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ABSTRACT

The subject of this paper is, emerging from the sustainable development discourse, the regenerative paradigm. It is intended as a response to the progressive degradation of the environment by human activity and the effects of climate change. The main thrust of the thesis is to discuss the role of the regenerative paradigm in urban transformation resulting from climate change. The object of this thesis is also to consider the question of whether regenerative development that strives for resilient, healthy systems can provide benefits, adaptation and mitigation actions at the settlement scale.

The thesis is divided into two parts: theoretical and applied. The theoretical part introduces the research problem of the negative consequences of climate change, globally and locally. It also presents the most important events and documents, from the author's point of view, which have influenced today's definition of sustainable development. Subsequently, an attempt is made to systematise the dominant concepts related to sustainable design in the built environment in architecture and urbanism, to relate them over time and to define them. This part of the thesis presents the theories of the regenerative approach - histories, key assumptions and answers the question of what distinguishes it from conventional or sustainable approaches. Ecosystem services are also an important concept in the context of this thesis.

On the basis of the knowledge gained in the first part, it was decided to propose a development strategy in a regenerative spirit for one of Gdansk's housing estates. Zaspa-Młyniec was chosen as the object of study, a settlement of great importance at the city scale, with a rich history and identity of place. After analysing the social, natural and urban systems, it was decided to study two, opposing strategies for the development and transformation of the district. Both concepts are described and their solutions are supported by illustrated examples used worldwide.

Based on the own research method, the most optimal solution for the future of the project area was evaluated and later selected. The conditions and implementation process of the selected scenario are briefly presented and the whole is concluded with a summary.

Keywords: regenerative design, regenerative development, climate change, sustainability,

STRESZCZENIE

Przedmiotem niniejszej pracy jest, wyłaniający się z dyskursu zrównoważonego rozwoju, paradygmat regeneratywny. Ma on być odpowiedzią na postępujące degradowanie środowiska naturalnego przez działalność człowieka i efekty zmian klimatycznych. Głównym założeniem pracy jest omówienie roli paradygmatu regeneracyjnego w przemianach miejskich wynikających ze zmian klimatycznych. Przedmiotem niniejszej pracy jest też rozważenie odpowiedzi na pytanie czy rozwój regeneratywny, który dąży do odpornych, zdrowych systemów może zapewnić korzyści, działania adaptacyjne i mitygujące w skali osiedla.

Praca została na dwie części: teoretyczną oraz aplikacyjną. Część teoretyczna przybliża problem badawczy, jakim są negatywne konsekwencje zmian klimatu, w skali globalnej oraz lokalnej. Przedstawione zostały również najważniejsze z punktu widzenia autora wydarzenia i dokumenty, które wpłynęły na dzisiejszą definicję zrównoważonego rozwoju. Kolejno, podjęto próbę usystematyzowania dominujących konceptów, związanych z zrównoważonym projektowaniem w środowisku zabudowanym w architekturze i urbanistyce, odniesienia ich w czasie oraz zdefiniowania. W tej części pracy przedstawiono teorie podejścia regeneratywnego - historie, najważniejsze założenia oraz udzielono odpowiedzi na pytanie, co rozróżnia go od podejścia konwencjonalnego, czy zrównoważonego. Ważnym pojęciem w kontekście niniejszej pracy są również usługi generowane przez ekosystemy.

Na podstawie wiedzy zdobytej w części pierwszej postanowiono zaproponować strategię rozwoju w duchu regeneratywnym jednego z gdańskich osiedli. Na przedmiot badań została wybrana Zaspa-Młyniec, osiedle o dużym znaczeniu w skali miasta, bogatej historii i tożsamości miejsca. Po przeanalizowaniu systemów społecznych, naturalnych i urbanistycznych, zdecydowano o przebadaniu dwóch, przeciwstawnych strategii rozwoju i transformacji dzielnicy. Obie koncepcje zostały opisane, a rozwiązania w nich zawarte poparte są zilustrowanymi przykładami stosowanymi na świecie.

Na podstawie własnej metody badawczej, oceniono i później wybrano najbardziej optymalne rozwiązanie dla przyszłości terenu projektowego. Po krótce przedstawiono warunki i proces implementacji wybranego scenariusza, a całość zakończono podsumowaniem.

Słowa kluczowe: projektowanie regeneratywne, zmiany klimatyczne, zrównoważony rozwój

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1. Introduction

There is no getting away from the fact that we are living in a climate change crisis. Extreme weather events such as high temperatures or torrential rain are already a reality in our part of the world too, rather than a distant problem. Cities are a particularly vulnerable area where the causes of climate change are concentrated at the same time. They cause multiple crises: floods, flooding, droughts - direct threats to the safety of residents, the socio-economic system and the infrastructure of cities. Although there are many concepts of urban organisation that aim to adapt and mitigate the urban structure against the negative effects of extreme weather events, none of them seem to offer sufficient solutions to prevent their intensification. For this reason, there is a need to work on new urban concepts that reverse the course of climate change. The thesis's objective is to explore how the regenerative paradigm can contribute to urban transformations resulted from the climate change. aim of this work is to present foundations of the growing regenerative paradigm and compare it with other concepts in the present language of sustainable development.

2. Methodology

This study uses various research methods to get to know the topic in-depth. The theoretical part is based on qualitative data, consisting of the literature on the subject of issues of sustainability, ecosystem services and foremost the theory and principles of regenerative paradigm. Through a historical account of their evolution from a cultural and social standpoint, the goal of this work is to compare the growing "regenerative" paradigm in urbanism in the present language of sustainable development paradigms. In the analytical section, the author-selected case study of a housing estate that have been using regenerative solutions is also included. Both good and bad design approaches are given and evaluated in order to asses a chosen project.

In the second part, a number of site analyses with a focus on a particular project area were completed. Historical, demographic and transport contexts were presented, as well as an in-depth analysis of the environmental conditions that create the microclimate of the district.

3. Identification of the research problem

More than half of the world's population is residing in urban areas that only account for about 3% of the Earth's land surface. It is predicted that as a result of urbanization and migration from rural areas, this disproportion will continue to increase in a global scale. Already today in Poland, 60% of the population is urban. This distribution of population means that poorly designed cities become centers that exacerbate climate change through increased greenhouse gas emissions. In the Polish case, this is mainly due to district heating systems based on coal burning or low energy efficiency. What is more, cities are particularly susceptible

locations, according to researchers from the National Academy of Sciences, because of the high levels of investment, population density, and infrastructure.

The escalation of extreme weather events, including heat waves, torrential downpours, violent storms, or hurricane-force winds, may result in major material losses as well as direct and indirect risks to human life and health as well as socioeconomic stability. Extreme weather phenomena can be further amplified by local features of the urban climate.

3. 1. Climate change in the global context

Before the impacts of the identified problem are presented, the question of what climate change is needs to be answered. As defined by the Intergovernmental Panel on Climate Change (IPCC), it is a change in the state and characteristics of the climate that persists over an extended period of time, decades or longer. This refers to any change in climate over time, whether as a result of natural change or human activity.

Unfortunately, today, IPCC scientists are in no doubt that it is human activity that contributes enormously to this phenomenon all over the world, as confirmed by the Sixth Assessment Report. IPCC is an advisory body to the United Nations, dedicated to providing scientific data and information on climate change. It was founded to regularly provide policymakers with scientific assessments of climate change, its effects, and possible threats in the future, as well as to provide solutions for adaptation and mitigation. The main documents published by the IPCC are „Assessment Reports". The purpose of IPCC's reports is to offer a complete, impartial examination of the current research on the nature and causes of climate change, its potential environmental and socioeconomic implications, and viable response choices. In its assessments, the IPCC follows a policy of using only publicly available scientific and technological data. Although expert meetings and workshops may be arranged in advance of an assessment to give feedback on specific concerns, the IPCC does not conduct research to assist the process[1]. There are three working groups within the IPCC: first handles the Physical Basis of Climate Change, second - Climate Impacts, Adaptation and Vulnerability, and Climate Change Mitigation. Furthermore, there is the Task Force, whose aim is to create and enhance the technique for estimating and reporting national greenhouse gas emissions and removals[2].

Until today, 6 reports have been prepared. Since the time of the first report, its rhetoric has clearly evolved, reflecting the growing evidence of observation and the progress of scientific research on climate change[3]. The first report, published in 1990, read about "little evidence of a distinct human effect on the climate". The second IPCC report, issued in 1996, already mentioned "the distinct human impact". The third report, issued in 2001, made a much stronger statement: "Most of the observed warming in the last 50 years is probably the result of an

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[1] *Climate Change Assessments: Review of the Processes & Procedures of the IPCC,* 2010, https://archive.ipcc.ch/pdf/IAC_report/IAC%20Report.pdf2010, (date of access: 12.02.2022).

[2] About the IPCC, https://www.ipcc.ch/about/, (date of access: 23.02.2022).

[3] Kundzewicz Z., Kowalczak P. (2008). *Zmiany klimatu i ich skutki*, Warszawa.

increase in the atmospheric concentration of greenhouse gases[4]". Finally, the latest, sixth IPCC report, published in 2021 even more clearly than the previous ones, emphasizes the undeniable influence of man on heating the atmosphere, oceans and land caused by greenhouse gas emissions. Human activities that exacerbate climate warming include: burning of fossil fuels both for transport and energy production, deforestation and associated with this process land use changes, industry, and livestock production, primarily cattle breeding. With each successive increase in global warming, the changes in heat extremes, including heatwaves, are getting bigger. Each additional 0.5°C of global warming contributes to the occurrence of agricultural and environmental droughts, as well as other extreme events such as rainstorms and tropical cyclones.

Moreover, global warming is contributing to the rising sea level. First of all, when the temperature is warmer, ice from the Greenland and Antarctic ice sheets melts, as well as ice from mountain glaciers - a process that now accounts for more than half of sea level rise. There is also a warming of seawater - as the water warms up, thermal expansion occurs, with the consequence that it takes up more surface area[5]. As long as the world does not exceed a temperature increase of 1.5 - 2°C, which would accelerate the increase in natural CO2 emissions, sea level changes are slow - with the current concentration of greenhouse gases, sea level is rising by about 3 mm per year - however, even such a slow rise in sea level translates, inter alia, to the level of winter storm surges caused by wind and waves[6].

3.2 Climate change in the local context

The aforementioned processes can already be felt during our lifetime, in the most vulnerable areas, such as coastal zones. Due to their location and terrain, Gdańsk is a city particularly sensitive to the effects of climate change. All the analyses carried out by the staff of the City Climate Change Adaptation Plan, as well as the recorded effects of natural hazards, show that the most serious threat to the city of Gdańsk is mainly the occurrence of flash floods, riverine floods and storm surges.

Strong wind gusts and rising sea levels also contribute to increased ingression of seawater into usable aquifers. Freshwater sources close to the sea can become so saline as to be unusable, and water supplies will deplete. Another consequence is changes in surface water runoff, which can cause landslides that threaten buildings or communication or transport infrastructure.

The second most significant threat identified in Gdańsk's Climate Change Adaptation Plan, which affects the functioning of the city, is the occurrence of intense thunderstorms and heavy rainfall. The city of Gdansk has repeatedly fallen victim to heavy rainfall. Although new

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[4] Kundzewicz Z. (2011). *Zmiany klimatu, ich przyczyny i skutki – obserwacje i projekcje,* Landform Analysis, Vol. 15 (pp. 39–49), http://geoinfo.amu.edu.pl/sgp/la/la15/la15_39-49.pdf, (date of access: 24.02.2022).

[5] Marcin Wandałowski's interview with prof. Jacek Piskozub from the Institute of Oceanology of the Polish Academy of Sciences, newsletter „Thinkletter - Idee dla Pomorza", published by the Gdańsk Institute for Market Economics.

[6] *Ibidem.*

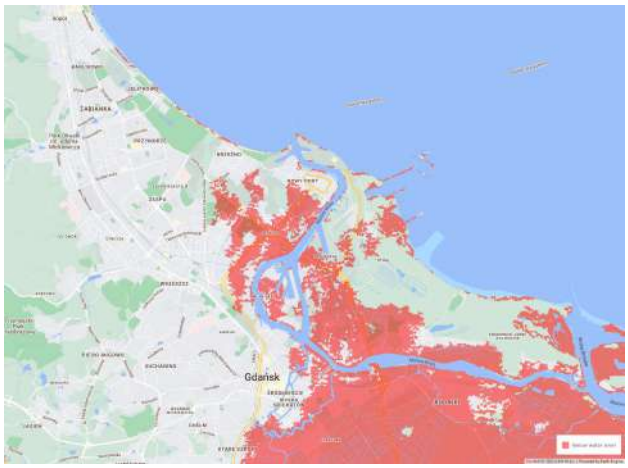

Fig.3.1. Map of projected flooding risk in the event of a 1.0m sea level rise.
Source: https://coastal.climatecentral.org

flood protection measures such as the reconstruction of the Radunia Canal and the construction of new retention reservoirs were introduced after the torrential downpour of the century in 2001, they did not improve the situation enough to avoid future flooding. In 2016, a storm passed over the city, which paralysed the lower terrace of the city. What's more, during the summer, the city is regularly waterlogged locally.

Moreover, the rapid and inconsiderate process of urbanisation has a number of negative consequences, including: excessive sealing of urban surfaces, resulting in an increase in the volume and velocity of surface run-off, overloading of the sewerage network and, consequently, an increased risk of flooding and waterlogging. Although this process occurs on a worldwide level, it is particularly evident in Polish cities. Gdańsk is not very highly urbanized. Due to the city's ongoing development, significant new housing are being constructed. The number of dwellings completed in Gdansk has been increasing steadily since 2000, with over 242,000 completed in 2020, which is over 50,000 more than ten years before[7]. Unfortunately, the majority of projects are centered on the developer's rapid profit rather than the greenery that will

Fig.3.2. Flooded intersection of Grunwaldzka, Żołnierzy Wyklętych avenues in 2016 (left), photography by P. Hukało, source: https://dziennikbaltycki.pl/wielka-ulewa-w-gdansku-w-2016-r-trzy-lata-temu-deszcz-zatopil-wiele-ulic-miasta-zdjecia-wideo/ga/c1-12255725/zd/24618076, Flooded intersection of Nowe Ogrody, 3 Maja, Hucisko streets in 2018 (right), source: https://www.trojmiasto.pl/wiadomosci/Krotka-ulewa-i-centrum-Gdanska-pod-woda-Jak-temu-zaradzic-n126143.html

[7] Gdańsk w liczbach: zasoby mieszkaniowe, https://www.gdansk.pl/gdansk-w-liczbach/nieruchomosci,a,108054, (date of access: 25.03.2022).

connect the local ecology to the entire urban area. The majority of private investors in Tricity only follow the rules in the design phase, and already during the realisation of the project partial assumptions are not realised, due to barriers, as the investors explain themselves. What is more, often the designed greenery is lost through neglect, after the project is handed over, at first glance the greenery is preserved, diverse, but after a few months, due to lack of care or lack of opportunity for trees to grow by concreting around, the vegetation dies.

Fig.3.3. Podmłyńska street before revitalisation (left) photography by Ł. Unterschuetz, source Trojmiasto.pl, Podmłyńska street after the revitalisation (right), photography by P. Hukało, source Trojmiasto.pl

Another issue concern decrease in biologically active surfaces during revitalization processes. This applies mainly to the formal public spaces of cities: markets, squares or pedestrian areas. As a part of the framework, many revitalized areas are „modernized” by covering the surface in concrete. Examples in Polish cities are numerous, one of a good example of a bad design practice is revitalized in 2020 Ruch Młodej Polski Square in the centre of Gdańsk. Single trees rooted inside a concrete flooring, only a year after the finalization of the project, has dried out. This example shows that plants in small areas or only individual trees are unable to adapt to bad conditions and often die.

An often used argument in favour of such an investment is the inclusiveness of movement on such surfaces, and economic costs of maintenance. Although, the paving of before mentioned area may be justified by the high pedestrian flow, as it is the city centre and an area of increased tourist traffic, this example, and the current trend, indicates that we are concreting more land than we are naturalising, even in climate-challenged cities like Gdańsk.

I - THEORETICAL & RESEARCH PART

4. Modern history of the ecological paradigm

Progressive industrialization and the great increase in population in the second half of the twentieth century caused irrefutable changes in the appearance and functioning of cities around the world. The increase in demand for raw materials or food production, combined with the free market system and the globalization process, only deepened the inconsistencies between cities, as well as within them. Moreover, a mutually reinforcing consumption and economy contributed to the depletion of natural resources[8]. The expanding social, economic, and environmental concerns in cities have prompted dozens of new movements, initiatives, and declarations advocating ecology and sustainable development. For the purposes of this paper, the history of the most important events that shaped today's understanding of ecology in the context of urban planning will be presented.

4.1 Man and the Biosphere

The concept of sustainable development began to take shape during the meeting of the first **UNESCO International Conference of Scientific Experts** in 1968. The conference was devoted to the study of the relationship between the environment and development. Its result was the creation of the international, interdisciplinary program "**Man and the Biosphere**" (MAB). Its goal was to achieve a balance of social and economic growth while preserving local cultural values and protecting the natural environment and ecosystems[9].

Then, one of the turning points in the history of shaping the concepts of sustainable development that should be noted was **U'Thant's speech** presented at the General Assembly nr 2390 session in 1969. The then Secretary-General of the United Nations initiated discussions on the interrelationships between the environment and the further economic development of the world. He presented the first document in the world that indicated a significant degradation of the environment on a global scale and documented this thesis with alarmist statistical data. Report „The problems of human environment" had been calling for international action to protect ecosystems and cooperation between member states in counteracting the dangerous consequences of environmental destruction.[10] In the context of urban issues, U'Thant's report raised almost the same problems that were contained in the **Athens Charter of 1933**, which was a reaction to the chaotic urbanization, lack of access to green spaces and industrialization which destroyed the former harmony of the urban fabric and is not related to the requirements of the environment protection.

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[8] Sas-Bojarska, A., Walewska, A. (2013). Od garden city do ecocite. In P. Lorens, I. Mironowicz (Ed.), *Wybrane teorie współczesnej urbanistyki,* pp. 133.

[9] Hadley M. (2006). A practical ecology: The man and the biosphere (MAB) programme, In P. Petitjean, V. Zharov, G. Glaser, J. Richardson, B. de Padirac, G. Archibald (Ed.), *Sixty Years of Science at UNESCO 1945– 2005,* pp. 260–296.

[10] *The Human Environment,* Bulletin of Peace Proposals, vol. 1, no. 1,1970, pp. 102–111, doi: 10.1177/096701067000100112.

Publishing of the report has contributed to the creation, convened 3 years later, **United Nations Conference on the Human Environment.** It was the first time that the environment was a significant topic at an international summit. **The Stockholm Declaration (1972)** represented the beginning of discourse between developed and developing countries on the relationship between economic expansion, global well-being and pollution of the oceans, water and air[11]. Actions for environmental protection were recognized as one of the basic functions of the state, and the term environmental protection policy was created.

4.2 Our Common Future 1987

Another landmark event, in terms of environmental protection was in 1987, when the World Commission on Environment and Development published the „**Our Common Future**" report. The report is sometimes referred to as the "**Brundtland repor**t" because former Norwegian Prime Minister Gro Harlem Brundtland served as the chairman of the committee. One of the most important findings of the report, in retrospect, was the accurate definition of the term "sustainable development," which is now frequently used. Defined by Brundtland, sustainable development is: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[12].

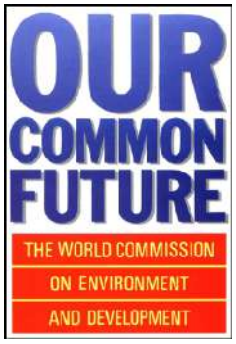

Fig.4.1. Our Common Future cover by Oxford University Press, 1987

The report emphasized that creating a fully sustainable model of life, i.e. improving the quality of life for people around the world without the destructive exploitation of the Earth's natural resources, requires different activities in individual regions of the world[13]. Environment and development are inextricably linked, so development cannot come at the expense of exploiting natural resources. Environmental and development issues cannot be dealt with in isolation, by separate institutions or policy[14]. The paper was widely translated and contributed to the establishment in 1988 of the, mentioned in the previous chapter, **Intergovernmental Panel**

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[11] United Nations Conference on the Human Environment, https://www.un.org/en/conferences/environment/stockholm1972, (date of access 14.03.2022).

[12] Report of the World Commission on Environment and Development: Our Common Future, (pp. 16), https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf, (date of access: 17.03.2022).

[13] UNESCO a Dekada Edukacji dla Zrównoważonego Rozwoju, https://www.unesco.pl/edukacja/dekada-edukacji-nt-zrownowazonego-rozwoju/unesco-a-zrownowazony-rozwoj/, (date of access 22.03.2022).

[14] Our Common Future, op.cit., pp. 61.

on Climate Change, but was also used used as the foundation document for the **1992 Earth Summit in Rio de Janeiro**, which resulted in the establishment of the **UN Commission on Sustainable Development** later that year.

4.3 Rio de Janeiro 1992, Agenda 21

The final document of the conference in Rio de Janeiro is the interdisciplinary program of activities of global, national and local United Nations organizations in every area where humans have an impact on the environment. Its signatories are 172 UN countries, including Poland. The Rio conference was politically groundbreaking, **Agenda 21** not only proposed general solutions for improving the state of the environment on a global scale, but also stimulated a systemic approach to local problems in relation to the global situation. According to its assumptions, starting from 1996, local authorities together with residents should create local ecological programs, the so-called **Local Agendas 21**. Cities and agglomerations are described in Agenda 21 as sites where action should be taken first. Environmental effects of urban expansion must be considered, not only of local interest. Because cities and metropolises are rapidly increasing, changes in the approach to urbanization must occur quickly. The issue of squalid housing and urban poverty, which contribute significantly to many diseases, was also explored[15].

Fig.4.2. Poster of Earth Summit in 1992 (left), cover of Agenda 21 (right)

4.4 New Athens Charter

In 1998, the European Council of Town Planners published the **New Athens Charter: The Charter of European Cities for the 21st Century**, replacing the aforementioned Athens Charter from 1993. Already in its introduction we read about the enormous importance of spatial planning for the delivery of sustainable development. In particular, it is noted that land and space is a finite natural resource for which demand continues to grow. The ECTP Charter must be contrasted with the original Athens Charter of 1933, which featured a vision of how European cities should evolve, with dense living and working zones connected by highly efficient mass transportation systems. In contrast, the New Charter and this assessment place a greater emphasis on the city's citizens and users, as well as their requirements in a constantly changing world. This is related to the fact that cities house approximately three-quarters of the European population. It was decided at that time that the ECTP will review and amend the Charter every four years. The result of one of the updates is the **New Athens Charter from 2003**. The

[15] Sas-Bojarska A., Walewska A., *op.cit.*, pp. 133.

updated charter advocates a vision of The Connected City, which may be realized via spatial planners, and other professionals. It incorporates new governance systems and methods for incorporating citizens in decision-making processes, leveraging new forms of communication and technology. Simultaneously, it is a practical vision, differentiating between those parts of city growth where planning may have a significant impact and others where it has a limited impact[16].

4.5 Leipzig Charter

Its very name shows how important it has been in the sustainable development discourse. **The Leipzig Charter for Sustainable European Cities** is a 2007 document of the EU Member States that inspired the development of more sustainable urban policies in Europe and worldwide. The Charter emphasises the role of cities as centres of immense economic, cultural and social value. Its main objective was to promote integrated sustainable urban development. In addition, the following reccomendations were made: improving the physical conditions of urban space, ensuring high quality public spaces, focusing on the poorest neighbourhoods in the context of the city as a whole, upgrading infrastructure networks and improving energy efficiency; policies promoting innovation and education; strengthening the local economy; planning efficient and accessible urban transport[17].

Mention should further be made of its updated version, **The New Leipzig Charter**, which was adopted at the Informal Ministerial Meeting on Urban Matters in 2020. It builds on the earlier version but take into account new concerns for cities that have emerged with the development of technology and social transformation[18].

4.6 Earth Summit Rio +20, 2012

Twenty years after the previous conference in Rio de Janerio, representatives of over 100 countries met at the next Earth Summit in Rio de Janeiro, entitled "**Rio +20**". In the 20 years that have passed since Agenda 21, the number of people in the world has increased from 5.5 billion to almost 7 billion, and with it the scale of the world's problems has also increased, including national poverty affecting every fifth world citizen, the existence of 2.5 billion people without access to basic sanitation, increasing greenhouse gas emissions, threatening the

Fig.4.3. Logo of the Earth Summit Rio+20 in 2012

[16] The New Charter of Athens: The European Council of Town Planners' Vision for Cities in the 21st century (2003).

[17] Leipzig Charter on Sustainable European Cities (2007), https://ec.europa.eu/regional_policy/sources/activity/urban/leipzig_charter.pdf, (date of access: 20.04.2022).

[18] New Leipzig Charter - The transformative power of cities for the common good (2020), pp. 2.

extinction of a third of species living on the planet. At the "Rio +20" Summit, several hundred commitments were made, including: shaping more friendly and efficiently functioning urban organisms, spreading the idea of sustainable mobility and using renewable energy sources on a larger scale.

During the opening of the Summit, Irina Books, UNESCO Director-General of that time, said: “A new direction of development is needed. For UNESCO, the green economy is not enough. The future we want is a fair green society with equal opportunities. Achieving sustainability requires much more than investing green in green and reducing carbon dioxide emissions. Besides the economic and environmental dimensions, there is a very important human and social dimension to success.” In her remark, one can see how non-governmental groups are paying attention to how the idea of sustainable development may be extended to the green economy, which from a contemporary viewpoint is a step towards the idea of regenerative development. Investing in science, technology, and innovation to foster "green solutions" to local and global problems; promoting integrated policies for green societies through social innovation, resilience, and social inclusion, were just a few of the ways she described UNESCO's work to create green societies[19]. Recognition of social structures and cultural concerns as an inherent part of ecosystems is a key component of the regenerative paradigm.

4.7 Sustainable Development Goals of United Nations 2015

Another opportunity to deliberate sustainable development was a three-day summit at United Nations Headquarters in New York in 2015. An ambitious new agenda for sustainable development was publicly approved in front of more than 150 international leaders. At the meeting, all UN member states unanimously adopted the resolution "Transforming our world: the 2030 Agenda for Sustainable Development", which resulted in the creation of the world development strategy called "**Agenda 2030**". It is a continuation of Agenda 21, which set forth 21 goals under the banner of the Millennium Development Goals at the Rio de Janeiro UN summit in 1992 and then incorporated into the UN Millennium Declaration in 2000. The new ambitious plan sets out **17 Sustainable Development Goals** and 169 related goals to be achieved by the world by 2030 in order to alleviate poverty, safeguard the environment, and guarantee that everyone lives in peace and prosperity. The 15-year plan have been divided into 5 groups - the so-called 5xP that stand for: people, prosperity, peace, partnership and planet.

In the context of the subject matter of this work, despite important other goals, the most crucial goal to discuss is goal nr 11: „sustainable cities and communities: make cities and human settlements inclusive, safe, resilient and sustainable” and goal nr 13: „take urgent action to combat climate change and its impacts”. The tasks aimed at achieving this goal include strengthening inclusive and sustainable urbanization and the capacity for participatory, integrated and sustainable planning and management of settlements in all countries. Objective

[19] UNESCO Director-General Outlines Preparations for Rio+20, https://sdg.iisd.org/news/unesco-director-general-outlines-preparations-for-rio20/ (date of access: 25.07.2022).

Fig.4.4. The Sustainable Development Goals, United Nations

11 strongly emphasized the role of multi-stakeholder, active participation in the development process and institutional strengthening of social involvement[20].

The focus of the agenda on all countries and their internal socio-economic policies was to make the agreement universal and based on shared responsibility. It was decided to designate a sustainable and environmentally friendly socio-economic and environmental management system, regardless of the socio-political and economic systems of the signatory states. In principle, such a complexity of the 2030 Agenda should allow for better implementation of measures to inhibit climate change.

Nevertheless, it appears that it will be challenging to fully implement all of the 2030 Agenda's objectives, and this uncertainty is further supported by the fact that the less comprehensive Millennium Agenda 21 has not been entirely implemented. It might be difficult to put into action such a vast and global sustainable development plan, especially when it comes to the complete eradication of hunger and poverty. Goal 11 seems to be easier to meet, but the question arises whether universal principles and recommendations are appropriate for a variety of cities around the world, with different potentials, problems, and barriers.

Since this paper focuses on issues relevant for Polish cities, there is a need to expand this topic with how Poland is implementing the Sustainable Development Goals. The Polish government adopted the **Strategy for Responsible Development in 2017**, which defined over 700 measures to strengthen the country's social, economic, environmental and territorial cohesion, as well as indicators to monitor progress in achieving the goals. The strategy, under the leadership of the Ministry of Development, aims to create a new development model for Poland consistent with the global goals of sustainable development. It should cover most areas of the 2030 Agenda, but the OECD report states that some goals received more attention than others. Most of the activities are oriented towards economic growth, the majority of activities is related to SDG 9 (innovation, industry, infrastructure) and SDG 8 (economic growth and decent

[20] The Global Goals: Sustainable cities and communities, https://www.globalgoals.org/goals/11-sustainable-cities-and-communities/, (date of access: 25.07.2022).

work)[21]. There is a need to do more to enhance housing accessibility, lessen cities' negative environmental effects, and generally improve urban residents' quality of life. Despite performing better than the OECD average in terms of the availability of green space (577 m2 per million inhabitants in 2013 compared to the OECD average of 500 m2), a relatively high percentage of the population is exposed to pollution in metropolitan areas (16.4% in 2013 compared to the OECD average of 11.0%), which has a negative impact on health. The proposed solution to this problem is the introduction of fuel standards and taxes on carbon dioxide emissions, while closely monitoring the distribution effects at the national level[22].

As agreed, Poland undertook to report on the implementation of **the Strategy for Responsible Development in 2018**. The Polish report states that the priority of achieving goals 10 and 11 is „the socially sensitive and territorially sustainable development, characterised by a high levels of employment, good quality jobs and a large scale of entrepreneurship, with focus on the importance of all areas, including agglomerations, small towns and rural areas, in the development process. The benefits of economic growth should be available to all, regardless of their place of residence[23]". National priorities constantly emphasize the issue of industrial and technological development, which is to be followed by economic growth, ignoring the issue of environmental protection and combating climate change. Despite the increasing public awareness, the state's priorities have not changed and in the latest SDG target implementation report from 2022, we read that: no progress was observed in the implementation of the 5 out of 17 SDGs. Among them are: sustainable cities and communities (SDG 11), as well as combating climate change (SDG 13). Moreover, the road to achieving the second of mentioned goals is still defined as one of the biggest challenges for Poland[24].

Actions and initiatives to implement Objective 11 on a regional scale are also not consistent with global recommendations. In the Pomorskie Voivodeship, they have been focused on institutions and cultural heritage: efforts to protect cultural diversity, inter-institutional cooperation, as well as to improve accessibility and develop the e-culture offer have been strengthened. No example of a programme supporting resource efficiency or energy transition in cities can be found in the cited documents.

4.8 Paris Agreement

Crucial for the achievement of the Sustainable Development Goals is implementation of **the Paris Agreement**, which is one of the most up-to-date international agreements on climate change mitigation. Adopted at the UN Climate Change Conference (COP21) in 2015, the Paris Agreement is the second binding document, after the **Kyoto Protocol** signed in 1997, uniting all nations in pursuing demands to combat and adapt to climate change. It aims to keep global

[21] Agenda na rzecz zrównoważonego rozwoju 2030: w kierunku pomyślnego wdrażania w Polsce. (2017) OECD, https://www.oecd.org/poland/Better-Policy-Series-Poland-Nov-2017-PL.pdf (access: 14.08.2022).

[22] Ibidem pp. 14

[23] Implementation of the Sustainable Development Goals in Poland: The 2018 National Report, https://sustainabledevelopment.un.org/content/documents/19409Poland_VNR_20180615.pdf, (date of access: 14.08.2022).

[24] Sustainable Development Report (2022), pp. 360 (access: 14.08.2022).

warming far below 2 degrees Celsius, ideally below 1.5, relative to pre-industrial rates.To achieve this long-term temperature goal, governments aspire to minimize global greenhouse gas emissions as soon as feasible to achieve a carbon neutral world by 2050[25].

From 2020 onwards, 191 nations have committed to announcing voluntary targets to reduce greenhouse gas emissions. On the basis of current policies, we are on course to attain 3.5 degrees Celsius of global warming by 2100, much over the maximum aim of 2 degrees, what is more, the world is still far from achieving the goal even if we take into consideration official undertakings, of the amount by which nations want to decrease their emissions in the future[26].

The implementation of the Paris Agreement is hugely influenced by global events. The COVID-19 pandemic and the economic stunting caused by the global lockdown will translate into a minimal reduction in global warming of 0.01 degrees Celsius by 2050[27]. However, the military situation in Europe in 2022 has caused a return to a hazardous trajectory. Russia's invasion of Ukraine and the associated energy market situation are increasing global coal consumption this years, which represents the largest single source of energy-related carbon emissions. According to the latest report from the International Energy Agency, global coal consumption continues to rise and could beat 2013's record consumption[28].

4.9 New Urban Agenda 2016

The document that strengthens the mission of the 2030 Agenda in the field of supporting sustainable urbanization is **New Urban Agenda** launched at the United Nations Habitat III conference in October 2016. Prompted by the majority of people on the planet living in urban settings, the document contains a number of rules that should be followed when creating or managing cities. It pays particular attention to appropriate planning and design in cooperation with stakeholders and urban actors at all levels of government as well as the private sector, which aims to ensure fair, safe, healthy, accessible, affordable, resilient and sustainable cities and human settlements, ensuring that all prosperity and high quality of life. According to the New Urban Agenda the most important are: translation into local policies, particularly those that shape city form, urban mobility, social participation, as well as the implementation of the idea of "smart city" by promoting innovation, data collection and technology development[29].

In Europe, it is important to have the provisions of the Agenda translated to the level of the **EU Urban Agenda**, endorsed in 2016 through **the Amsterdam Pact**, which has been ratified by urban policy ministers from EU member states. The effort is directed towards making

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[25] The Paris Agreement, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement, (date of access: 16.08.2022).

[26] The Paris Agreement: Is The World’s Climate Action Plan on Track?, https://www.visualcapitalist.com/sp/the-paris-agreement-is-the-worlds-climate-action-plan-on-track/, (date of access: 20.08.2022).

[27] Ibidem.

[28] Global coal demand is set to return to its all-time high in 2022, https://www.iea.org/news/global-coal-demand-is-set-to-return-to-its-all-time-high-in-2022, (date of access: 21.08.2022).

[29] New Urban Agenda (2016), http://habitat3.org/wp-content/uploads/NUA-English.pdf, (date of access: 22.08.2022).

the European Urban Agenda a document more focused on making better use of existing financial, legal and knowledge resources, in clearly marked 12 thematic areas.

Fig.4.5. Cover and diagram of the core dimensions of the New Urban Agenda

4.10 Conference of Ministers of Culture in Davos, 2018

The most recent event mentioned in this thesis that notes the link between sustainability and the quality of the built environment is the **Davos Declaration: Towards a high-quality Baukultur for Europe** adopted by European Ministers of Culture in January 2018. Derived from the name of a Swiss city, the declaration was created as a response to a noticeable trend of decreasing quality of construction and design both in the artificial and open landscapes, among them, a disregard for sustainability across Europe[30]. The headword of the Davos Declaration is the German term "**Baukultur**" - a broad term for a building culture that combines the comprehensive design approach typical of the sustainable approach, with an emphasis on the social and psychological needs of people.

In order to strengthen the scientific and political dialogue of the Davos Declaration the "**Davos Baukultur Quality System**" handbook was developed, aimed at professionals such as i.e. public authorities, planning and design professionals or developers and investors. Eight criteria serve as the guide's foundation: diversity, governance, environment, context,

Fig.4.6. Cover of Davos Baukultur Quality System. Eight criteria for a high-quality Baukultur, source: https://issuu.com/bak-ofc-ufc/docs/01-en_davos_baukultur_kurzbroschure_web_210428

[30] Davos Declaration: Towards a high-quality *Baukultur* for Europe (2018), https://baukultur--production--storage.s3.amazonaws.com/baukultur/2022-06-09-081317--davos-declaration.pdf, (date of access: 23.08.2022).

functionality, beauty, economy and sense of place. What distinguishes this method from the ones presented in this chapter is that, instead of ready-made design solutions, the guide presents questions to ask oneself during the design process in order to ensure the "high quality Baukultur" of a place. In the final chapter, a quality assessment is proposed - the answers to the questions on the form are intended to enable the placement on a scale of fulfillment of the criteria. However, in order to be able to assess the effectiveness of the declaration, there is still time to wait, the signing countries committed to reconvene, no later than in 10 years' time, to discuss the progress made towards achieving a high quality Baukultur in Europe.

4.9 Conclusions

Due to their diversity and complexity, it is impossible to cite all events and documents concerning the concept of sustainability. Their multiplicity could constitute a separate research work. The author has made a subjective selection, referring largely to issues not only related to environmental protection and minimising the effects of climate change, but mainly because of their connection to urban planning and the built environment. The use of a chronological sequence helps to see the causes and effects of the building up of the definition of 'sustainability' in relation to cities as we know them today.

It is difficult not to agree with the postulates of the reviewed papers. However, several concerns arise. Above all, the vagueness of the provisions and their non-binding nature. For example, neither the Agenda nor the Leipzig Charter or Davos Declaration contain any penalties for non-implementation - they contain vague, implementation measures that rely primarily on a commitment by the authors to support or promote the ideas contained therein. Finding measurable, tangible goals or deadlines is futile. All this, despite their plainly positive implications, puts into doubt their usefulness.

Nevertheless, emphasizing the positive impact of the aforementioned events is crucial. Each of them, through an increasingly grand narrative of human impact on the environment and climate change, has led to the state of educational awareness of people in which we now find ourselves.

5. Paradigm shift - beyond sustainability

At the time when international organizations have been meeting at the summits and preparing the documents mentioned in the previous section, in the community of architects and town planners the discussions on the spatial organization of the city in the context of quality of life, securing areas for the development of recreational functions, and the efficiency of transport were taking place.

If we are to understand the changes that have taken place in the domains of spatial planning, architecture, and urbanism over the past 100 years, we must conduct research on the history of sustainability in the built environment. The basis for deliberations on this topic was the classification presented by Shady Attia in the article: „Towards regenerative and positive impact architecture: A comparison of two net zero energy buildings" (Fig.5.1). The author has attempted to relate Attia's classification to the topic of interest of this thesis - paradigms that have dominated urban planning and spatial planning. The selection of the concepts: ecocity, compact city, green city, was based on the "Classification of selected models and concepts of sustainable development" prepared by Mierzejewska in 2010, however, the other distinguished paradigms were intuitively selected by the author.

Fig.5.1 Sustainability paradigms influencing architecture in 20th and 21th century, elaborated by S. Attia (2016)

Paradigm	Years	Influencer	Paradigm
Bioclimatic Architecture	1908–1968	Olgay, Wright, Neutra	Discovery
Environmental Architecture	1969–1972	Ian McHarg	Harmony
Energy Conscious Architecture	1973–1983	AIA, Balcomb, ASES, PLEA	Energy Efficiency
Sustainable Architecture	1984–1993	Brundtland, IEA, Faust	Resource Efficiency
Green Architecture	1993–2006	USGBC, Van der Ryn	Neutrality
Carbon Neutral Architecture	2006–2015	UN IPCC, Mazria	Resilience
Regenerative Architecture	2016–Future	Lyle, Braungart, Benyus	Recovery

Towards the end of the last century, there is a clear shift in cultural paradigms in the approach to city planning. The new, ecological aspect of urban space was first highlighted by Ian McHarg in his well-known book Design with Nature in 1969. Environmental ideas were developed, among others, by representatives of the **ecocity** paradigm. The first reports about this idea come from 1975 and are linked to the establishment of an NGO called Urban Ecology. The activists' activities focused on matters such as urban transport, environmental protection, spatial order and social participation. One of the founders, Richard Register, subsequently defined an ecocity as a location where people may coexist with the environment while significantly decreasing their ecological imprint in his 1987 book, "Ecocity Berkeley: Building cities for a healthy future".

The second distinguished paradigm is the **compact city.** This term was introduced in 1973 by two American mathematicians (G. Dantzing, T. L. Saaty), and popularized among urban planners in the 1980s. The compact city idea placed a strong emphasis on making the most use of the space "within" the city through high building densities, multipurpose neighborhoods and housing developments, and a reliable public transportation network. The major premise was to prevent suburbanization processes by making sure that essential social and economic services were close by and readily available where people lived. Reduced energy use and fewer pollution emissions were made possible by the compact design, close proximity to amenities,

and availability of paths for pedestrians and cyclists. The idea of compact city can be found, among others in the writings of M. Jenks, H. Frey, E. Burgess.

The concept that has developed much further in the considerations on the organization of the city as a whole is „**green urbanism**". Beatley, Kahn, Lehmann wrote about it in the early 2000s. Green urbanism stresses the importance of natural resources and processes by applying ecosystem theory. Creating closed circuits in cities, a high level of waste recovery and reuse, the production of energy from renewable sources, and a high proportion of green areas in the city structure are just a few examples of how using solutions that operate in nature and can improve functioning in various areas of city activity.

New urbanism, ca critical response to modernism, was propagated in the 1980s by American architects Elizabeth Plater - Zyberk and Andreas Duany[31]. The "Charter of the New Urbanism," which was translated and published in Poland in 2005, was the idea's manifesto and was accepted in 1996 at the 4th Congress of New Urbanism[32]. The document calls for a return to the traditional urban planning of cities, characterized by compact, multifunctional buildings, creating attractive systems of public spaces, as well as protection of the natural environment and cultural heritage. The implementation of this idea in practice may be numerous projects by Leon Krier, including his most famous construction project of he Poundbury in Great Britain.

Another alternative concept is **sustainable urbanism**. It is defined by Douglas Farr as "walkable and transit-served urbanism integrated with high performance buildings and high-performance infrastructure". Preventing waste and pollution and improving recycling are a few more measures that are highlighted. Through improving the quality of the items that are supplied and by providing greater accessibility to nearby activities and locations the welfare and public health of inhabitants of sustainable cities can be greater[33]. Also, supporters of this paradigm believe that the preservation of green spaces, such as parks and squares in cities and, in a broader sense, woods, farmlands, and landscapes, should go hand in hand with high intensity development.

Similar terms to sustainable urbanism are „green urbanism" and „ecological urbanism", although they might be regarded as putting a greater emphasis on ecosystems and the natural world than on economic, welfare and social factors. The concept quickly spread around the world and found many supporters, among the most important ones describing the concept and strategies of sustainable urban planning are: Steven Egger, Clover Moore, Peter Calthorpe, Steward Pickett et al.

Mentioned above, **ecological urbanism** first emerged in 1998 in a book „EcoUrbanism" written by researcher and architect Miguel Ruano, who defined it as „the development of multi-dimensional sustainable human communities within harmonious and balanced built environments34". This expression was applied later by Jeffrey Hou, and then developed by

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[31] Solarek K. (2011). *Współczesne koncepcje rozwoju miasta*, Kwartalnik Architektury i Urbanistyki, T. 56, z. 4, pp. 57

[32] Karta Nowej Urbanistyki, przekład P. Choynowski, M.M. Mycielski, „Urbanista", 2005, nr 6.

[33] Farr, D. (2008). *Sustainable Urbanism*. Hoboken, New Jersey: Jon Wiley & Sons.

[34] Ruano M., (1998). *Eco-Urbanism: Sustainable Human Settlements, 60 Case Studies*

Mohsen Mostafavi. Ecology is used as inspiration to design cities that are more socially and environmentally responsible. According to this movement's theory, urban initiatives should be planned with the potential and constraints of already-existing natural resources in mind. Ecological urbanism aims to transform the existing linear pattern into a loop, where wastes become energy. These "artificial ecosystem" cities would attain the same interdependent efficiency and life-preserving redundancies as natural ecosystems35. Researches say, that ecological urbanism, which advocates for a more comprehensive approach to the design and administration of cities, is in many respects a development of and critique of „landscape urbanism".

Landscape urbanism is another example of a movement created as a response to modernism, standing in contrast to the idea of "New Urbanism". The most famous representative of this concept is Charles Waldheim, who writes that in order to describe the purpose of the area, the notion of "program" is replaced with "potential" and "environment," and the system of diverse linkages is more frequently examined than a single building[36]. A method of thinking about the complex urban state that may address issues with technical infrastructure, water management, biodiversity, and human activity is offered by landscape urbanism: this method questions and investigates the implications of the the landscape in the urban tissue[37].

The idea of **Smart Cities** emerged with the development of technologies used to create reports and collect data in the 1960s and 1970s. The term was first used when the US Community Analysis Bureau began using databases and aerial photographs as a disaster prediction solution[38]. This contributed to the first definition of a smart city - a city where ICT plays a key role in improving the quality of life and achieving economic excellence, sometimes referred to as "open-air computers". The World Bank's definitions states, that smart city is: "a technologically advanced metropolis, with sensors everywhere and extremely effective public services, owing to information that is gathered in real time by thousands of networked devices." Nowadays, the term has changed its meaning somewhat, according to which a smart city today strives for sustainable development. According to the European Commission's definition: „A smart city goes beyond the use of digital technologies for better resource use and less emissions. It means smarter urban transport networks, upgraded water supply and waste disposal facilities and more efficient ways to light and heat buildings (…), safer public spaces and meeting the needs of an ageing population[39]". These are just a few examples of definitions, we can find a large number of them in the literature, and the term itself is likely to evolve with changing external and internal conditions.

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[35] Hagan S. (2015). Ecological urbanism, source: https://www.architectural-review.com/essays/ecological-urbanism, (date of access: 02.09.2022).

[36] Solarek K., *op.cit.*, pp. 62 - 63.

[37] Corner J. (2006). *Terra Fluxus in The Landscape Urbanism Reader,* New York: Princeton Architectural Press.

[38] Monitoring trendów w innowacyjności: raport 12, (2022), pp. 39, https://www.parp.gov.pl/storage/publications/pdf/220627_RAPORT_Monitoring-trendw-w-innowacyjnoci-vol.-12_czerwiec-2022-www.pdf, (date of access: 03.09.2022).

[39] Smart cities, https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en, (date of access: 03.09.2022).

5.1 Conclusions

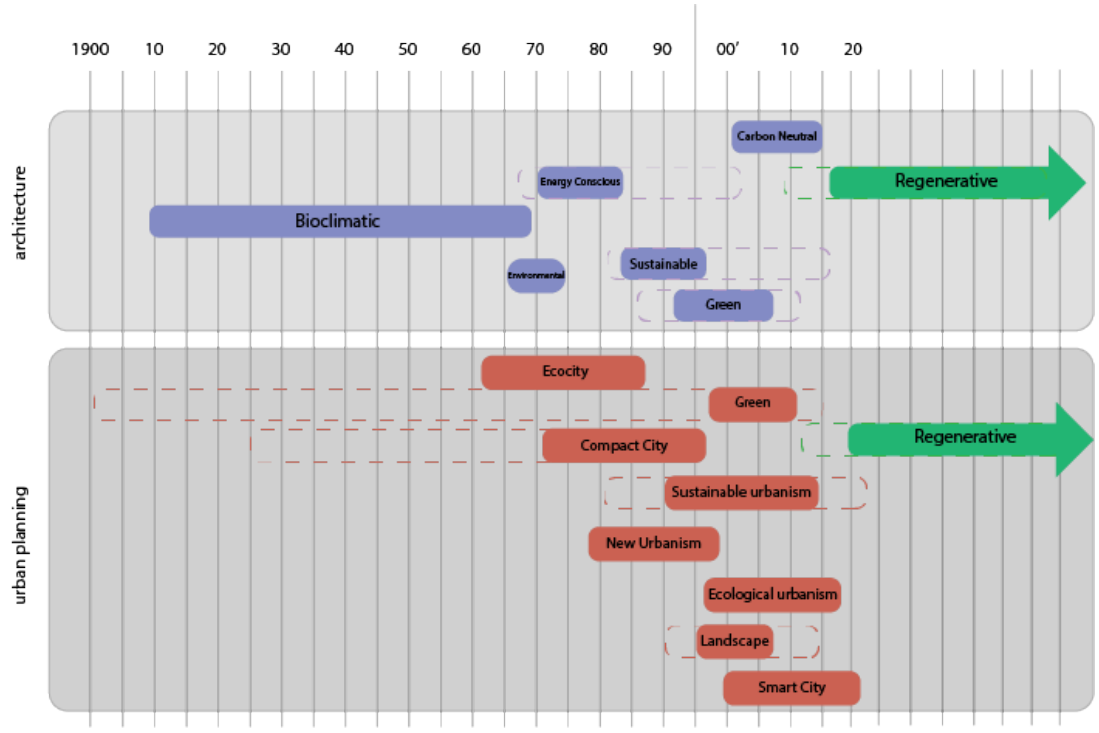

Fig. 5.2. Paradigms placed on a timeline. Own elaboration.

An attempt to summarise this section of work is provided by a graphic (fig. 5.2.) - which aims to facilitate the observation of trends connected to sustainability occurring in the built environment since the 20th century. The timeline juxtaposes the styles dominant in architecture at the time - based on Attia's classification and their urban counterparts - as described in this chapter.

Spreading idea of sustainability has significantly influenced the multiplicity and diversity of concepts. A common element in most contemporary urban design trends, is the essence of an interdisciplinary approach that takes into account the important role of natural conditions and nature-based solutions. On the other hand, the presented urban design paradigms largely differ, and some even contradict each other in their recommendations as to the expected vision of city development. Most of the paradigms are still evolving and researchers are having trouble clearly defining their underpinnings, as well as their duration. This indicates how difficult it is at present to strictly classify and define the identified paradigms. For this reason, the graphic chooses to use dashed lines to show the loosely-defined time frame stated by different researchers.

Perhaps in hindsight, over the next few decades researchers will systematize knowledge on the subject. Currently, we can only observe how trends regarding the built environment are changing and what trends will prevail in the near future. According to the author of the cited classification of paradigms influencing architecture we are on an inevitable road to a new paradigm, which has been called regenerative design.

6. Regenerative design framework and principles

Nowadays cities function as an organism of linear metabolism. The basis for the functioning of cities is the use of huge natural resources and energy, enabling the creation of satisfactory living conditions and carrying out various activities in their area. It is believed that inputs and outputs in urban systems are essentially unrelated. The waste gases produced during the extraction, refinement, and burning of fossil fuels are released into the atmosphere. Raw materials are collected, mixed, and processed to create consumer items, which ultimately become trash and cannot be reabsorbed in a useful way by living nature. Trees are cut down in far-off woods for their lumber or pulp, yet forests are much too frequently not replanted. Similar open-loop process can observed in agriculture: as food is collected, prepared, and consumed, agriculture loses nutrients and carbon. The resultant sewage is subsequently released into rivers and coastal waterways downstream from populated areas, with or without treatment, and is often not transferred back to agriculture[40]. Regenerative design is based on drawing inspiration from nature, which is the best example of how circular metabolism works. There are no landfills in the natural environment, each by-product is used as a resource input to the vital functions of another organism. Regenerative design seeks to see humans and nature as one complex, interconnected system, in which social and natural systems are able to become more viable and robust.

Regenerative design is not a new concept, it is rather a rebirth pattern of thinking: indigenous human settlements had to coexist and adapt to nature in order to develop and live. It is a rediscovered and formulated thought, which is a synthesis of several other fields, such as landscape ecology, geohydrology, landscape architecture, permaculture, regenerative agriculture, general systems theory and cybernetics, living systems theory and thinking, and developmental psychology[41].

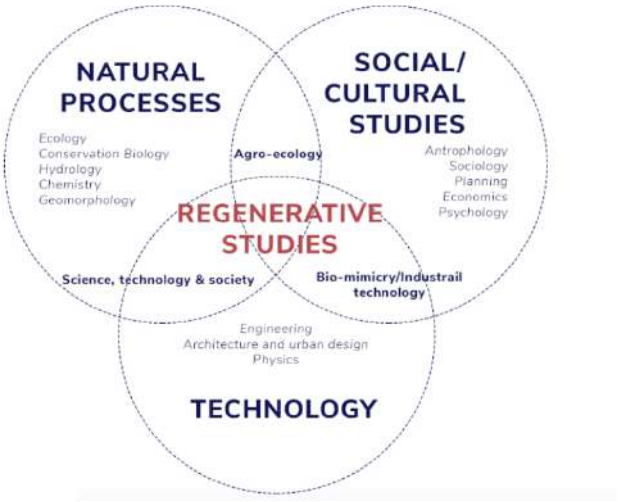

Fig. 6.1. Mapping the territory of regenerative studies. Source: own elaboration, adopted from Lyle Center for Regenerative Studies.

[40] Regenerative Cities, World Future Council, 2016

[41] Pamela M., Reed B. (2012). *Regenerative Development: regenerative development and design*, pp.15

The first formulation of the theoretical and practical foundations for regenerative approaches to the built environment, both its development and design appeared in two different sources in the middle of the 1990s. It was the work of Regenesis Collaborative Development Group and John Tillman Lyle[42]. Their definition emphasizes the role of humans as significant participants influencing the health and prosperity of the network of global living systems, and human development, social structures and cultural issues as an integral part of ecosystems. This viewpoint suggests that whether people engage in these webs as collaborators or exploiters will primarily decide whether the real estate construction sector, which directly relies on them, is sustainable[43].

Nevertheless, miles stone for the regenerative concept widespread use in cities was Girardet's World Future Council brochure, which was later extended and published as a book entitled "Creating Regenerative Cities" in 2015. In 2013 UN-Habitat published a document "The Future We Want, The City We Need", that stated: "The city we need is a regenerative city[44]".

6.1 Fundaments of the regenerative theory

Firstly, both regenerative design and development must be taken into account within the more general theoretical framework of sustainability[45]. It emerged from ecological stream (Fig. 6.2) and leads to a redefinition of the scope of the built environment and its necessary function.

Fig. 6.2. Own elaboration based on article by Mang, P., Reed, B. „Regenerative development and Design" (2012).

It seeks to address the continued degradation of ecosystems by developing the built environment to restore the capacity of ecosystems to function at optimal health for the mutual benefit of both human and non-human lives[46]. This will be made feasible by incorporating eco-friendly technology into a framework that emphasises the environment. As stated by proponents,, the regenerative design relies on a systems-based approach, in which structures and a single buildings are seen as nodes in a system, much like organisms are components of

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[42] *Ibidem.*

[43] Mang N. (2009). Toward a regenerative psychology of urban planning, Saybrook Graduate School and Research Center, http://powersofplace.com/pdfs/ Toward_a_Regenerative_Psychology_of_Urban_Planning.pdf, (date of access: 18.09.2022).

[44] The Future We Want, The City We Need, UN-Habitat (2013), pp. 10 - 11.

[45] DuPlessis C. (2012). Towards a regenerative paradigm for the built environment, Department of Construction Economics, University of Pretoria.

[46] Raymond C. (2012). Transitioning from Green to Regenerative Design. Building Research & Information.

an ecosystem.The objective is to promote intricate interactions between the built environment, the natural world, and the inhabitants of it that are mutually beneficial[47].

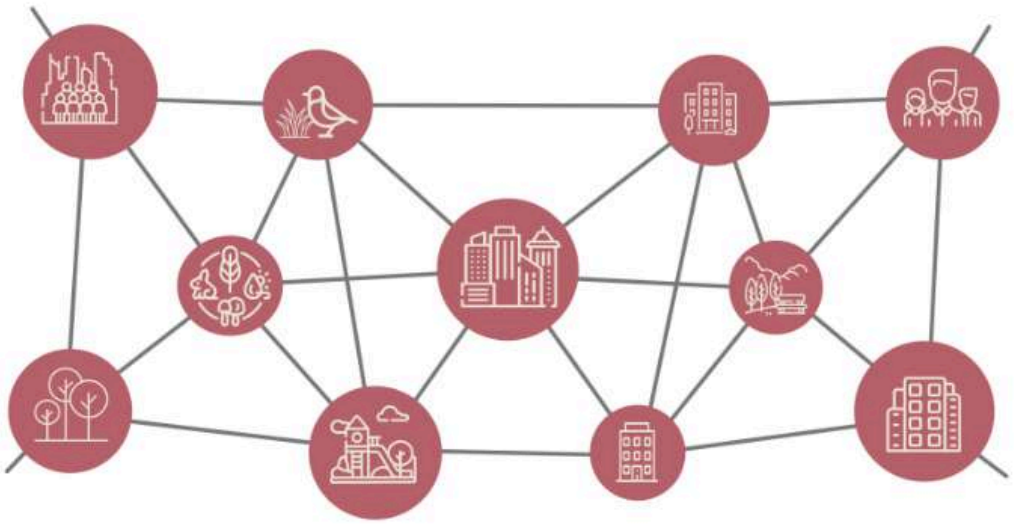

Fig. 6.3. Examples of nodes in urban system, own elaboration.

The regenerative approach emphasizes the contrast between development and design, which are viewed as two independent processes that must operate in tandem to be really effective. Although there is often confusion in the literature around the peculiar character of regenerative development and design, this distinction was clearly highlighted in Jenkin and Pedersen Zari's paper, "Rethinking the Built Environment", where regenerative development is defined as establishing the intended outcome, and regenerative design is defined as the tools to achieve it.

For the purpose of this paper, we will use their definition, as it gives a clarification between design and development, which will make it easier to understand the aim and scope of the second part of this paper. Development is being seen as a broader term, implying a more staggered process, and usually of a larger scale. Development as a longer scale development that moves towards some defined future state. Design is a project, a short-term activity as a tool to reach development.

6.2 What differs regenerative from *sustainable*?

The previous interpretation of sustainability proposed that a transition from the present "unsustainable" condition to the future "sustainable" state could be accomplished by abiding by a predetermined set of guidelines, then, people would concentrate on preserving this idealized situation[48].

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[47] DuPlessis K., *op.cit.*, p.

[48] Zari P., (2012). *Ecosystem services analysis for the design of regenerative built environments*, Building Research and Information, Vol. 40, No. 1, pp. 54-64. Special Issue: Regenerative Design and Development.

A perfect illustration of the answer to this question is the following diagram, adapted from Living Building Challenge. It underlines the fact that, a regenerative approach shifts the focus of sustainable design from slowing down entropy to building the capability of living communities to evolve toward greater value[49], resulting in a positive environmental impact.

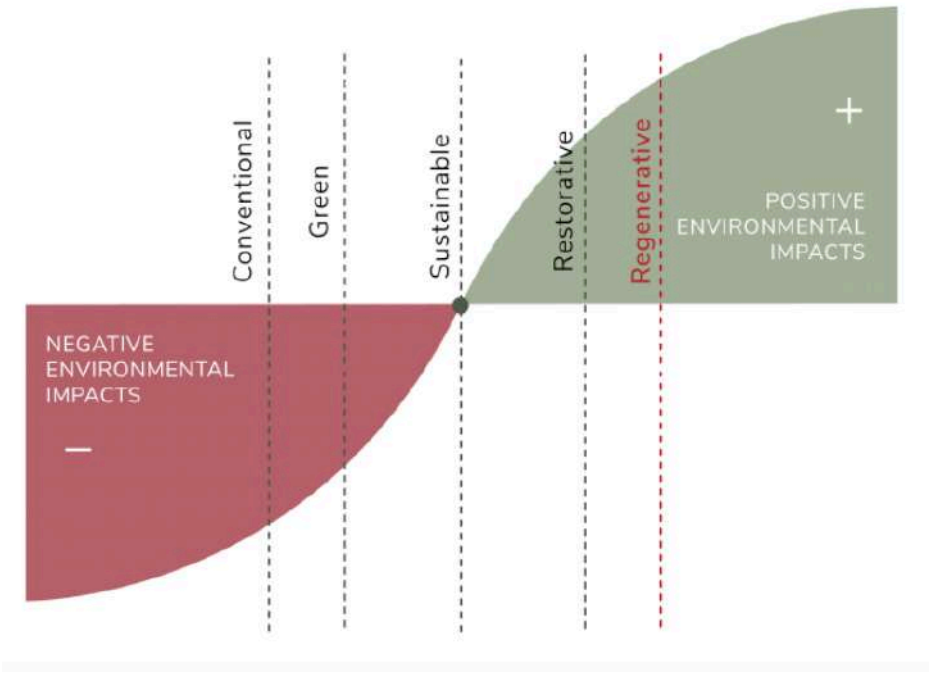

Fig. 6.4. Scheme presenting impacts of building practice, adapted from Living Building Challenge, 2014

Conventional

Conventional is the contemporary building method, which works within the framework of modern thought. The design process is carried out in separation form nature and its effects are destructive. Aim of the design is the most economically-efficient solution for the developer and other actors.

Green

Green design is a slightly improved version of traditional design. Improvements are being made to the damaging structures and paradigms that already exist; for instance, the introduction of solar panels or low-carbon materials can lessen the greenhouse gases emissions.These solutions are more environmentally friendly, but green design does not take into account the overall negative effects it generates.

Sustainable

Sustainable by design is related to its longevity and reduced environmental impact. Professionals work to make projects better than conventional ones, less destructive, but it does

[49] Ibidem, p. 21.

not reverse the damage caused by their activities. Sustainable project's impact is neutral, for this reason, „sustainable" is marked as 0 in the diagram.

Restorative

The next stage is restoring, which is supposed to mean „restoring nature to its original condition", but according to Reed nature is always changing so there is no way to go backwards to restoring, because nature is evolving. By using this method, early interventions are often made to restore the health of an ecological and community subsystem, such as wetlands, forests, riparian corridors, dune systems on beaches, social systems, and so forth. This strategy is biocentric. However, once the human intervention is over and the system's ability for self-organization is activated, individuals stop being engaged. Regeneration and restoration are two distinct ideas that are not interchangeable.

Regenerative

Regenerative design aims to improve the development impact area in addition to restoring. Implemented designs improve the environment compared to those without them. They make new habitats, clean the water, improve the soil, enrich the soil, and establish cultures that can continue the favorable effects. Regenerative projects highlights positive role of humans to play in nature.

7. Regenerative urban design by mimicking ecosystem services

One of the strategies in regenerative design is the method of analyzing ecosystem services. The first step in the method proposed by Pedersen Zari is to examine the ecosystem services provided in a given area before building it up, which then should be compared with the ecosystem services provided by a city or a settlement established later in the same area. The author claims that thanks to such an analysis it is possible to define measurable and tangible indicators of regeneration goals of given projects based on ecological reality. However, to obtain a better understanding of the usefulness of this method, and be able to evaluate it, it is necessary to define what ecosystem services are.

7.1 Urban Ecosystems Services

Urban ecosystems services are the benefits that human populations can derive from ecosystems[50]. These are all features, functions and ecological processes that contribute directly or indirectly not only to the improvement of the quality of human life, but also to sustain the ecosystems themselves. In order to facilitate debates, evaluations, and modeling, categorization

[50] R. Costanza, R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. O'Neill, J. Paruelo, R. Raskin, P. Sutton, M. van den Belt (1997). *The value of the world's ecosystem services and natural capital,* Nature, 387 (15), pp. 253-260.

methods were required to further refine the idea of ecosystem services. In 2005 a classification systems that is used worldwide was completed. The Millennium Ecosystem Assessment connected ecological services and human well-being with socioeconomic considerations and on the basis of that a conceptual framework was established, which divided ecosystem services into the four categories. For each of these groups, the aspects related to urban areas are discussed below:

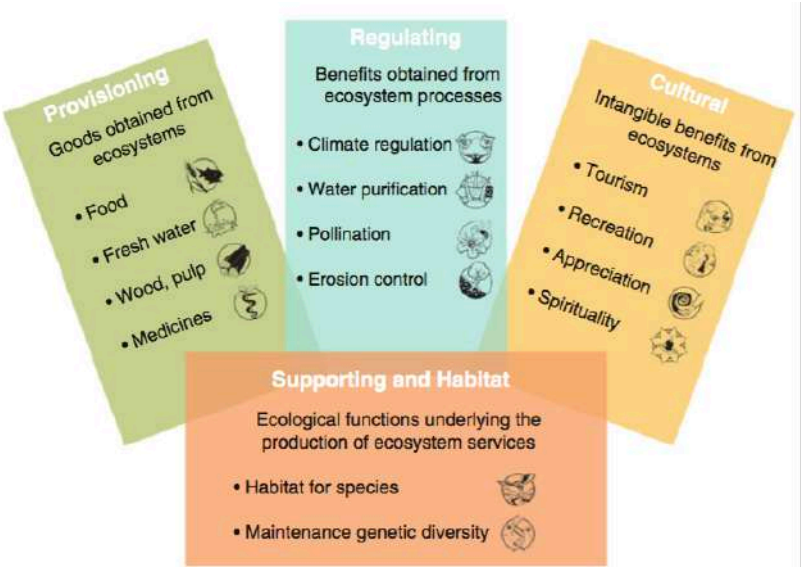

Fig.7.1. Classification of ecosystem services based on the Millennium Ecosystem Assessment (MA 2005) and the Economics of Ecosystems and Biodiversity initiative (TEEB 2012) (Produced by Gómez-Baggethun 2013 with icons designed by Jan Sasse for TEEB

Provisioning services - relate to the production of all products of living organisms that can be used by humans as a source of food, materials or energy. The production and edibility of plant parts provides food as well as a part of medical resources. Food production from urban agriculture can play an important role in food security in the future. It also concerns water supply and retention (surface and underground). Ecosystems provide cities with fresh water for infrastructure and drinking by securing storage and controlled release of water flows. They provide natural resources, for example tree plantations and reed fields, which are construction materials, as well as energy sources without which cities could not function.

Regulating services regulate processes and systems that support life keep them running smoothly. They include, among other things, controlling the climate, preserving the quality of the air, noise reduction and controlling water flow. Urbanization has a strong influence on the local water regime. Permeable surfaces inhibit water infiltration and cause surface runoff, leading to more frequent flooding and overloaded water treatment plants. The capacity of urban soil to filter water is reduced, which favors groundwater contamination. Crucial advantage of this service group is regulation of the temperature in the urban tissue and minimizing the effect of a „heat island". Phenomenon of higher temperature in the city compared with the surroundings is caused by physical properties of materials that cover the surface of city - asphalt, concrete,

roofing felt, dark facades that have a lower albedo, small amounts of biologically active surface and intensified human activity - industry, traffic or heating. Regulation aspects include erosion control, but also pollination without which provisioning services would not exist.

Green spaces, parks, forests, and blue infrastructure are examples of elements of **cultural services**. They are an inseparable element of human well-being. Green and recreational areas have a positive effect not only on physical health, but also on mental health. Being in nature reduces stress, lowers tension and influence level of happiness, as well as increases the place attachment of people to their place of residence. Many scientific research indicate the direct impact of the proximity of a natural landscape on the price of real estate. Today the demand for recreation and landscape amenities in the nearby is rising, that is why housing located near vast natural areas, with access to sunny and quiet places, or located near open bodies of water, or of urban parks is much more expensive[51].

Supporting and habitat services emphasizes the role of ecosystems as a habitat for numerous species of plants, birds, amphibians, and insects. They provide living spaces and all the resources needed. Urban systems aren't just a habitat for human beings, but also a diversity of breeds of animals or plants. Essentially we should provide breeding places for migratory species and to protect the gene pool. Biodiversity is the key to the functioning of the entire natural system, which people are a part of.

[51] Schaerer C., Baranzini A., Ramirez J., Thalmann P., *Using the hedonic approach to value natural land uses in an urban area: An application to Geneva and Zurich. Public Econ*

8. Method: Case studies

A high number of ecological districts or low carbon communities can be found around the world. Nevertheless, the amount of integrated high-efficiency examples that can provide not only reduced impact but also regenerative development is proportionately low. The methodology of this chapter is based on the analysis and evaluation of examples of regenerative neighborhoods in Europe.

8. 1 Hammarby Sjöstad in Stockholm, Sweden

The first case study was selected as an example of good design practice in the context of this thesis, due to the micro-scale of the project, which focus on district and neighborhood level. Moreover, it is a world famous example of a prosperous new urban area with sustainable approach.

Hammarby Sjöstad is a modern housing development built-up on brown fields in the south-eastern part of Stockholm. It owes its name to its location near Lake Hammarby Sjö. At the beginning of the 20th century, the area was polluted and degraded the home of workers' families. To avoid a natural disaster, the authorities decided to buy the area and create a housing estate the main purpose of which will be to create a circular resource loop and reduce the negative impact on the environment in comparison to typical housing estates of the 1990s. Jan Inge-Hagström, Stockholm's Chief Planner, in 1994 has created a strategic masterplan for a mixed-use residential neighborhood with the assumption that the designed urban interiors are to be adapted to the needs of residents, but above all to shape their habits in the field of transport, consumption and waste sorting. Following that, a design code was used to verify that the plan's general character was carried out in practice. From the beginning, the planning process was the result of the integrated work of many actors, such as municipal authorities, urban planners, developers, architects, landscape architects, engineers at eco-tech businesses, as well as, local energy company Fortum and the Stockholm Water Company.[52]

Nowadays, Hammarby is a modernized, block-based, residential neighbourhood with water vistas and green parks. Despite the location outside of the city, the buildings are designed to be urban, adhering to Stockholm City requirements for street width (18m), block sizes (70x100m), density mix, and functional land use[53]. The hierarchy of public spaces and the buildings next to it is preserved in the urban form. As a result, along the avenue, large-scale multi-functional buildings have been constructed, with small-scale backstreet and courtyard residences constructed between the dock and the park promenade. The landscape near the canals, Sickla Udde, and Sickla Kanal is more intimate and small-scale, with natural shorelines (Gaffney A., 2007). Also, the height of building varies from 4 to 5 floors buildings along the Sickla Canal to 6 to 8 floors buildings along the main avenue, to provide attractive view to the

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[52] Hammarby Sjöstad, https://www.urbangreenbluegrids.com/projects/hammarby-sjostad-stockholm-sweden/, (date of access: 30.03.2022).

53 Gaffney, A, Huang, V, Maravilla, K, Soubotin, N. (2007), *Hammarby Sjostad Stockholm, Sweden: A Case Stud*y, CP 249 Urban Design in Planning, http://www.aeg7.com/assets/publications/hammarby%20sjostad.pdf, (date of access: 24.04.2022).

max of the inhabitants.[54] The majority of balconies and terraces face the streets, seaside pathways, and open areas. Many of these flats are built in a semi-open block format, allowing for easy access to the residential towers' planned courtyards (CABE 2007). Architecture style of the buildings refers to Hammarby Sjöstad's natural environment, it is particularly visible in the selection of materials, mainly glass, wood and stone were used. On the ground floors of the buildings there are commercial, leisure and social premises, and in the entire area there are also public facilities such as a sports centre, including a ski slope, a church or educational institutions. Exceptional facility is an environmental centre called GlashusEtt that provides communities with information and education on all elements of sustainable urban development. All this aspects make a Hammarby a living social space of good quality.

The main goal of the project was promoting environmental and social sustainability (Grönlund, 2011). Aims of the project relates well to the Sustainable Development Goals of the UN: apart of target to create safe, resilient and sustainable neighborhood (SDG 11) and create Sustainable consumption and production (SDG 12) some of the issues are also focusing on water management (SDG 6), ensuring green spaces, habitats and improving biodiversity (SDG 15). One of the elements that made Hammarby a recognizable example of a contemporary ecological estate in the international arena is the created eco-cycle model, which describes environmental solutions used for energy, water, sewage and waste management. It has been developed on the national level however, all of the water, waste, and energy companies collaborated to create it, with the goal of implementing or maintaining existing expedient solutions for interconnecting their particular infrastructures and flows[55].

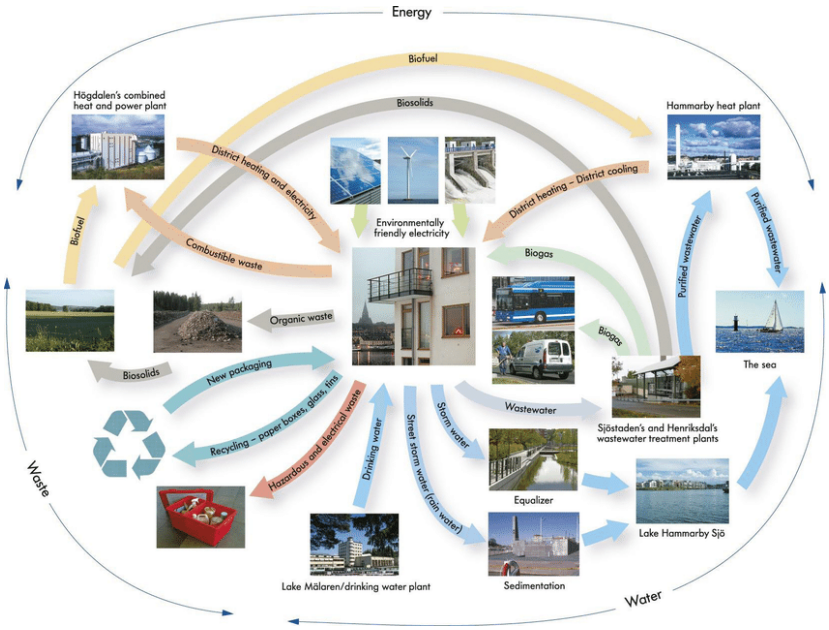

Fig. 8.1.The Hammarby Model, author: Lena Wettrén, source: www.hammarbysjostad.se

[54] Commission for Architecture and the Built Environment, Hammarby Sjostad, Stockholm: Case Study, https://webarchive.nationalarchives.gov.uk/ukgwa/20110118184847/http://www.cabe.org.uk/case-studies/hammarby-sjostad/description, (date of access: 24.04.2022).

[55] Rutherford J. (2013), Hammarby Sjöstad and the Rebundling of Infrastructure Systems in Stockholm. First draft - discussion paper for the Chaire Ville seminare Paris.

The housing estate is powered by geothermal power and renewable energy sources from solar panels on residential building's roofs. An interesting solution was used in the case of waste collection. To reduce the amount of carbon emissions from transportation of the waste management, an infrastructure system that suctions waste to the utilization plant has been built. In addition, there are stations located in the estate for precise sorting of waste, ranging from everyday to major waste. (Stockholms Stad, 2011).

In the Hammarby model, a lot of emphasis is placed on local management, and it is no different in the case of water management. Drainage water in particular is being cleansed and cared locally. Rainwater, for example, is channeled through a sand filtration system that cleanses the water before it is discharged into Hammarby Lake. Another form of rainwater management is the installation of roof gardens on top of buildings. Rainwater is absorbed into the plants on the rooftops in this manner. (Gaffney A., 2007).

Over the years of the estate's construction, numerous independent studies and reports were created to check whether Hammarby was meeting its ambitious environmental goals, for example Jernberg and study. It says that: in 2015, renewable energy accounted for almost 80% of total energy consumption in Hammarby Sjöstad. According to the study, the following overall goals have been met: all contaminated soils have been sanitized (soil remediation goal); 100 percent of all development land has been adapted to the district (land use goal); the majority of commuters walk, cycle, or take public transportation (transportation goal); the goal to purify water has been nearly achieved, and 90 percent of local waste collection traffic has been eliminated and the goal to purify water has been nearly achieved (water and waste goal). The energy objective has not yet been fully realized, but the average energy consumption of 118kWh/m2 is still better than the 150kWh/m2 standard for building at the time (energy target), and the overall consumption is still lower than the Stockholm average[56].

Despite the estate's many advantages and creative solutions, there remain some voices of opposition. First and foremost, there is mention of high apartment costs and a shortage of cheap rental flats, resulting in limited ethnic variety and a largely income-segregated neighborhood. Another issue mentioned is that as long as Lake City's waste-food cycle is not adequately developed on micro-regional and local dimensions, the entire sustainability idea is in danger. Also, in comparison to the ordinary Swedish cities, Hammarby now provides a more sustainable framework for everyday living, but it scarcely challenges its residents to live more robust lives.

To conclude, it can be assumed that the main component of Hammarby's success was the cooperation of many stakeholders with a high level of local government leadership. The focus was not only on lowering carbon emissions, but also creating green spaces for biodiversity and a better quality of life for residents. Futhermore, it is adressing the following ecosystem service categories: provisioning (water, biofuel), regulating (flood control) and cultural.

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[56] Jernberg J., Hedenskog S., Huang C. (2015), *Hammarby Sjöstad: An urban development case study of Hammarby, Sjöstad in Sweden, Stockholm*, https://energyinnovation.org/wp-content/uploads/2015/12/Hammarby-Sjostad.pdf, (date of access: 1.05.2022).

9. Conclusions of the theoretical part

It can be concluded that over the years different theories have been born, proposing different approaches to shaping urban areas in the spirit of sustainability.

The damage reduction paradigm has profoundly influenced sustainable urbanisation. Regenerative urbanism, in contrast, aims to produce net benefits for both people and the environment. The understanding that all human endeavours are directly related to and reliant on "nature" is another essential component of regenerative urbanism. Unfortunately, an analysis of global landmark events and documents in the context of the built environment indicates that the regenerative paradigm has not made it into the mainstream and political discussion. Perhaps it is a matter of time, as trends show that the regenerative concept is increasingly being explored.

The situation on the Polish scene is similar, if not worse, when it comes to the awareness of politicians and local government officials. This is indicated by the documents and strategies analysed, which do not place adaptation and mitigation of cities to climate change as a priority for action. This is why it is such an important role for urban planners and planners to consider new paradigms related to sustainable development and try to use them in creating the future of cities or settlements.

For this purpose, I will will want to consider the future of the development of an important human-settlement in the central urban area with an understanding of the importance of the regenerative design theory. Then, based on a deep understanding of place after conducting features recognition, apply my evaluation criterion and see which of the scenarios I have presented is the more optimal solution to ensure regenerative development, providing health for both humans and natural subsystems.

II - APPLICATION PART

10. Introduction

In the second part of the thesis, I will attempt to answer the question of how settlements can be shaped in the urban fabric in the context of the ecological risks associated with climate change. For this purpose, I will choose a location within the Tri-City where I want to test strategies related to the regenerative paradigm. Consistent with systems thinking, analyses of the social, environmental and infrastructural subsystems will be carried out.

The result of the implemented strategies, will be development scenarios, which will later be evaluated using my own method, which will also be described in this section. On the basis of the evaluation, I will be able to determine in which direction the unit should develop and which future will be most consistent with the concept of regenerative development.

11. Justification for the selection of the design location

The main criterion for selecting the project location was a large amount of green elements and long-term existence. Therefore, Zaspa-Młyniec district has been selected. It is a place that has been developing for 50 years, which means that it is constantly undergoing changes, not only in the urban fabric but also in the natural one. The rich vegetation makes it possible to observe the changes over time. Changes to the district's plant ecosystems are not the only thing that is changing in Zaspa's case, the urban layout itself is also being transformed, as Zaspa has been successively densified with buildings for over the decade. In the context of Zaspa's location in the heart of the Gdansk agglomeration and its multiple functions for residents, this raises the question: is this a threat or an opportunity to limit the negative phenomenon of suburbanisation?

Fig.11.1. Satellite image of Zaspa, source: http://gdansk.ukosne.pl/?hg=884

It must be mentioned, that Zaspa is one of the largest residential complexes in Poland. When emerging, this part of the city was to be a symbol of an ideal, modernist urban organism. However, during the implementation, there were problems that were manifested by other Polish estates from that period of time. The most debatable is the fact that the project did not manage to complete all planned social infrastructure inside the quarters. Today, Zaspa evokes mixed feelings in the people of Gdańsk. Some residents appreciate the large distance of arrangement of buildings and huge free spaces, while opponents talk about the dehumanizing scale. In order to successfully conduct the assessment and propose solutions that will make Zaspa a more regenerative place, it is necessary to understand the broader context of its location, history and main characteristics.

11.1 Context

Zaspa is located in the lower terrace of the city of Gdańsk, in its central part. It is adjacent to Wrzeszcz, Przymorze and from the north to Brzeźno. Currently Zaspa is divided into two city auxiliary units: Zaspa-Młyniec and Zaspa-Rozstaje. In my work the focus will be put on the southern unit, which is Zaspa-Młyniec, but to present the precise background of the application part, there will be presented a historical and urban context of Zaspa as a whole.

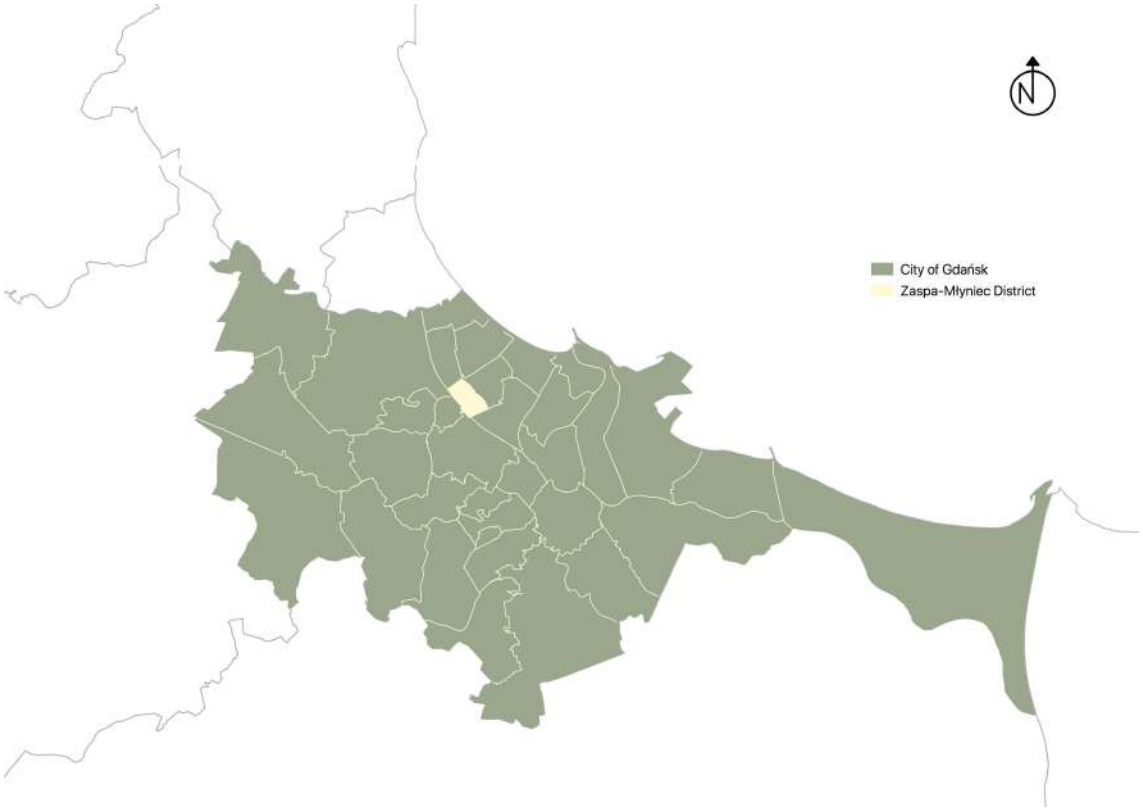


Fig.11.2. Location of Zaspa in the scale of the city of Gdańsk, own elaboration

The first time Zaspa was mentioned was in the turn of the 12th and 13th centuries when it was a fishing village located on the west shore of the lake of the same name, which no longer exists.[57] The name means "dune" and derives from the geomorphological forms that could have been found in the area. Initially, it belonged to the Cistercian monastery in Oliwa.

The estate itself was built on the site of the former Wrzeszcz airport. It was opened in June 1923 for the needs of the German army. Although the name referred to the present-day Wrzeszcz, the greater part of the airport was located in the area of today's Zaspa. After World War II, the rebuilt airport became a civilian-military port. However, as early as the 1970s, the limitations of the development of the airport, resulting from the location between the coastal belt and the railway tracks, began to be noticed. Due to the growing field requirements, the airport was moved to the outskirts of the city, and the construction of a large housing complex was started there.

The competition organized by the Association of Polish Architects for the land development plan of the former airport was won by the concept of a design group led by Roman Horodyński. It assumed the creation of a modern residential district with accompanying infrastructure: shops, schools, kindergartens, sports and cultural centers. The project was to constitute a new city center, which ambitiously implement socialist social and urban thought. Ultimately, the plans turned out to be too ambitious, and the implementation was limited to the residential part and basic public services. A characteristic hexagonal layout of buildings was created, inside which there are vast green areas. In order to differentiate the height, a stepped layout was used and the buildings have from five to eleven storeys.

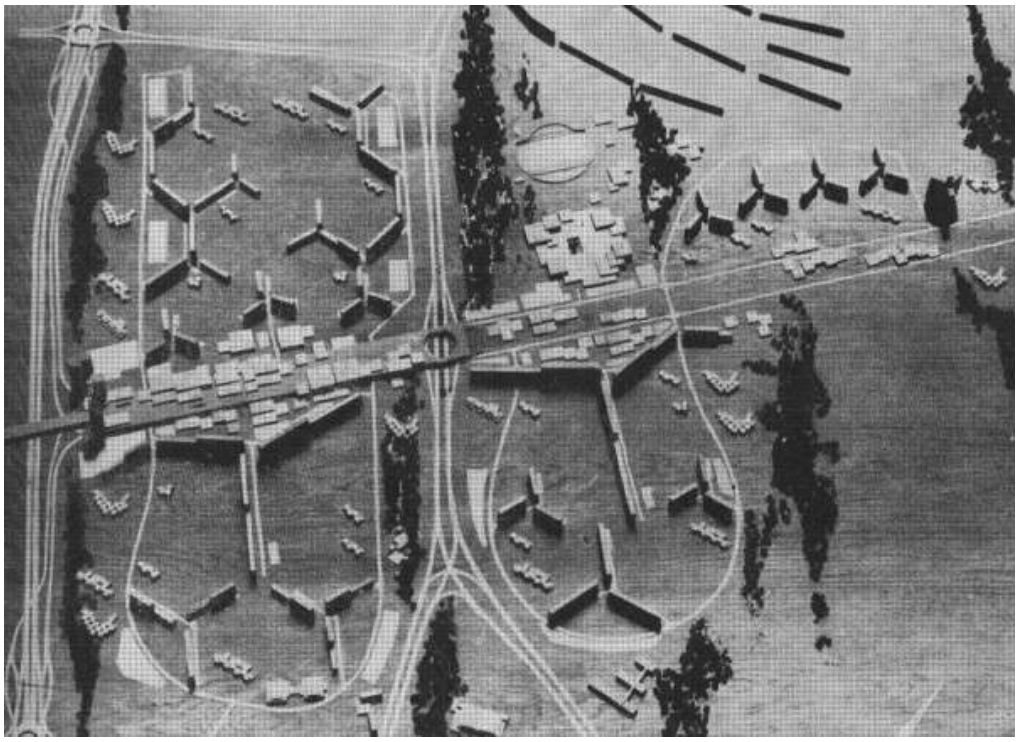


Fig.11.3. Urban layout of the Zaspa estate created by R. Hordyński, S. Grochowski, T. Opic, model by Z. Wiklend

[57] Jednostki morfogenetyczne Gdańska, https://web.archive.org/web/20090120071845/http://gdansk.pl/_podstrony/turystyka/gfx/gdamorf/jednmorf/jednostk/TABELA.HTM, (date of access 31.03.2022).

The axis of the establishment is the Rzeczpospolita Avenue, which divides the estate into two administrative units: Zaspa Młyniec and Zaspa Rozstaje, and the Jana Pawła II Avenue, perpendicular to it, is a remnant of one of the runways of the former passenger airport and forms the main communication axis. The whole establishment is well communicated with the rest of the city, unfortunately, the priority was placed on individual communication. Rzeczpospolita Avenue is a two-lane road connecting the Main City with the districts of the lower terrace of the city.

Numerous significant features make up the identity of the district. Aside from notable historical themes, the district's area hosts artistic and cultural activities. As a result, residents of Gdańsk began to view Zaspa in a new light. Zaspa is particularly distinguished by its enormous collection of large-format paintings on buildings walls. It has one of Europe's greatest collections of street art, attracting many fans of monumental paintings.

12. Zaspa Młyniec

The railway tracks that run from the allotment gardens on st. Hynka to the allotments on st. Solikowski form the district's limits. To av. Rzeczpospolitej and then down the avenue to the intersection of st. Hynka on the outskirts of these gardens (without them). Then, at the height of allotments, it becomes st. Hynka and runs straight towards the railway rails[58].

Fig.12.1. Land use analysis, own elaboration

[58] Appendix nr 1 to the Statute of the Zaspa Młyniec District, Resolution nr LII/1186/14 of Gdańsk City Council from 24 of April 2014.

Zaspa-Młyniec itself consists of two urban layouts, which are characterized by a separate composition and functional program. The part on the north-west side of al. Jana Pawła II and its continuation - ul. Lewoniewski brothers includes a district community center, a Catholic church with a complex of Catholic schools, a public primary and secondary school, a kindergarten, as well as four sizable commercial pavilions, the largest of which is at st. Pilotów, along with smaller ones, at st. Startowa and at the promenade connecting st. Hynka with the Tricity Rapid Transit Rail (SKM) station.

In the south-eastern part of al. John Paul II there is, among others a kindergarten, a commercial and residential complex that stands out from the landscape of blocks of flats, as well as several small commercial pavilions. This part once housed the former Gdask-Wrzeszcz Airport's hangars, but they were destroyed in 2005. In the south-eastern part of al. John Paul II there is, among others a kindergarten, a commercial and residential complex that stands out from the landscape of blocks of flats, as well as several small commercial pavilions. Analysing the neighbourhood from a functional point of view, it can be concluded that the goal set in the 1970s of creating a multifunctional settlement unit where residents can meet their basic needs has been achieved. Although there is a predominantly residential function, the ratio of services and green areas is really high, presented in figure 11.4.

12.1 Analysis of communication links

The public transportation system in the area is well-developed. Zaspa is served by many types of public transport. The Zaspa tram loop is exactly adjacent to the district's administrative border. Additionaly, a large part of passenger traffic is handled by an SKM station. The average

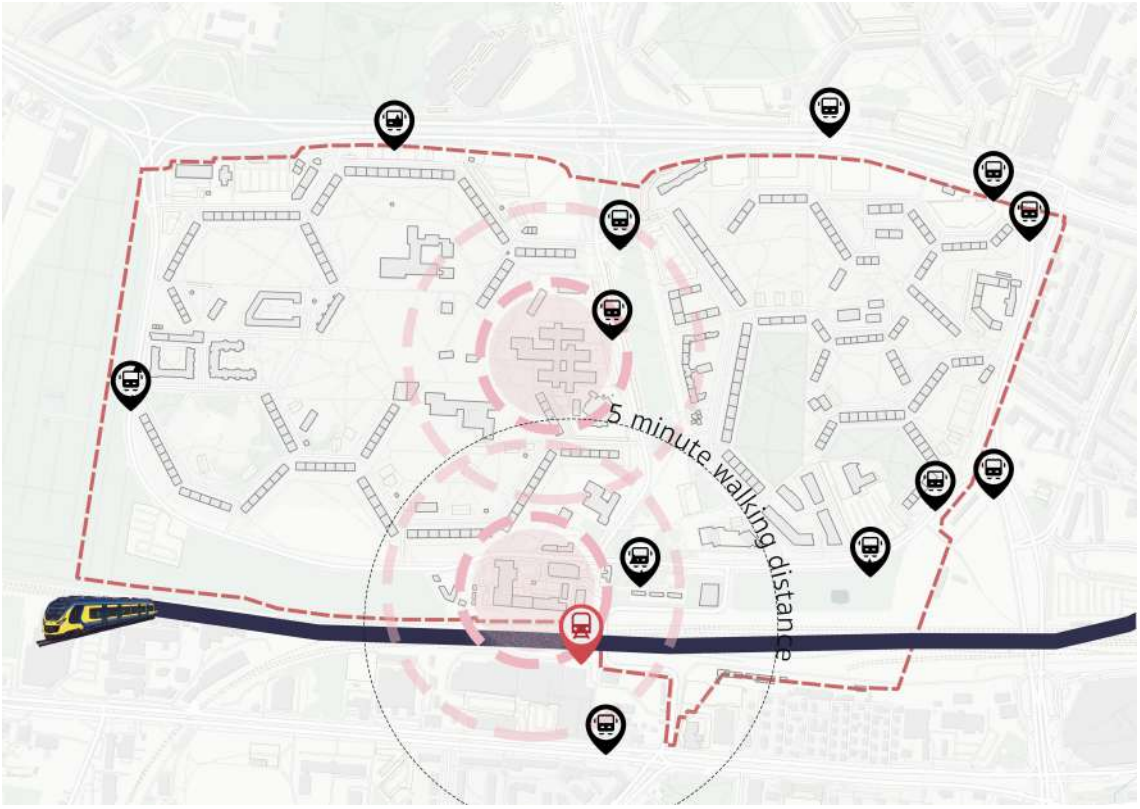


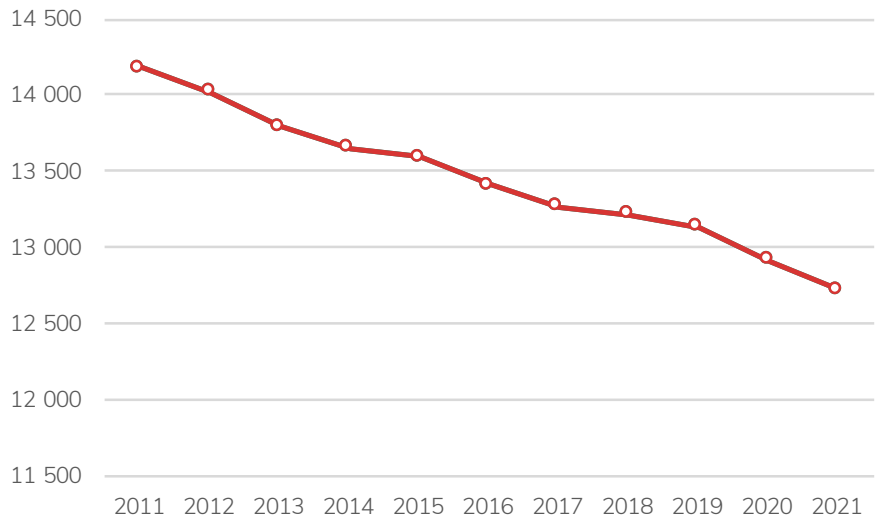
Fig.12.2. Distribution of public transport stations and centers with activity intensity.

passenger exchange at the Gdańsk station was 3000-4000 passengers daily[59], which proves the great importance of the station locally. It is worth noting that in the vicinity of the station the development is lower and chaotic, inconsistent with the urban fabric of the estate. There are small service establishments, mainly catering, near the station. The entrance to the platform itself has to be preceded by climbing a long staircase leading to the viaduct, or crossing the tracks on a poorly marked surface crossing. The current solution can be called the opposite of the currently promoted Transit-oriented development, which promoted high-density, mixed-use development around transit stops.

12.2 Social analysis

Zaspa-Młyniec has 12 723 persons enrolled by the end of 2021. In comparison to 2020, the number of residents declined by 192, or 1.5 percent. A continuous decline in the population has been observed for the last 10 years (fig. 11.6). The district is placed in the middle of the classification in terms of the number of inhabitants (the 16th district with the largest number of inhabitants out of 35), but because the area of the district is only 1.22 square kilometers, the population density was 10,429 persons per square kilometer last year. As a result, in 2021, it was Gdańsk's most densely inhabited district. However, the trend is negative, with a population density change of -157 persons per km2.

Fig. 12.3. Number of inhabitants of Zaspa Młyniec District in 2011-2021

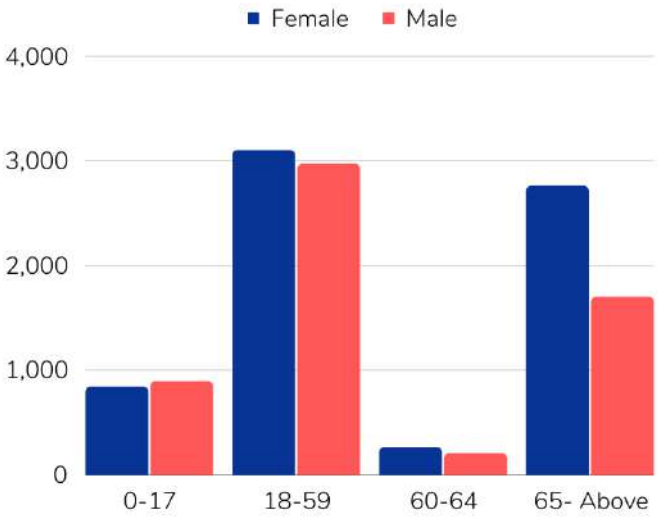


Source: Own elaboration based on the data from the population records of Gdańsk, Civil Affairs Department of the city of Gdańsk

What is more, the district recorded a negative birth rate last year. It was -125. This is an even worse result than the year before, when the birth rate was -118. It is another negative trend, which means that there is no generation exchange in the district. The balance of internal

[59] Wymiana pasażerska w 2020 roku, Urząd Transportu Kolejowego, https://dane.utk.gov.pl/sts/przewozy-pasazerskie/wymiana-pasazerska-na-s/archiwum/18211,Przewozy-pasazerskie.html#PLIKI, (date of access: 05.04.2022).

Fig. 12.4. Number of inhabitants of Zaspa Młyniec District in 2021 by age and gender



Source: Own elaboration based on the data from the population records of Gdańsk, Civil Affairs Department of the city of Gdańsk

migrations was also negative, reaching -48. More than twice less than in 2020, meaning more people are moving out than moving into the district[60].The most numerous group in the district are people of working age. There are slightly less elderly people over 60 years of age, being a particularly vulnerable group to climate change-related phenomena. Women constitute a larger group than men.

12.3 Climatic conditions

Many years of observations conducted by climatologists show that cities are characterized by a specific microclimate. On average, the frequency and abundance of rainfall is increased by 10%, and the number of sunny days is reduced. Long-term data from climatological measurements for Gdańsk show that the average temperature in the city has been steadily increasing since the mid-nineteenth century.

The increase in the average temperature in Gdańsk since 1851 is not as high as in cities in the central part of the country, but still amounts to 1,4°C. The data series presented in the

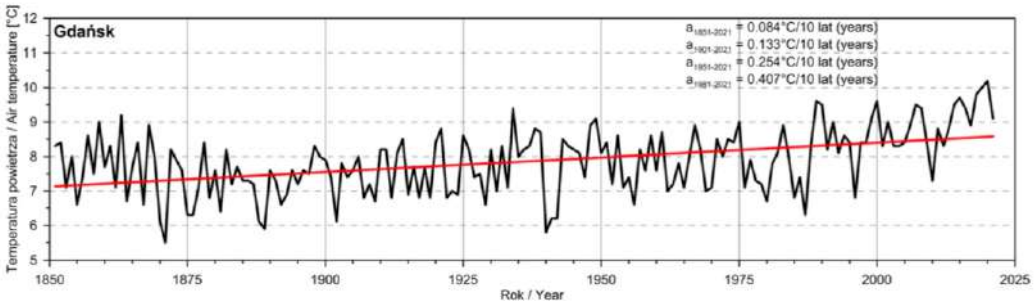


Fig.12.5. Air temperature - variation of thermal conditions 1851-2021, source: Klimat Polski 2021, IMGW-PIB 2022.

[60] Demografia dzielnicy Zaspa-Młyniec, https://www.gdansk.pl/zaspa-mlyniec/ludnosc-i-ilosc-mieszkancow,a,170926, (date of access: 01.04.2022).

report clearly show that the rate of warming is steadily increasing. The trend coefficients calculated for the period 1901-2021 are higher than those for the period 1851-2021, and those calculated for the period from 1951 even higher. Another unsettling trend is that, in the most recent year, heat wave episodes were more frequent and unquestionably lasted longer than cold wave episodes[61].

Continuous increases in average temperature will require appropriate shaping of the urban space, including shaping the microclimate by, among others, designing and implementing green areas that will help mitigate adverse climate changes on the quality of life of people in the city. The effects of climate change have a local dimension. Consequently, a territorial approach is essential. There should be projects and activities tailored to the conditions and needs of cities or even smaller units: districts, neighborhood units. Thus, it is essential to investigate the microclimate of the design area.

To investigate the climatic conditions in the district, data from the Agency of Regional Atmosphere Monitoring of the Gdańsk Agglomeration (ARMAAG) station was collected. The closest one to design area is located in a radius of 3 km from the center of the Zaspa-Młyniec district (fig.11.9). The station monitors temperature, humidity, pressure, rainfall, wind speed and direction, as well as air pollution by presenting PM10 and PM2.5 dust pollution in real time from the network of automatic measurements. Based on the averaged data and the annual summary of the ARMAAG foundation, information will be provided on meteorological conditions and air quality near the project area, which will allow to determine the sensitivity of the site to phenomena related to climate change, and to effectively implement various strategies to mitigate these phenomena.

Fig.12.6. Location of the measure station AM8 in Gdańsk Wrzeszcz. Source: Own elaboration

[61] Raport Instytutu Meteorologii i Gospodarki Wodnej – Państwowego Instytutu Badawczego: Klimat Polski 2021, pp. 15

Ventilation.

On the one hand, use of natural ventilation can reduce the number of air conditioning, on the other the direction and speed of the wind have a great influence on the distribution of pollutant concentrations. According to wind rose diagram (fig. 11.10) air masses that flowed from the west (from WSW to WNW) and subsequently from the south east dominated in 2020. The average annual wind speed was 1.1 m/s. In 2020, calm days dominated, i.e. winds blowing below 1.0 m/s, 41.1% of cases were days of light breeze with wind speeds below 3.00 m/s. No records of moderate breezes that would encourage effective ventilation exist.

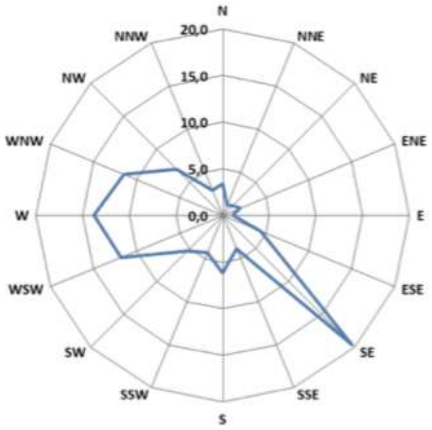


Fig. 12.7. Wind rose diagram for AM8 station in 2020. Source: Haas M. (red.), The status of air pollution in the Tri-city agglomeration in 2020 and information on the activities of the Armag Foundation, Foundation „Agencja Regionalnego Monitoringu Atmosfery Gdańsk-Gdynia-Sopot", Gdańsk 2021

Fig.12.8. Locations of increased wind pressure in between the building, own elaboration.

An interesting phenomenon in the context of the urban layout is the narrow gaps that separate the stacked blocks. In these gaps, wind pressure and wind speed increases, which can be observed particularly when the most frequent wind directions are present. Figure 11.12 shows where this phenomenon is intensified.

Air quality.

Tab 12.1. Medium-term and average annual concentrations of sulphur dioxide.

Station	Concentrations [ug / m3]		
	heating season	summer season	Year
AM8 Station (Gdańsk Wrzeszcz)	2,4	1,6	2,0

In 2020, the 24-hour average concentrations of sulphur dioxide at station AM8 did not exceed the permissible level, amounting to 14, 4 ug/m3 in the summer season, and 18.4 ug / m3 in the heating season, which constitutes respectively 11.5% and 14.7% of the permissible norms.

Groundwaters.

The geological structure, which encourages infiltration of rainwater will have an increasing impact on ground and water conditions especially in the context of climate change. The occurring rapid precipitation significantly affects the fluctuations in the level of the groundwater observed in recent years, which in turn may have a negative impact on the stability of the buildings. The groundwater system in Gdańsk is highly variable. This is caused by the complicated geological structure, coexisting aquifers, different layer thickness and distribution, and diverse lithology of the sediments[62]. Zaspa-Młyniec is located in the lowland part of the city, where there is the Pleistocene-Holocene level, which is the basis for supplying the Gdańsk agglomeration with water. It is provided by the Main Underground Water Reservoir 112 Żuławy Gdańskie (GZWP 112) with an area of 100 km2. The design area includes its northern part - the Seaside Terrace. The reservoir's waters are exploited by the largest municipal intakes: Czarny Dwór, Zaspa and Lipce. The one located in Zaspa is one of the eight main water intakes in the Gdańsk water supply system.

Their protection zones have been established in order to safeguard the waters of municipal intakes. One to several meters below the surface, the groundwater table is found at a fairly shallow location. Furthermore, precipitation penetration is encouraged by the geological structure. This fact will affect soil and water conditions in the context of climate change to a greater extent. The recent oscillations in the level of the groundwater table are strongly influenced by the current quick precipitation, which might have an adverse effect on the stability of the building. Another important reservoir for the Gdańsk aquifer is the Main Underground Water Reservoir 111 Subniecka Gdańska (GZWP 111), separated in Cretaceous level. It is located at considerable depths, and its approved exploitation resources amount to 4500 m3 / h. Due to the deep location of the reservoir, its water intake requires drilling deep wells, but it has a positive effect on the protection of the reservoir from pollution and does not create the need to designate a protected area.

[62] Plan Adaptacji Miasta Gdańska do zmian klimatu do roku 2030, https://baw.bip.gdansk.pl/api/file/GetZipxAttachment/216/1169238/preview, (date of access: 27.07.2022).

Precipitation.

As one of the most crucial elements of the hydrological cycle, rainfall data analysis is crucial for reducing and regulating environmental flows, floods, and water demand in city. In case of AM8 station a total rainfall data was measured using a Thies Clima laser sensor. The highest monthly rainfall occurred in June and October, and the driest month was April.

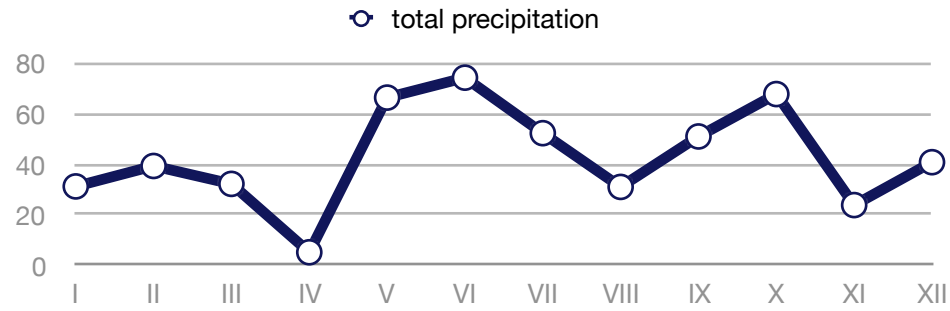


Fig.12.9. Total amount of precipitation recorded at the AM8 monitoring station throughout each month in 2020, source: Own elaboration based on the data provided by the ARMAAG

Morphology.

Surface retention is closely related to the morphology of the terrain. Due to the fact that the terrain is flat, the surface retention is evenly distributed. The terrain slightly slopes towards the north, the inclination of the working area is approx. 1%.

Fig.12.10. Topography map, own elaboration

12.4. Vegetation

Vegetation as the basic component of the biosphere shaping the environment - has an impact on the ecosystems of cities. It is a fundamental element that cannot be replaced with another substitute. According to International Energy Agency, well-designed landscapes could save 25% of the energy used for cooling in residential areas[63].

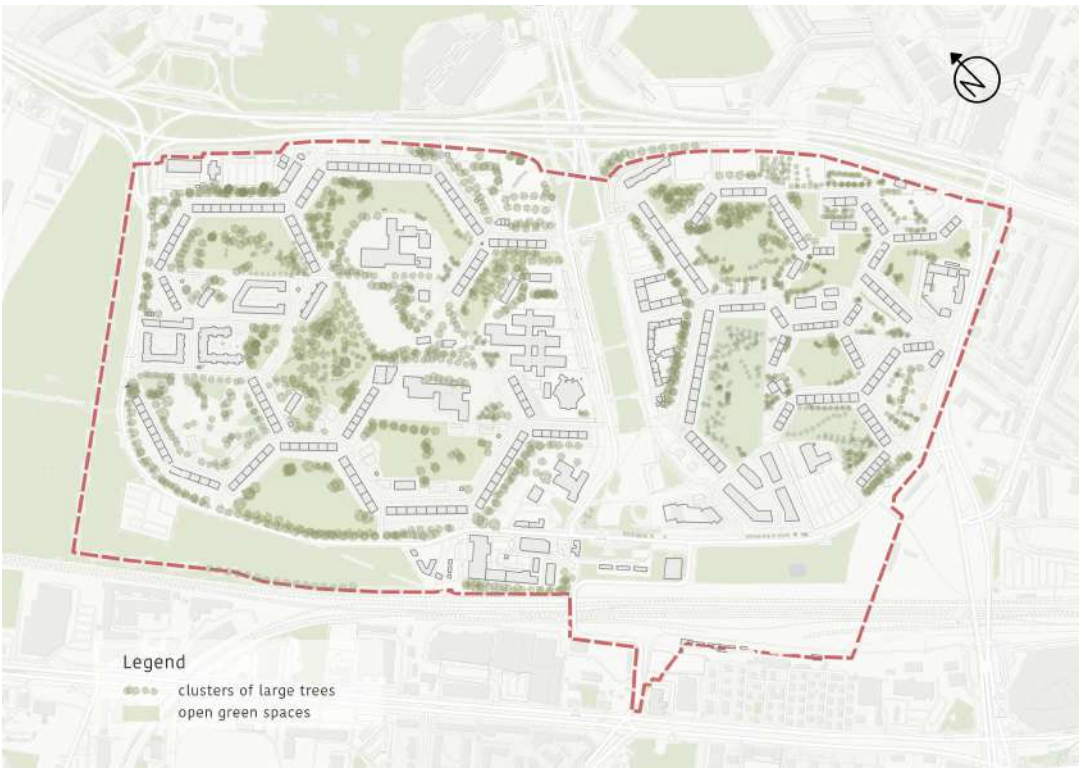


Fig.12.11. Scheme of open green spaces and trees location in Zaspa Młyniec. Source: Own elaboration.

Trees are an element of particularly high value in urban space. They play a special role as a spatial element, shaping the identity and character of a place for centuries. They enhance architecture and public spaces, and thanks to their dominant feature in the urban structure, they contribute to the creation of spatial order - covering up unattractive places and creating conditions of privacy and comfort. Zaspa is distinctive for its old growth of trees. It is dominated by maples and lime trees interspersed with picturesque white willows, birches and coniferous trees. The trees are complemented by cleverly contrived spaces within the hexagons - artificially designed hills and valleys to add variety to the repetitive landscape.

12.5 Development and densification

According to city of Gdańsk authorities, due to the current economic realities, old modernist districts are are being filled with new buildings. Over the past 10 years, additional development of Zaspa has changed its face. New residential buildings are being built between the free spaces of the blocks and on the former runway. One of the first new buildings was a church built in 1984. At the beginning of the 2000s, 5-storey residential complexes began to be

built at Jana Pawła II and Dywizjonu 303 streets. These were followed by 7-storey blocks of flats at Skarżyńskiego 3 and a 6-storey building at Pilotów 23, completed in 2009. More recent developments include the eight-storey "Impuls" housing estate at Hynka Street and the 17-storey towers forming part of a housing estate on the runway, which is currently under construction.

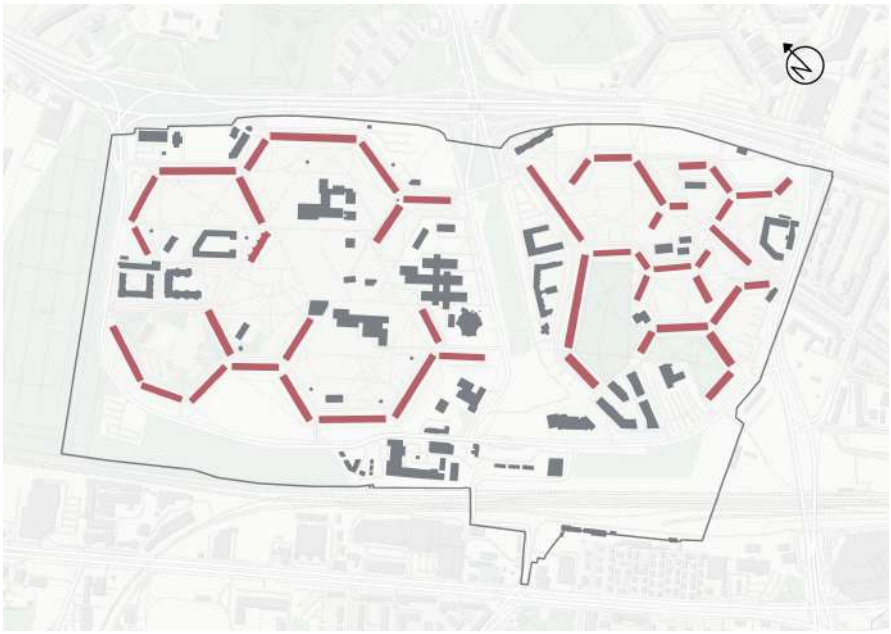


Fig.12.11. Scheme of development from the 70s marked in red, and newer marked in grey. Source: Own elaboration.

At the same time, the green fabric was also developing at this location. The changes in its characteristics over the last 70 years were one of the criteria for choosing Zaspa's location as the object of study, as they make it possible to apply the Pedersen Zari research method mentioned in Chapter 7 of this thesis.

In the material from which the shots are shown (fig.11.17) we can hear the journalist saying, 'we are in an open field'. Photographs of the area from the 1960s indicate the same; there was a grassy area in what is now Zaspa-Młyniec, with isolated, low shrubs. Today, there is

Fig.12.12. Images from footage produced as part of the EU project „Digitalizacja Regionalnego Dziedzictwa Telewizyjnego i Filmowego z Archiwum TVP S.A.", Miasta - Zaspa, cz. 1, source: https://cyfrowa.tvp.pl/video/miasta,zaspa-cz-1,58360062.

definitely more greenery, especially tall ones. Numerous clusters of greenery provide shade for residents on hot days and produce huge amounts of oxygen. It can be definitively stated that although the biologically active area has decreased, the quality of greenery has increased after the construction of the housing estate. What's more, it continues to increase because the vegetation grows, the trees get taller and the biodiversity in such a natural system increases.

A comparison of specific ecosystem services offered by green infrastructure before and after the development of the Zaspa housing estate was conducted to examine this assumption. For this purpose, the typology used by the European Commission and the European Environment Agency was used, which distinguishes following categories: building greens, urban green areas connected to grey infrastructure, allotments and community gardens, parks and (semi) natural urban green areas, including urban forests, agricultural land, green areas for water management, blue areas[64]. Each consists of elements of the most typical components in an urban setting. Some of these categories have been selected as being suitable for the research location and presented in the table with the selected roles that it can play in the urban system.

Tab.12.2. Categories of urban green infrastructure producing local and direct services, prominent for area of Zaspa-Młyniec, before the development.

Categories of urban green infrastructure and their selected roles	**External Building greens**	**Allotments and community gardens**	**Green features connected to grey infrastructure**	**Parks**	**(Semi) Natural urban green areas**
Microclimate management					x
Rainfall drainage					x
Noise reduction					
Air filtration					x
Socialising					
Food provisioning					
Recreation and leisure values					

Source: own elaboration using the evaluation of Ecologic Institute based on Cvejić et al. 2015, Xing et al, 2017.

The green elements that provided beneficial services at the beginning of the establishment of the settlement were grassy areas with small patches of wilderness and shrubland, which, according to the typology used, fall into the category of semi-natural urban green areas. Based on the historical footage mentioned earlier, it can be concluded that there were no other elements of green infrastructure at the time that provided ecosystem services.

[64] Typology of green infrastructure, https://biodiversity.europa.eu/green-infrastructure/typology-of-gi, (date of access: 18.09.2022).

Tab.12.3. Categories of urban green infrastructure producing local and direct services, prominent for Zaspa-Młyniec, after the development.

Categories of urban green infrastructure and their selected roles	External Building greens	Allotments and community gardens	Green features connected to grey infrastructure	Parks	(Semi) natural urban green areas
Microclimate management		x	x	x	x
Rainfall drainage	x	x	x	x	x
Noise reduction	x	x	x	x	
Air filtration	x	x	x	x	x
Socialising		x		x	
Food provisioning		x			
Recreation and leisure values		x	x	x	

Source: own elaboration using the evaluation of Ecologic Institute based on Cvejić et al. 2015, Xing et al, 2017.

Vegetation analysis and numerous on-site-visits have made it possible to identify the role and part of ecosystem services that are locally generated by multiple greenery types. Allotments provide the most services and external building greenery the least - represented in Zaspa Młyniec by balcony greens and green fences.

12.6 Conclusions from analytical part

Knowing the system in which we are to create is required by regenerative design. This is why studying natural, social, and infrastructure systems is crucial. We can produce more beneficial things for people and the environment the more thoroughly the analysis is done and the lessons are learnt.

Using the ecosystem services examination, it can be stated that implementing new urban development is not necessarily connected with a decrease in the standard of ecological services generated locally. Green infrastructure have a major influence on the quality of life in cities and should be take should be taken into account in spatial planning.

Analyses have shown that the Zaspa-Młyniec area is well located in the urban system, providing good transport links and natural assets. It fares much worse in the social context, which may account for its shrinking population. The urban structure does not support local neighbourhood integration, the monotonicity of the layout and poorly organised pedestrian routes can create a sense of confusion for non-regular visitors. Nevertheless, the layout of the buildings and the greenery do mean that Zaspa-Młyniec has great potential. Hopefully, this potential will be fully exploited in the design section.

13. Introduction and aim of the project

Achieving the sustainability of a settlement or neighbourhood requires that its spatial form is shaped accordingly. The aim of the application part is to consider the future of the Zaspa-Młyniec neighbourhood and propose a transformation path that will be most in line with the regenerative paradigm, thus helping to mitigate the negative effects of climate change on urban life. In order to deliver the most optimal development scenario, two, opposing development paths for the Zaspa-Młyniec district will be analysed. The first, involves densifying the hexagonal fabric of the estate and filling it with buildings, in accordance with the 'compact city' concept. The greenery taken away from the new buildings would be compensated for by designing green roofs or vertical gardens. The second concept is based on the idea of a gren city and in the second development scenario the most important aspect preservation and enhancement of the greenery, constituting as the green lungs of the agglomeration. Each scenario will be described in this chapter and supported by design solutions from the world. In the next step, an evaluation of the two scenarios will take place using the own quantitative comparative method that will be described beforehand. This is because different consequences from the point of view of the regenerative paradigm will be generated by a city with an intensive, compact urban fabric and others by a city with dispersed development with a dominant number of green spaces. The question remains, however, whether either of these forms guarantees the possibility of realising the assumptions of regenerative design in practice, or whether the combination of both should be considered a regenerative unit. The answer to the thesis outlined is to be found in this proposal.

Before starting work on the development scenarios, the planning documents in force in the project area were analysed in order to decide whether the design concepts would be realised as laid down in the plans or whether, however, for the purpose of freedom of creation and not being limited by indicators, it would be better to reject the provisions. The coverage of

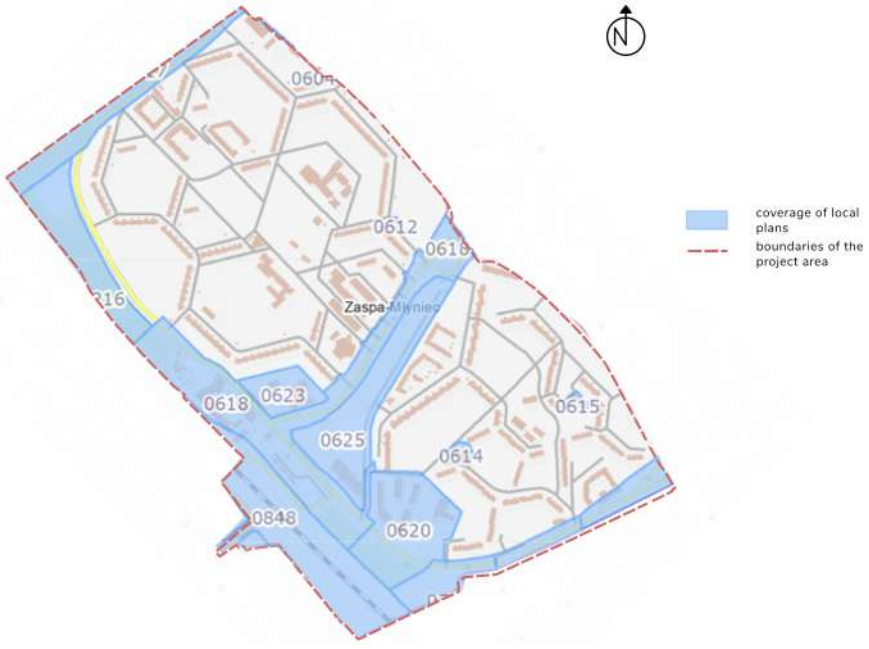


Fig.13.1. Coverage of local plans in Zaspa-Młyniec. Source: https://mapa.gdansk.gda.pl/ipg/app/index#

the area with local plans is relatively low, being one quarter of the total site. It can be deduced that the site is mainly developed at the northern, western and southern boundaries of the district, as well as in the vacant area in the central part - the former runway area (fig.13.1). There are no existing local plans within the original premise - hexagons.

In order to collate the indicators from the plan and be able to relate them to the current situation, the BCR, FAR, BAS and max. height indicators were analysed for the entire settlement. The data to calculate the current values of BCR and Biologically Active Surface were downloaded from QuantumGIS. Due to the lack of data on the FAR at Zaspa-Młyniec, its size was estimated. In the lower option, an average of 7 storeys was assumed for buildings for which data on the number of storeys was missing, in this version the total built-up area was 79.4 ha. In the higher version, in which an average of 9 storeys was assumed, the PCZ was 85.1 ha. After averaging, the PCZ was estimated to be approximately 82.3 ha, giving a development intensity of 0.67 in the district. On the basis of these calculations, averaged values for the Zaspa Młyniec district were determined in table 13.1, where they are compared with summary of the binding assumptions in force in the revieved local plans.

Tab 13.1. Current areas and ratios calculated for Zaspa-Młyniec district, own elaboration.

Calculated areas		
Area of the district		121,95 ha
Built-up area		12,99 ha
Area of paved roads		11,76 ha
Biologically Active Surface		97,2 ha
Building's total floor area	Overstated version	85,1 ha
	Understated version	79,4 ha
	Averaged	82,3 ha
Floor Area Ratio		0.67

Having analysed the plans, it can be concluded that the local plans provide for much more intensive development, in some areas occupying up to 50% of the plot area. The minimum size of the development area in relation to the area of the development plot is not established in all plans. In parts planned as more urban, the minimum percentage of biologically active area for the development plot is 10%. Looking at the current situation, where almost 80% of the area of Zaspa-Młyniec is made up of green and permeable areas, the provisions make it possible to completely change the character of the settlement.

Tab 13.2. Analysis of local plans in Zaspa-Młyniec, own elaboration.

	PLANS NUMBER					Averaged values for all plans	Averaged values for the Zaspa-Młyniec
	0618	0620	0623	0625			
				01-M/U	02-M/U		
Building Coverage Ratio (BCR)	**max. 40%,** for area KZ9, **max. 60%** for area P/ U41	**max. 30%** for residential and service areas, **max. 50%** for service areas	**max. 50%** for area marked with „a", **max. 40%** for areas „b"	**max. 35%**	**max. 65%**	**max. 46,3%**	**10,6%**
Biologically Active Surface	**min. 10%**	**min. 30%**	**min. 10%** for „a", **min. 30%** for „b"	**min. 35%**		**min. 25%**	**79,70%**
Floor Area Ratio (FAR)	**min. 0,1** for area KZ94, **min. 0,2** for area P/ U41, max.	min. - **max. 1,5**	min. - **max. 1,8** for „a", **max. 1,5** for „b"	min. - **max. 3.4**	min. - **max. 4.2**	**min. - max. 1,5**	**0,67**
Permissible building height	**max. 15 m**	**min. 8 m, max.15, and max. 21** along st. Hynka	**max. 15 m** for „a", **max. 12 m** for „b"	**max. 55 m** for „a", **max. 15 m** for „b",	**max. 20 m** for „a", **max. 23 m** for „b", **max. 40 m** for „c"	**min. - max.**	**max. 33 m**

Clarification of denotations: "min. -" means no minimum building intensity is determined for the development parcel.

14.1 Scenario nr 1

In this scenario, we assume that development should be densified to ensure high population and employment densities. In line with the compact city concept, priority for development is given to land that has been previously urbanised and developed with existing infrastructure. Zaspa is predestined for this - due to its large stock of developable land or its location in the centre of the agglomeration. By doing so, we are able to counteract the very un-ecological process of suburbanisation. Increasing the availability of a variety of housing units with attractive public spaces and services in close proximity can dissuade some people from the idea of moving out of the city. Compact settlements are known to safeguard important natural resources, improve the efficiency of infrastructure and land usage, and lessen inhabitants' carbon footprints[65].

The focus of the densification project should be on the quality of the development in order to ensure a high quality of life for current and future residents. As part of the parking area is to be taken away from the development an efficient public transport system has to be created.

[65] Lehmann S. (2016), *Sustainable urbanism: towards a framework for quality and optimal density?,* https://link.springer.com/article/10.1186/s40984-016-0021-3 (date of access: 14.09.2022).

What's more, by creating new housing, we are able to design high-tech solutions from scratch that would be difficult to introduce in old housing.

Fig.14.1. Conceptual map of transformation in the first scenario, own elaboration.

- **Urban scale**

Aim of the urban aspect of this scenario is to ensure a compact and continuous urban structure through multifunctionality and urbanising activities.

In this scenario, following land should be allocated for development:

- Former runway area
- Interiors of hexagons - existing building quarters
- Areas of Family Allotment Gardens located at the district boundary
- Surrounding area of the SKM stop and service area - reorganisation of the area, elevation of buildings, design according to Transit-Oriented-Development principles.

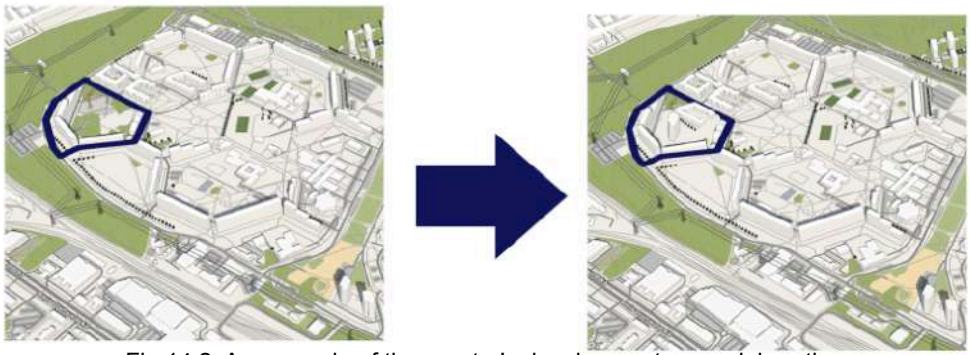


Fig.14.2. An example of the quarter's development, own elaboration.

An example of the quarter's development (fig.14.2) is intended to serve as a symbol of change rather than the target form proposed by the author. It is a conceptual representation of the densification of the hexagons. If densification is decided upon, detailed urban planning analyses would need to be carried out to propose a reasonable form of development.

- **Greenery**

The microclimate of cities is directly impacted by density. By adding more greenery and plants, selecting materials and surfaces that reduce solar heat gain and boost the albedo effect, and increasing the quantity of green space, the adverse effects on urban climate can be mitigated. The introduction of green facades is a solution that allows us to increase the benefits of nature when open green spaces will be partially built up. Vertical greenery dampens noise, has high aesthetic qualities and also effectively regulates the microclimate. In summer, it creates shade and, by providing evapotranspiration, reduces the need for cooling. When they lose their foliage in winter, sunshine helps warm the building, resulting in less energy being used to heat the building.

Today, technology allows living walls to be introduced in a variety of ways - the simplest solution is to set up climbing plants and allow them to climb up directly on the building façade. In other cases, additional supporting structures installed on the facades are needed. Often used solutions are rope systems or structures made of stainless steel or impregnated wood. Although it may take some time to completely green a façade, upkeep is minimal, and watering may not even be required when plants are rooted into the ground. A much more complicated method is establishing „Living Walls", which allows structural elements to be reduced to a minimum. It boils down to the use of prefabricated system inserts, made of a special plastic resembling horticultural foam. The plants that form part of the façade are rooted in the inserts and attached to the frame, and are usually watered using irrigation systems.

Fig.14.3. Stadthaus M1, Freiburg using rope system (left), steel structure connected to the elevation (right) source: GreenSolutions Catalogue by Jakob Rope Systems,

Green roofs are a solution where vegetation is planted horizontally atop a structure. Although the idea itself hasn't changed in a while, new technologies allow the idea and its definition to be expanded. Green roofs are now divided into two main categories: intensive and extensive. Intensive ones are often called rooftop gardens or parks. Food can be grown on them because the artificial growing media is deeper on intensive roofs than on extensive ones.

The second are typically covered with low-demanding, low-growth, drought-tolerant vegetation so that irrigation and maintenance are reduced as much as possible. The authors of the report „Living Roofs and Walls from policy to practise: 10 years of urban greening in London and beyond", Gary Grant and Dusty Gedge, further distinguish derivatives of the two main categories, such as **biodiverse green roofs**, also referred to as semi-intensive roofs, **biosolar roofs**, which combine an extensive roof with photovoltaic arrays, and **blue green roofs**, which are intended to collect rainwater[66].

Fig.14.4. Intensive green roof in Germany (left),https://efb-greenroof.eu/work/intensive-green-roof-germany-4/, extensive green roof in Portugal (right), https://efb-greenroof.eu/work/extensive-green-roof-portugal/.

- **Infrastructural and technological**

By building new housing estate units from scratch, the circulation systems for different types of domestic and rainwater wastewater can be separated for conversion into energy. This was the premise behind the planning of the Jenfelder Au district in Hamburg, where

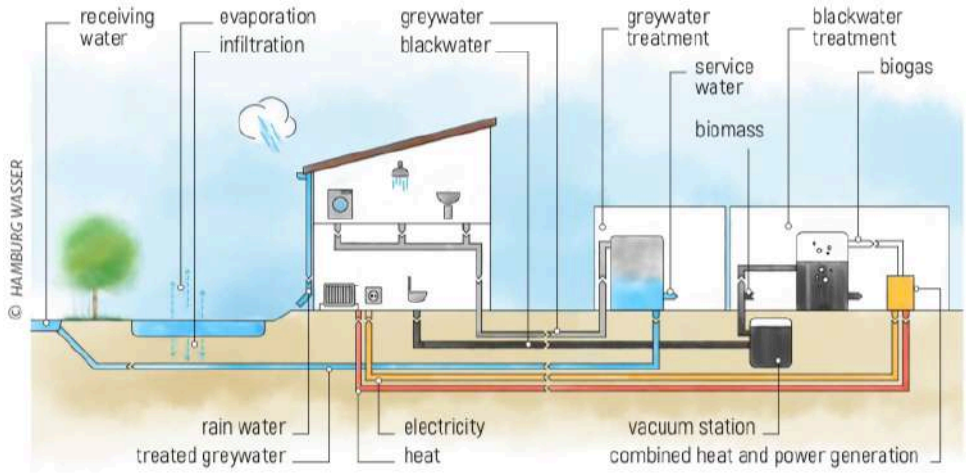


Fig.14.5. Diagram of the Hamburg Water Cycle® in the Jenfelder Au district, where black sewage is used for energy production, source: https://www.ecologic.eu/sites/default/files/publication/2020/addressing-climate-change-in-cities-nbs_catalogue.pdf

[66] Grant G.,Gudge D. (2019). *Living Roofs and Walls from policy to practise,* https://lroofs.b-cdn.net/wp-content/uploads/2019/05/LONDON-LIVING-ROOFS-WALLS-REPORT_MAY-2019.pdf, (date of access: 10.09.2022).

rainwater, toilet wastewater, kitchen and bathroom wastewater are separately discharged and processed[67] (fig.14.3). Powered by black sewage, the local biogas plant allows energy to be recovered so that the district's heating and electricity needs can be met. The surplus generated by the CHP plant can meet the needs of 50-100 households, depending on the energy standard of the building[68].

The water recovered in this system is used locally. It is used to maintain green spaces or replenish blue infrastructure.Retention and recycling systems for rainwater have a big influence on resource preservation.

The Eco Zathe's combined heat and power plant proves that the clunky industrial form of a power station can be modernised, aesthetically pleasing and matching its surroundings. Energy is generated from cow dungand hot biogas, and when heating demand is lower, the gas engine cannot deliver heat directly to the houses, so the heat generated is stored in two large storage tanks of 65 m3 and 75 m3[69]. The facility is not large in size, covering an area of approximately 460 m2. If the gas engine and storage tanks are unable to meet the heat demand, then two auxiliary boilers provide additional heat. A facility of this volume can meet the needs of 9,988 homes. The location of a similar facility in the proposed location by the railway tracks in Zaspa could meet the needs of part of the district and reduce CO2 emissions.

Fig.14.6. Eco Zathe combined heat and power plant, photo by Gerard van Beek.

[67] Hamburg Water Cycle, https://www.hamburgwatercycle.de/en/hamburg-water-cycler, (date of access: 27.09.2022).

[68] *Ibidem.*

[69] Eco Zathe combined heat and power plant, https://archello.com/project/eco-zathe-combined-heat-and-power-plant, (date of access: 27.09.2022).

14.2 Scenario nr 2

The main idea of this scenario is to use the existing green potential of the district and develop it towards increasing this potential.

The aim is to create a green enclave that will strengthen the green system of the city of Gdansk and act as the 'green lungs' of the agglomeration. In this scenario, the author proposes to leave the built-up area at the existing level, but to increase the total area by growing buildings upwards.

Fig.14.7. Conceptual map of transformation in the second scenario, own elaboration.

- **Landscape architecture**

By identifying wild plants as an ecologically acceptable component of urban greenery with high aesthetic value, the author would suggest restoring the wilderness of the landscape. A slow-growing (free) hedge is cheaper to maintain than a trimmed hedge, and a natural flower meadow in a park is easier to manage than an equally sized artificial grass lawn. Wildereness in the quarters often gives an illusory sense of danger - a thicket of trees and shrubs makes such spaces less likely to be visited after dark. To balance this feeling and improve safety, upgraded and illuminated pedestrian and cycle routes would need to be provided. The increased feeling of safety will make these semi-public spaces start to be used longer and more often.

- B**lue infrastructure**

Whole Zaspa may have considerable green spaces compared to other districts, yet it lacks blue infrastructure. Within three kilometres of Zaspa-Młyniec's center to the north is the Baltic Sea, which has a huge impact on the settlement's microclimate. However, sustainable

Fig.14.8. Renewal of the city centre - Empreinte - Bureau de paysages, source: http://www.empreinte-paysage.fr/projet/renovation-urbaine-centre-ville (left), Frederik Hendrikplantsoen park, source: https://landezine.com/fredrik-hendrikplantsoen-by-carve/ (right)

solutions must take into account water elements at various sizes, especially ones locally introduced. Water bodies or streams could serve as a habitat for flora and fauna, produce a cooler microclimate, and store extra rainwater during storms. Water in public space in addition to being aesthetically pleasing, diversifies the public space functionally, and makes people more willing to relax and socialise.

- **Energy efficiency**

The main power supply of buildings in this scenario is to be provided through photovoltaic electricity production. Solar panels can be located on the roofs of the buildings from the 70s, which are flat and have a averaged surface area of approximately 1100 m2.

Fig.14.9. Example buildings for PV installation, source: https://mapy.geoportal.gov.pl/

According to the “Solar panels calculator” on solar.otovo.com website, on each of the 3 roofs of the buildings we can install about 100 solar panels. And they will produce about 40 000 kWh per year for every 100 panels. Due to „Theoretical and actual energy demand for central heating and ventilation of apartments in multi-family housing” by T. Weber, it can be assumed that 1 flat uses 200 kWh per year, so the energy generated by panels will cover the demand of 200 flats.

T**hree solutions for self-consumption:**

1. PV energy can be used for collective services in the building like elevators and lighting; In general, this solution is not considered collective self-consumption, as the consumer is only one entity, namely an association of apartment owners. In this case of solutions owners benefit from a reduced electricity bill as they are members of the association of owners.
2. In the second solution, individual apartment owners actually own part of the full PV installation on the roof, which is directly connected to the apartment.
3. Third is a combination of both options in which a distributor is needed.

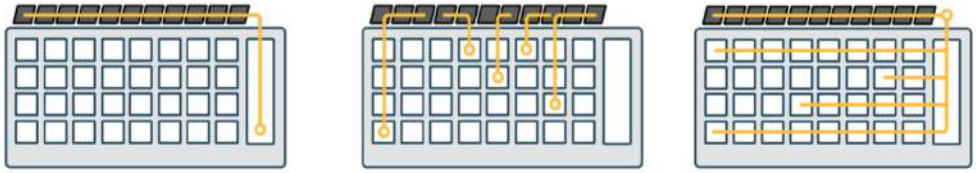


Fig.14.10. Models of self-consumption for a residential building: PV for collective services (left), PV for individual apartments (center), PV for both collective services and apartments using a distributor (right), source: https://devvezonnecoach.nl/oplossingen/

- **Architectural aspects**

A great example of raising the quality of the urban fabric is the transformation of the buildings of the Cité du Grand Parc' in Bordeaux, France. The award-winning project proposed an extension of the facades of the 1960s buildings. The prefabricated structure created glazed 'conservatories' that can be accessed from the flats' living rooms. The original windows and concrete sills were removed, and thermal curtains were added to provide additional insulation for the heated interiors. A lightweight façade of transparent corrugated polycarbonate panels and glass in aluminium frames was fitted with reflective solar curtains. Three architectural firms were responsible for the modernisation of the buildings: Lacaton & Vassal architectes; Frédéric Druot Architecture; Christophe Hutin Architecture. The transformation added 8 flats to the top of the buildings. An analogous solution could be applied in the project area as the buildings are positioned using passive strategies.

Fig.14.11. Building in Cité du Grand Parc before (left) and after (right) the transformation, photos by Philippe Ruault.

Analyses have shown that the positioning of the buildings on Zaspa creates a wind-blown effect in the isthmuses between the buildings. Such a phenomenon can be used to generate some energy from the wind. Urban Green Energy's 4 kW Eddy turbines, which are mounted in groups of three or twelve, are utilised in Electricity Flowers, which may be planted where power is really required, for example near the wind pressure gaps in Zaspa. The unusual trees can be located even in very urban spaces, as they do not require a lot of space, are quiet and do not need to be positioned directly into the wind, and can Moreover, their interesting form means that they can be part of artistic urban installations that attract people and give identity to a place. The energy used from the wind-trees could be used to light up the streets or common spaces of a neighbourhood. There is an increasing number of urban lights on the market that take energy from wind and solar combined.

Fig.14.12. Tree Vent concept created by Designer NewWind R&D, source: https://www.businessinsider.com/wind-turbines-that-look-like-trees-2015-1?IR=T (left),

15. Evaluation of the scenarios

A proprietary research method will be carried out to evaluate the scenarios and select a better solution. There are 24 criteria divided into 4 main subsystems such as built, environmental, economic and social. Each criterion is related to regenerative design and will be scored on a 3-point scale. Once added up, the most optimal path for the development of Zaspa-Młyniec will be selected.

Tab 15.1. Evaluation of the first scenario of transformations in Zaspa-Młyniec, own elaboration

SCENARIO 1		3-grade evaluation		
	CRITERIA	1	2	3
BUILT	Reduced water use	-	-	O
	Waste management	O	-	-
	On-site renewable energy generation	-	O	-
	District heating and cooling	-	O	-
	Modernisation of existing urban fabric	O	-	-
	Wastewater management	-	-	O
ENVIRONMENTAL	Heat Island Effect reduction	O	-	-
	Stormwater management	O	-	-
	Rainfall drainage	-	O	-
	Biodiversity preservation	O	-	-
	Wind orientation/air filtering	O	-	-
	Solar orientation/natural heating and cooling	O	-	-
ECONOMIC	Diversity of functions and services	-	-	O
	Diversity of housing units	-	-	O
	Access to public transport	-	-	O
	Employment growth	-	-	O
	Efficient land use	-	-	O
SOCIAL	Minimazing light pollution	O	-	-
	Access to public space	O	-	-
	Access to sport and active spaces	O	-	-
	Community involvement	-	O	-
	Inclusiveness/accessibility	O	-	-
	Cultural heritage	-	O	-
	Municipal services	-	O	-

Total points: 44/72

Tab 15.2. Evaluation of the second scenario of transformations in Zaspa-Młyniec, own elaboration

	SCENARIO 2	3-grade evaluation		
	CRITERIA	1	2	3
BUILT	Waste management	-	-	O
	On-site renewable energy generation	-	O	-
	District heating and cooling	O	-	-
	Modernisation of existing urban fabric	-	-	O
	Wastewater management	O	-	-
ENVIRONMENTAL	Heat Island Effect reduction	-	-	O
	Stormwater management	-	-	O
	Rainfall drainage	-	-	O
	Biodiversity preservation	-	-	O
	Wind orientation/air filtering	-	-	O
	Solar orientation/natural heating and cooling	-	-	O
ECONOMIC	Diversity of functions and services	O	-	-
	Diversity of housing units	-	O	-
	Access to public transport	O	-	-
	Employment growth	O	-	-
	Efficient land use	-	O	-
SOCIAL	Minimazing light pollution	-	-	O
	Access to public space	-	-	O
	Access to sport and active spaces	-	-	O
	Community involvement	-	O	-
	Inlclusiveness/accessibility	-	O	-
	Cultural heritage	-	O	-
	Municipal services	-	-	O

Total points: 51/72

Conclusions

With a higher score, the second scenario - the one without densification and with a focus on improving the quality of existing buildings, together with simple sustainable measures such as photovoltaic electricity generation, hybrid lighting systems with integrated wind turbines and the introduction of new elements of blue-green infrastructure - may ultimately have a more beneficial effect than the technologically innovative but costly and long-toimplement non-passive strategies of the 'compact' scenario.

The selected scenario primarily implements goal 11 of SDGs: Sustainable cities and communities (SDG 11), but also Life on land (SDG 15) and Climate action (SDG 13).

However, it should be noted that the difference in the scoring of the two scenarios is not large, at 7 points. Perhaps to achieve full scoring it would be necessary to create hybrid solutions based on both scenarios.

16. Conditions for implementing chosen scenario

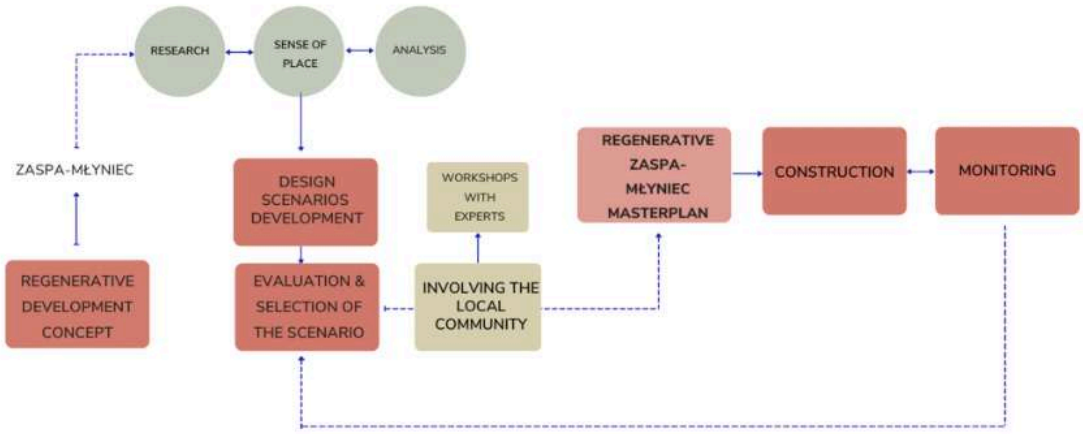


Fig.16.1. Diagram of the development process, own elaboration

The transformations plan can be implemented jointly by governmental and non-governmental actors as a local strategy. The main beneficiaries of the project are expected to be current and future residents, as well as cultural and ecological community groups from Gdańsk, It is therefore important to include them in the design process through design charities with professionals and online surveys combined with on-site interviews.

The project's execution can be made feasible in significant part by the presence of enough funding, whether from a single or from several sources for specific initiatives. Public funds (EU, national, regional, and municipal) as well as private funds can be used as sources of funding (foundations, corporate investment, crowd-sourcing, and NGO).

A significant element in the final phase is monitoring. It is proposed to use formal monitoring systems, e.g. publish monitoring or evaluation reports and involve citizens in monitoring activities.

17. Summary

Summarising, regenerative development is all about thinking in whole-systems, meaning that it aims for each individual element in each system to rely on the others for health and support. If we as humanity followed these noble principles, we might be able to reverse the course of climate change.

Spreading idea of sustainability has significantly influenced the multiplicity and diversity of concepts. A common element in most contemporary urban design trends, is the essence of an interdisciplinary approach that takes into account the important role of natural conditions and nature-based solutions. On the other hand, the presented urban design paradigms largely differ, and some even contradict each other in their recommendations as to the expected vision of city development. Most of the paradigms are still evolving and researchers are having trouble clearly defining their underpinnings, as well as their duration.

The damage reduction paradigm has profoundly influenced sustainable urbanisation. Regenerative urbanism, in contrast, aims to produce net benefits for both people and the environment. The understanding that all human endeavours are directly related to and reliant on "nature" is another essential component of regenerative urbanism. Unfortunately, an analysis of global landmark events and documents in the context of the built environment indicates that the regenerative paradigm has not made it into the mainstream and political discussion. Perhaps it is a matter of time, as trends show that the regenerative concept is increasingly being explored.

When it comes to the awareness of legislators and local government representatives, the situation in Poland is comparable, if not worse. The papers and initiatives examined, which do not prioritise measures to adapt and mitigate cities to climate change, provide evidence of this. Due to this, urban planners and planners have a crucial role to play in considering new paradigms of sustainable development and attempting to apply them to the future design of cities or settlements.

However, we are in a position to definitively state that going beyond sustainability is capable of improving the quality of life for people living in urban areas. Regenerative practices offer opportunities to reduce the negative effects of climate change in the urban environment through mitigation and adaptation, leading to safe, resilient and healthy living conditions. Their success lies primarily in the fact that they are based on a holistic, integrated approach carefully adapted to a project location. Regenerative solutions embrace the uniqueness of local ecosystem and local culture, so they can be managed at the local level and therefore can have significant impact. The results of the design chapter showed that Zaspa-Mlynetz is an ideal area to consider regenerative strategies, and that allowing greenery to grow and a couple of simple ecological solutions can have a more beneficial effect than building up the area with high-tech urban tissue.

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Appendixes

Regenerative neighbourhoods opportunity to reduce the negative effects of climate change in the urban environment.

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Abstract

Progressive urbanization and climate change are forcing urban planners to invent new approaches that will benefit not only people's lives, but entire ecosystems. For this purpose, a regeneretive framework was created. The article recommends going beyond sustainable urban planning to regenerative urban planning, which can help reverse the negative trend of degrading earth's resources and stop the course of the climate change. This paper will explore the concept of the regenerative approach. It will present its historical background and compare it with more conventional ways of approaches to the built environment. Lastly, paper will look into the ecosystem services assessment and how they can be used to evaluate regenerative design.

Keywords: Regenerative design, climate change, sustainable neighbourhoods, urban ecosystem services, neighbourhood regenerativeness assesment.

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1. Introduction

More than half of the world's population is residing in urban areas that only account for about 3% of the Earth's land surface. It is predicted that as a result of urbanization and migration from rural areas, this disproportion will continue to increase in a global scale. Already today in Poland, 60% of the population is urban. This distribution of population means that poorly designed cities become centers that exacerbate climate change through increased greenhouse gas emissions. In the Polish case, this is mainly due to district heating systems based on coal burning or low energy efficiency. What is more, cities are particularly susceptible locations, according to researchers from the National Academy of Sciences, because of the high levels of investment, population density, and infrastructure.

2. Circular metabolism of cities

Nowadays cities function as an organism of linear metabolism. The basis for the functioning of cities is the use of huge natural resources and energy, enabling the creation of satisfactory living conditions and carrying out various activities in their area. It is believed that inputs and outputs in urban systems are essentially unrelated. The waste gases produced during the extraction, refinement, and burning of fossil fuels are released into the atmosphere. Raw materials are collected, mixed, and processed to create consumer items, which ultimately become trash and cannot be reabsorbed in a useful way by living nature. Trees are cut down in far-off woods for their lumber or pulp, yet forests are much too frequently not replanted. Similar open-loop process can observed in agriculture: as food is collected, prepared, and consumed, agriculture loses nutrients and carbon. The resultant sewage is subsequently released into rivers and coastal waterways downstream from populated areas, with or without treatment, and is often not transferred back to agriculture[1].

3. Regenerative paradigm fundaments

Regenerative design is based on drawing inspiration from nature, which is the best example of how circular metabolism works. There are no landfills in the natural environment, each by-product is used as a resource input to the vital functions of another organism. Regenerative design seeks to see humans and nature as one complex, interconnected system, in which social and natural systems are able to become more viable and robust.

Regenerative design is not a new concept, it is rather a rebirth pattern of thinking: indigenous human settlements had to coexist and adapt to nature in order to develop and live. It is a rediscovered and formulated thought, which is a synthesis of several other fields, such as landscape ecology, geohydrology, landscape architecture, permaculture, regenerative agriculture, general systems theory and cybernetics, living systems theory and thinking, and developmental

[1] Regenerative Cities, World Future Council, 2016

psychology[2].

4. History of regenerative paradigm

The first formulation of the theoretical and practical foundations for regenerative approaches to the built environment, both its development and design appeared in two different sources in the middle of the 1990s. It was the work of Regenesis Collaborative Development Group and John Tillman Lyle[3]. Their definition emphasizes the role of humans as significant participants influencing the health and prosperity of the network of global living systems, and human development, social structures and cultural issues as an integral part of ecosystems. This viewpoint suggests that whether people engage in these webs as collaborators or exploiters will primarily decide whether the real estate construction sector, which directly relies on them, is sustainable[4].

Nevertheless, miles stone for the regenerative concept widespread use in cities was Girardet's World Future Council brochure, which was later extended and published as a book entitled "Creating Regenerative Cities" in 2015. In 2013 UN-Habitat published a document "The Future We Want, The City We Need", that stated: "The city we need is a regenerative city[5]".

5. Difference between regenerative development and design

Both regenerative design and development emerged from ecological stream and leads to a redefinition of the scope of the built environment and its necessary function.

It seeks to address the continued degradation of ecosystems by developing the built environment to restore the capacity of ecosystems to function at optimal health for the mutual benefit of both human and non-human lives[6]. This will be made feasible by incorporating eco- friendly technology into a framework that emphasises the environment. As stated by proponents,, the regenerative design relies on a systems-based approach, in which structures and a single buildings are seen as nodes in a system, much like organisms are components of an ecosystem.The objective is to promote intricate interactions between the built environment, the natural world, and the inhabitants of it that are mutually beneficial[7].The regenerative approach emphasizes the contrast between development and design, which are viewed as two independent processes that must operate in tandem to be really

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[2] Pamela M., Reed B. (2012). *Regenerative Development: regenerative development and design*, pp.15

[3] *Ibidem*

[4] Mang N. (2009). Toward a regenerative psychology of urban planning, Saybrook Graduate School and Research Center, http://powersofplace.com/pdfs/Toward_a_Regenerative_Psychology_of_Urban_Planning.pdf, (date of access: 18.09.2022)

[5] The Future We Want, The City We Need, UN-Habitat (2013), pp. 10 - 11.

[6] Raymond C. (2012). Transitioning from Green to Regenerative Design. Building Research & Information.

[7] DuPlessis K., *op.cit.*, p.

effective. Although there is often confusion in the literature around the peculiar character of regenerative development and design, this distinction was clearly highlighted in Jenkin and Pedersen Zari's paper, "Rethinking the Built Environment", where regenerative development is defined as establishing the intended outcome, and regenerative design is defined as the tools to achieve it.

6. Impacts of different building practice

The previous interpretation of sustainability proposed that a transition from the present "unsustainable" condition to the future "sustainable" state could be accomplished by abiding by a predetermined set of guidelines, then, people would concentrate on preserving this idealized situation[8].

Conventional

Conventional is the contemporary building method, which works within the framework of modern thought. The design process is carried out in separation form nature and its effects are destructive. Aim of the design is the most economically-efficient solution for the developer and other actors.

Green

Green design is a slightly improved version of traditional design. Improvements are being made to the damaging structures and paradigms that already exist; for instance, the introduction of solar panels or low-carbon materials can lessen the greenhouse gases emissions. These solutions are more environmentally friendly, but green design does not take into account the overall negative effects it generates.

Sustainable

Sustainable by design is related to its longevity and reduced environmental impact. Professionals work to make projects better than conventional ones, less destructive, but it does

not reverse the damage caused by their activities. Sustainable project's impact is neutral, for this reason, „sustainable" is marked as 0 in the diagram.

Restorative

The next stage is restoring, which is supposed to mean „restoring nature to its original condition", but according to Reed nature is always changing so there is no way to go backwards to restoring, because nature is evolving. By using this method, early interventions are often made to restore the health of an ecological and community subsystem, such as wetlands, forests, riparian corridors, dune systems on beaches, social systems, and so forth. This strategy is biocentric. However, once the human intervention is over and the system's ability for self- organization is activated, individuals stop being engaged. Regeneration and restoration are two distinct ideas that are not interchangeable.

[8] Zari P., (2012). *Ecosystem services analysis for the design of regenerative built environments*, Building Research and Information, Vol. 40, No. 1, pp. 54-64. Special Issue: Regenerative Design and Development.

Regenerative

Regenerative design aims to improve the development impact area in addition to restoring. Implemented designs improve the environment compared to those without them. They make new habitats, clean the water, improve the soil, enrich the soil, and establish cultures that can continue the favourable effects. Regenerative projects highlights positive role of humans to play in nature.

7. Ecosystem services assesment

One of the strategies in regenerative design is the method of analyzing ecosystem services. The first step in the method proposed by Pedersen Zari is to examine the ecosystem services provided in a given area before building it up, which then should be compared with the ecosystem services provided by a city or a settlement established later in the same area. The author claims that thanks to such an analysis it is possible to define measurable and tangible indicators of regeneration goals of given projects based on ecological reality. However, to obtain a better understanding of the usefulness of this method, and be able to evaluate it, it is necessary to define what ecosystem services are. Urban ecosystems services are the benefits that human populations can derive from ecosystems[9]. These are all features, functions and ecological processes that contribute directly or indirectly not only to the improvement of the quality of human life, but also to sustain the ecosystems themselves. In order to facilitate debates, evaluations, and modeling, categorization methods were required to further refine the idea of ecosystem services. In 2005 a classification systems that is used worldwide was completed. The Millennium Ecosystem Assessment connected ecological services and human well-being with socioeconomic considerations and on the basis of that a conceptual framework was established, which divided ecosystem services into the four categories. For each of these groups, the aspects related to urban areas are discussed below:

Provisioning services

relate to the production of all products of living organisms that can be used by humans as a source of food, materials or energy. The production and edibility of plant parts provides food as well as a part of medical resources. Food production from urban agriculture can play an important role in food security in the future. It also concerns water supply and retention (surface and underground). Ecosystems provide cities with fresh water for infrastructure and drinking by securing storage and controlled release of water flows. They provide natural resources, for example tree plantations and reed fields, which are construction materials, as well as energy sources without which cities could not function.

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[9] R. Costanza, R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. O'Neill, J. Paruelo, R. Raskin, P. Sutton, M. van den Belt (1997). *The value of the world's ecosystem services and natural capital,* Nature, 387 (15), pp. 253-260.

Regulating services

regulate processes and systems that support life keep them running smoothly. They include, among other things, controlling the climate, preserving the quality of the air, noise reduction and controlling water flow. Urbanization has a strong influence on the local water regime. Permeable surfaces inhibit water infiltration and cause surface runoff, leading to more frequent flooding and overloaded water treatment plants. The capacity of urban soil to filter water is reduced, which favors groundwater contamination. Crucial advantage of this service group is regulation of the temperature in the urban tissue and minimizing the effect of a „heat island". Phenomenon of higher temperature in the city compared with the surroundings is caused by physical properties of materials that cover the surface of city - asphalt, concrete, roofing felt, dark facades that have a lower albedo, small amounts of biologically active surface and intensified human activity - industry, traffic or heating. Regulation aspects include erosion control, but also pollination without which provisioning services would not exist.

Cultural services

Green spaces, parks, forests, and blue infrastructure are examples of elements of cultural services. They are an inseparable element of human well-being. Green and recreational areas have a positive effect not only on physical health, but also on mental health. Being in nature reduces stress, lowers tension and influence level of happiness, as well as increases the place attachment of people to their place of residence. Many scientific research indicate the direct impact of the proximity of a natural landscape on the price of real estate. Today the demand for recreation and landscape amenities in the nearby is rising, that is why housing located near vast natural areas, with access to sunny and quiet places, or located near open bodies of water, or of urban parks is much more expensive[10].

Supporting and habitat services

emphasizes the role of ecosystems as a habitat for numerous species of plants, birds, amphibians, and insects. They provide living spaces and all the resources needed. Urban systems aren't just a habitat for human beings, but also a diversity of breeds of animals or plants. Essentially we should provide breeding places for migratory species and to protect the gene pool. Biodiversity is the key to the functioning of the entire natural system, which people are a part of.

8. Summary

The damage reduction paradigm has profoundly influenced sustainable urbanisation. Regenerative urbanism, in contrast, aims to produce net benefits for both people and the environment. The understanding that all human endeavours are directly related to and reliant on "nature" is another essential component of regenerative urbanism.

[10] Schaerer C., Baranzini A., Ramirez J., Thalmann P., *Using the hedonic approach to value natural land uses in an urban area: An application to Geneva and Zurich. Public Econ*