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## *Modern design strategies for integrating new urban ecosystems with housing architecture in Antwerp as an example of the aspiration to achieve climate neutrality*

### *Introduction*

Nowadays, the importance of the city in the process of achieving climate neutrality is enormous. It is estimated that almost 2/3 of humanity will live in city agglomerations by 2050 [1, p. 2], [2]. Therefore, it is advisable to develop appropriate design strategies which are aimed at remodelling urban structures so as to reduce the effect of the urban heat island, ensure the retention of rainwater, its collection, storage, and purification, as well as to improve the quality of urban air. The key action in the process of achieving climate neutrality is to ensure the largest possible biologically active area in cities, which would be permeable to rainwater and biodiverse water. Therefore, urban brown fields should play an important environmental role in urban pro-climate policy, as areas for urban agriculture, including community gardens and new models of urban parks – ecological education parks serving nature conservation. Their creation is associated with the reconstruction and protection of local species biodiversity, especially in the coastal zones of urban water bodies. Due to the significant size of these areas in the city, these activities visibly increase the so-called qualitative porosity of the urban tissue, which is a key goal in achieving climate neutrality. They are additionally supported by the intensive use of green composite roofs of buildings and trees in shaping the terraces and loggias of the buildings. These solutions constitute the city's green acupuncture, especially where there is a deficit of green areas. They offer an additional biologically active surface, slowing down the peak flow of rainwater, which they purify and store. They

are also home to a variety of fauna and flora. An important role in the process of increasing local biodiversity should be played by eco-education of city residents, which is directly connected with the need to implement wild ecosystems into the urban tissue and create Ecological Education Parks within them. These new urban ecosystems, which are integrated with housing architecture, services for residents, and pro-social functions, generate eco-structures which remain in constant synergy with nature. Their creation is undoubtedly related to a change in the lifestyle of potential users, including lowered consumption, spending more time outdoors, and necessary restrictions on travelling by road in favour of rail and bicycle transport. These practices are heading towards a new bioclimatic model of the city whose inhabitants protect local biodiversity and integrate around actions for nature.

A model example of a city which has decided to implement necessary planning activities in order to enable it to achieve climate neutrality is Antwerp – a recently dynamically developing metropolis with numerous green suburbs which were organized on the model of garden housing estates. The aim of the study is to demonstrate, based on the presented case studies – selected implementations in Antwerp – the advisability of successively increasing the biologically active area in cities and biodiversity, through the use of green roofs of buildings and the reconstruction of local wild ecosystems on urban brown fields. These biologically active areas of various scales, in accordance with the principles of deep ecology, should combine the functions of protected areas with eco-field education of residents and ecological crops. The described implementations indicate that both strategies, both the idea of implementing wild ecosystems in cities in the form of ecological education parks integrated with residential eco-architecture, and the city's green acupuncture in the

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form of green, combined roofs of buildings, terraces and loggias, are equally important and implemented depending on the context of the place. The best solution seems to be a deliberate combination of both strategies into one, as a conscious, responsible action consisting in shaping a new image of an organic city with protected, wild ecosystems and the possibility of breeding and grazing of small animals, which additionally favours the preservation of agricultural functions in cities. The idea of a city shaped in this way and the introduction of nature into cities in various forms of eco-architecture are part of the long-term movement of deep ecology initiated in Norway, becoming a means to fight the ecological crisis, i.e. global warming, water deficit, loss of biodiversity and decreasing qualitative porosity of the urban tissue [3].

### *State of research*

Studies on the syndrome of nature-deficit disorder in cities and on the importance of new urban ecosystems in the context of environmental psychology along with their influence on man were carried out by Richard Louv [4]. Gernot Böhme emphasizes the significance of designing wild ecosystems in the city as necessary for the harmonious functioning of the human psyche [5, p. 60]. In his research, Todd Christopher, the author of the theory of “one green hour a week” for children for unrestricted fun in nature, emphasizes the need to increase the availability of wild green areas in cities for the youngest age group as a condition for their proper development [6]. In his research, Robert I. France indicates a direct relationship between eco-education of children and protection of biodiversity in urban areas [7, pp. 127–237]. Tony Kendle’s and Stephen Forbes’ studies prove that along with spreading the knowledge and making natural elements of the environment in Ecological Education Parks more understandable, social acceptance for its wild disordered aesthetic form increases, which as a result leads to greater empathy and sensitivity to the spontaneity of manifestations of all possible lives [8, pp. 319–335]. Agata Zachariasz defines greenery as a city-creative factor and considers the availability of wild ecosystems for city residents to be one of the fundamental measures of sustainable development [9]. Deep ecology and the related need of joy to identify with wild nature, i.e. *friluftsliv* (Norwegian), is present in the studies by Arne Næss [10], [11], David Abram [12], Bill Devall, and George Sessions [13]. Research into the use of ecological succession in cities in the areas abandoned by man by implementing interesting urban projects which create the synergy of architecture and nature, as well as studies on new models of city parks in favour of nature protection service are present in Kasper Jakubowski’s works [14, pp. 87–97], [1, p. 2]. In his research, Richard Mabey discusses the environmental role of urban brown fields as an opportunity to realize the idea of returning to urban countryside in cities [15]. In his studies, Andy Millard draws attention to the significance and the resulting need to protect the biological diversity of post-industrial brown fields in cities [16, pp. 63–65]. Research on the anthropogenic environment, the effects of changes in the

natural environment caused by urbanization processes and ecological importance of transformed city ecosystems are present in the works by Tomasz Molenda [17, pp. 76–80]. Considerations on the impact of a building on the urban heat island effect, the idea and image of which are a combination of art and biology, can be found in the studies of Alexandra Martins Tavares and Ines Daniel de Campos [18].

### *Research method*

Literature studies and case studies (theory and practice analysis) supported by the in situ method, i.e. local visits in the field became our workshop method. The criterion for collecting data, systematization of issues and their synthesis depended on the interdisciplinary approach to the subject and the openness of ideas. When selecting publications, efforts were made to present items representative of a given subject group. When no suitable monograph was available, publications from specialized journals and the Internet were used (the choice of websites was verified by checking their credibility, inter alia, people and institutions).

### *Case studies – selected implementations*

Design strategies which are applied in Belgium can be described as exemplary, especially since in recent years many solutions have been adopted to reduce the effect of the urban heat island, which perfectly match the pro-climate policy of the city.

The first of the strategies which have been introduced in Antwerp is the implementation of biologically active surfaces into the urban tissue. They perform the role of wild ecosystems in the form of crowning of buildings, i.e. integrated green roofs and terraces which are filled with trees and fruit shrubs. In this solution the building forms a supporting structure for the designed ecosystem. A proper selection of plants belonging to native species and growing in a given location and the new ones which could coexist with them is the key to such solutions. This type of strategy was used in Palazzo Verde in Nieuw Zuid District.

The second trend being developed is the conscious design of forest and park areas as ecological education parks, integrated with residential architecture. These new urban ecosystems are being created in revitalized areas, which gives the opportunity to recreate the original ecosystems, which consist of native plant species and the return of locally occurring life forms. A representative example is the HoboKense Ecological Education Park in Hoboken District and housing complexes Polderstadt and Groen Zuid which are connected with it.

The latter Groen Zuid represents the third direction – a combination of two strategies, where a residential structure with green, composite roofs remains in close synergy with urban crops and a new urban ecosystem – an ecological education park.

These concepts are part of actions which are aimed at increasing the quality porosity of the urban tissue and species biodiversity of urban local ecosystems as well as creating optimal conditions for rainwater retention. They significantly improve the air in the city and reduce the effect

of the urban heat island. While the first of them, defined as the city's green acupuncture, applied pointwise on relatively small areas of building roofs, gives the desired effects on a city scale only as the sum of additive green surfaces and requires additional construction expenditures, the second strategy concerns urban brown fields and areas revitalized, which often constitute a significant percentage of the city's area, which ultimately determines whether it should be treated as a priority over the former. Additionally, ecosystems organized on green roofs of buildings limit access only to the facility's users, while new urban ecosystems in the form of ecological education parks allow participation and eco-education for both local residents and people from other parts of the city.

**Palazzo Verde**  
– an example of a new urban ecosystem  
on the building's combined roofs and terraces

The use of trees and shrubs in shaping the image of a building can be considered to be a certain form of art integrated with biology [18]. It is also a method to support actions which are aimed at increasing the biologically active area and local biodiversity as well as an opportunity to improve the quality of air in the city. Stefano Boeri's buildings which are defined as *Vertical Forest* constitute an excellent

example of this. Representative projects were implemented in Milan, Italy (2014, Fig. 1), in Switzerland (Lausanne, 2017), and in the Netherlands (Eindhoven, 2021 and Utrecht, 2024). Among the Polish examples, the green roof of the University Library in Warsaw (landscape architect Irena Bajerska, implementation in 2002) is worth noting.

Antwerp can boast its own implementation of this type from 2018. Palazzo Verde in Nieuw Zuid District is a layout which consists of 66 flats. Its integral part include a lot of rooftop gardens in the form of one whole, which provide a common space for residents and home to numerous representatives of flora and fauna (Fig. 2). They are accompanied by green individual private terraces adjacent to housing units. This local ecosystem, which is arranged on the roof of the building, consists of 86 trees, 1000 shrubs and 1200 plants. Many of them are fruit trees and shrubs such as pear trees (*Pyrus*) and black currant shrubs (*Ribes nigrum L.*) [19]. Stefano Boeri, the author of the project, emphasizes that every place where Vertical Forest is to be created is first checked in terms of climate conditions and plant species occurring in a given area and which create a local ecosystem as well as other life forms connected with them, mainly from the world of insects [20]. It is only on this basis that plant species which coexist with native species creating a vertical garden in the structure of a building, i.e. a new urban ecosystem, are selected.



Fig. 1. Trees as integral parts of the building structure in Vertical Forest pilot layout – Bosco Verticale in Milan, architect S. Boeri, implementation in 2014 (photo by A. Van Herck)

Il. 1. Drzewa jako integralne części struktury budynku w pilotażowym założeniu Vertical Forest – Bosco Verticale w Mediolanie, arch. S. Boeri, realizacja 2014 (fot. A. Van Herck)

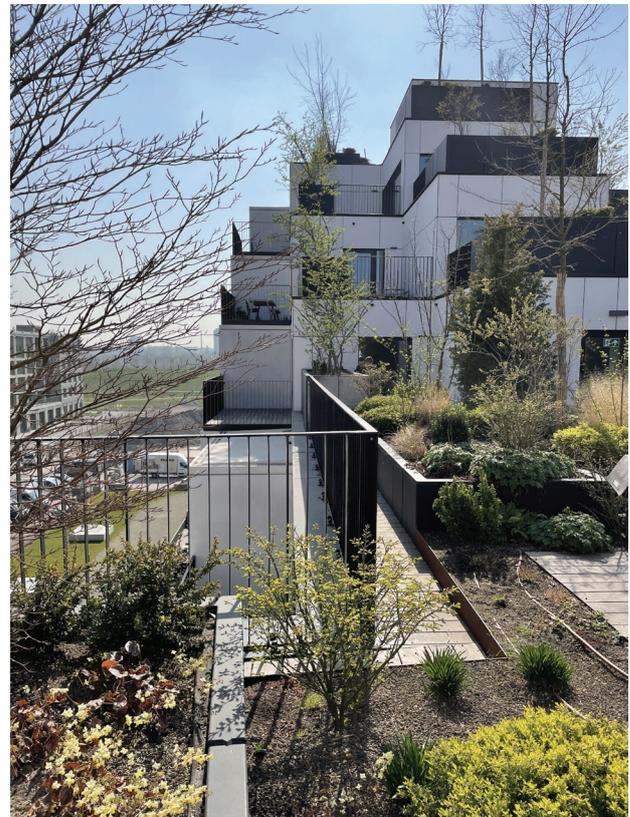


Fig. 2. Composite roof gardens of Palazzo Verde layout in Antwerp, architect S. Boeri, implementation in 2018 (photo by E. Cisek)

Il. 2. Zespolone ogrody dachowe założenia Palazzo Verde w Antwerpii, arch. S. Boeri, realizacja 2018 (fot. E. Cisek)

The concept of their selection must also be applied in the future, which means that owners of flats cannot interfere in the designed plant compositions, change them, or eliminate them. Thanks to this approach, ecosystems are stable, native, and remain in a constant balance. At the end of this complex process, the functional and spatial system of a building with a division into publicly available, semi-private, and private spaces within the structure of flats and created gardens is designed.

Similarly to the other Dutch implementations of the author of the project, apart from the office space and apartments, 30% of this layout are social flats with significantly reduced rents. This detail proves that pro-environmental and social activities are combined, which brings satisfactory results.

Façades, which are filled with trees and shrubs, are not only cyclically recurring colour phenomena as an imitation of the year-round vegetation cycle of plants. They also form a design strategy to increase the share of the biologically active tissue in the structure of the city. These actions substantially improve the quality of urban air and significantly reduce the urban heat island effect. The trees in the structure of towers produce an average of 41 tons of oxygen per year, sucking carbon dioxide and capturing fine particles of dust. They produce the amount of oxygen equivalent to the one obtained from one hectare of forest. The green tissue clearly cools the façade in summer and provides full insolation in winter when plant branches shed their leaves. Thanks to this solution, the costs connected with air conditioning of buildings are reduced [21]. At the same time, the sun rays which filter through the crowns of trees, give the effect of Nordic light in residential interiors – a phenomenon occurring on forest glades surrounded by high trees or in Norwegian small churches *stavkirke*. This quality of space was used for the first time in architecture by Norwegian architect Sverre Fehn when designing Nordic Pavilion (Norwegian *Nordens paviljong*, implementation in 1962) at Venice Biennale, where a key role in the structure of the building was played by trees – newly designed and those outside within the park [22].

This implementation from Belgium is an example of constructing a stable ecosystem which consists of fauna and flora species characteristic of a given location. The building is a supporting structure for it, with a given form which improves the plant exposure to sunlight and supplies the plants with rainwater. This concept promotes the reconstruction and protection of local wild ecosystems as a method of increasing the species biodiversity and eco-education.

Palazzo Verde is a vertically designed local ecosystem, which is a kind of green acupuncture of Antwerp. Appearing in the city, it plays the role of “vanguard” of changes and sets a new direction by introducing native nature into the structure of the built environment. This solution is an alternative to the existing urban planning which isolates natural systems and dehumanizes the human living environment. The colours which finally the image of the building obtains, i.e. unique just like in nature, are cyclically changed, which makes them harmoniously become a part of a larger image of the organic city, and thus becoming its unrepeatable and attractive showcase.

### *Hobokense Ecological Education Park – an example of transforming urban brown fields into a new urban ecosystem*

Eco-friendly architecture which is integrated with Ecological Education Parks constitutes another form of spatial organization of housing architecture that is conducive to climate neutrality in cities. These new urban ecosystems form closed wild local ecosystems which are created on the basis of the existing forest and park greenery centred around watercourses and water reservoirs. They are characterized by semi-natural vegetation, limited maintenance treatments, emphasis on education, and the use of ecological succession as the creator of the park or a part of it [1]. The environmental context seems to be crucial for organizing this type of eco-structures because development on the basis of place is the basis of all actions. This long-term approach supports such values as increasing biodiversity and eco-education of inhabitants of the city. Its fundamental assumptions include *friluftsliv* (Norwegian) – the joy of identification with wild nature, i.e. going out to nature, which ensures necessary balance and empathy [22]. In the urban context, this role is performed by new urban ecosystems, i.e. Ecological Education Parks and related functions such as housing, including houses for seniors and educational – forest kindergartens and schools, service – small gastronomy based on local products and community spaces.

The main purpose of designing these urban eco-structures is the reconstruction of local ecosystems, which leads to an increase in biological diversity in a given area, modelling of ecological succession processes, as well as the mosaic character of plant communities. Jakubowski aptly notes that adaptations of urban brownfields for ecological education parks make it possible to create new models of leisure and recreational parks, where wildness is a form consciously protected or introduced [1, p. 2]. This function results in another goal, which is eco-education. Thanks to it, inhabitants acquire knowledge about natural processes and cycles which take place in ecosystems and integrate in connection with protective actions. The last and most important purpose, which is closely related to the previous ones, is the reduction of the heat island effect in the city and the improvement of air quality.

Such activities are perfectly reflected in the Hobokense Ecological Education Park in Antwerp and two connected housing complexes, i.e. Polderstadt and Groen Zuid (architect Binst Architects, implementation in 2020). This implementation is an example of restoring and reconstruction of the local wild ecosystem in the former polder of the Shelde River and its strict integration with housing architecture. Numerous small water reservoirs, eco-educational thematic paths, wooden shelters – walls for observing water avifauna and bridges above the wetland habitats were designed within the park (Figs. 3, 4). There has also been a return to the idea of farm animals grazing in cities, which helps protect meadow environments and makes it possible to maintain biodiversity appropriate for the early stages of succession and exposure of valuable views. Quoting Jakubowski [...] *the presence of animals*

Fig. 3. Ecological Education Park Hobokense – reconstructed in a revitalized area, wild ecosystem of the Shelde River in Antwerp (photo by E. Cisek)

Il. 3. Park Edukacji Ekologicznej Hobokense – odbudowany na terenie rewitalizowanym dziki ekosystem rzeki Schelde w Antwerpii (fot. E. Cisek)



Fig. 4. Wooden shelter – a wall for observing water avifauna in Hobokense Ecological Education Park in Antwerp (photo by A. Van Herck)

Il. 4. Drewniany schron – ścianka do obserwacji awifauny wodnej na terenie parku edukacji ekologicznej Hobokense w Antwerpii (fot. A. Van Herck)



*is a magnet and an argument to visit these places and to get acquainted with the recreational and educational offer and natural wealth [1, p. 5].*

The Polderstadt residential complex is located directly at the border with Hobokense Park. The spatial layout of the complex was formed still in the 1970s. It was designed on the plan of header systems consisting of short streets ending with small squares, concentrating residential development (Fig. 5). It consists of single- and multi-family buildings, where social flats with reduced rents constitute 30% (Fig. 6). This arrangement was characteristic of cit-

ies-gardens. The layout allows greenery to freely intermingle with architecture and keeps ecological corridors which connect the residential complex with the park. In the centre of the housing estate there is a retention reservoir which is integrated with the system of water reservoirs in the Ecological Education Park. Pro-social functions along with community rooms and services for residents were located in this part of the layout (Fig. 7). Recently, a part of them have been adapted to flats. The residential layout and the new urban ecosystem within the park are closely interconnected and form one eco-structure.

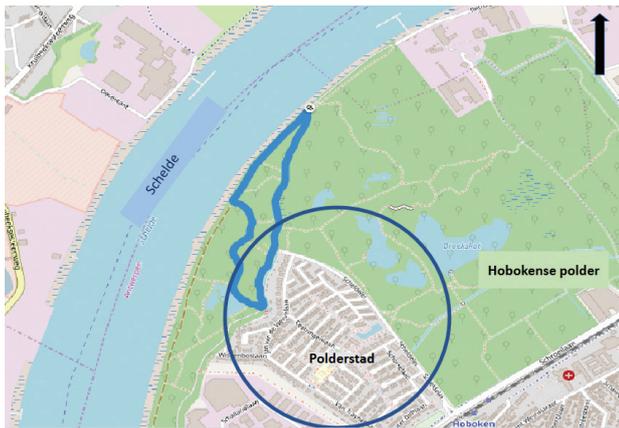


Fig. 5. The Polderstad housing complex closely connected with Hobokense Ecological Education Park – plan, Antwerp (elaborated by E. Cisek based on Google Maps)

Il. 5. Zespół mieszkaniowy Polderstadt ściśle połączony z Parkiem Edukacji Ekologicznej Hobokense – plan, Antwerpia (oprac. E. Cisek na podstawie Mapy Google)

### ***Groen Zuid – an example of combining green, composite roofs of a residential structure with a new urban ecosystem***

The second of the cited housing complexes is Green South – Groen Zuid which is located south of Hobokense. It is connected with the Ecological Education Park by means of an underground tunnel for cyclists. It is an example of a housing structure with green roofs integrated with green areas consisting of urban crops and a new urban ecosystem, with an eco-educational character. This layout is a fusion of two design strategies that support and complement each other. Sequences of buildings designate internal quiet garden interiors of a cultivated and recreational character and gradually change into forest and

park greenery with three small lakes – rainwater tanks (Fig. 8). This layout reflects an interesting trend for maintaining the agricultural function in cities [15]. The layout is shaped in such a way as to recreate elements of a traditional landscape such as tree, meadows, and water reservoirs, as well as crops with fruit trees and shrubs which are characteristic of the countryside [1]. At the same time, the skilful shape of the development ensures the comfort of living in the city. The entire layout takes into account both the local environmental and cultural conditions. The housing complex was harmoniously connected with the existing buildings and green areas and ensured the so-called qualitative porosity of the urban tissue. Thanks to the communication solutions applied, the entire layout was car-free. The whole space has been optimally used, which indicates the compactness of solutions. Sustainable energy and water management was provided. Architecture is characterized by respect for diversity, which is characteristic of Flanders. The buildings are characterized by the additive nature of forms, a diversity of their heights, and types of developments (Fig. 9). Apart from apartments, there are social flats which constitute 25% of the entire built environment, whereas multi-family housing is accompanied by single-family housing. In total, the layout consists of 500 houses and flats, including 393 owner-occupied flats, 90 social flats and 120 flats for the elderly – the flats which are in tower forms, with solutions emphasizing the role of light in shaping living rooms for seniors [23]. The closing of observation axes at the ends of internal courtyards and the border with the park by means of dominants was provided. Private space was also separated from public space thanks to the small volume of utility rooms. The screen development on the side of traffic arteries makes it possible to acoustically separate a quiet space of internal garden courtyards which linearly change into the park space (Fig. 10). Three retention infiltration reservoirs collect rainwater, then purify and store it.



Fig. 6. Architecture of housing development along cul-de-sac streets of the Polderstad complex in Antwerp (photo by E. Cisek)

Il. 6. Architektura zabudowy mieszkaniowej, skupionej wzdłuż ulic zaułkowych zespołu Polderstadt w Antwerpii (fot. E. Cisek)

Fig. 7. Rainwater retention tank with community buildings and services for inhabitants within the Polderstadt housing complex in Antwerp (photo by E. Cisek)

Il. 7. Zbiornik retencyjny na wodę deszczową z zabudowaniami wspólnotowymi i usługami dla mieszkańców w obrębie zespołu mieszkaniowego Polderstadt w Antwerpii (fot. E. Cisek)



Excess of water is discharged into the ground and some amount is reused as green water. Green roofs of buildings perform a compensation function. They constitute a biologically active area within the place taken from nature. They absorb rainwater, reduce the peak flow of rainwater and, most importantly, support biodiversity becoming home to many forms of life. The whole area around buildings is a biologically active area of various categories of availability. Rainwater is purified through ground culverts, drainage troughs, and meadow plantings [24].

The aforementioned housing layouts of Polderstadt and Groen Zuid, which are connected with Hobokense Ecological Education Park in Antwerp, show the importance of genius loci and the environmental context in planning actions [25]. Biological diversity often goes hand in hand with the variety of architectural forms and their aesthetics, which is part of the organic city idea.

### Summary and conclusions

The described implementations from Antwerp show that the introduction of the design strategies presented in them, maintained in the trend of *deep ecology*, into architectural education should be associated with the use of the educational system from the pre-school level in the place of residence. *Friluftsliv* (Norwegian) – education in wild nature and new urban ecosystems which are designed in this spirit, in the form of crowning of buildings and ecological education parks, with eco-structures located on their outskirts with the following functions: housing with elements of city crops, education, exhibitions and services, are one of the possible paths to achieving climate neutrality and biodiversity. The presence of ecological education centres next to new urban ecosystems, sensory sound pavilions with exhibition and eco-educational functions, as well as forest kindergartens with sensory spaces

which are created on the basis of image, sound, touch, and smell – shapes an empathetic attitude towards other forms of life in the youngest children, i.e. through living, playing, learning, and working in direct contact with wild nature. Each time they are created on the basis of place – the existing ecosystem and the local audio-sphere create the sensual complementary environment in which images, sounds, and smells stimulate the harmonious development of all forms of life without any exception.

The characterized examples also show that the implementation of green areas in the form of wild ecosystems on composite roofs and terraces of housing complexes as well as ecological education parks, which are created in urban revitalized areas, is part of actions aimed at increasing the qualitative porosity of the urban tissue and thus the

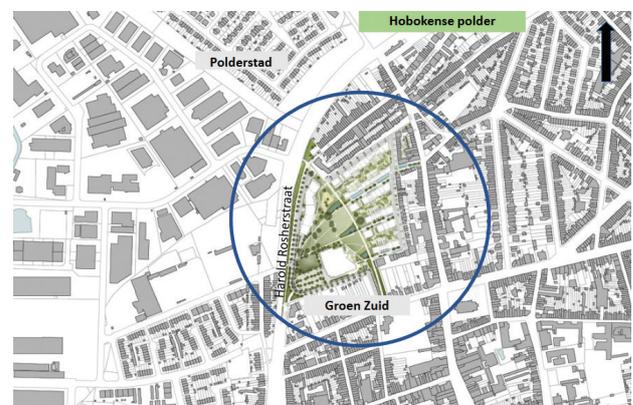


Fig. 8. Green South housing complex – Groen Zuid in Antwerp, plan designed by Binst Architects, implementation in 2020 (elaborated by E. Cisek based on Google Maps)

Il. 8. Zespół mieszkaniowy Zielone Południe – Groen Zuid – w Antwerpii, plan, arch. Binst Architects, realizacja 2020 (oprac. E. Cisek na podstawie Mapy Google)



Fig. 9. Screen development with architecture characteristic of Flanders – additivity of various forms of buildings and the unity of material, Groen Zuid, Antwerp, designed by Binst Architects, implementation in 2020 (photo by E. Cisek)

Il. 9. Zabudowa parawanowa o architekturze charakterystycznej dla Flandrii – addytywność różnorodnych form budynków i jedność materiału, Groen Zuid, Antwerpia, arch. Binst Architects, realizacja 2020 (fot. E. Cisek)



Fig. 10. Internal quiet garden courtyards of a cultivated and recreational character, Groen Zuid, Antwerp, designed by Binst Architects, implementation in 2020 (photo by E. Cisek)

Il. 10. Wewnętrzny cichy dziedziniec ogrodowy o charakterze uprawowym i rekreacyjnym, Groen Zuid, Antwerpia, arch. Binst Architects, realizacja 2020 (fot. E. Cisek)

biologically active area and obtaining climate neutrality. These new urban ecosystems are conducive to increasing biodiversity, eco-education of inhabitants, creating architecture as a form of art combined with biology, reducing the effect of the urban heat island and improving the quality of air in the city.

The solutions presented in the cited implementations indicate that situating residential eco-architecture with urban

cultivation (city crops) areas on the border with new urban ecosystems and the possibility of raising and grazing small animals or organizing apiaries for bees supports the trend for maintaining agricultural functions in cities and small gastronomy which is aimed at promoting local products.

*Translated by  
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## Abstract

*Modern design strategies for integrating new urban ecosystems with housing architecture in Antwerp as an example of the aspiration to achieve climate neutrality*

The article discusses the issues of deliberate design strategies aimed at reducing the effect of the urban heat island and improving the quality of air in the city, which have been implemented in recent years in Antwerp, Belgium. Literature studies and case studies (theory and practice analysis) supported by the in situ method, i.e. local visits in the field became our workshop method. The criterion for collecting data, systematization of issues and their synthesis depended on the interdisciplinary approach to the subject and the openness of ideas.

The implementation of green areas in the form of wild ecosystems on composite roofs and terraces of housing complexes (e.g. Palazzo Verde in Antwerp, architect Stefano Boeri, implementation in 2018) and ecological education parks which are established in urban revitalized areas (e.g. Hobokense in Antwerp along with housing estates of the Polderstad and Groen Zuid, architect Binst Architects, implementation in 2020), is part of actions aimed at increasing the quality porosity of the urban tissue and thus the biologically active area and effective rainwater retention. These new urban ecosystems, which are based on native species of plants and new ones coexisting with them in full synergy, are conducive to increasing local biodiversity, eco education of inhabitants and creating architecture as a form of art combined with biology. The location of housing eco-architecture along with urban crops areas on the border of new urban eco ecosystems and the possibility of breeding and grazing of small animals or organizing bees apiaries supports the trend for maintaining agricultural functions in cities and small gastronomy which is oriented to the promotion of local products. These strategies are part of the city pro-climate policy as effective grassroots actions aimed at obtaining the climate neutrality of our planet.

**Key words:** bioclimatic architecture, ecological education park, deep ecology, vertical forest

## Streszczenie

*Współczesne strategie projektowe integrowania nowych ekosystemów miejskich z architekturą mieszkaniową w Antwerpii jako przykład dążenia do osiągnięcia neutralności klimatycznej*

W artykule poruszono problematykę celowych strategii projektowych wdrażanych w ostatnich latach w Belgii, w Antwerpii, mających służyć zmniejszeniu efektu miejskiej wyspy ciepła i poprawie jakości powietrza w mieście. Warsztatową metodą badawczą stały się studia literaturowe i studia przypadków (analiza teorii i praktyki) wsparte metodą in situ – wizjami lokalnymi w terenie. Kryterium zbierania danych, systematyzacji zagadnień oraz dokonywania ich syntezy uzależniono od interdyscyplinarnego ujęcia tematu i otwartości idei.

Implementacja terenów zielonych w formie dzikich ekosystemów na zespolonych dachach i tarasach kompleksów mieszkaniowych (np. Palazzo Verde w Antwerpii, arch. Stefano Boeri) oraz parków edukacji ekologicznej powstających na miejskich terenach rewitalizowanych (np. Hobokense w Antwerpii i powiązane z nim osiedla mieszkaniowe Polderstadt i Groen Zuid, arch. Binst Architects) wpisują się w działania zmierzające do zwiększenia jakościowej porowatości tkanki miejskiej, a tym samym powierzchni biologicznie czynnej i skutecznej retencji wody deszczowej. Te nowe ekosystemy miejskie oparte na gatunkach rodzimych roślin i nowych współegzystujących z nimi w pełnej synergii sprzyjają zwiększeniu lokalnej bioróżnorodności, ekoedukacji mieszkańców i kreowaniu architektury jako formy sztuki połączonej z biologią.

Sytuowanie na styku z nowymi ekosystemami miejskimi ekoarchitektury mieszkaniowej z terenami upraw miejskich oraz możliwością hodowli i wypasu małych zwierząt lub organizacją pasiek dla pszczoł wspiera zachowanie funkcji rolniczych w miastach i małej gastronomii, nastawionej na promocję lokalnych produktów, wytwarzanych na miejscu. Strategie te wpisują się w politykę proklimatyczną miasta jako skuteczne, oddolne działania zmierzające do uzyskania efektu globalnego – neutralności klimatycznej naszej planety.

**Słowa kluczowe:** architektura bioklimatyczna, park edukacji ekologicznej, ekologia głęboka, wertykalny las