

*Article***The impact of the relation between political borders and ecosystems in creating Green infrastructure opportunities - the city of Prague****Jenan Hussein ^{1*}, May Salama², Peter Kumble³, Henry.W.A. Hanson IV ⁴.**

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Cities are small on earth's surface but they are the most attractive places for people to live and work; cities are developing quickly, thus it's important to keep it a better quality place to live as it has the major of the economic activities and more job opportunities and other social and economic advantages to be a more green and sustainable place.

Seeking to achieve sustainable use of ecosystems and conserve natural resources in the city of Prague; integrating ecological sustainability goals, the political borders as a reflection of urban development in the city, and ecosystems edges in blue and green functions impact the city development, and present opportunities to create strategies for green and blue infrastructure and clarifying threats could slow down the process to achieve the sustainability and greenery application.

Also checking possible urban areas for development like brownfields and clarifying their relationship with political borders and ecosystems to find possible areas to add for sustainable green use, which will create better places for people to live and raise the value of life as well.

Keywords: political borders; ecosystem edges; green infrastructure, blue infrastructure; opportunities; threats; sustainability.

1. Introduction

The concept of Green Infrastructure (GI) has been present in city development for several decades. Throughout the theoretical considerations, and so have its interpretation, meaning, as well as ways of its generating in the form of definitions, as among others indicated by Wang and Banzhaf [1]. The concept doesn't come from anywhere; representing a long period in theories and practices in different contexts in many levels in city planning [2,3,4]. The evolution of green infrastructure is far from linear to connection areas, the concept started from The U.S. These 1004 H. Wright include Victorian parks, US greenways, Garden Cities and New Towns and more recently the ecological city and sustainable urbanism [5,6], and then the concept developed in European cities to become leaders in sustainable green solutions based on creating green infrastructure systems The European Union considered Green Infrastructure (GI) as a smart solution for today's needs Cities need as much green infrastructure as possible, given how dense and impermeable they tend to be. In the urban environment, green infrastructure covers everything from parks to street trees and green roofs, anything that helps absorb, delay, and treat stormwater, mitigating flooding, and pollution downstream. Green infrastructure also creates oxygen, sequesters carbon, and creates wildlife habitat. Urban greenery has also been proven to improve mental health and well-being [7]. The EU Green Infrastructure Strategy, as a key step towards the success of the Biodiversity and Conservation Strategy, was adopted in 2013, aims to create a robust policy framework in order to promote and

facilitate Green Infrastructure projects utilizing existing legal, policy, and financial instruments. The city of Prague was part of it since 2013 to start major steps to be a more sustainable city. The city adapting its strategy against Climate Changes aiming to improve the environment for its inhabitants since 1998, and got involved in the Project “**Cities Environment Report on Internet – CEROI**”. Within the framework of the United Nations Environmental Program (UNEP) who supports the Project a set of indicators for the urban level was developed as well. [8,9].

Czech cities have relatively low population density by EU standards. That of Prague is the country’s highest, yet its density level is low by comparison with the most densely populated cities in neighboring countries with a surface area of about 298 kilometers squared (115 square miles). The population density comes to 4,600 residents per square kilometer (12,000 people living per square mile). [10].

This case study focuses on Prague, the capital and largest city of the Czech Republic with a population of 1.3 million, population density in Prague varies by district, ranking the 14th largest city in the European Union and included in the UNESCO list of World Heritage Sites. The city was founded in the 6th century and is located on the Vltava River, in the center of the Bohemian Basin. Figure 1. [11, 12].

The political city district borders developed from the historic core straddling the Vltava River Prague has expanded East and West along stream corridors and over the hillsides that separate the stream valleys with a higher preference for South facing slopes. Significant areas of steep hillsides remain less intensively developed with primarily old orchards and vineyards, many of which have been abandoned and are in various stages of natural succession. Residual green areas within the historic fabric primarily include chateau gardens, urban parks, and cemeteries as well, since 1949, there has been a fundamental change in the administrative division. Since then, the boundaries of many urban districts, administrative districts, and city districts are independent of the boundaries of cadastral territories and some cadastral territories are thus divided into administrative and self-governing parts of the city. Prague is divided into 10 municipal districts (1–10), 22 administrative districts (1–22), 57 municipal parts, or 112 cadastral areas. Figure 2. [13, 14, Authors].

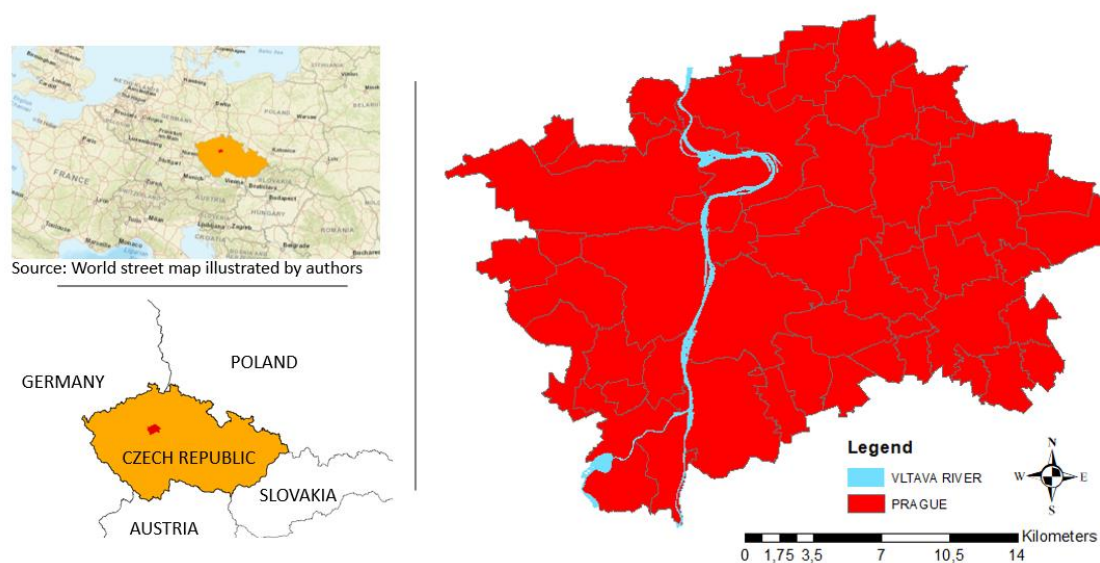


Figure 1. Prague- Czech Republic. Source: [14, Authors].

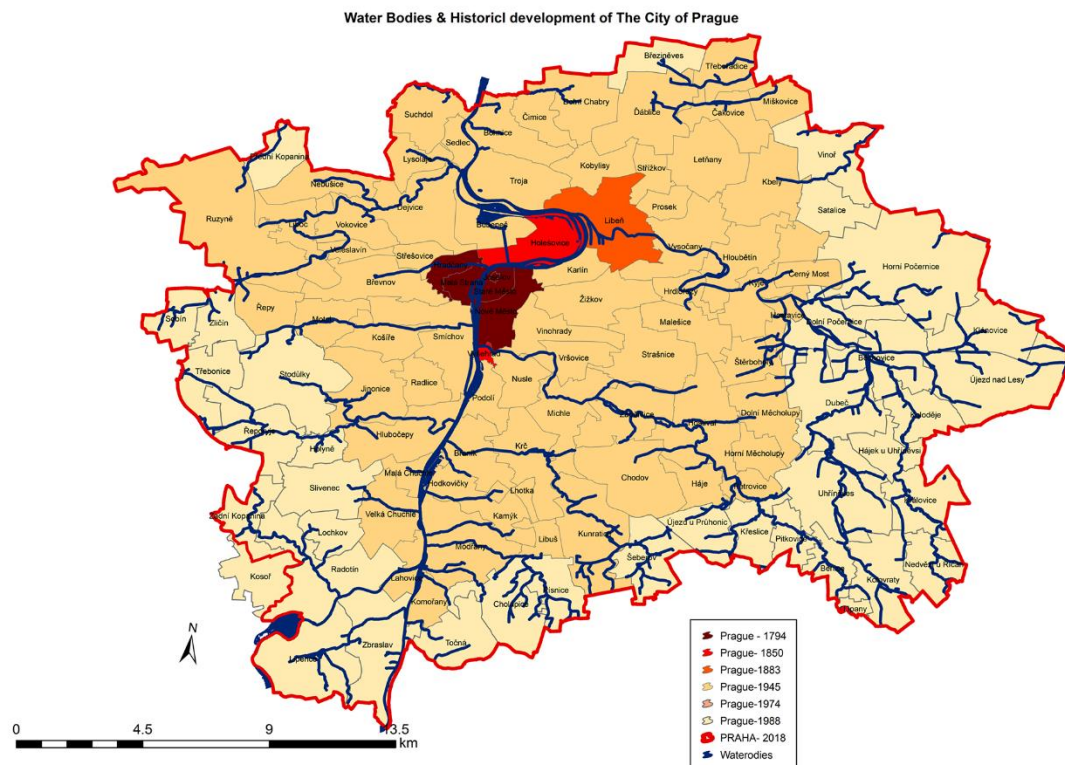


Figure 2. Development of the city of Prague and water bodies. Source:[13, 14, Authors].

The share of green urban areas in Prague is 55.3 % and the biodiversity is divided into separate classes of vegetation to represent the most intensively vegetated areas (main vegetation (wooded) and shrubby vegetation) and impermeable areas (water, soil exposed, built areas, and shadow). The classifier which identifies natural breaks divides the set of information into parts of similar behavior. Figure 3. [15, 16, 17, 18].

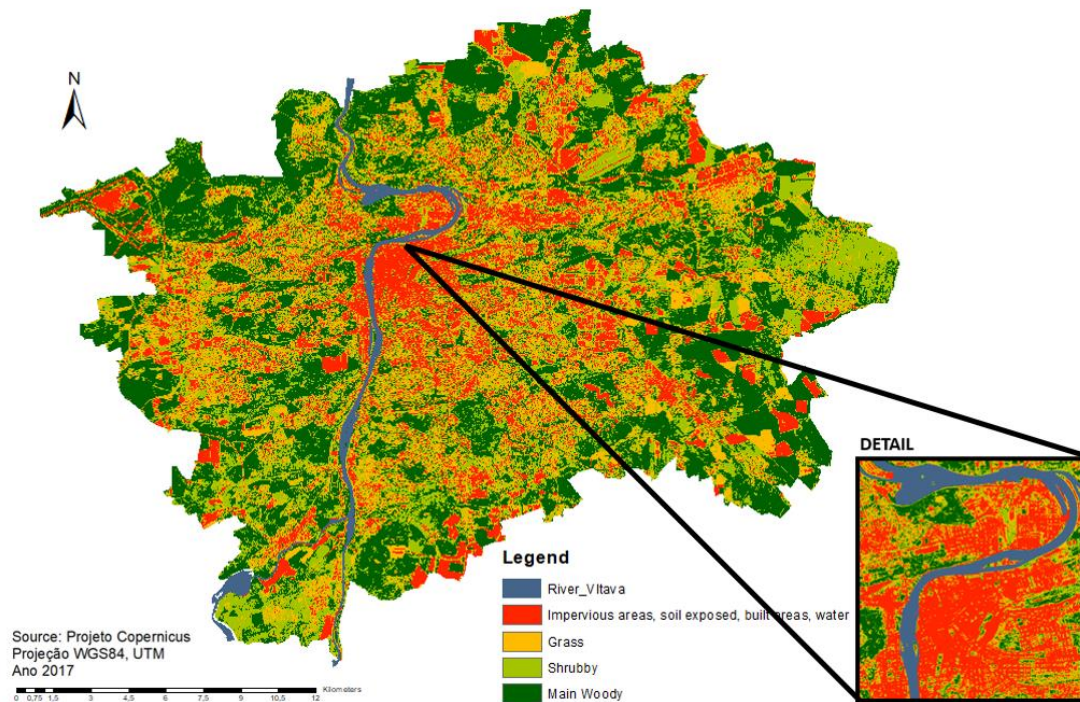


Figure 3. NDVI map classified – Green map. Source: Authors.

The data was collected in the year 2017 with 10 meters resolution was used to produce the NDVI map, this satellite has the mission to monitor variability in land surface conditions, and its wide swath and high revisit time supporting and monitoring of changes to vegetation within the growing season [19], to have the ability to make a clear major vision for the biodiversity in the city before studying specific system. This ability is described by M. Alberti as *“the ability of earth’s processes to sustain life over a long period of time. Biodiversity is essential for the functioning and sustainability of an ecosystem. Different species play specific functions, and changes in species composition, species richness, and functional type affect the efficiency with which resources are processed within an ecosystem.”* [20].

Prague strategic plan also sets the basis for general flood management and drainage plan for the city and a water supply and sewerage system development plan. The former, adopted in 2002, is a strategic tool to guide the planning, investment, and operation of measures to manage floods and ensure the drainage of rainwater and sewage. The water supply and sewerage plan aim to ensure drinking water supply to the city and wastewater treatment. Prague has an integrated transport system which we can call it grey infrastructure system but the idea of creating green infrastructure is still an aim, The city is adopting a platform for green and blue infrastructure for the second time in 2020 in planting millions of trees along streets fighting against climate change with the help of people; related to that we will clarify some relation could give an idea about the impact of urban development functions on the idea of G.I. creation.[21,13,22].

2. Materials and Methods

Defining the opportunities of the city to help to create green and blue functions by checking the impact of the political city district borders and their relation with the ecosystem of green and blue functions (green areas, water bodies, brownfields, and city political district borders) to clarify the ability to create a green infrastructure system in the future; using the GIS techniques to create the maps and needed reports.

The Green and Blue system in Prague:

I quote Green or blue infrastructure is a network providing the „ingredients“ for solving urban and environmental challenges by urban with nature. The main components of this approach Including stormwater management, climate adaptation, less heat stress, more biodiversity, food production, better air quality, sustainable energy production, clean water, and healthy soils, as well as the more anthropocentric functions such as increased quality of life leading to sustainable development.[23].



Example of green areas in Prague



The skyline view in Prague- River Vltava

Figure 4. Example of green and blue functions in Prague. Source: [25,26].

3. Results

Green and blue infrastructure refer to the spatial structure of natural and semi-natural areas (including different functions of greenery and water bodies), but also other environmental features that enable citizens to benefit from its ecosystem services. Application of G.I. could be in many scales from design to planning strategies include: green roofs - increasing the energy efficiency of buildings, green walls, and green public spaces as well as the development of blue infrastructure: increasing water retention, the permeability of the terrain in the cities, lakes, and rivers in the city, suggesting future development strategies for land use and public transportation with economic development and distribution of finance. [24]. Examples of green and blue functions in Prague. Figure 4. [25, 26].

- **Green Infrastructure:**

Prague considered as one of the world's top 10 greenest cities by the total percentage of green space: (56.74%) in varying types from historical special gardens in the heart of the city to modern developed ones The Zoo and Botanical Gardens and Natural Retreats, with open public spaces between residential areas; accessible for people to enter and enjoy different activities from sports to sitting, reading and enjoying the views. Figure 5. [27, 28].

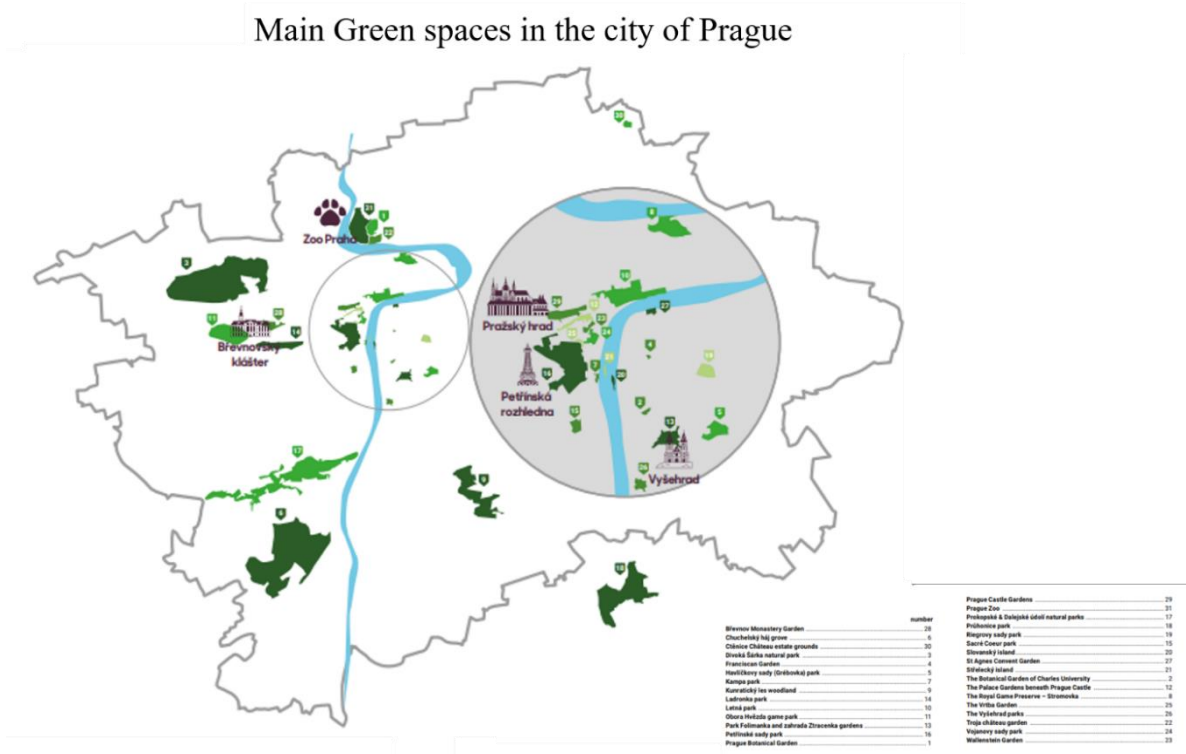


Figure 5. Parks and Orchards in Prague. [29].

In total, 12.6% of Prague is made up of forests and woodlands, and 4.76% of the city is nature reserves – relatively low numbers of natural green spaces compared to some of the other cities on the list. More than 10% of Prague consists of man-made green spaces, including parks (2.18%), public gardens (5.80%), maintained grasslands (2.16%), and golf courses (0.74%). [28, Auhtors].

While the historic center of Prague’s Old Town may have relatively few green spaces, Malá Strana contains the extensive Petřín gardens and surrounding parks in Prague 7 (Letná and Stromovka) and Prague 6 (Ladrinka, Obora Hvězda, and Divoká Šárka) offer some of the largest green spaces near the city center and surrounding the city and expanding out the region. [31, Auhtors]. Most of them have a clear relation with political city district borders explained in the following (Figure 6.7).

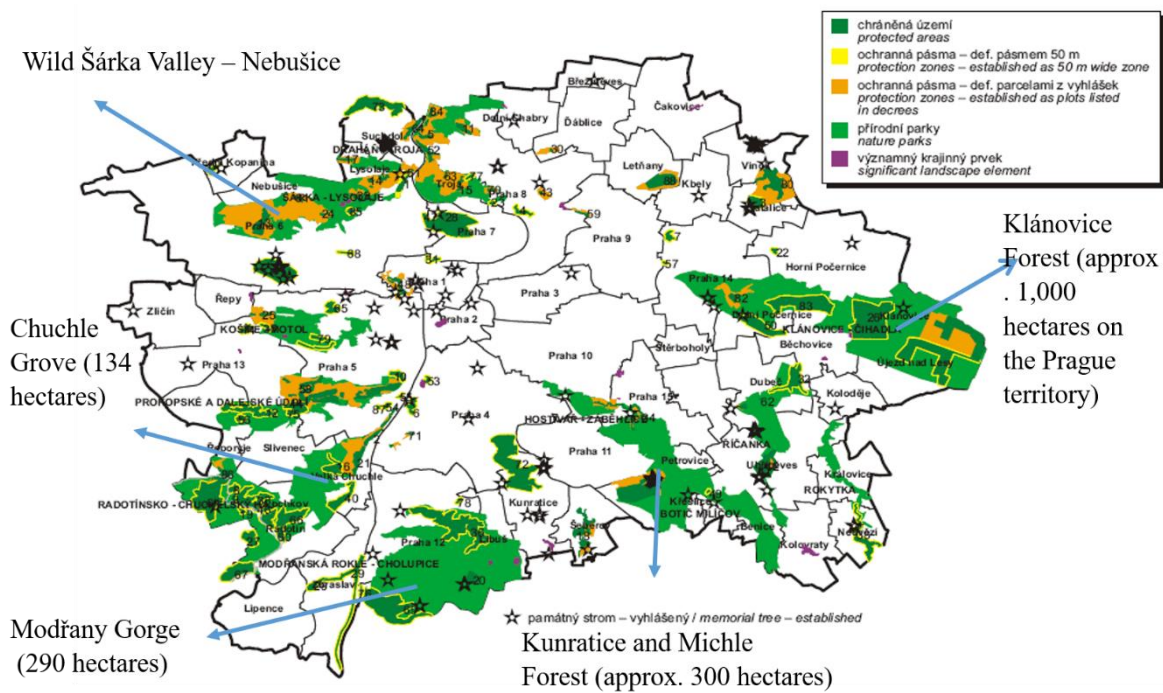


Figure 6. Main Parks in the city of Prague. [30, Authors].

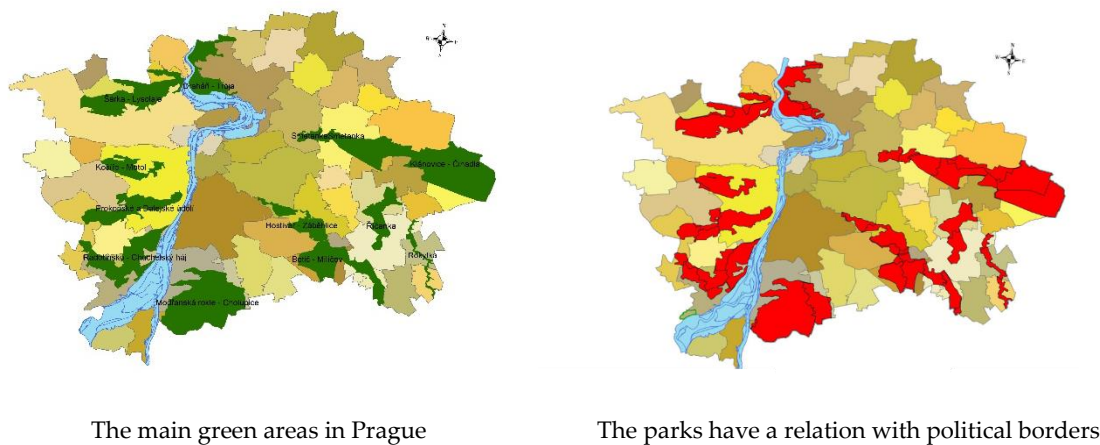


Figure 7. The relation between parks and political borders [Authors].

Most of the green areas have a relation with political borders that gives the ability to better manage and gives people in different districts have the right to share green areas in one hand, and on the other hand, it will reflect in the future in creating green infrastructure system in the city of Prague.

• **Blue infrastructure:**

The water bodies in the city create a blue infrastructure system, the main river in the city is the Vltava River: The River is an important city-wide public space.

The area of the river in the whole city is a correlative whole and its development, even in partial parts, must always be addressed in a city-wide context. Prague Waterfront Concept

The river and its banks are an important city-forming element, and that is how they should be approached. Until now, Prague lacked a concept for developing the potential of the river and its environs. The Prague Waterfront Concept, approved in 2014, rectifies this situation. Many of the most attractive riverside localities have been neglected, poorly managed, and inappropriately privatized. The new concept should coordinate the plans and investments made by public administration, the City of Prague, and even private investors so that the area around the river becomes a much sought-after public space. Both banks of the Vltava should thus be freely accessible along their entire length within Prague city limits. The newly appointed City Waterfront Manager is actively pursuing the implementation of the concept, especially on Prague's riverfront. European Climate Adaptation Platform (2016), Realization of flood protection measures for the city of Prague was presented with a specific zone area for protection from floods to prevent negative effects from crises [31,32].

The important point in the river that it is located in the middle of the city and has a strong relationship with many city districts in almost all its rank. Figure 8 :

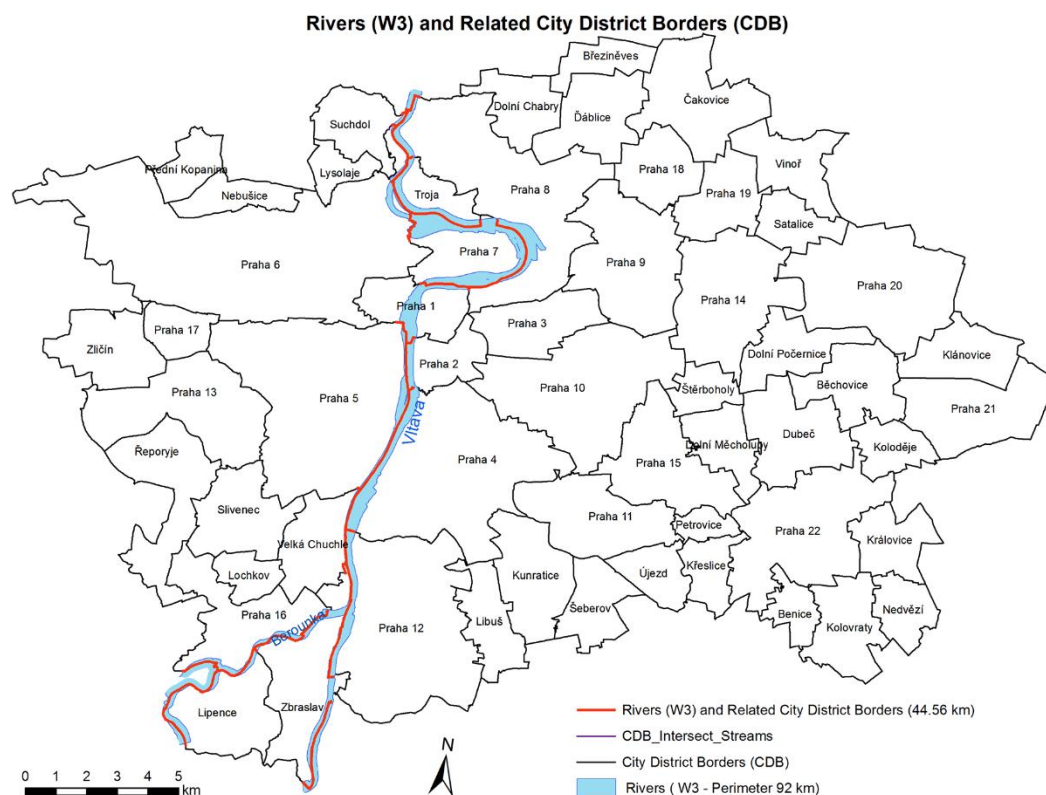


Figure 8. The River and related city district borders parts. [Authors].

The river can be considered as the main skeleton for the city with its location, connection of both parts of the city, also with its activities and now; the newly appointed City Waterfront Manager is actively pursuing the implementation of the concept, especially on Prague's riverfront. the city is working on creating more accessible places with new activities from swimming, fishing, and a new building to renew the waterfront to manage sustainable uses and raise new incomes for people. [31].

- **Brownfields in the city of Prague:**

Brownfields belong to the major urban problems in Czechia. These derelict areas are characterized by decayed, abandoned buildings and sometimes by contaminated land, while on the other hand it could be a great place for development "Brownfield redevelopment projects often emphasize economic development and may produce neighborhood-wide increases in property

values, decreased availability of affordable housing, and changes in commercial/retail presence. Such changes can contribute to the quality of life improvements and reduce place-based vulnerabilities associated with soil contamination; however, increases in the cost of living associated with remediation and redevelopment have the potential to facilitate gentrification” [33,34]

Now Prague authorities are aiming to give these areas a new lease of life in an attempt to ease an acute housing shortage, create jobs, and attract investment in projects for residential areas and open green spaces.[35].

Brownfields are located in places with already existing public transport and are connected to other infrastructure. For the city, support for private construction on brownfields is the best solution to the current housing crisis, according to Central Group.

Unused “brownfield” sites in the center cover an estimated 940 hectares, the equivalent of 1,000 soccer fields. Proposed projects include converting an abandoned milk factory into shops and apartments, and turning part of a derelict train station into office and residential space. [33].

Studying the relation between brownfields and city district borders and ecosystem edges will give a clear vision for the chance of using brownfields as development areas especially in natural creation uses in Figures (9, 10, 11, 12, 13, 14, 15) as follows:

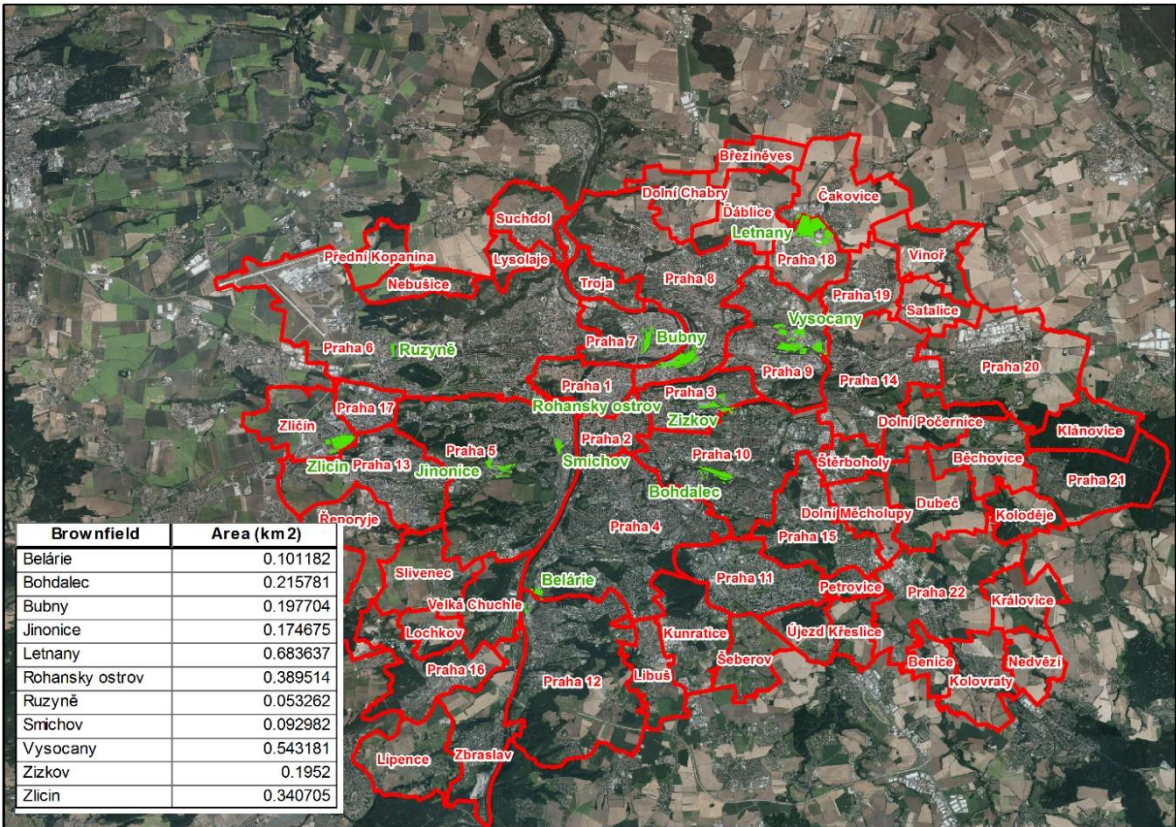


Figure 9. Brownfields in the city of Prague. [Authors]

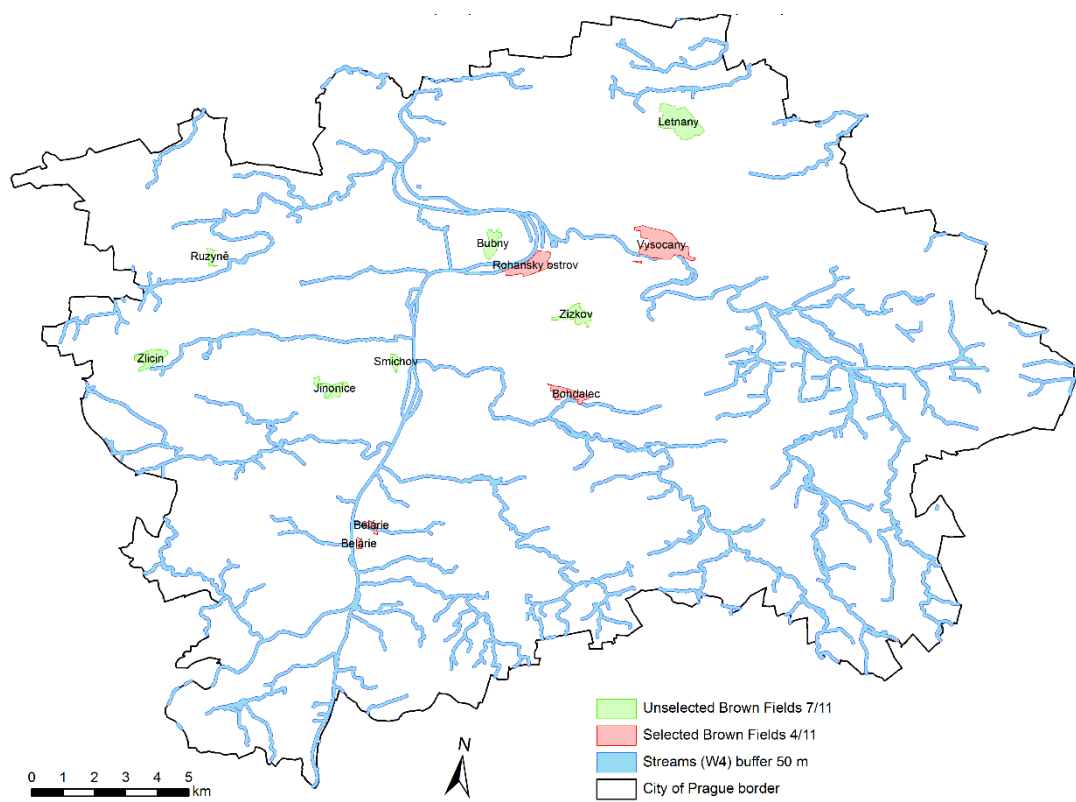


Figure 10.The relation between Brownfields and streams (Authors)

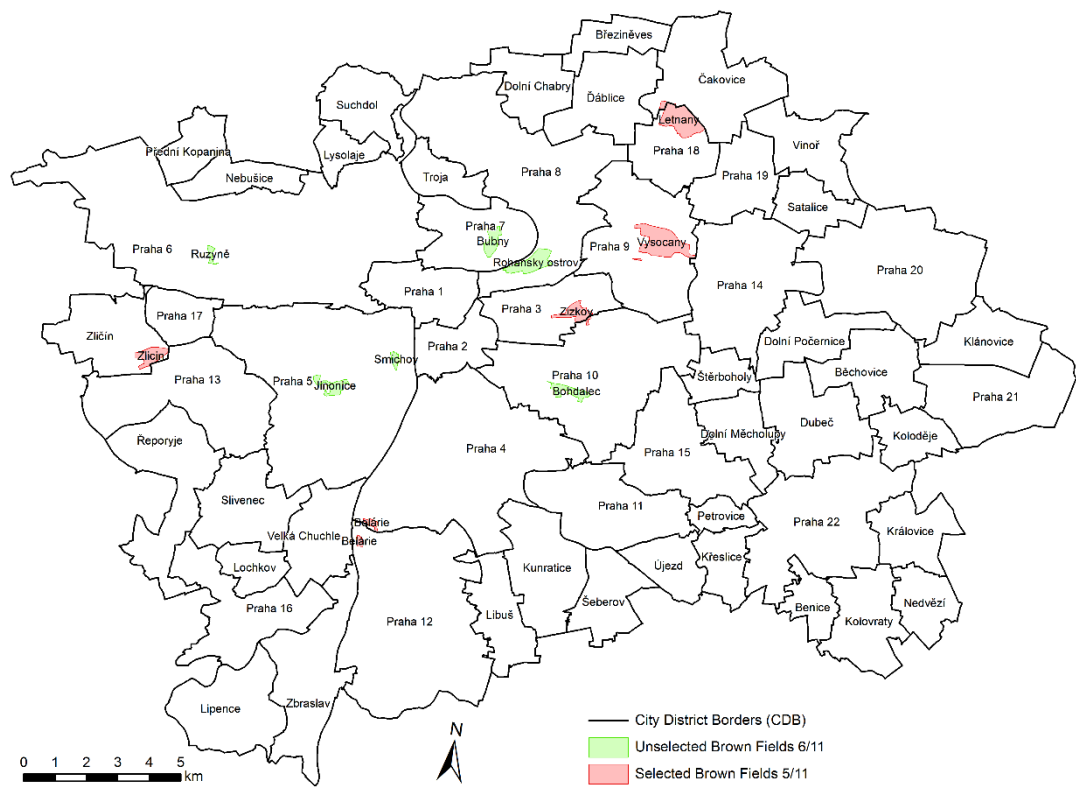


Figure 11. The relation between Brownfields and C.D.B. (Authors)

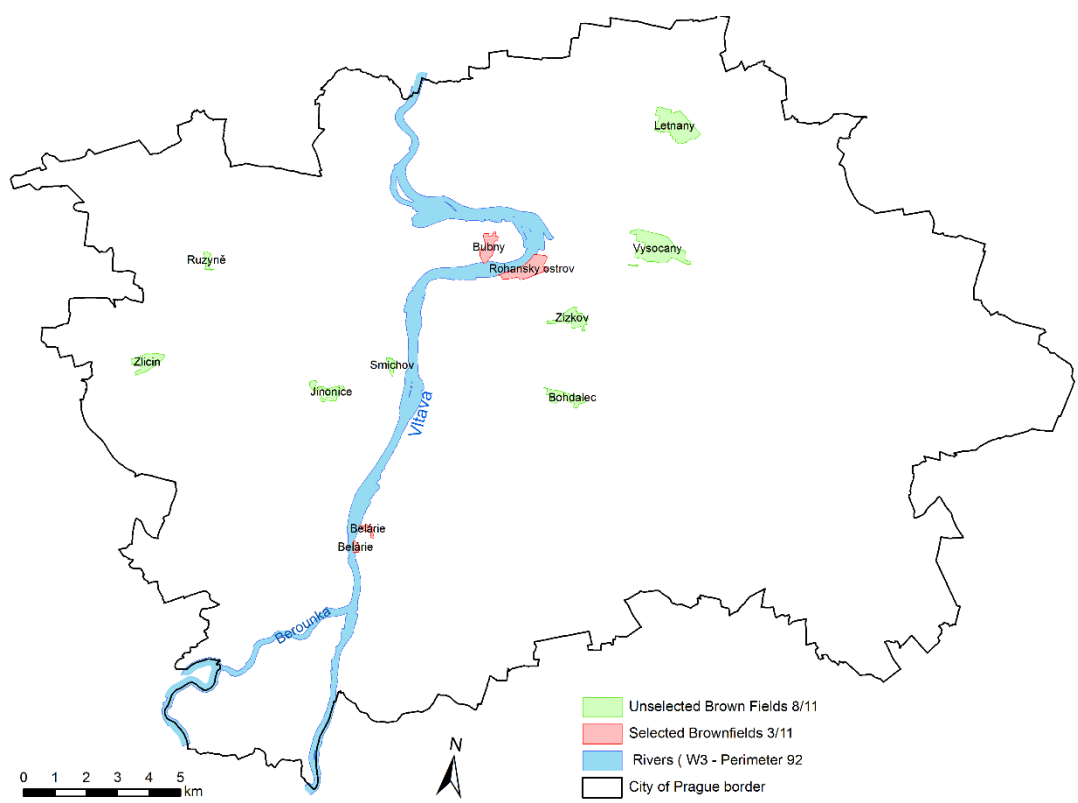


Figure 12. The relation between Brownfields and C.D.B. (Authors)

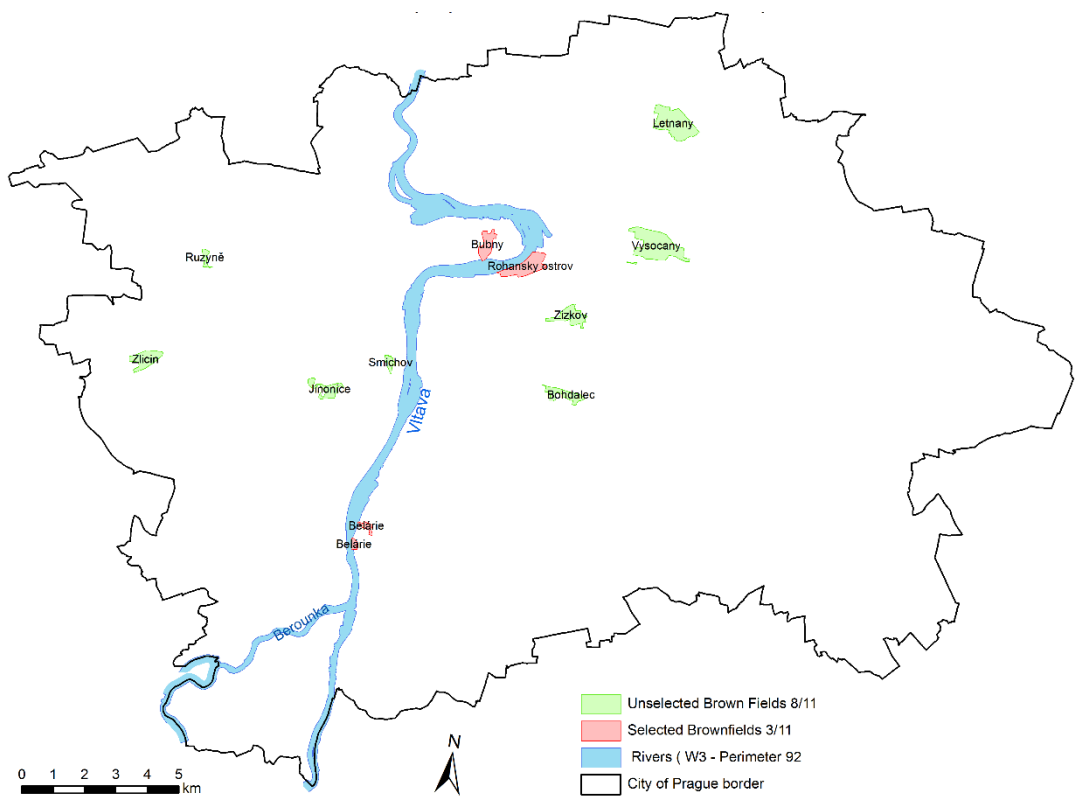


Figure 13. The relation between Brownfields and Waterbodies (Authors)

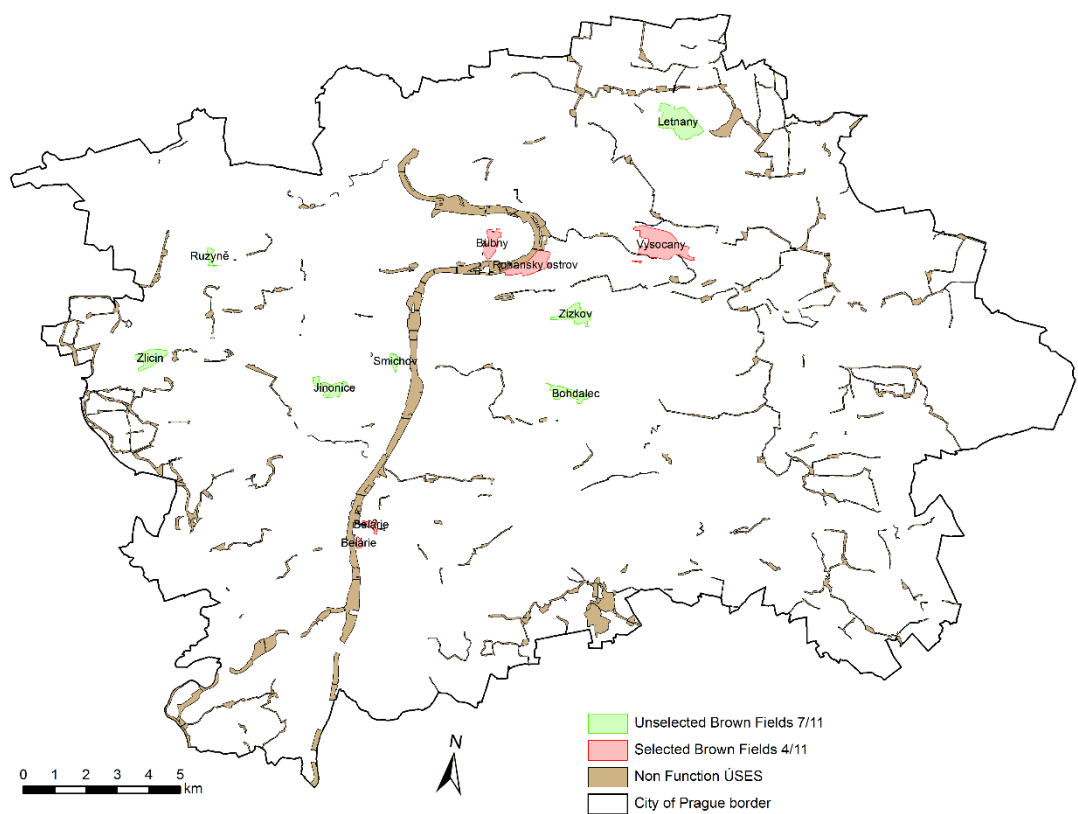


Figure 14. The relation between Brownfields and USES N.F. (Authors)

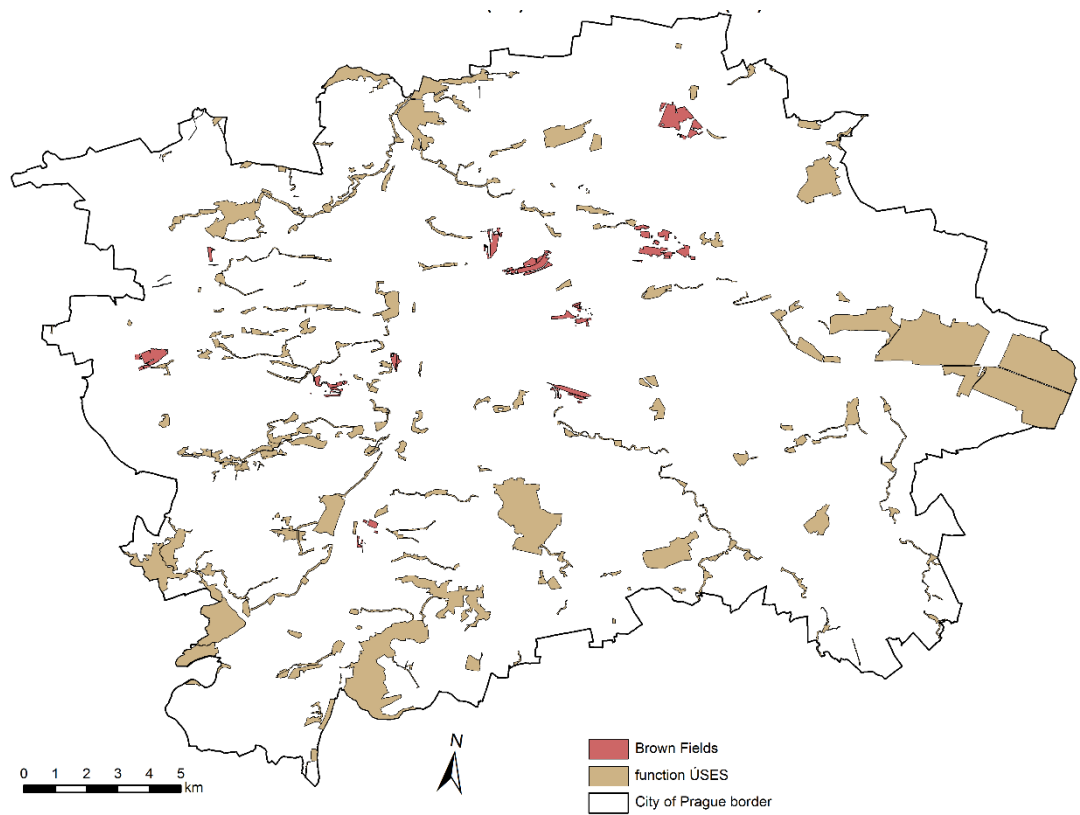


Figure 15. The relation between Brownfields and USES. F. (Authors)

As a result, the most related and the frequent brownfield which has the strongest relationships that will give them priority in development are as follows. Figure 16.

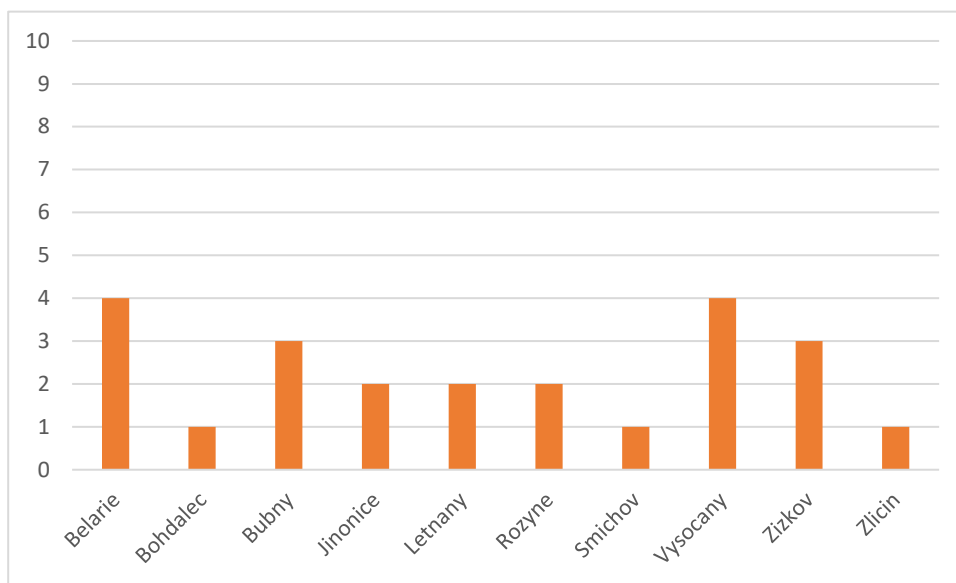


Figure 16. Frequency of the most related B.F. (Authors)

4. Conclusions and Discussion

Despite the importance of GI in defining and planning the green and blue system based on existed natural and semi-natural resources in conservation for valuable resources, reducing pollution, crises, improve wildlife habitat; also creating spatial connectivity based on its ecological, social benefits to create functional ecosystem services, based on the previous clarification the city of Prague has a fundamental advantages to create the system of GI from environmental expanse and diversity greenery that makes up about one fifth of Prague, economic, social, management to planning opportunities, with also existed well serviced grey infrastructure and the famous cultural and historical valuable areas with Prague natural sites offer more than just peace and relaxation, development areas like brownfields; accessibility and connections for the green areas is one of Prague strongest points to have the system design that will reflect on the city strangles and future sustainable land use planning.

The impact of the relationship as a reflection of urban development, this study summarized the main challenges that are facing and affect the creation and development of GI based on the process of GI, is complicated such as:

- Policy and design standards: no political vision for the city has been articulated to allow for the objectives and coordination of the various green and blue functions; a timeline or long-term investment plan for development for the sustainable green land use, the liveability of most public green areas is poor despite the people needs of better activation of them. Even if the city has a well-serviced grey infrastructure but thinking about green relation is not a series step for now.
- Socioeconomic and Faience: Prague budget does not have a general investment expenditure heading for green areas. There are only separate headings for technical and infrastructure investments, there is no concept for the city priorities for developing the public affective

participation also the participation of architects and ecologists must be more effective in creating and developing new sustainable areas.

As a result, the city strategic policy failure to use the city's potential Prague's urban and social structure which has great potential for the creation of high-quality living conditions, and the city has almost all the needed opportunities to become one of the greenest and most development sustainable cities, most of the threats are possible to be solved using new strategies and giving environment more priority working on raising quality over quantity, sharing the vision with people to be part of the future city development.

Appendix A

Next step of the research after defining the elements of the system and clarify their relation with political borders, will be working on a method of spatial analysis to start generating the system of green and blue infrastructure and looking for possible connection areas with the help of NDVI images in analysis and building a practical method can be used in any other case studied based on its opportunities and needs.

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