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The Green Infrastructure in Cities as A Tool for Climate Change Adaptation and Mitigation: Slovakian and Polish Experiences

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Abstract: Climate change could be seen as a 21st century phenomenon. This topic has been taken up equally by professionals as well as the general public. Adaptation and mitigation actions are needed, especially in cities where the concentration of population and an increased demand for resources (e.g., water, food, land) are expected in the coming years. Already, 400 cities have been declared to be in a "climate emergency" state. There are no longer any doubts that current environmental state requires actions and solutions for both the alarming climate situation and urban quality life development. If such action is not going to be taken, the environmental state will deteriorate. One possible solution could be the use of green infrastructure. This research compares approaches to green areas and green infrastructure development in Bratislava (Slovakia) and Wrocław (Poland). A comparison was made for projects realized between 2013 and 2018—i.e., since the publication of the European Union (EU) Strategy on Adaptation to Climate Change in 2013. The research presents an overview of delivered projects regarding land use. The overview, which is supported by a density map of implemented green projects, verifies whether the new greenery fits and fills in the existing natural areas. Secondly, the green projects were analyzed according to years and land use types using Tableau software. Moreover, the legislation of climate adaptation mechanisms and practical aspects of green infrastructure implementation are shown. Finally, actions concerning the greening of the cities were categorized into practical, educational, and participatory ones, and the potential of green infrastructure as a positive landscape, micro-climate, health, and aesthetic influence was examined.

Keywords: climate change; climate emergency; climate adaptation; green infrastructure; cities; sustainability

1. Introduction

Climate change is a topic that resonates with professionals, politicians, cities and the general public as well. According to the World Economic Forum Global Risks 2013 Report, climate change ranks among the top five most serious problems of our times [1]. Although global warming is still an issue of discussion, there are no longer any doubts regarding its progress—individual scenarios only differ in the value of temperature increase (1.5–4.0 °C on average) [2]. Temperature increases are more related to weather extremes, uneven rainfall levels, more frequent windstorms and floods, soil degradation, and a higher frequency of forest fires, etc. [3,4]. Climate change brings a wide range problems, of which the implications can be seen for natural systems, as well as in all sectors and spheres of human life [5,6]. Moreover, the state of the environment may deteriorate, which could

be associated with the increase of human population, especially in cities [7,8], and the increasing demand for natural resources: water, food, and land [9–11]. Already, over 400 cities have declared a "climate emergency" state [12]. Therefore, the implementation of solutions for enhancing the current state of the environment is required [13].

Within the EU context, "climate emergency" is a part of the 7th Environmental Action Program to 2020 [14] "Living well, within the limits of our planet". One of the priority objectives of the 7th Environment Action Programme (EAP) is to provide sufficient resources and investments to support environmental and climate protection policies. Other equally important objectives include strengthening the sustainability of cities in the EU and ensuring the use of state-of-the-art knowledge in environmental policy making [14]. Morover, revised Environmental Impact Assessment (EIA) directive includes also an appeal for integrating climate change into environmental impact assessments. The EIA directive indicates the importance of assessing climate change risk associated with planned land use or investment, as well as conducting other analyses of characteristics, i.e., in relation to areas vulnerable to natural hazards [15].

Apart from strategic documents, the relevance of the issue is demonstrated by the large number of conferences, summits, and global initiatives, for example, the 100 Resilient Cities or C40 Cities. The former, 100 Resilient Cities, is a network of cities supported by Rockefeller Foundation, that aim to become more resilient by adapting resilience strategies, supporting and learning from each other [16]. C40 is a group consisting of more than 80 of the world's cities. The group's aim is to support measures that lead to reduction in greenhouse gasses and climate change consequences, and an improvement in health and quality of lives of city inhabitants' [17]. Giving an interview to C40, Patricia de Lille, the mayor of Cape Town, stated: "Cities are the drivers of change around the world" [18].

Cities' efforts to adapt to higher temperatures would come at enormously high costs. When preparing adaptation strategies, it is important to assess the vulnerability of the individual environmental components including urban landscape and the vulnerability of the population [19,20]. The mitigation measures themselves were addressed by the third Intergovernmental Panel on Climate Change (IPCC) Working Group [21], which has three parts focusing on consequences, vulnerability, risks, building resistance, and adaptation mechanisms. For city planning, these issues should be essential. In this context, it is important to determine the vulnerable areas and subsequently to identify the degree of their resistance or vulnerability. Based on the knowledge of these parameters, it is possible to plan appropriate measures (adaptation and mitigation) in the planning policies. Well-chosen and implemented adaptation and mitigation measures allow for reduction of overall risks [21]. The strategic documents should be a guideline for more sustainable development, resilience increasing and undertaking actions for climate change adaptation and mitigation [22,23].

In this regard, cities are trying to find a suitable method of mitigating climate change consequences, typically in relation to green infrastructure (GI). According to European Commission (EC) definition, green infrastructure is "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings" [16]. GI should be designed to provide a wide range of ecosystem functions and services (e.g., water regulation, the heat island effect mitigation, ensuring flood protection, stabilize soils through the elimination of erosion, as well as human wellbeing, quality of life, etc.). The role of green infrastructure is to improve the life in different ways, through its environmental, social and economic potential based on a multifunctional use of the natural capital [16].

Investing in greenery in cities focused mainly on parks, forests, open spaces or gardens with the assumption that new green areas will not interfere with residential, commercial and industrial lands [24]. However, there has been a change in the perception of greenery in cities by its inhabitants (city dwellers are willing to pay higher prices for the growth of green areas [25]), as well as city authorities'. "[G]reen growth is suggested to be a key element in achieving sustainable development:

on the one hand, protecting the environment, while on the other hand allowing economic growth. This arguably makes the concept more attractive to politicians and other decision makers than traditional environmental protection approaches, which were often assumed to lead to economic slowdown" [26]. The green areas in cities could be supported by additional "networks of green space that conserve ecosystem values and functions and provide ecological services of benefit to human populations" [24] which are ensured by blue-green infrastructure, i.e., storm water flow-through planters, bio retention gardens or swales, retention storage basins, rainwater harvesting, green facades, blue or green roofs [27]. The green growth is not limited to public spaces, it extends and is assumed also in private and semi-public spaces [28], for example in green balconies, terraces, or community gardens [29].

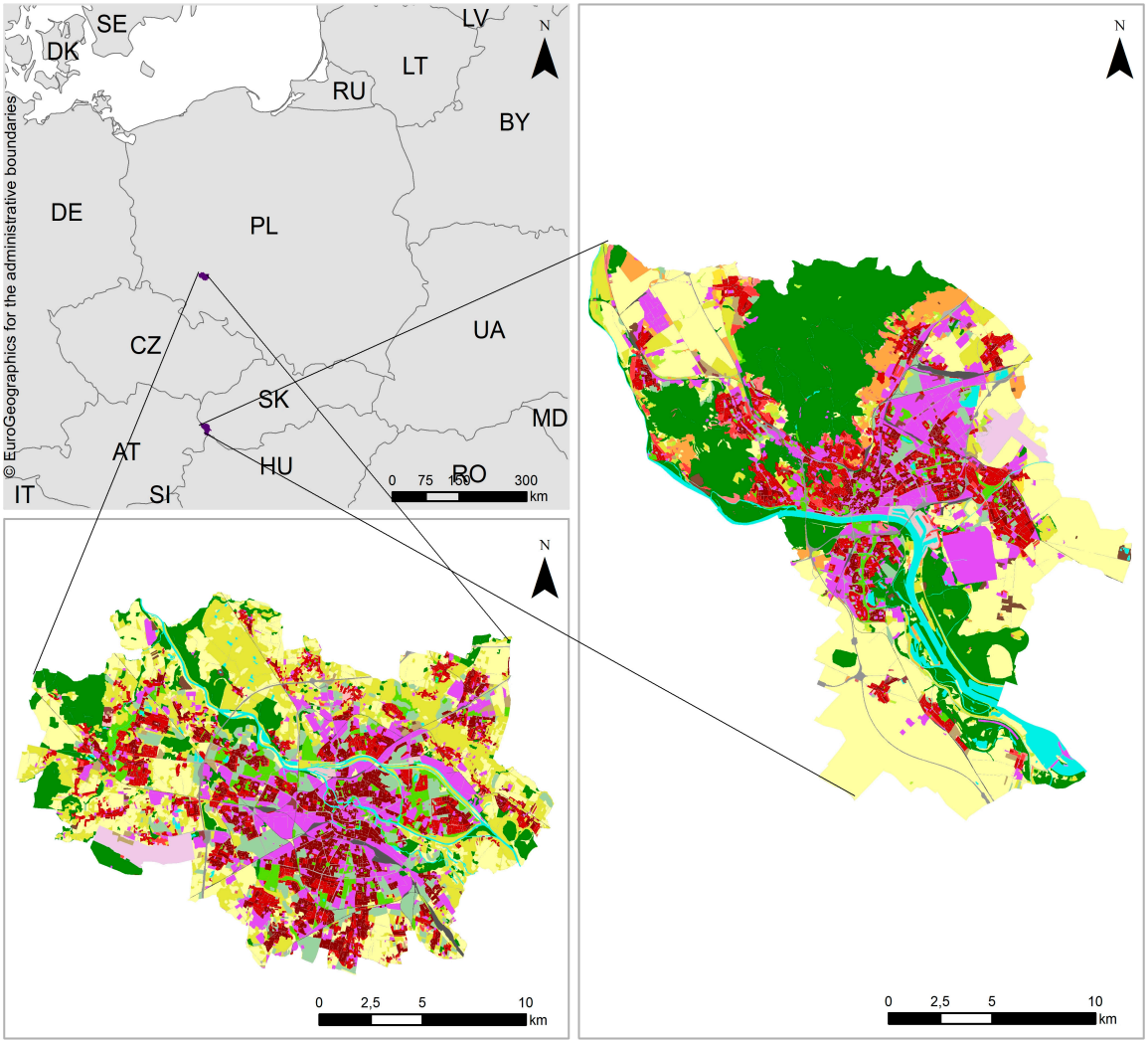
Although adaptation to climate change features appears in master plans and strategies, there is a wide spectrum of approaches. One common approach is the implementation of nature-based solutions [30,31]. "Activities in nature-based climate adaptation seek to prepare ecosystems for climate change so that they can continue to provide humans with required services, as well as buffer the negative impacts of climate change" [30]. Services provided by ecosystems also have an impact on micro-climate, and many other functions such as landscape, health, aesthetic, symbolic, communication, psychological, production or water-management [32–34]. Ecosystems help to create and define the quality of the urban environment [35], which is a key aspect of creating living cities [36]. Thus, there is need for increasing green actions i.e., by protection of forests, grasslands and peatlands, planting new trees and native vegetation, creating new and improving the quality of the existing green spaces [30]. Cities may try meet this goal through legislation, issuing binding provisions, public education, organizing events to raise awareness, involving the public, supporting the participation of inhabitants [37]. Many large European and non-European cities have been formulating concepts in the long-term regarding developing greenery, involving inhabitants, and inspiring them to work with the city administration in order to meet the aims set by urban planning [38–44].

The research presents legislation and practical aspects of investments in green infrastructure in terms of climate change adaptation on a local level by methodological comparison of two European cities, namely Bratislava (Slovakia) and Wrocław (Poland). The aim of strategic documents review was to compare cities approach towards the role and significance of green infrastructure in climate change adaptation. The analysis of projects allowed for the verification of whether cities consider the investments in green infrastructure as a tool for climate change adaptation. Therefore, the greenery actions were divided into practical, educational and participatory ones. Finally, an overview of realized projects is presented in relation to land use types (based on the Urban Atlas database), which led to the verification of whether the new greenery fits and fills in the existing natural areas.

2. Materials and Methods

2.1. Study Areas

The research was undertaken for Bratislava (Slovakia) and Wrocław (Poland) cities (Figure 1). While Bratislava is the capital of the Slovakia country, Wrocław is not the capital of Poland. It is, however, the capital city of the Lower Silesia region (voivodeship) and has been chosen as the most representative allowing for a comparison of similar features: strong business service focus (Wrocław is the third business service centre in Poland, after Warsaw and Kraków [45]; Bratislava is the most frequented location for business service centres from all Slovakian and Czech cities [46]), rapidly spreading suburban zone [47,48], having a similar value of the Quality of Life Index [49].



Legend:

- Cities of research: Bratislava [SK], Wrocław [PL]
- national borders

Land use (base on Urban Atlas):

- 11100: Continuous Urban fabric (S.L. > 80%)
- 11210: Discontinuous Dense Urban Fabric (S.L.: 50% - 80%)
- 11220: Discontinuous Medium Density Urban Fabric (S.L.: 30% - 50%)
- 11230: Discontinuous Low Density Urban Fabric (S.L.: 10% - 30%)
- 11240: Discontinuous very low density urban fabric (S.L. < 10%)
- 11300: Isolated Structures
- 12100: Industrial, commercial, public, military and private units
- 12210: Fast transit roads and associated land
- 12220: Other roads and associated
- 12230: Railways and associated land
- 12300: Port areas
- 12400: Airports
- 13100: Mineral extraction and dump sites
- 13300: Construction sites
- 13400: Land without current
- 14100: Green urban areas
- 14200: Sports and leisure
- 21000: Arable land (annual crops)
- 22000: Permanent crops
- 23000: Pastures
- 24000: Complex and mixed cultivation patterns
- 25000: Orchads
- 31000: Forests
- 32000: Herbaceous vegetation associations
- 33000: Open spaces with little or no vegetations
- 40000: Wetlands
- 50000: Water

Figure 1. The study area of Bratislava (Slovakia) and Wrocław (Poland). Source: Own elaboration using ArcGIS (Esri, Redlands, CA, United States).

2.1.1. Bratislava

Bratislava is one of the youngest capitals in Europe and a political, economic and cultural center of the country. The city is situated in the central Europe bordering with Austria and Hungary (Figure 1) on both sides of the Danube River, the second-longest European river. Bratislava has a total area of 367.9 km^2 [50]. The landscape of the town is quite heterogenous as it is located partly on Little Carpathian Mountains (102–550 m) on the north and partly on Danube Lowland on the south (200 m). Bratislava has a moderate climate (annual temperature of 10 °C, precipitation between 500 and 700 mm). Forest land on the city's territory covers approximately 8095 ha, which is roughly 23% of the city area, or 190 m^2 per capita. Agricultural land is about 13,851 ha [50].

According to the master plan of the city, the built-up areas of Bratislava are formed by three fundamental kinds of surface: continuously built-up older areas serving chiefly for housing and services, looser housing, industrial, transportation, and recreational areas, and finally, large residential areas from the socialist period, usually designed as dormitories, on the city fringes [50]. The whole territory of Bratislava comprises many areas with non-urban function, for example, agricultural land, forests, and water. In comparison to other European capitals, the population of Bratislava is quite young (with the average age of 38 years in 2001 41 years and in 2013), relatively low mortality (in 2011) and a high share of family households (about 70%). The city has a comparatively high level of economically active people (more than 55% of all permanent residents). The most positive characteristic of Bratislava's population is a high proportion of residents with a completed university degree (more that 24% of adult population) There are more than 430,000 inhabitants. The population density in Bratislava is 1135 inhabitants per km^2 [51].

Since mid-20th century changes in climate change related to hydrological patterns and temperature patterns are evident in Slovakia. In the last three decades alone, the average temperature has increased by 0.5 °C and the number of tropical days has doubled. In regions with lower altitude and lowlands, such as the Bratislava region, the increase in average temperature doubles [52]. According to the Slovak Hydrometeorological Institute, the Bratislava region suffered the consecutive period of drought in 2016 and 2017 since 1981. The outlook is not very positive either. According to the climate change scenarios developed by the same institute, the average temperature will continue to rise to 2–4 °C until end of 21st century. In other words, while temperatures around 30 °C used to be a common feature of some of the summer's hottest days, soon 40 °C will be as common. In addition, the decrease in rainfall will continue, and by the end of the 21st century it is expected that the majority of Slovakia's territory will suffer from increase in long-term average surface run-off of −40% [52]. Furthermore, the heat will be multiplied by heat island effects, air humidity will decrease, and flood risk will increase. It is very likely that other extreme weather events will also increase in frequency, such as whirlwinds, windstorms, and snow calamities [53].

In 2012, the City Parliament in Bratislava approved the accession to the Covenant of Mayors with resolution no. 545/2012. The City parliament subsequently adopted with resolution no. 1658/2014 the accession to the "Mayors Adapt" initiative, thereby supporting the climate change adaptation goals of the EU. At the same time, Bratislava participated in the project EU Cities Adapt funded by the European Commission [54,55].

Bratislava's city policy has been focused for the last 10 years on issues of sustainable city development and urban planning, climate change resiliency, and the urban water agenda following the goals of enhancing sustainable urbanization, developing climate change mitigation and adaptation as well as the improvement of risk management and resilience.

2.1.2. Wrocław

Wrocław is a European city and the capital city of region (voivodeship)–Lower Silesia (Poland). Wrocław is a metropolitan area with a surface of 293 km^2 [56]. It is located at moderate latitudes, thus could be characterized by transitional climate. The annual average temperature is 9 °C, winds are mainly from the western and southern sectors, and the precipitation was noted as 569.75 mm (according

to long-term period 1995–2014). The Oder River flows through the city and divides its territory into eastern and western part. Moreover, the Oder River has also an influence on the climate, which is connected with the occurrence of frequent fogs and high humidity [57]. The forest land in Wrocław represents area of 2470 ha (8%), croplands 6497 ha (22%), grazing lands 9467 ha (32%), waterlands 790 ha (ca. 3%), and built-up land 10,049 ha (ca. 35%) [9].

Wrocław is the fourth biggest city in Poland. The number of registered inhabitants is over 640,648. The density of population is known as 2188 per square kilometer (according to data of the Local Data Bank, stated as of 31 December 2018). The total number is much higher, and is connected with the number of students (114,825 according to data of the Local Dara Bank, stated as of 31 December 2017), as well as domestic and foreign migrants.

Wrocław is known as a strongly transforming city, with a very large residential and suburban area [58]. Suburbanization could be listed among the other problems the city is facing, such as the heat island [59] effect or air pollution [60].

2.2. Materials

The research is based on data of executed municipal projects and investments connected with the climate change adaptation in each city during period 2013–2018—since the publication of EU Strategy on Adaptation to Climate Change in 2013. Data for Bratislava city was obtained from Bratislava Municipal Office. Data for Wrocław city was attained from public available sources–the website of the Wrocław Participatory Budget (originally Wrocławski Budżet Obywatelski—WBO) [61], the website of Municipal Greenery Management company (originally Zarząd Zieleni Miejskiej we Wrocławiu–ZZM) [62], the Public Information Bulletin of ZZM [63], as well as based on our professional experience and knowledge. The obtained data was geocoded and mapped using ArcGIS (version 10.6) (Esri, Redlands, CA, United States). Thereafter, data was collated, analysed and finally compared.

The data was also compiled in relation to land use cover based on Urban Atlas data set [64] and using Tableau software (version 2019.1) (Tableau Software, Seattle, WA, United States). The Urban Atlas (UA) is a pan-European comparable land use and land cover dataset, which is provided for Functional Urban Areas (Large Urban Zones) with more than 100,000 inhabitants according to Urban Audit definition. The land use data are provided together with the administrative map of given urban area [64]. "The Urban Atlas is a joint initiative of the European Commission Directorate-General for Regional and Urban Policy and the Directorate-General for Enterprise and Industry in the frame of the EU Copernicus programme with the support of the European Space Agency and the European Environment Agency" [64]. The use of UA dataset allowed for comparability of Bratislava and Wrocław according to the same land use types. The administrative units—national boundaries in shapefile format, were obtained from Eurostat's geodata [65].

2.3. Methods

The research is comparing approaches of green areas and infrastructure development in Bratislava (Slovakia) and Wrocław (Poland). It presents overview of realized projects on a land use map. The overview of projects was supported by the density analysis using ArcGIS tools (version 10.6). Therefore, the tool Point Density was used. The Point Density tool "calculates the density of point features around each output raster cell. Conceptually, a neighborhood is defined around each raster cell center, and the number of points that fall within the neighborhood is totaled and divided by the area of the neighborhood" [66]. The density of implemented greenery projects is presented per square kilometer. It was examined whether new green projects fitted in and whether they were imposed onto existing natural areas. Secondly, the implementations of green projects were analyzed according to years and land use type using Tableau software. The ArcGIS and Tableau analyses were a basic for Bratislava and Wrocław comparison. Moreover, the comparison showed the legislation and practical aspects. Finally, we made a simple division of greenery projects into practical, educational, and participatory ones.

3. Recent Experience in Green Areas and Green Infrastructure Development: Bratislava and Wrocław Case Studies

3.1. Bratislava Experiences in Green Areas Development

During the last years, the city of Bratislava has been very much concentrated on climate change problems. Therefore, several policy documents have been implemented. "The Program of economic and social development of the city from 2010 to 2020" was approved by the city parliament in 2008, incorporating the issues of climate change into an adaptation strategy [67]. The municipal office realised a vulnerability assessment according to several themes/sectors (for example health, water management, agriculture, energy, transport, infrastructure) and vulnerable groups of citizens (young and elderly people). Regarding the urban greenery issue, the Municipal Authority of the Capital City of Bratislava has recently focused mainly on the issue of adapting to climate change.

Bratislava Local Legal Regulations and Funds for Green Projects Realization

In June 2014, the Adaptation Strategy on the Adverse Impacts of Climate Change in the Region of the Slovak Capital City of Bratislava (hereinafter referred to only as the "Strategy") [42] was published, discussing suitable adaptation measures. In 2017, the Strategy was followed by the approval of The Adaptation Action Plan entitled "Action Plan for Adaptation to the Adverse Effects of Climate Change on Territory the Capital City of the Slovak Republic Bratislava, 2017-2020" together with Environmental Action Plan in 2017. The Action Plan is in line with the objectives of the Strategy and includes a set of specific measures, including identifying individual responsibilities and deadlines for monitoring compliance, as well as the possible sources of their funding. In the material, measurable indicators were proposed for each measure that allows the collection and evaluation of the information needed to fulfill the second commitment of the Mayors Adapt Initiative. Given the needs of city development the plan has determined sectors within which the adaptation measures will have to be implemented such as environmental health, green and blue infrastructure, urbanized environment, rainwater and water resources, transport and energy [44].

The adaptation strategy was supposed to define the framework for intended measures. It emphasises the sustainable development of cities, stipulated by Act No. 17/1992, Collection of Laws, On the Environment, and concerns "a development which would safeguard the ability of present and future generations in meeting their basic life necessities, while maintaining nature's diversity as well as the natural functions of ecosystems" (2017, § 6). The adaptation strategy's aim was to lower the impact of climate change on city's life, to prepare for extremes, and draw-up strategies for dealing with and reducing them. In the interest of sustainable development, the emphasis is placed on alternative energy sources or supporting public transport and biodiversity [54].

Regarding the urban greenery issue, such measures concern increasing the quantity of vegetation in the city by planting trees in streets and parking lots, creating small green areas ("pocket park"), planting vegetation on facades, setting-up vegetation on roofs, improving the quality and accessibility of vegetation, ensuring the revitalisation of selected green areas, and renewing areas in courtyards. Green infrastructure is also discussed, namely the idea of combining individual green areas into one system and connecting built-up areas with rural areas [54]. The city tries to accomplish these aims through regulations, instructions, guidelines. The Action Plan following the Strategy includes such strategic objectives as: (1) the vulnerability assessment of the city to climate change (contains three cross-cutting measures for all sectors); (2) adaptation to Climate Change and Local Policies of the City (contains measures mainly for green and blue infrastructure and rainwater and water resources); (3) climate-neutral city (contains measures for health and quality of life, energy, transport, green and blue infrastructure); (4) awareness, information sharing, participation, cooperation (contains two cross-cutting measures for all sectors); (5) climate change adaptation assessment (contains three cross-cutting measures for all sectors).

City's actions have been intensified by implemented activities and projects. Some of the projects were funded by international grants, including EU funded projects. In 2014 Bratislava took part in project "Bratislava is preparing to the climate change" (duration of the project: 2014–2017), which was supported by the European Economic Area (EEA) and Norwegian Financial Mechanism. Since 2015, the project has been ensuring the implementation of a number of adaptation measures (i.e., increasing of the amount and accessibility of the city greenspaces, new plating trees, green roofs constructions, sustainable rainwater management) and also develop an Action Plan for Adaptation. The project's objective was to prepare the city for the consequences of climate change, with a focus on the implementation of pilot solutions to relieve heat stress and problems with rainwater discharge (Figure 2).

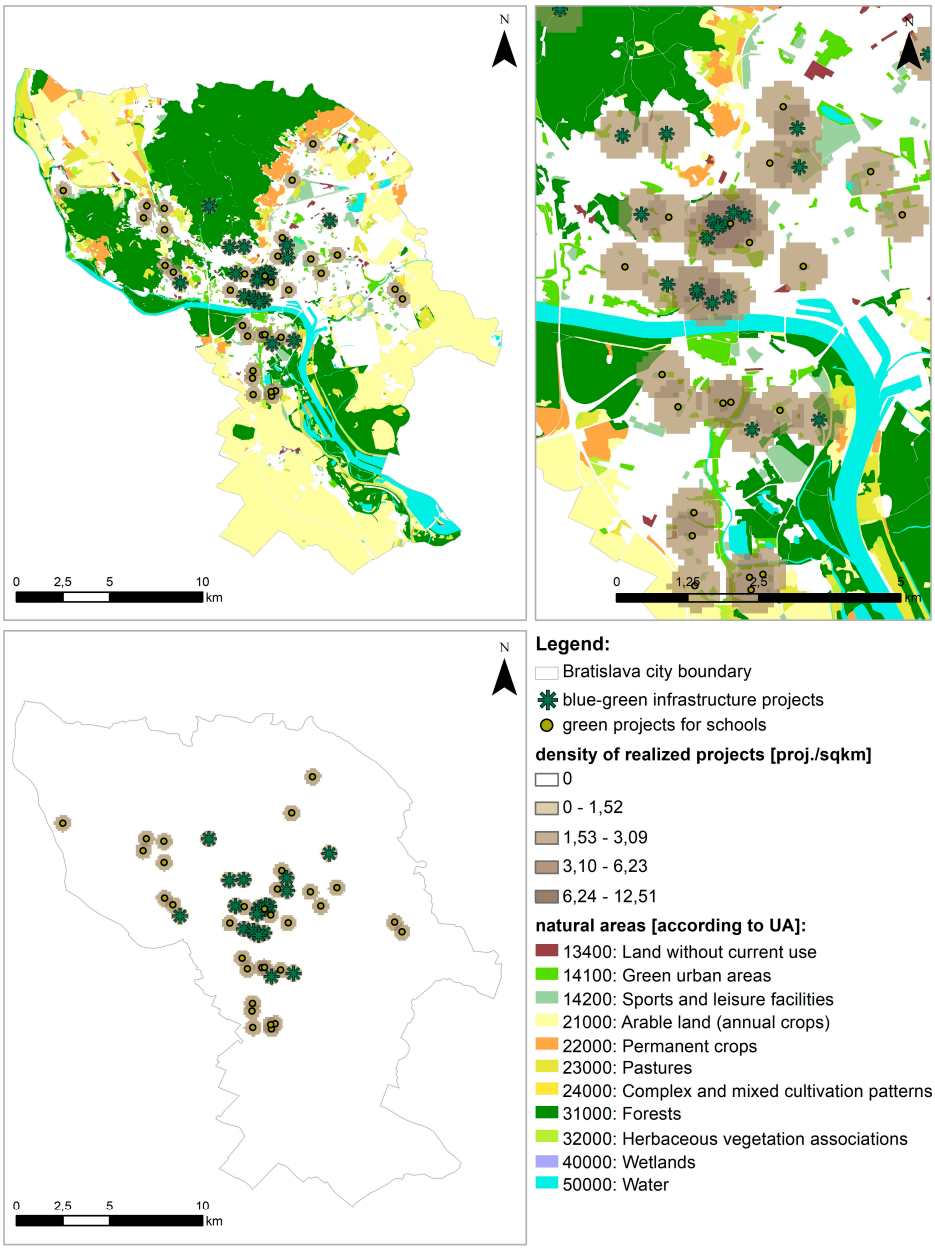


Figure 2. The green projects realized during period 2015–2018 in Bratislava. Top side of the figure shows the overview and density of projects regarding to natural areas in city (top-right figure shows the zoom to the city center). The lower section of the figure shows the overview and density map of projects [No. of projects per square kilometer]. Source: Own elaboration using ArcGIS software.

The green school project was dedicated for the educational eco-program designed for kindergartens, grammar schools and high schools. The main goal of the project was to encourage children to solve the real needs of their schools and the outer environment with a help of their teachers and parents. The program distinguished seven main steps: green school consortium, environmental action plan, pro-environmental education, eco-codex, environmental audit of their school, monitoring and evaluation, information and the community involvement.

Several other programs have been implemented to involve inhabitants in urban greenery development. One of these programs, "Adopcia zelene" (eng. Adoption of greenery), allowed for taking care of a green area selected by residents. Furthermore, the municipal authority opened a small grant scheme program to the city's inhabitants, with intention to support rainwater retention solutions. The municipal authority co-financed 50% of the investment that cost up to 1000 EUR. Inhabitants were provided with relevant consultancy services. Both initiatives were a step towards improving the relationship between the city and its citizens. The city communicates with inhabitants through an integrated website. At the same time, the implementation of a whole range of "non-investment" activities were performed, such as public counselling for sustainable management of rainwater, a subsidy scheme for the purchase of rainwater management installations, and sustainable drainage systems as a follow up activity.

Recently Project H2020 RESIN No. 653522 "Climate Resilient Cities and Infrastructures" (2015–2018) has been finished. Bratislava was one of the core cities in the project, among Paris, Manchester, and Bilbao. Climate Resilient Cities and Infrastructures (RESIN) project helped Bratislava City to understand better the impacts, vulnerabilities and risks, to select the most appropriate interventions, to prepare the catalogue of adaptation options, to choose the best implementation strategy and to implement adaptation measures and appropriate monitoring system.

3.2. Wrocław Experiences in Green Areas and Infrastructre Implementation

Wrocław's journey into greenery perceived as a tool in climate change adaptation has started with the document The Principles of ecological policy of Wrocław, 1998, which set the environmental vision, prioritized e.g., energy, sustainable transportation, waste management, water protection, and ecological awareness. This vision was later developed in subsequent environment protection programes and incorporated in city strategic documents and local law. It had been the whole process, visible through small steps that resulted in city's strategic documents, tools and investments. In 2017, a new Sustainable Development Department was established with two offices: Climate and Nature Protection Office and Sustainable Mobility Office. The department director, who reports to the Deputy Mayor, as a permanent member of the Mayor's Council, is responsible for reviewing and implementing the environmental vision. In 2019, due to new Mayor, changes had been made and Sustainable Mobility Office was moved into different department, and new office was created—Water and Energy Office, as a complimentary office to existing Climate and Nature Protection Office. A municipal company—Municipal Greenery Management (ZZM)—is responsible for creating and maintaining public greenery, including parks, squares, and greenery along roads as well.

Wrocław Local Legal Regulations and Funds for Green Projects Realization

One of the first city's strategic documents referring to blue-green infrastructure is the Wroclaw City Masterplan which is the main document shaping the spatial planning policy in the city. The new Masterplan was adopted by the City Council of Wroclaw in January 2018 and states that direct access to greenery is one of the most important features of the future cities. "Urban greenery, agricultural areas and spontaneous greenery of various degrees of transformation and functional interconnections, become an integral part of the Wroclaw city landscape. Depopulation of the city center and the development of the suburban area, industrialization of the landscape and the metropolisation processes are inevitably associated with the transformation of undeveloped areas for future investments. This situation forces a change in the approach of shaping green areas. That is why the principle of

creating "greenery without borders" has been established, according to which greenery is an equal or even dominant element of the city's spatial structure". According to this approach undeveloped areas in the city should be treated as green areas, creating the natural ecosystem of the city, regardless of the ownership and land use structure. This leads to the disappearance of the border between the urban structure and the natural environment. Greenery is to be present everywhere and to penetrate the urban tissue, changing its form depending on the function—with different function in the park, different in a multi-family housing estate, and in the city center.

The new master plan reflects the changes regarding planning green areas and the growing importance of greenery in the city. Certain provisions were also introduced to the land use plans such as protecting trees, protection of water ecosystems and their buffer zones against urban infrastructure development, providing blue and green infrastructure territorial coherence (blue and green corridors), defining new principles of development rules (limiting the use of impermeable surfaces, imposing the requirement of rainwater management on the facility owner, increasing the width of road belts for surface water drainage).

The new master plan was preceded by other regulations such as a Mayoral Ordinance on actions to protect and develop greenery in 2016 (new ordinance is from 2019). The main goal was to improve the greenery administration in terms of planning, coordination and monitoring of planting trees. There was created "green area bank" used as a reserve for planting trees, as well as the "register of green investments" (i.e., new tree planting, tree cutting, greenery inventory). Annual and multi-year plans for planting trees are created which include recommendations for locations of new parks, forests, and accompanying greenery.

Another act supporting the development of blue-green infrastructure and having influence on spatial planning documents is the Ordinance of the Mayor of Wroclaw from year 2017 on rainwater management in Wroclaw and it focuses on sustainable rainwater management. Water should be managed either in the place of the rainfall, with the use of e.g., infiltration, evaporation or greywater systems or the runoff that could not be managed should be delayed due to permeable or green surfaces, as well as investments in the water discharging systems. A tool following the act is the Good Practice Catalogue on rainwater management along pavements.

Another good example is a City Council resolution on greening/real estate tax decrease. Wroclaw Municipality offers for resident' financial incentives that encourage and promote creating green roofs and walls. Residents may apply for an exemption or decrease in real estate tax: if the greenery covers over 80% of the entire roof a full exemption is granted; if the greenery covers 50–80% of the roof the tax reduction is proportionate, similar rules apply to green walls.

The latest document is the Urban Adaptation Plan for Wroclaw. The development of plans to adapt to climate change in cities with over 100 thousand inhabitants was an innovative project of the Polish Ministry of the Environment. The major objective was to assess the vulnerability to climate change of 44 largest Polish cities and to plan appropriate adaptation actions and measures. The Urban Adaptation Plan has a very strong focus on nature-based solutions. The City Council resolution on the Urban Adaptation Plan is expected to be adopted in fall 2019 and certain actions in the field of blue-green infrastructure will follow such as increasing the number of green tram tracks, creating green bus and tram stops, promoting city meadows and pollinators.

One of the programs funded by municipality is the Wroclaw Participatory Budget (WBO)–a tool that has been used by citizens to green the city. It has started in year 2013 and at first there was a strong focus on projects dedicated into mending sidewalks, creating bicycle paths and creating playgrounds. But in time the number of green projects had increased, sometimes the solutions proposed by citizens were quite innovative such as winning project in year 2017 dedicated green bus and tram stops (however, the project delivery has not been finished yet). The Municipality runs and funds projects and programs dedicated blue-green infrastructure such as the "grey into reen" project which is aimed at transforming grey, concrete areas at schools and kindergartens into green areas, friendly to the pupils. Since 2017, the program has been an element of climate change adaptation through

the land-use development projects promoting local rainwater management, increasing biodiversity and noise protection. Schools are encouraged not only to "unseal" concrete courtyards, but also to enrich development projects with blue and green infrastructure elements such as rain gardens, flower meadows, creepers on fences creating natural green walls or barrels for rainwater, which could be used for watering the garden with the help of children. City leads also pilot program that combines education with creating new parks called "Park of young citizens—GROw into WROclaw" (WROśnij we WROcław). In areas that will be new parks in the future, citizens could plant trees dedicated to their children. Each of the tree has its number and parents get special certificate of tree dedicated to their child. This program gives an opportunity to create new green areas together with citizens, learn about trees and their maintenance. Similar actions such as "Come and plant a tree", "Green Day: planting shrubs", replacement plantings in of the parks, or the development and revitalization of green areas were realized.

Most municipal investments have had a strong focus on blue-green infrastructure, which was not so obvious few years ago. It was due to the city's strategic documents along with acts that had helped to set new standards in this field. Few years back it was easier to cut down the trees for new road construction, now in the phase of designing the projects are being adjusted in order to safe as many trees as possible and introduce new blue and green solutions.

The mayoral ordinance on actions to protect and develop greenery led to developing an innovative mechanism concerning creating future parks. Whenever investor is obliged to plant new trees as a replacement for trees that had to be cut down and has no parcel to plant such trees, the city offers a solution—the"green area bank". The municipality chooses an area, based on the bank, and annual and multi-year plans for planting trees for an investor to plant the trees in an organized and planned way, to create future park.

WBO and "grey into green" projects are good examples of actions increasing greenery and in cooperation with citizens (in case of WBO) and educational institutions ("grey into green"). Actions such as tree planting also engage citizens. There is international project combining art with environmental education - C-Change funded from Urbact program. This project focuses on the use of arts and culture in leading climate action in cities. Educational and information campaign called "Small steps, big changes" (org. Małe kroki, wielkie zmiany) is focusing on biodiversity and air quality protection. The aim of this project, financed from European Regional Development Fund (ERDF), is the education about the importance and role of biodiversity and topics related to air quality protection by showing good examples and solutions and encouraging citizens to chance some of their habits. Generally, the city is testing different solutions and approaches regarding increasing greenery, with the support of strategic documents, regulations, and tools described above.

4. Results

4.1. Bratislava–The Implementation of Green Projects for Climate Change Adapttaion and Mittigation

Since the publication of EU Strategy on Adaptation to Climate Change in 2013, Bratislava city realized 53 projects connected with blue-green infrastructure. In 2015 there was implemented one project, in 2016, eight projects, in 2017, 31 projects, and in 2018, 13 projects. These projects could be divided into two categories (1) blue-green infrastructure projects, and (2) green projects for schools. The green projects for schools were analyzed as a separate category because these investments represent educational eco-program designed for kindergartens and schools and in Wroclaw there is also educational program dedicated to schools.

The blue-green infrastructure projects represent such investments as green spaces and corridors in urban areas as well as the water sensitive urban and building design. The total number of these projects was 21. The second group of projects was realized at schools and was connected with environmental education. During 2015 and 2018 period, there were delivered 32 of such projects.

The blue-green infrastructure investments were focused mainly on city centre and two Bratislava city—Nove Mesto and Petržalka. These investments arose from the need for introduction of greenery in places where deficiency of it was observed, mainly planned at built-up and impervious areas. There could be seen, that new greenery investments fill in the existing natural areas (Figure 2). It could have positive impact on the environment, especially in context of Bratislava's climate challenges as heat and rainwater management. Some of investments were also performed on existing green areas (northerly part of the city and investments along the river). These realizations were connected with the necessity for revitalization or maintenance of existing green areas. New greenery areas have been completed within the project "Bratislava is preparing to the climate change". The analysis of green infrastructure development according to types of actions (investments) showed that the highest number of green infrastructure investment (marked as dark green stars at Figure 2) was delivered in the city centre. Such a concentration of projects being realized was not noticeable for green projects for schools (marked as yellow points on Figure 2). However, there could be seen that more school projects were realized in northerly part of the city— north of the river.

4.2. Wrocław–The Implementation of Green Projects for Climate Change Adapttaion and Mittigation

Green infrastructure development in Wrocław during 2013–2018 was carried out mainly by three types of activities: (1) green infrastructure projects, (2) green projects for schools (3) WBO green projects (Figure 3).

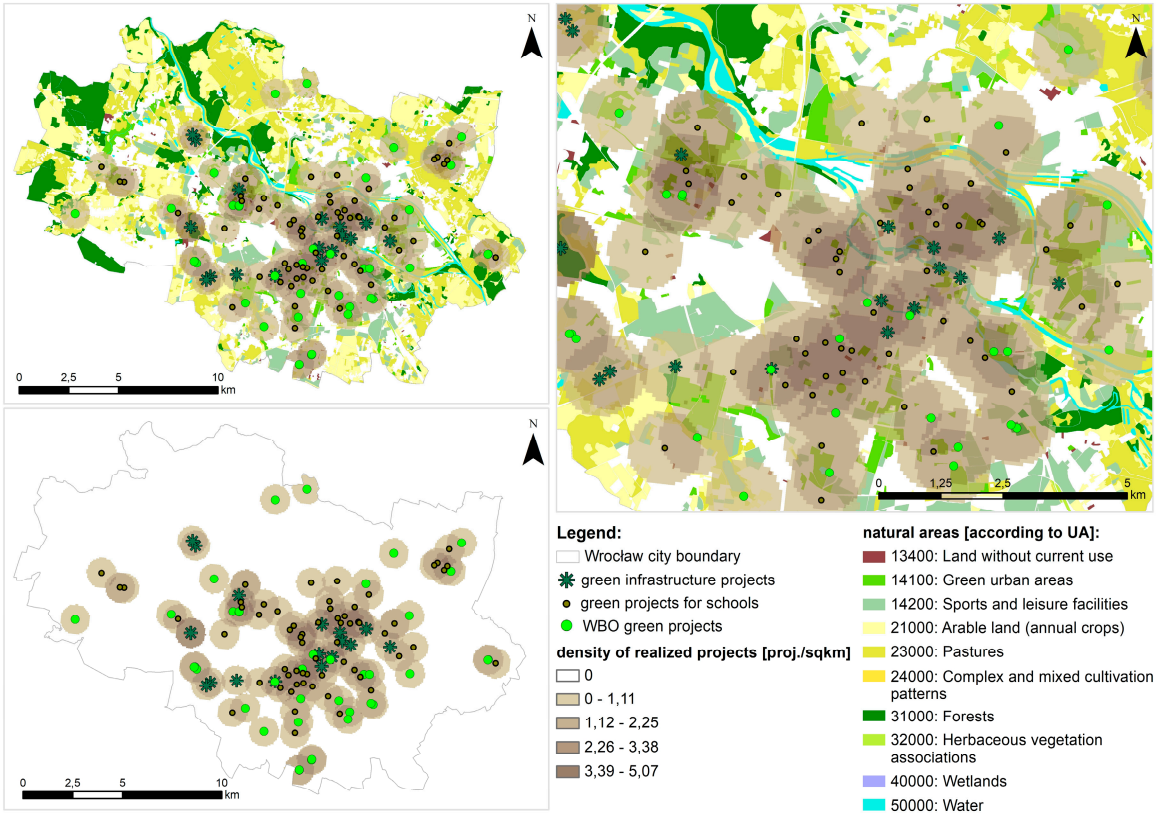


Figure 3. The green projects realized during period 2013–2018 in Wrocław. Top side of the figure shows the overview and density of projects regarding to natural areas in city (top-right figure shows the zoom to the city center). The lower section of the figure shows the overview and density map of projects [No. of projects per square kilometer]. Source: Own elaboration using ArcGIS software.

The green projects for schools were analyzed as a separate category because these investments were realized within the framework of special project dedicated for kindergartens and schools "grey into green" and in Bratislava there is also educational program dedicated to schools. During period 2013–2018, 126 green projects were realized in total. In 2013, two projects were completed (from WBO's first edition), 11 projects in 2014, 19 projects in 2015, 12 projects in 2016, 42 projects in 2017, and in 2018, 40 projects. It is apparent that the highest number of green projects was implemented in city centre and the eastern part of the city (Figure 3).

Similarly to Bratislava, the location of green infrastructure projects focuses mainly on city centre. One of the measurable effects of these projects was the fact that the 618 trees were planted during four editions (between 2017 and 2019) of action "Park of young citizen—GROw into WROclaw". "Come and plant a tree" has brought 1200 new trees (during four editions between 2014 and 2016), the "Green Day - planting shrubs" action allowed for the planting of 3000 shrubs in 2017. Moreover, in one of the parks 1601 trees were planted in total. These trees were planted as a compensation for the ones cut down during investment process. The city also took actions of development and revitalization of green areas (all green actions are marked as green stars on the map).

In relation to the green projects for schools during period 2017–2018, there were delivered 77 projects (33 in 2017, and 34 in 2018) within "grey into green" program (marked by yellow points on map). In 2019 there have been delivered 10 projects in schools, so far. The analysis showed that the highest number of investments was delivered in the city centre.

Taking into account WBO projects delivered during 2013–2018, it gives 126 green projects in total. More detailed analysis showed, that during the first edition of WBO in 2013, only two green projects were implemented. A year later, residents selected seven green projects, and all of them were delivered. Also, all projects from the 2015 edition were completed—14 green projects in total. Currently, there is still realized the last one of the 12 winning green projects from 2016 edition of WBO. Due to the great interest and large number of green project applications for 2017 edition of WBO, a two-stage project selection was carried out. The first step was the regular WBO's procedure, in which 12 green projects were selected (currently five of them were completed and other seven are in progress). During second stage, called 'special green edition', additional eight projects have been selected by the public. These projects focused on such actions as planting vegetation and trees in whole city, planting melliferous species, green bus/trams-stops or parks development - all of the projects are in progress. Furthermore, 25 green winning projects from WBO 2018 edition are continuing as well. The WBO 2018 edition, similar to 2017 edition, resulted in projects dedicated for planting trees, pocket parks, creating new or maintenance of existing parks and city gardens.

In general, the western part of the city is green with plenty of natural greenery, especially along the rivers and parks and large areas of forests, the eastern part has more one-family houses or settlings with adjacent gardens, thus there may be noticed a lower number of implemented green projects. Projects were mainly executed at built-up areas, as well as at some greenery areas. These investments were mainly connected with maintenance of existing green areas or plants filling in these areas. Despite the green investments in either existing green areas or undeveloped areas, there could be noticed that new greenery fills in existing natural areas. Some new green areas were planned along rivers which currently serve as a meeting place as well as sports and recreation venues for local residents. It also shows that there is a higher number of green projects in the city center and downtown, where the density of buildings is higher with less parks and green areas.

4.3. Bratislava vs. Wrocław—The Comparision

The implemented assumption for Bratislava and Wrocław development could be divided into two types of approved local documents: (1) strategies and policy documents, and (2) programs and plans. There could be seen some similarities between Bratislava and Wrocław. Both cities had prioritized urban actions within cities' strategies. One of the priorities is climate adaptation and actions for increasing the quality of the environment and urban space. Moreover, each city declared the standards i.e., for urban greenery development in Bratislava or development of modern green infrastructure in Wrocław. Furthermore, both cities focus on public transport including such aspects as climate adaptation responsibility, noise reduction, pedestrian-friendly standards (Table 1). There could be noticed, that Wrocław has enacted a greater number of strategic documents, which were mainly connected with preparation of detailed standards i.e., for transport development (public and pedestrian ones).

Table 1. Local law for green infrastructure development.

Formal Aspects	Bratislava	Wrocław
STRATEGY (POLICY DOCUMENTS)	1. The Bratislava Social and Economic Plan 2010–2020 (approved in 2010 including adaptation to climate change as a priority); 2. The Covenant of Mayors (2012) signed by the city of Bratislava; 3. Mayors Adapt (2014) signed by the city of Bratislava; 4. The Strategy on adaptation to negative effects of climate change (approved in 2014)- the Strategy includes 16 measures, out of which three should be implemented within three years, nine within five years, one within three and more years, and three within five and more years; 5. The Smart Twin City Bratislava policy (focused on smart governance of city ecosystem services, determination of urban greenery standards for the territory of the city); 6. The Policy of public transport in Bratislava for the period of 2013-2025, which includes the elements of climate adaptation responsibility; 7. The Policy of Urban Forests Development in Bratislava for the period of 2016–2018.	1. The Principles of ecological policy of Wrocław (1997) set the environmental vision, prioritized, e.g., energy, sustainable transportation, waste management, water protection and ecological awareness. 2. Multi-Annual Plan of Development and Modernization of Water and Sewage Devices for 2017-2021 (2017); 3. Sustainable Development Plan for Public Transport for 2016–2022 (2016) 4. Tram Program (2016); 5. Low-Carbon Economy Plan (2015); 6. Composter Program (2014); 7. City Exploitation Plan (2014); 8. Program for protecting the environment against noise (2013); 9. Mobility Policy (2013); 10. Pedestrian-friendly standards for public space (with chapter dedicated to modern designing greenery along pavements); 11. Catalogue of cross-sections of streets along with the zoning of high greenery (2010)—now, the new version has been designed; 12. Wroclaw City Strategy (2018) one of the priorities is the quality of environment and urban space and it could be obtained through development of modern green infrastructure, especially in the downtown area 13. Compact of Mayors; 14. National partner of the Ministry of Environment-member of "Climate Adaptation" EU Urban Agenda Partnership.

Table 1. *Cont.*

PROGRAMS AND PLANS	1. Land Use Plan (approved on May 2007 by the Resolution of Bratislava City Council No. 123/2007). 2. The Action Plan for adaptation to climate change in Bratislava (2017–2020), the Plan has five main strategic aims ("the vulnerability assessment on climate change, climate change adaptation and local policies, climatically neutral city and awareness—information—participation—cooperation, the adaptation process evaluation") and it distinguishes six sectors in which the adaptation measures should be realized (health and wellbeing of citizens, green and blue infrastructure, urban environment, rainfall and water sources, transport, energy), 27 measures all together out of which 15 should be implemented within three years, eight within five years and four measures within more than five years, green and blue measures, grey measures, soft measures 3. The Action Plan of sustainable energy development of Bratislava city (2013), the plan is focused on CO2 reduction of 20,74% by 2020, on the increase of energetic effectivity and on the decrease of Bratislava carbon footprint the Plan includes 31 mitigation measures, mostly grey and "soft" ones	1. City Master Plan (2018) with new approach towards greenery in the city, promoting idea "greenery without borders"; 2. Land use plans (cover around 60% of the whole city, they are the local law, include elements of blue-green infrastructure) 3. Mayoral Ordinance on rainfall water management (2017); 4. The Urban Adaptation Plan (the development of plans to adapt to climate change in cities with over 100 thousand inhabitants was an innovative project of the Polish Ministry of the Environment, the major objective was to assess the vulnerability to climate change of 44 largest Polish cities and to plan appropriate adaptation actions and measures. The Urban Adaptation Plan has a very strong focus on nature-based solutions).

Moreover, both Bratislava and Wrocław declared (within frameworks of land use plans) the implementation of green infrastructure (Table 1). Therefore, each city implemented local solutions for green growth on urban areas together with the blue-green infrastructure development (Table 2). There could be seen that cities focused on actions connected with the increase of number of green areas, better accessibility for green areas, green roofs projects, actions connected with water retention elements or planting trees. Each city decided on educational programs, which were implemented in schools and kindergartens. Moreover, except education aspect, cities involved inhabitants for their green actions. Therefore, in Wrocław within the WBO, inhabitants decided where new green areas should be implemented, or which green areas required revitalization or maintenance. Each city co-operates also with universities and NGO's i.e., in actions connected with the planting of new trees.

Table 2. Local solutions of green infrastructure development.

Solutions	Bratislava	Wrocław
Practical	- The vulnerability assessment of Bratislava territory following the ICLEI methodology; - Thermovision measurement of selected city localities; - Realization of pilot project financed by EHP and Norwegian funds 2014–2017 (11 pilot practical projects already finished - the increase of number of green areas, better accessibility of green areas, green roofs projects, the realization of water retention elements + 10 other practical already realized adaptation projects); - Green school projects.	- Mayoral Ordinance on actions to protect and develop greenery (2019), the main goal was to improve the greenery administration in terms of planning, coordination and monitoring of planting trees; the green area bank has been created used as a reserve for planting trees. There is a register of changes in green areas. Annual and multi-year plans for planting trees are created. They include recommendations for locations of new parks, forests, and accompanying greenery;
Educational	- Educational activities within the framework "EU Cities Adapt Project" financed by EC DG Climate (capacity building, guidelines, training courses, seminars, workshops); - Green school projects.	- "Grey into Green" program converting grey and "sealed" courtyards of schools and kindergartens into green spaces with the elements of blue-green infrastructure; - C-Change—Urbact project, arts and culture leading climate action in cities; - "Small steps, big changes" campaign.
Participatory	- Participation between city central administration and Bratislava boroughs administration, - Cooperation among city central administration and city district offices, citizens and external partners (for example consulting group, urban forest administration, Bratislava water management, universities, NGOs).	- Wroclaw Participatory Budget, in 2017 there was special "green edition", there were 39 green projects which did not win during regular participatory budget voting and Mayor has decided to give the green projects second chance and citizens could vote on these 39 projects and choose 8 winning projects; - "mikroGRANTY ESK Wrocław 2016" is a mechanism established within the European Capital of Culture for co-organising undertakings in any discipline of the arts, education, social and cultural fields of activity, addressed to individuals, associations, societies, residential communities; over 100 projects have been implemented including: Local Laboratory of Nature, Green Reading Room, protecting bees, an educational game about water, planting trees and bushes and a district garden.

Bratislava and Wrocław show some similarities and differences in aspects of implemented local law and implemented projects. There could be seen that both cities developed green areas in built-up areas (Figure 4), which according to Urban Atlas could be classified as: "Continuous urban fabric" (Surface Land-S.L.: >80%), code 11100, "Discontinuous dense urban fabric" (S.L.:50–80%), code 11210, and "Industrial, commercial, public, military and private units", code 12100. There could be noticed, that Bratislava's 25 green investments were realized in industrial (...) areas, seven of them at discontinuous dense urban fabric (...) areas, six on continuous urban fabric (...) areas, and three of the green actions were implemented on areas classified as other roads and associated land (code 12220). Some of the projects were accomplished on areas classified as green ones, i.e., a summary 10 projects were realized on areas described as "Sports and leisure facilities" (code 14200) and "Green urban areas" (code 14100).

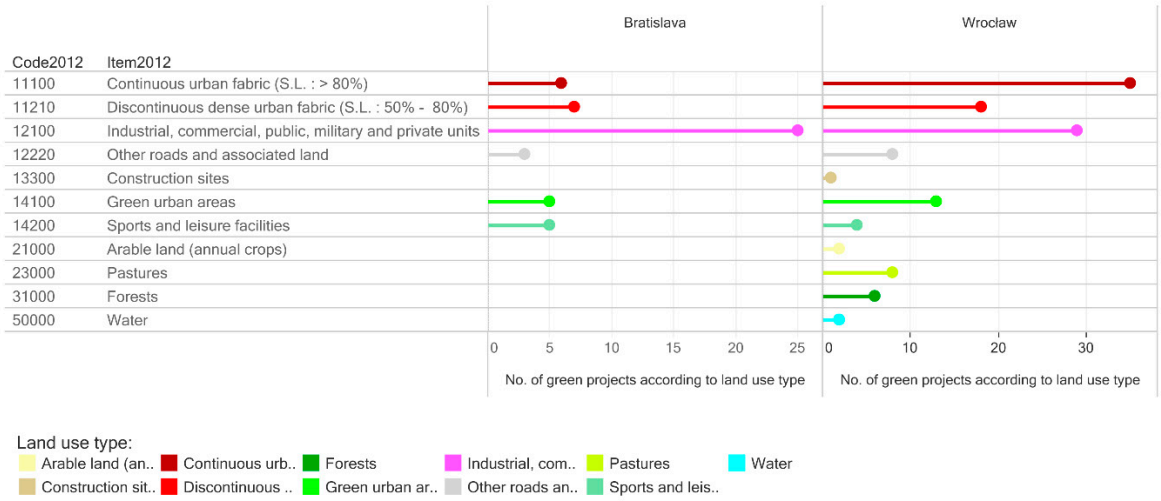


Figure 4. The comparison of projects implemented in Bratislava and Wrocław according to land use type. Source: Own elaboration using Tableau software.

Similar as for Bratislava, a lot of green actions were implemented on areas classified as Industrial (. . .)—25 of 126 green projects. However, the highest number of realized green projects was noticeable on continuous urban fabric (. . .) with 35 projects. On discontinuous dense urban fabric (. . .) areas 18 projects were completed. There could be noticed that, in built-up areas, more than nine projects were implemented, eight in areas classified as other roads and associated land, and one on construction sites (code 13300). Some of Wrocław' investments were implemented on natural areas, as 13 projects were realized on areas coded as green urban areas, eight projects on pastures (code 23000), six on Forests (code 31000), four in sports and leisure facilities, two projects each were carried out on areas classified as water (code 50000) and arable land (annual crops)—code 21000. The investments on areas classified as water involved green growth or vegetation planting along the river.

The detailed analysis (Figure 5) showed that in 2013 Wrocław' green projects were realized on industrial (. . .) and discontinuous dense urban fabric (. . .). one year later, there could be seen domination of three land use types where green actions were implemented: industrial (. . .), pastures and green urban areas—18.18% of green projects realized in 2014 per each of land use type. In 2015, 100% of green projects in Bratislava were completed on areas classified as other roads and associated land. This land use type was also the most commonly chosen for green investments in Wrocław —26.32% of projects from 2015 was implemented there. The second land use type selected for green development in Wrocław were discontinuous dense urban fabric (. . .), where 21.05% of project were realized. Moreover, green urban areas and forests were selected for project realization (15.79% of projects per each class) which could be associated with the green maintenance or revitalization of green areas. During 2016, 66.67% of green realizations in Bratislava were mainly made in industrial (. . .) areas. There could be hard to select the dominating class in Wrocław during this year. However, it could be summarized that 75% of projects were implemented on natural areas (25% on green urban areas; 16.67% each on water, pastures and forests lands) and 25% on built-up lands (16.67% on discontinuous dense urban fabric and 8.33% on industrial.

Again, in 2017 in Bratislava, the highest rate of projects was realized on industrial (. . .) areas—55.17%. In summary, ca. 28% of projects were delivered on urban fabric areas, as well as ca. 17% at urban greenery/recreational areas. Wrocław's green actions were implemented mainly on urban fabric areas—ca. 52% of projects and ca. 29% of projects were completed on industrial (. . .) areas. In 2018, most of Bratislava' projects were performed also at industrial (. . .) areas—41.67% and 33.33% of projects were implemented at continuous urban fabric (. . .) areas and 25% on green urban areas. In Wrocław seen some similarities to Bratislava could be identified—45% of projects were implemented on continuous urban fabric (. . .) and 32.5% on industrial (. . .) areas.

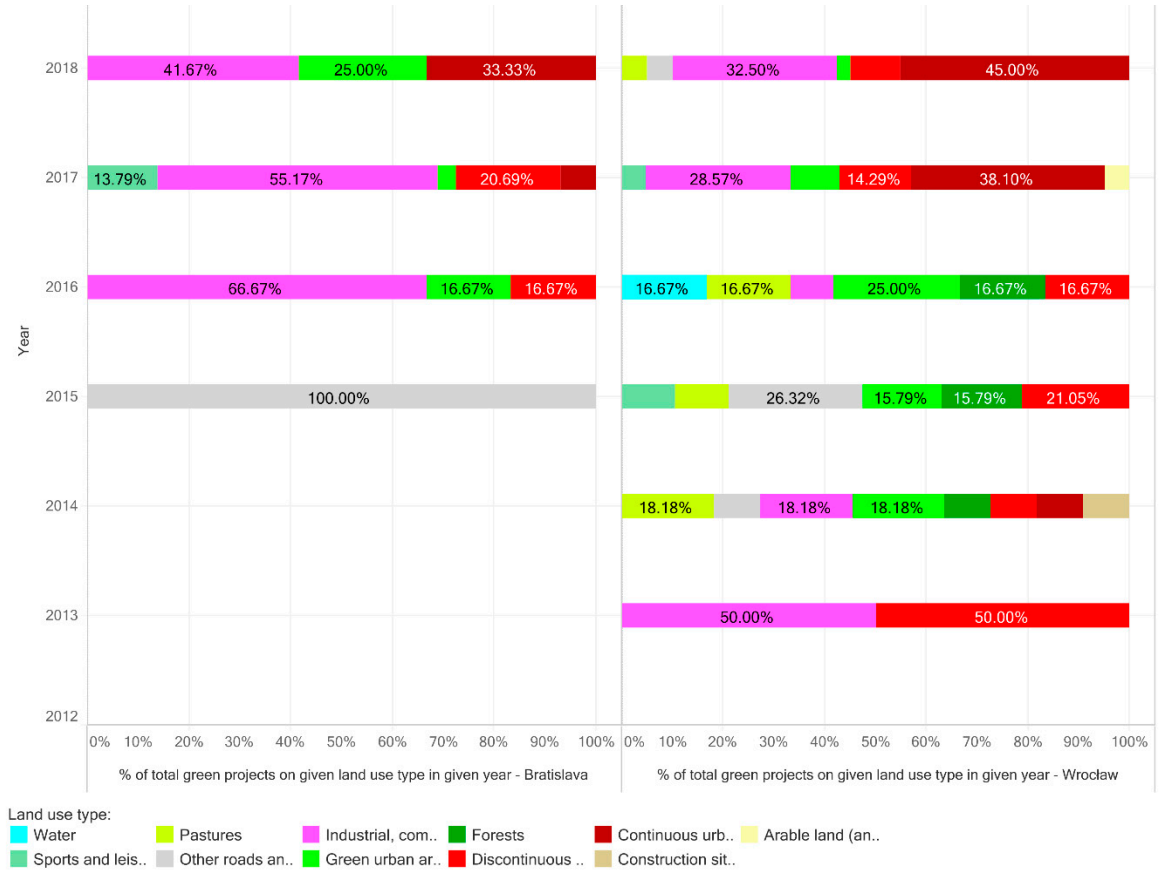


Figure 5. The comparison of projects realized in Bratislava and Wrocław according to year and land use type. Source: Own elaboration using Tableau software.

5. Discussion and Conclusions

Managing greenery in the urban environment and its role in addressing the multiple problems that society currently faces are very current issues not only in Bratislava (Slovakia) or Wroclaw (Poland), but globally. Countries have accepted the obligation to focus on the issue of adaptation strategies in the Framework Convention on Climate Change [68,69], as well as in the Kyoto Protocol [70], adopted in view of the aim to decrease greenhouse gas emissions (published as an amendment to the Framework Convention). In this context, the European Commission issued important publications such as Green Paper (2007) adapting measures to climate change on the EU level, White Paper (2009) adapting European framework of measures to climate change, EU Strategy on Adaptation to Climate Change 2013 and Europe 2020 Strategy (lowering greenhouse gas emissions by 20% from 1990 levels) [71]. The cities, and local governments in general, must fulfill the obligations accepted by governments.

Both, Bratislava and Wroclaw have adopted strategic documents that emphasize the climate change issue and the role of green infrastructure with respect to adaptation and mitigation. In terms of programs and projects–each city has green educational programs implemented in kindergartens and schools. As for funding, both cities use local funding or EU funds. Such mechanism as crowdfunding or private companies funding green investments, are not popular yet.

With regard to the long-term urban greenery planning and maintenance in Bratislava, however, vision is needed, a vision which would exceed the obligations imposed by measures for climate change adaption. The issue of climate change is pivotal, therefore requiring an investment in terms of time and funding. There is no room left to address other problems (i.e., the creation of a new Greenery Master Plan for the City of Bratislava). Bratislava lacks a general concept for greenery planning, and there is no map of green areas with recorded ownership. As a part of addressing the greenery issue in the context of climate change adaptation mechanisms, our research had focused also on new ways of

defining the attitudes of inhabitants, and their partial role in creating a whole. From a single resident to a group of dwellers in a single house or all of Bratislava's over 400,000 inhabitants—anyone can help to improve the city's greenery concept. By adding individual areas, a private greenery system would be established to supplement the public vegetation system, cooperate within the implementation or provide valuable execution manuals and advice on funding specific projects. This establishes a private and semi-public greenery system which complements the public greenery system. In this sense, it is necessary to map the current condition of urban greenery in the city of Bratislava and to establish the untapped development potential of small vegetation areas. In the near future, urban greenery planning administration in Bratislava should focus on small green areas typology together with formulation of a proposal to take measures which would improve communication with inhabitants and the motivation to set -up these areas in an urbanized environment [55]. A proposal to implement a new system of private and semi-public green areas which would supplement the present public greenery system is viewed as a possible promising solution. It's also necessary to analyze the effect of multiple types of information media have on the strengthening relationship between the city and the citizens, to improve communication between the city and the public by creating an online platform which would address the greenery issue, and raise interest as well as increase inhabitants' participation in public life by using new trends. The purpose for proposing such a platform is to support public interest in the very creation of these areas, which is why the selected region is not delimited by individual city districts but covers the whole city of Bratislava. In addition, inhabitants' participation should be accompanied by issues related to funding and executing the relevant municipal policies.

Wroclaw does not have blue-green infrastructure strategy but the vision of city's development into a greener and more sustainable city is present in its strategic documents, especially in Wroclaw City Master Plan and supported by legal documents and the role of green infrastructure in climate change adaptation is underlined. Currently, Wrocław has been implementing a lot of green actions. The green investments seem to be in accordance with city's strategic and legal documents promoting development of blue-green infrastructure. Most of the investments are either Municipal investments or are being delivered with the involvement of local authorities, with the support of local communities, local action groups, NGO's, university representatives, members of student scientific organizations etc. The case of WBO reflects the needs of citizens and shows the growing interest in green projects.

In terms of data, and the availability of information concerning projects, some of them—as these delivered within the WBO, are strictly available at dedicated WBO website. However, actions conducted by ZZM are more hidden, so there is needed more time to get information about tasks covered by ZZM. Moreover, presented context of realized tasks/projects provide mainly information about the location of investment. There could be added more information, highly advantageous in the scope of mapping realized investments. This information could be presented as an area not as a point or centroid of given investment. Therefore, similarly to Bratislava, there could be created a platform showing realized green projects, projects in progress, as well as planned investment. Such platform could be a decision support for localization selection for future green projects by inhabitants, ie. within WBO. Even though Wrocław is on a right way to green grow in city, there is still a lot to do in context of intensification of green projects and blue-green investments realizations.

There could be also mentioned the limitation of conducted research connected with the data source. Our research used shapefiles, which represented the point geometry. Thus, it allowed us to carry out density analyses of realized projects. It would be more appropriate to use the shapefiles which represent the polygon geometry. This gives an additional information i.e., the surface of the revitalized areas or new green areas development. However, the lack of many maps of the projects being implemented made the compilation of the polygon data set impossible.

Bratislava, as well as Wrocław, faces the need to address the policy of greenery development not only in the context of mechanisms for adapting to climate change, but also in regard to the aesthetic and psychological functions that vegetation can provide to the city's inhabitants. When dealing with the influence of vegetation on humans, the human factor needs to be considered. In view of a

human perspective, vegetation is often perceived somewhat differently than it is when observed from a small-scale urban planning perspective [36]. Inhabitants who pass through the city perceive urban greenery in the moment and define it with their current views. A living city is also created by the variability of impulses and inspirations. Looking at cities from a human perspective, small green areas that find themselves in an inhabitant's field of vision gain prominence. These include spaces which are visually perceived as greenery, although they are publicly inaccessible (private and semi-public spaces). These impulses can be embodied in multiple types of spaces, for example in café terraces, green balconies and walls, or in front gardens. Apart from the possibility of planting vegetation, these areas make it possible for people to remain in the urban environment, which is a key aspect of creating living cities [72].

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