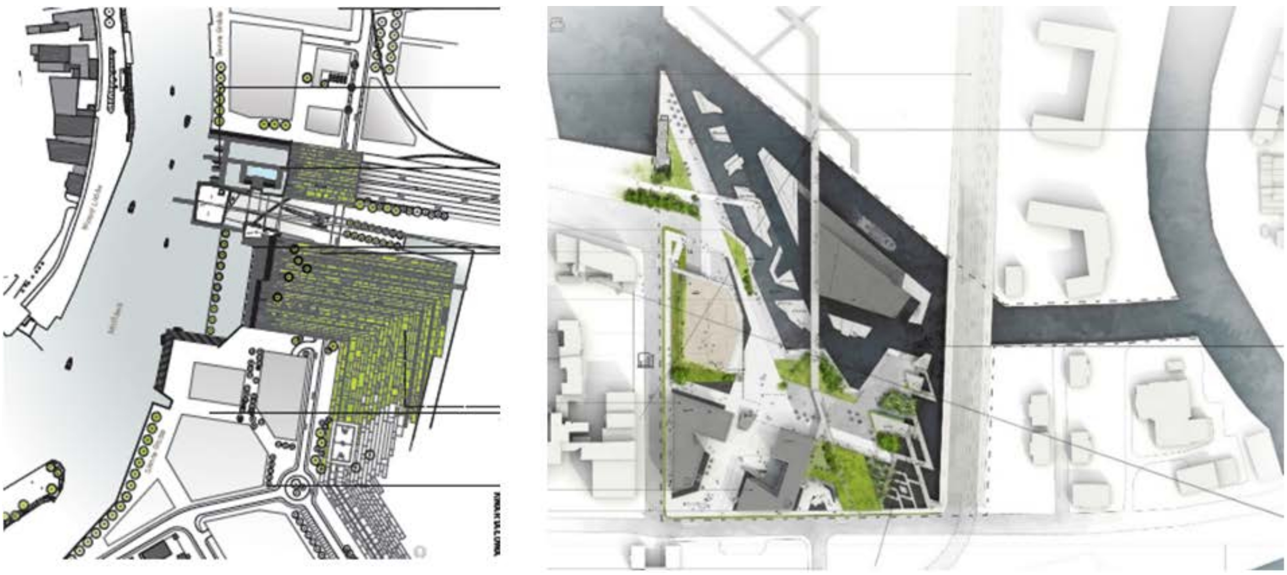

Figure 5: Different forms of land-water boundaries with green areas and constructed wetlands (E. Morawska, P. Puciłowska, M. Gerszewski).

CONCLUSIONS

Projects developed by students reveal the benefits of integrating environmental concerns into architectural and urban concepts. The final ideas referred both to the quality of public spaces and landscapes, and to the need to respond to challenges related to climate change, which gave students new insights into the expectations regarding their future profession. Another advantage was that students' concepts for post-industrial conversions integrated with climate adaptation and mitigation solutions aroused the interest of municipal authorities and local stakeholders, which may contribute to the overall understanding of this topic.

Although results were fully satisfactory, directing students into water management and environmental issues was relatively difficult, at least at the beginning of the process. Students worked easily on activating urban areas, proposed interesting public spaces and new blue-green connections, but in the majority rather tended to restrain from the endeavour to study environmental engineering solutions for water-resilient cities, considering them as not belonging to the discipline. However, with time, it appeared that delving into specific technical environmental engineering issues in many cases required corrections to the initial urban schemes, with the final benefit for the overall proposal.

At the start of the project, 29 international students (second semester of Master's studies) were interviewed, which revealed that only two of them, at least once during their study programme, considered climate-related circumstances, such as rising sea level or unprecedented weather events as a factor influencing the overall design concept. It means that individual initiatives of university teachers do not contribute significantly to the overall profile of a graduate architect. Consequently, without formal changes in legal regulations on the qualifications of architects, there is just a small chance that graduates will participate efficiently in the process of enhancing the resilience of cities and making them more sustainable in the context of the climate crisis.

Almost two decades ago, Robert France, professor of landscape ecology at the Harvard University School of Design gave a statement to a book series on integrative studies in water management and land development. He opined:

> *Ecological issues and environmental problems have become exceedingly complex (…) As a result, socially acceptable and sustainable solutions must be both imaginative and integrative in scope; in other words, garnered through combining insights gleaned from various specialized disciplines, expressed and examined together (…) landscape architecture, land-use planning, economics, education, and environmental management, history, and art* [21].

The pursuit of such integration is equally valid today. Without transcending traditional boundaries of disciplines and professions, coming changes could not be faced, with all the consequences that has for cities.

REFERENCES

1. World Population Prospect, United Nations, 16 November 2018, https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf
2. Heat Island Impact. USA Environmental Protection Agency (EPA), 16 November 2018, https://www.epa.gov/heat-islands/heat-island-impacts
3. Şen, Z., Applied *Drought Modelling, Prediction, and Mitigation*. Amsterdam-Boston-Tokyo: Elsevier (2015).
4. Climate Change Consequences, European Commission, 14 December 2018, https://ec.europa.eu/clima/change/consequences_en
5. Transforming our World: the 2030 Agenda for Sustainable Development, 25 October 2018, https://sustainabledevelopment.un.org/
6. Borucka, J. and Macikowski, B., Teaching architecture - contemporary challenges and threats in the complexity of built environment. *Proc. IOP Conf. Series: Materials Science and Engng.*, 245, 082058 (2017).
7. Celadyn, W., Controversy over the visions of the architectural profession. *World Trans. on Engng. and Technol. Educ.*, 17, **1**, 71-75 (2019).
8. European Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the Recognition of Professional Qualifications. 16 November 2018.
9. Celadyn, M., Adaptive reuse design method in a sustainable interior design model. *World Trans. on Engng. and Technol. Educ.*, 16, **4**, 338-343 (2018).
10. Szczepański, J., Sustainable monument preservation in architectural education. *World Trans. on Engng. and Technol. Educ.*, 17, **1**, 42-47 (2019).
11. Smatanová, K. and Urban. J., Outcomes of the experimental assignment in Studio Project I - Urban Design. *World Trans. on Engng. and Technol. Educ.*, 16, **2**, 115-120 (2018).
12. De Meulder, B. and Shannon, K., *Water in the City. The Great Stink and Clean Urbanism*. In: De Meulder, B. and Shannon, K. (Eds), Water Urbanism. Amsterdam: SUN, 5-9 (2008).
13. Armanini, A., *Water Resources and Environmental Engineering - Educational Problems at Undergraduate-Graduate Level*. In: van der Beken, A. (Ed), Water Related Education, Training and Technology Transfer. Oxford, UK: Eolss Publishers Co., 93-106 (2009).
14. Van der Beken, A., *Water-Related Education, Training and Technology Transfer*. In: van der Beken, A. (Ed), Water Related Education, Training and Technology Transfer. Oxford, UK: Eolss Publishers Co., 1-30 (2009).
15. Altomonte, S., Environmental education for sustainable architecture. *Review of European Studies*, 1, 2, 12-21 (2009).
16. Ressano Garcia, P., *Waterfront: Tagus River Gateway, Introduction*. In: Ressano Garcia, P. (Ed), Tagus River Gateway. Architecture and Climate Change. Lisbon: Universidade Lusofona, 9-10 (2018).
17. Nyka, L. and Szczepański, J. (Eds), *Culture for Revitalisation - Revitalisation for Culture*. Gdańsk: CSW Łaźnia (2010).

18. Nyka, L., *Architecture and Water - New Concepts on Blurring Borders*. In: Nyka, L. (Ed): Water for Urban Strategies. Weimar: Verlag der Bauhaus-Universität Weimar, 20-27 (2007).
19. Burda I. and Nyka L., Providing public space continuities in post-industrial areas through remodelling land/water connections. *Proc. IOP Conf. Series: Materials Science and Engng.*, 245, **8**, 082037 (2017).
20. Drapella- Hermansdorfer, A., *To Water, or to* Room for Water*? - That is the Questio*n. In: Januchta-Szostak, A. (Ed), Sensitive Approach to Water in Urban Planning, Landscape Design and Architecture. Poznań: Politechnika Poznańska, 107-116 (2011).
21. France, R.L. (Ed), *Handbook of Water Sensitive Planning and Design*. Boca Raton-London-New York-Washington, D.C.: Lewis Publishers CRC Press (2002).