

## **SUSTAINABLE DEVELOPMENT OF URBAN SPACES TOWARDS CLIMATE PROTECTION AND ADAPTATION TO ITS CHANGES**

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### **A b s t r a c t**

The article concerns urban spaces highly responsible for climate change in the country, Europe, and the world. This topic is now of major importance because it reflects on every citizen of Europe and the world in that we all confront the necessity of climate protection and adaptation also in law, to climate change in urban areas. It is associated with a radical change of lifestyle in the world's cities, mainly in terms of energy consumption and its methods of production. The research results presented in the article indicate the need to adapt current methods for slowing down adverse climate change into functional and spatial systems of urban development and their economic, legal, and social conditions affecting the pace of implementation of new technologies for climate-friendly sources such as low-carbon, energy-saving, and renewable energy. Attention was also paid to the possibility of ecological revitalization of the existing urban structure of buildings, among other things, in order to significantly reduce greenhouse gas emissions adversely affecting the climate. On the other hand, modern ideas for an Eco-City and solutions for a Green-City and Solar-City, presented in the article, implemented through sustainable development in the field of planning activities and energy management methods, can be additional indicators of the direction of sustainable development for Polish cities for climate protection and adaptation to its changes.

**Keywords:** sustainable cities, urban climate policy, climate action plans

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## **1. INTRODUCTION**

### **1.1. Purpose and subject of research**

The article presents the results of research carried out at international, national, regional, and local levels, of changes to climate policy which, over the past 40 years, have had a significant impact on the way and pace of sustainable urban development.

The main purpose of this research was to determine the type of actions taken and methods developed and used to implement the principles of sustainable development in urban areas towards climate protection and adaptation to its changes.

The research results present, among others, interesting and innovative pro-climatic solutions in the field of creating favorable economic, legal, and social conditions for building healthy and safe cities, both at the stage of urban planning as well as design architecture and greenery, and the way of their implementation by the administrative and private sector, together with NGOs.

### **1.2. Description of the method and scope of research**

The research results presented in the article were obtained on the basis of the following analyzes:

- policymaking mechanisms at global, European, national, and regional levels in the past 40 years, in relation to climate change in the urban sector,
- climatic factors having a significant impact on current socio-economic, cultural, and environmental conditions and the related selection of methods for introducing the principles of sustainable development of urban areas,
- implementation of pro-climate actions for sustainable urban development in the country, Europe and the rest of the world, presented as case studies.

## **2. RESEARCH RESULTS AND DISCUSSION**

### **2.1. Climate policy and activities at international, national, regional, and local levels in urban areas**

Climate policy is primarily closely related to the energy economy, which affects adverse climate changes and creates a huge growth of other pollutants dangerous to human health. The accelerative increase in the excess concentration of greenhouse gases (GHG) in the atmosphere is caused by massive burning of fossil fuels by humans. According to the data included in the latest IPCC report<sup>2</sup>,

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<sup>2</sup> The Intergovernmental Panel on Climate Change (IPCC) is an organization that collects and summarizes the results of all global climate change research, including human impacts on global

the highest emissions are related to the production of electricity and heat – 25%, land use (including agriculture and forestry) – 24%, industry – 21%, transport – 14%, and construction – 6,4%, and also related to various other emissions from the energy sector – 9,6% [16]. It should be noted that these emissions do not stop at national borders. This is a problem on both a global and local scale. It mainly concerns areas with increased population density, which are urban spaces<sup>3</sup>.

### **2.1.1. Global, European, and national changes in climate policy in the last 40 years influencing the development of urban spaces**

The history of many successive international protocols and climate agreements, not always fully implemented, starting with the first in 1979, arising from the World Climate Conference in Geneva, to the present time proves that in an increasing number of countries in the world, and amongst European politicians and society, all are in favor of reducing emissions of gases causing the greenhouse effect. In this respect, the emergence of climate law within the international environmental protection laws is of great importance. Currently, climate law in Europe and the world can be divided into two areas; climate protection law, and adaptation of the law to climate changes. While, the enforcement of this at the level of international agreements, inter alia, the Kyoto Protocol (1997: COP 3, Kyoto, Japan) and the Paris Agreement (2015: COP 21/CMP 11, Paris, France), is achieved by the application of monitoring mechanisms and control of the implementation by individual countries of their obligations<sup>4</sup>. Reports on the implementation of the provisions of the Parties to the Convention are reviewed by experts from the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) [1]. UN efforts are strongly supported by the European Union to extend international agreement in the field of global climate protection and adaptation to its changes at the local level.

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warming, and the assessment of the associated risks. It was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP).

<sup>3</sup> Europe is a place where 70% of the population live in urban communities, largely associated with the need for low-carbon transition in the context of ecological and sustainable urban planning [9].

<sup>4</sup> On the forum of the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Conferences on Climate Change have been taking place annually since 1995 as formal meetings of the Parties to the UNFCCC (Conference of the Parties – COP). These conferences have also been organized since 2005 as Climate Meetings of the Parties to the Kyoto Protocol (CMP), and since 2016 also as Climate Meetings of the Parties to the Paris Agreement (CMA) [13].

Climate policies and EU legislation create favorable conditions for member countries and their regions to reduce greenhouse gas (GHG) emissions<sup>5</sup>. They are also helpful in obtaining long-term grants for the development of low-carbon technologies and to adapt to the current and future effects of climatic changes<sup>6</sup>. The most important consultation documents of the European Commission, created during the preparation of EU legal acts, are the Green and White Papers<sup>7</sup>. Following the Commission initiated in the form of a Green Paper for the presentation of views on a specific subject (in this article on the subject: "Adaptation to climate change in Europe - options for EU action", 2007 Communication COM (2007) 354 final ), further White Papers are created (among others in this topic: "Adaptation to climate change: a European framework for action", 2009 Communication COM (2009) 147 final), containing proposals for specific EU and Member State actions to build legal solutions. These solutions become binding law after the legal act by the Council giving them form and are published in the Official Journal of the EU. It organizes and accelerates the implementation of many joint adaptation programs both between countries and European cities.

Currently, the climate policy of Poland as (one of more than 190 countries) a Party to the United Nations Framework Convention on Climate Change (UNFCCC), is conducted in the EU in accordance with the provisions of the Convention in terms of both reducing greenhouse gas (GHG) emissions and of adapting to climatic changes.

### **2.1.2. Methods of introducing the principles of sustainable development of urban spaces towards climate protection and adaptation to its changes**

At the present time, around 20% of all EU programs are implemented in support of climate policy, some of which are, among other things, co-funded by the EU "Life" program [7, 8] as well as under EU cohesion policy through cross-border, interregional, and transnational programs. In this way, some European cities have adopted comprehensive adaptation strategies or detailed plans to counteract

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<sup>5</sup> The EU is committed to climate neutrality by 2050 – an economy with zero net greenhouse gas emissions. This objective underpins the European Green Agreement (Resolution of the European Parliament – January 2020) and is consistent with the commitment of the EU to global climate action under the Paris Agreement (December 2015) [10].

<sup>6</sup> According to art. 4 point 19 of the Paris Agreement, EU Member States prepare national long-term strategies for the development of low greenhouse gas emissions by 2050 and forward them to the UNFCCC [2].

<sup>7</sup> Green and White Papers are translated into all official languages of the European Union and sent by the Commission to the governments and parliaments of the Member States, and are available on the website for Union citizens and the institutions concerned [11].

the adverse effects of climatic changes [4, 5, 6]. This requires integrated urban programs, with the possibility of benefiting from public and private investment, which the EU's "Urban Investment Support" program actively encourages [9]. Poland, as a rapidly growing country in the European Union, together with the other EU Member States, has committed to reducing emissions by 40% by 2030 compared to 1990 levels. Probably, it must be able to reduce CO<sub>2</sub> emissions by around 25% [16]. In recent years, in EU and international forums, including in Katowice at COP 24/CMP 14/CMA 1-3 in 2018, Poland repeatedly tried to block the development of the EU climate policy in terms of the transition to a low-carbon economy. Poland's declaration in pursuit of climate neutrality by 2050, by achieving a balance between emission and absorption, using primarily innovative solutions in the field of forest management as well as the use of the natural process of absorption of CO<sub>2</sub> by the soil and forests (the project "Forest Carbon Farms"), may give a reduction in CO<sub>2</sub> levels up to a maximum of 15-20%. This is not enough to meet Poland's obligations under the EU's 2030 energy and climate package and even less so the Paris Agreement. By switching to renewable energy, Poland can reduce emissions by up to 84% by 2050, while remaining with coal will reduce it by only 7% compared to 2005 [17]. Consistent moves away from coal will generate many benefits for the entire country, and most importantly, it will improve the quality of life and health of its inhabitants.

The results of many years of scientific research clearly indicate that climatic change is a real threat to the social and economic development of many countries, including Poland. For this reason, the international community has been undertaking measures to adapt to the current and future effects of these changes for many years. The Polish Government, adopting a position on this matter in 2010 from the White Paper, began to develop an adaptation strategy for sectors and areas sensitive to climate change under the name Polish National Strategy for Adaptation to Climate Change to 2020 (NAS 2020) within the perspective of the 2030 requirements. This document is part of a broader research project called "Klimada" implemented for the Ministry of the Environment of the Republic of Poland in the years 2011-2013, financed by the National Fund for Environmental Protection and Water Management, which covers the period up to 2070 [12]. The Strategic Adaptation Plan, approved by the Council of Ministers of the Republic of Poland in October 2013, largely concerns urbanized spaces. It includes climate change scenarios up to 2030 and impacts on sensitive sectors and areas such as energy, construction, and urban planning. Also defined were objectives and directions of actions in the scope of adaptation to climate change in spatial, construction, and energy management, as well as in ensuring sustainable regional and local development, taking into

account climate change in urban spatial policy and, in the scope of shaping attitudes socially conducive to adaptation to climate change.

## 2.2. Case Studies

Currently, many European cities are introducing sustainable development standards into their development programs, in line with the 2030 Agenda, in which one of the 17 main goals is the thirteenth goal: "Take urgent action to combat climate change and its impacts"<sup>8</sup>. Shaping public awareness in this respect is also a task undertaken by the New York Urban Green Council organization around the world. Its multilateral activities are focused on increasing the energy efficiency of green construction for the sustainable development of green urbanization [19]. Central and Eastern European countries such as Poland are still on the path of transformation and searching for their own methods of sustainable urban development.

Against this background, the results of environmental research carried out in 2010-2012 at the University of Zielona Góra in one of the Polish cities, Gubin in the Lubuskie Province are of interest<sup>9</sup>. The research methodology used takes into account the Polish specificity of measurement, in which only 3% of meters work in the so-called smart energy metering system "smart metering". Whereas, for example, in Finland and Sweden, 100% of meters work in this system [23]. This is, therefore, especially in the cities of the countries of the former Eastern European bloc, one of the most significant developmental problems regarding urban environment management, which requires a much quicker solution. For this purpose, in the city of Gubin, a comprehensive study has been done using social surveys and construction of technical reviews of objects in separate areas of the city according to selected environmental parameters of urban space, among others, such as the number of potential users, year of construction, construction technology, type of heating systems, costs and amount of primary and final energy consumption, the size of biologically active areas of

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<sup>8</sup> "Take urgent action to combat climate change and its impacts" in: Transforming our World: The 2030 Agenda for Sustainable Development, A/RES/70/1/, <https://sustainabledevelopment.un.org/content/documents/pdf/>, 25.

<sup>9</sup> As part of the strategic research project of the National Center for Research and Development (NCBR): "Integrated System for Reducing Energy Consumption in the Maintenance of Buildings", were done by employees of the former Division of Architecture and Urban Planning (now the Institute of Architecture and Urban Planning) of the University of Zielona Góra, research tasks No. 1 "Study of socioeconomic possibilities and effects of raising energy efficiency in civil engineering", and No. 7 "Energy saving conditions and possibilities created by municipal policy instruments" (contractor – University of Zielona Góra, activity completed), <https://www.ncbr.gov.pl/en/programmes/strategic-programmes/> – 2020 NCBR.

development, etc.<sup>10</sup>. The obtained research results made it possible not only to assess the condition of the urban environment but also to indicate potential interventions for the planned qualitative changes in urban buildings in order to reduce the negative impact of these buildings on the environment, among other things, by reducing greenhouse gas (GHG) emissions.

The collected and grouped results of these studies show the energetic and ecological features of urban buildings of Gubin in the following designated environmental urban zones: Zone ZI – including the area of the buildings in which the main source of heat energy comes from local boiler houses or individual tiled-storage stoves for solid fuel such as: coal, fine coal, coke, and the technology of these buildings is traditional, and beyond the standard of the current technical conditions – shows a total final energy consumption  $QK = 564.981,0$  GJ and  $CO_2$  emissions = 33.899,0 Mg/year; Zone ZII – including the area of the buildings in which the main source of thermal energy comes from a remote heating plant powered by solid or gaseous fuel, and the technology of these buildings is fully or partially industrialized (including large panel housing estates) – shows a total final energy consumption  $QK = 202.784,0$  GJ and  $CO_2$  emissions = 12.167,0 Mg/year; Zone ZIII – including the area of the buildings in which main source of the heat supply are local gas boiler houses, and the technology of these buildings is modern according to TR (Technical Requirements) – shows a total final energy consumption  $QK = 42.907,0$  GJ and  $CO_2$  emissions = 2.402,8 Mg/year; Zone ZIV – including the area of the buildings with low energy consumption, powered by own renewable energy systems (RES), alternatively with zero or plus energy features – potential reserve of land for this type of development. Thus, the final energy consumption of buildings in zone ZI in comparison with the buildings in zone ZII is almost three times larger and is ten times larger than in buildings potentially powered by RES in zone ZIV. This means that the cost of maintaining such buildings is a net burden on public expenditure and the environment. On the basis of the shared technical and accounting documentation and the data obtained from residents about energy consumption and operating costs, the average consumption of primary energy  $QP$  was also calculated in these zones. Among other things, in the zone ZI the consumption of this energy is  $2,45$  GJ/m<sup>2</sup>, while in the neighboring ZII zone it is half as much and amounts to  $1,2$  GJ/m<sup>2</sup> [14]. The results of these studies entirely justify the environmental necessity of introducing more favorable modern energy standards to older buildings, but this involves greater funding; co-financing for the ZI zone of old buildings in the city center usually reaches the level of 98,0% of the value of the buildings, which

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<sup>10</sup> Aggregation of technical and energy, ecological and socio-economic data of the built-up areas, concerned 548 reference buildings and 250 interviews with users and managers of these buildings.

confirms the importance and size of the problem, while in the ZII zone, it is at the level of 53,6%, and in the ZIII zone, it stands at 21,0%. Through such parametric analysis of urban buildings, it is possible to constantly monitor the city and improve techniques and procedures to eliminate negative environmental effects. Therefore, such parameterization of the environment should be primarily dedicated to city boards in order to control expenditure on pro-ecological activities [15]. In Poland, the energy economy is based mainly on coal, with the trend of introducing RES. Thus, the development of methodical activities for the assessment of the urban environment may also activate social action groups for the protection of the climate and adaptation of the city to its changes [16].

The only initiative of this type in Europe, unique because of the scale and scope of its activities, was implemented in the 44 biggest Polish cities in the years 2017-2019, the project, "Urban Adaptation Plans" (UAP), responds to the observed and documented climate changes. This project was the realization of the indications of the National Adaptation Strategic sectors and areas vulnerable to climate change (NAS 2020), the first such government document from 2013. The implementation of the UAP project was preceded by the preparation by the Ministry of the Environment of the Republic of Poland in 2014 of a textbook entitled: "Guidelines for the preparation of the Urban Adaptation Strategy". As part of the UAP project, a total of 132 workshops were conducted with the participation of the Ministry of the Environment of the Republic of Poland and the Institute of Environmental Protection of the National Research Institute as well as local governments and administrative units. Development of plans for adaptation to climate change in cities with more than 100 thousand residents was financed from EU funds through the Infrastructure and Environment Operational Program, Regional Operational Programs, and thanks to funds from the National and Provincial Funds for Environmental Protection and Water Management.

The proposed projects focus on reducing energy consumption as well as increasing the resilience of cities to extreme weather conditions such as storms and floods. Among local governments and residents participating in the program were inter alia: Łódź, Kraków, Warszawa, Wrocław, Zielona Góra, Bydgoszcz, Katowice, Gdańsk, Szczecin, Bielsko-Biala, and Olsztyn. The preparation of urban adaptation plans in the cities participating in the project (such as the "Adaptcity" project in Warsaw) will contribute to protecting about 30% of the Polish population against the effects of climatic changes. Implementation of the project will start similar activities at the local level in smaller cities and communities. Urban adaptation plans take into account local conditions and problems of cities, each of which has a different specificity and structure, and also differs in terms of the threats and difficulties it faces [18].

However, when implementing such plans, it is worth paying attention to and using the experiences of other countries. Broadly speaking, such activities in the

urban area include the "Green Strategy" in the construction and economic sector of Madrid as well as rapid implementation of plans approved by the City Council, including the "Plan for Sustainable Energy Use and Preventing Climate Change" (task – development of ecological transport rail/subway, tram, bicycle, and pedestrian traffic, effect – reduction of 35 thousand tons of CO<sub>2</sub> per year), "Water Management" (task – recycling 100% of polluted waters, effect – about 500 million m<sup>3</sup> returned to rivers or used to wash streets and irrigation of greenery), "Waste Management" (task – processing 50% of the city's organic waste, effect – construction of Bio-methane Center for obtaining biogas from 60% of this waste) [20], together with the ecological implementation by the Linz city authorities in 2001-2008 of the estate project Solar-City in the newly created district of Pichling, which is an example of good practice in solving climate problems, on both a local and global scale, through the sustainable urban development of solar construction in Austria [21]. Another modern urban solution, more towards Green-City, is represented by the medium-sized German city of Regensburg/Ratyzbona. The main planning principles of sustainable urbanization of this city, in order to increase the quality of the urban environment, are primarily focused on the development and protection of the "Urban Greenery System" through full integration with the city's building structures, while respecting its cultural and natural heritage, and also on the implementation of pilot projects for the construction of "Green" housing estates [22]. It is also worth mentioning the Canadian city of Vancouver, which hosted the 2019 Eco-City World Summit in the international conference series on assessing and guiding progress towards ecologically healthy cities. Vancouver is recognized as one of the world's most livable and greenest cities, having successfully completed the first phase of its Greenest City 2020 Action Plan. Vancouver is one of the few cities around the world that is achieving net reductions in greenhouse gas emissions despite a growing population. It is a diverse and multicultural city that represents 18 International Eco-City Standards in action, based on the four pillars of Urban Design, Bio-Geo-Physical, Socio-Cultural, and Ecological [3].

### **3. SUMMARY**

The research presented in the article shows that the disturbances in the balance of the Earth's environment caused by the changing climate are accompanied by intensifying unfavorable meteorological phenomena that directly or indirectly affect the functional and spatial development systems of an increasing number of cities. This growing interdependence over the last twenty years has a significant impact on the acceleration of the introduction of programs for sustainable urban development, activities related to policy strategy, and legislation on climate,

both worldwide and within Europe. This is clearly visible in the formation, for the benefit of sustainable development of urban spaces, of pro-climatic economic, social, and especially legal conditions. Currently, in Europe and the world as a whole, climate law can be distinguished between the area of climate protection law and the area of adaptation of the law to climate change. The enforcement of this law is implemented at the international and interregional agreement levels. For obvious reasons such as maintaining industry and energy (changes in technology and demand for water and energy, etc.), the safety of people and property (exposure to violent heavy rainfall and floods, strong insolation and heat waves, coastal erosion, sea-level rise, landslides, droughts, and fires), and efficiency of infrastructure (exposure to excess or shortage of water, storms, tornadoes), urban development plans in cities in the field of climate protection are increasingly focused on mitigation and adaptation activities. The results of the research on the applied methods of environmental diagnosis of a city's condition, also presented in the article, and the results of the research on pro-climate projects and standardization in the creation of sustainable urban space, confirm a significant differentiation in the ways of solving the urban climate problems, both on a local and global scale.

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