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# Rivers and terrain elevations role in city's green areas shaping

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*ABSTRACT. Natural environment where a city is established and develops always had and still has a great influence on urban tissue and a city silhouette. Among the natural factors, the most significant are river, terrain elevation and greenery. The paper is aimed to show relationship between the primary natural conditions of a city and green spaces localization within its area. It is also aimed to describe the role of a river and terrain elevation in a city development process. The determined four types of cities primary location are also examples of four schemes according to which city green spaces can be localized and developed (Róžańska 2010).*

*KEYWORDS. City, green spaces, green infrastructure, terrain elevation, river.*

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## **1. Introduction**

River and a terrain elevation are the natural factors mentioned by Ostrowski (2001) and Pancewicz (2004) as fundamental for city development and its urban structure shaping. Today, in urban tissue shaping, special emphasis is put on widely understood city green infrastructure forming. It is planned more or less in relation to a city natural conditions, and especially in relation with a river and terrain configuration. City green infrastructure consists of different kind of areas defined as: open areas, green areas, sport areas, reserves, urban green areas and others. Within a city, parks perform a special role. Many authors, such as Czerwieniec and Lewińska (2000) consider 'parks as basic units of recreational green areas in a city'. According to Jellicoe and Jellicoe (1991) 'established parks become a reflection of the society and its needs'. Zachariasz (2006) states that 'green spaces, and especially public parks, are an important contemporary city development driver'. Therefore, parks perform significant role in a process of human friendly urban environment shaping. The aim of the paper is to determine an influence of a river, as the dominating water element, and terrain elevation, as the dominating topographical element, on the urban green areas shaping. The authors assumed that green areas arrangement within a city is influenced by primary natural conditions of city location, and among them the most important factors are river and terrain elevation.

## 2. Materials and methods

The eight European cities located between the parallels which mark the geographical situation of Poland or located in their nearest surrounding were taken under research. Location of all cities within the moderate climate zone assures considerably homogenous natural conditions. Only European cities have been chosen because of common cultural background and urban planning tradition which derived from the achievements of the ancient Greek and Roman culture. Common feature of the European cities is also central situation of historically shaped districts.

All chosen cities should have fulfilled two conditions: through each city flows a river and the city topography is very diverse. It means that among the chosen cities there are those located on a flat terrain and those located within the area with different kind of terrain elevations such as an escarp, linear elevations or elevations creating mosaic form. It allowed to determine four types of cities primary localization. The first group of cities (Berlin, Paris) are those located on an island surrounded by one river course. The second group of cities (Poznań, Wrocław) are those established on few islands formed among courses of the largest river and its several tributaries. The third group of cities (Budapest, Warsaw) are those located on linear terrain elevations in the river vicinity. The fourth group of cities (Cracow, Prague) are those established on several scattered terrain elevations crossed by meandering river. (Fig. 1).

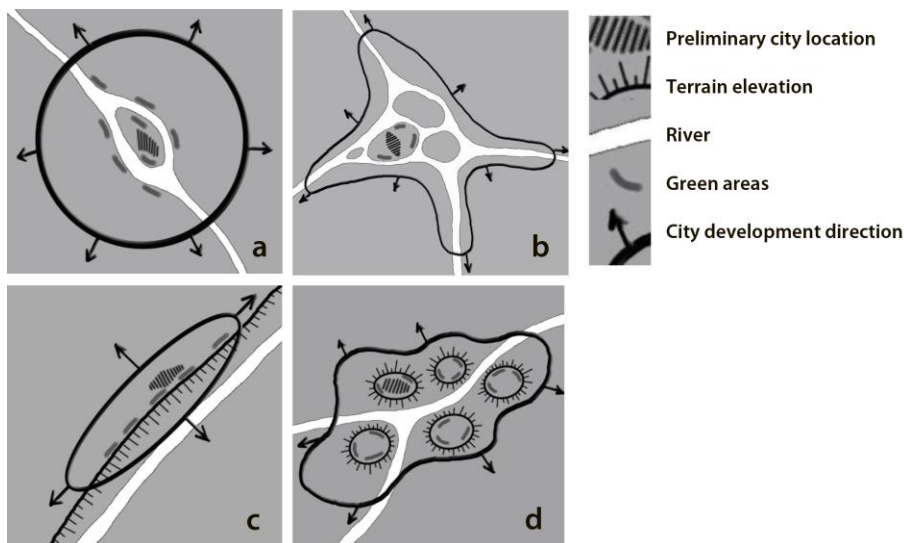


Fig. 1.

## 3. Cities on one island

Berlin and Paris are situated on a flat terrain in the vicinity of a river. Primary settlements of both cities were located on an island surrounded by one river course which constituted the center of the whole urban complex. Both cities developed in an analogous way. Initially, the island became intensively urbanized, then the

riverside more useful for building development and eventually the other riverside followed. Further territorial city expansion proceeded almost evenly within both riversides radiating like concentric rings which center was the island (Fig. 1 a). In both cities, green spaces were initially established on the island, then along the riversides in parallel to the island and later on also further according to the city development direction. Apart from designed green areas, in the nearest surrounding of both cities, natural riverside vegetation and vast forests occurred. They complemented the cityscape.

Since the early beginning of the urban tissue shaping, the island was the most meaningful element for the both cities. It can be described as the city center performing an analogous role to a marketplace. It was a prestigious urban public space where the most important buildings were established and the first gardens were created. In Berlin they occupied even half of the whole island. Further development of Berlin and Paris was strictly related to the river constituting an axis along which the most important public and private buildings were concentrated. Along a river also gardens and parks were established. Despite strong transformations of the cities' urban structure, which took place especially in the 19<sup>th</sup> century, still green areas are located along the river course.

Presently, both in Berlin and Paris, green spaces do not constitute dense system but they occur individually within the whole city area (in Paris) and within the oldest city part (in Berlin). The only linear system of the green spaces can be seen along the Seine and the Spree rivers, respectively (Fig. 2 a, b).

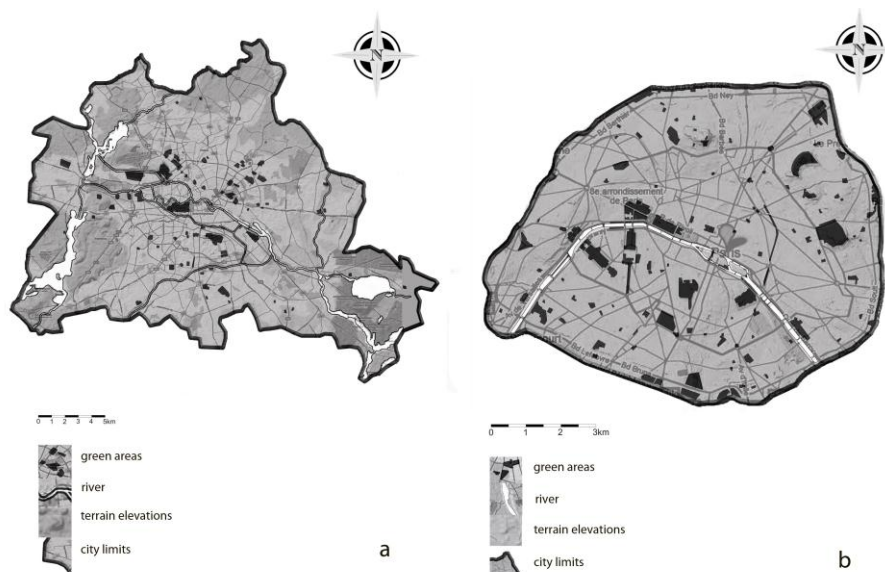


Fig. 2.

Legally binding master plans and green infrastructure plans treat the city green spaces differently. In Berlin they are included in the ring and axial system and perform an important role in the oldest city part green infrastructure shaping. The green spaces of Berlin create an interior belt and the axes along the river. They also connect historical urban spaces with the newest part of the city. The green infrastructure of Paris was shaped differently. It consists of the boundary city areas

including also green areas which create a 'green belt'. The infrastructure does not include the river and the green spaces located along the riversides.

Both Berlin and Paris originally were located on one island and developed in a similar way. Also green spaces location within both cities is similar and a significant role of the river in the process of their development is visible.

#### **4. Cities on islands**

Poznań and Wrocław are the cities located on a flat terrain where rivers and their tributaries created vast overflow area. The primary settlements of both cities were established on a few islands. Later on, one of them, where the city was established, became the leading urban center. In the next stage of cities development, the other islands became built up. River courses constituted the natural barrier for the cities spatial expansion. Further city development proceeded along the riversides within the areas useful for building development. The cities gained specific, organic shape resulting from the natural courses of the river surrounding the islands. The island with the established city was still the main center (Fig. 1 b). Here, within the city walls, the green spaces were created. Along the riversides, green spaces were not established because this was a marshy area overgrown with natural vegetation. Both cities were surrounded by meadows and forest complexes.

Since the beginning of urban tissue shaping of Poznań and Wrocław some analogies and similarities are visible. The primary settlements were established on each island. Gradually, while they developed, the interrelationships between them intensified and the leading urban center was constituted. In both cases the city was established as a typical medieval urban structure, independently from the earlier existing settlements and performed the priority function in the whole settlements complex. Here the most important buildings and the most prestigious public spaces were located. The first gardens, which accompanied buildings, were also established here. Further cities development proceeded along the riversides. Urban structure was strongly influenced by river courses system which resulted in a specific shape of the city. Significant urban transformations, especially in the 19<sup>th</sup> century, did not influence the green areas location. the riversides still were unfavorable place to establish this kind of areas. Further rivers regulation will only partially change this situation.

Presently, Poznań green areas are concentrated in the city center and create the belt form. Some green areas were established also along the main river (Warta) but only within the downtown. In Wrocław green areas are also concentrated in the city center and create the belt form. Other green areas are located as spots along the whole river courses of Odra, Bystrzyca and Ślęza (Fig. 3 a, b).



Fig. 3.

According to the legally binding master plans for both cities, green infrastructure including green areas will be shaped on a basis of the river courses system. In Poznań green areas are an important element of the 'green wedges' created by the rivers valleys and an interior belt based on the former fortifications transformed into the green areas. Thus, in the green infrastructure of Poznań, green areas established on a basis of natural environment conditions (rivers courses) and cultural factors (elements of the former fortifications) perform essential role. In Wrocław green areas were included in a belt-shaped system running through the rivers valleys including the widest valley of the Odra river. They are distributed as spots and they do not create a dense structure. An exception are green areas established within the former fortifications which formed a ring. However, they do not contribute to the green belt-shaped system.

Poznań and Wrocław are cities located on few islands surrounded by vast overflow area which developed nearly in the same way. The green areas location within both cities and a role of river in this process were also very similar.

### 5. Cities on linear terrain elevations

Budapest and Warsaw are the cities located on linear terrain elevations in a river vicinity. These elevations occur only on one riverside, the other riverside is flat. Initially, the settlements established on terrain elevations were dense but while city developed, they spread along the elevation. Although linear terrain elevations occur in both cities, their character and form are a little bit different. In Budapest, it is a row of single hills separated by ravines. In Warsaw, it is a steep escarp limiting a vast area of a postglacial plain. This difference of elevations form performed an important role in the cities territorial expansion but it did not influence their urban structure. The scheme of further stages of the cities' development is very similar.

Budapest, in further stage of urban development spread on the following hills which were used according to the topography of the terrain. Streets, traced within the ravines connected the hills. Opposite flat riverside of Budapest developed later. The area was much more extensive and had diverse urban composition. The green areas were established on the top of the elevation (Fig. 1 c) but not along the river as far as this area was hardly accessible because of steep slope and dense afforestation. Forests also grew on the other side of the elevation. The opposite riverside was overgrown by vast meadows and farther on by forest complexes.

Warsaw developed on one riverside along the escarp. Further, the postglacial plain became built-up. The opposite riverside developed later and always was in large territorial disproportion to the city located on the escarp. The green areas were established only on the escarp (Fig. 1 c) and their composition developed in a form of terraces towards the river but did not reach the river course. This was a marshy area overgrown by natural vegetation. Further from the river course vast meadows and large forest complexes occurred.

For Budapest and Warsaw, since the beginning of the urban tissue shaping, terrain elevation had a priority role. On a basis of the Warsaw escarp and the Budapest linear structure of hills important buildings and prestigious public spaces were established. Also only there the green areas were located. Further stages of the urban development of both cities are very similar. Initially, both cities developed on one riverside and later on the opposite riverside was urbanized. Intense development of the cities, started in the 19<sup>th</sup> century, caused large changes in their urban structure but it did not change the priority significance of the terrain elevations and their role in the green areas location process.

Presently, both in Budapest and Warsaw, the green areas create a linear system related to terrain elevations or are spread all over the urban complex. In Budapest, on the left riverside they form a linear system on the hills in the vicinity of the river and on the right riverside they are related to the communications routes. In Warsaw, green areas are scattered on the central part of the left riverside and create a linear system on the escarp and along the river within the downtown area (Fig. 4 a, b).

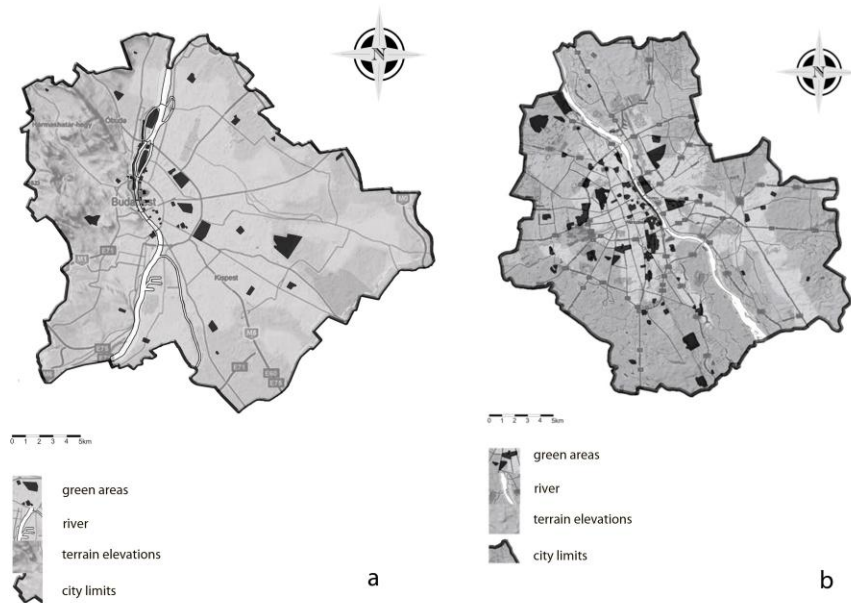


Fig. 4.

Legally binding master plans and green infrastructure plans of both cities include areas related to the terrain elevations but they treat diversely the river surrounding. In Budapest a 'green belt' was established which surrounded the whole city. The inner part of the belt, most of all, consists of the green areas located in the nearest surrounding of the city center. This green infrastructure includes the linear system of hills but does not include the terrains related to the river, although recently many green areas were established in the river vicinity. The Vistula river in Warsaw gained a diverse role. In the city green infrastructure the river is the main axis parallel to the escarp. This linear system links radiating green wedges.

Budapest and Warsaw are the cities located on linear terrain elevations in a river vicinity. They developed nearly in the same way. Also green areas location within both cities and a role of the terrain elevation in this process were very similar. The unfavorable influence on the green areas location had the river. This situation changed only partially in the last stage of the both cities urban development.

## 6. Cities on scattered terrain elevations

Cracow and Prague are the cities established on several scattered terrain elevations crossed by meandering river. The primary settlements of both cities were localized on few elevations. Later on, one of them gained the precedent significance and became the center of the urban complex. In further stage each settlement developed in two directions. The space between the settlements was built up and each settlement developed outside in different directions. In this way, the city has few points structuring urban development. In both cities the green areas were



established on the terrain elevations (Fig. 1 d). Some of the elevations slopes were overgrown by wild forests. The green areas were not established along the rivers because the slopes of the riversides were steep and the area was overgrown by natural vegetation.

For both cities, since the beginning of the urban structure forming, the terrain elevations had a priority significance. The scattered terrain elevations crossed by meandering river were convenient for separate settlements location on each elevation. Initially they developed independently. Each settlement had its prestigious places where significant public and private buildings surrounded by gardens were located. Within the river vicinity significant buildings and green areas were not established. During gradual urban development of each settlement relationships between them were established and one of them became the center of the urban complex. Further cities development proceeded along the communications routes traced in the ravines. The intense development since the beginning of the 19<sup>th</sup> century caused large changes in urban tissue but it did not changed priority role of the scattered terrain elevations in green areas location.

Presently, the green areas in Cracow and Prague mostly concentrate within the oldest city part and they are located on the terrain elevations. They do not create a dense system but have scattered form like the terrain elevations complex. In both cities, they are also located along the river. In Prague they constitute relatively small area located along the Vltava river within the oldest part of the city. In Cracow linear system of the green areas along the Vistula river is much longer however, it also concentrates within the oldest part of the city (Fig. 5).

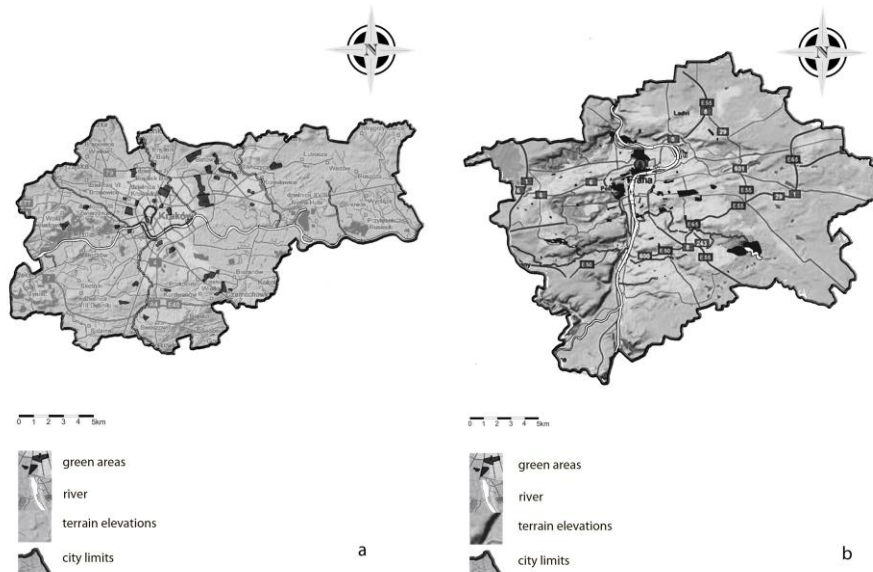


Fig. 5.

According to master plans, the green infrastructure of both cities includes terrain elevations but a question of river is treated diversely. In Cracow large part of the green areas has been included into the System of the Jura Regional Parks which location is related to the terrain elevations. The Vistula river and its tributaries also performs an important role in the city green infrastructure. On a basis of the river

course the Riverside Parks System has been established. In Prague large part of the 'green belt' surrounding the city consists of green areas located on the terrain elevations. The interior part of the belt includes also areas in the oldest city part surrounding. The marginal part of the Vltava is also included in the belt system. However, the rest of the river course is excluded from this system.

Cracow and Prague are the cities established on several scattered terrain elevations close to the river. Their urban development and green areas location were very similar. Also a role of the existing terrain elevations in the process of the green areas establishment seems to be similar. The river had unfavorable influence on green areas location. Only in the last stage of the cities' urban development this tendency slightly changed.

## **7. Recapitulation**

Based on the research, it could be found that a specificity of the preliminary city location conditions is crucial for the further urban development. The described four city location types, (Fig. 1 a, b, c, d) dependent on preliminary natural conditions such as river existence and terrain elevation type, present an original characteristic which decides about individual mode of urban space shaping.

The character of the preliminary conditions of city location influences the green areas form and spatial distribution. All analyzed cities are located on a river, however, at the beginning of urban development green areas were not established along the river course. In fact, the river was an unfavorable factor impeding green areas establishment in its vicinity. Among the analyzed cities only in two of them – Berlin and Paris, the green areas were located along the riversides. In the cities on islands – Poznań and Wrocław, the established green areas are related to the urban architecture but they are separated from the river. In the cities with a river and terrain elevations such as Budapest, Warsaw, Cracow and Prague, the green areas were located on the elevations and surrounded the buildings. In the cities with terrain elevations, parks and gardens were not located within the river vicinities. River was strong natural barrier impeding green areas establishment.

In further stage (since the 19<sup>th</sup> century till the present times) the cities' urban structure development was very individualized and depended on the specificity of the development conditions. It was influenced by numerous cultural factors. At the same time the influence of the natural factors became minimalized. In all analyzed cities it can be seen that the old city part is efficiently united with the newly created areas established according to the modern urban planning principles. The natural factors influence is displayed through the role of rivers and terrain elevations in a process of the green areas location (Table 1).

Only in Berlin and Paris a river has a significant influence on the green areas structure. For the other cities a river only partially favorites green areas location. The terrain elevation, the second analyzed natural factor, has a significant influence on green areas location in all four cities where it exists. In the cities where two analyzed natural factors occur, in all cases, terrain elevation has a significant influence on the green areas location while that of a river is only partial.

River and terrain elevation has also important meaning in present city green infrastructure shaping (Table 1).

City	Influence on the green areas location of		City's green infrastructure in relation to	
	river	terrain elevations	river	terrain elevations
Berlin	+	-	+	-
Paris	+	-	-	-
Poznań	+/-	-	+	-
Wrocław	+/-	-	+	-
Budapest	+/-	+	+/-	+
Warsaw	+/-	+	+	+
Cracow	+/-	+	+	+
Prague	+/-	+	+/-	+

+significant, +/- partial, - insignificant

Table 1.

According to the research, river performs significant role in green infrastructure shaping of five from eight analyzed cities. In two cities the river is included in the green structure only partially and in one case river is excluded from the structure. The terrain elevations in all four analyzed cities were included in their green infrastructure.

In all stages of urban development process, and in present times, river, terrain elevations and green areas perform an important role. These three natural elements are inseparable in urban tissue, complete each other and also decide about specificity, originality and identity of cityscape.

## 8. Legends

Fig. 1. Scheme of spatial development and green areas location. a) Berlin and Paris, b) Poznań and Wrocław, c) Budapest and Warsaw, d) Cracow and Prague

Fig. 2. Contemporary green areas distribution in a) Berlin, b) Paris.

Fig. 3. Contemporary green areas distribution in a) Poznań, b) Wrocław.

Fig. 4. Contemporary green areas distribution in a) Budapest, b) Warsaw.

Fig. 5. Contemporary green areas distribution in a) Cracow, b) Prague.

Table 1. Influence of a river and terrain elevation on green areas location in a city. Rivers and terrain elevations in the cities present green infrastructure.

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## 9. Biography

**Anna Różańska** was born in 1961 in Poland. She graduated from the Warsaw University of Life Sciences-SGGW, Faculty of Horticulture and Landscape Architecture. From 1991 to 1998 she worked as an assistant in the Landscape Art Department at the Faculty of Horticulture and Landscape Architecture in the Warsaw University of Life Sciences-SGGW. Since 1999 she works as an assistant professor in the same department. The major issues of her research and didactical activity are garden art history, historical gardens conservation and revalorization, city cultural landscape, role of the natural conditions in greenery shaping in cityscape.

**Małgorzata Kaczyńska** was born in 1978 in Warsaw, Poland. In 2002 she graduated from the Warsaw University of Life Sciences-SGGW, Faculty of Horticulture and Landscape Architecture and began postgraduate studies. In 2007 she defended her doctoral thesis entitled: 'The influence of the palace and garden complex in Wilanów and its filial manors on the southern Warsaw landscape transformations'. Her scientific interests concentrate on issues such as protection and conservation of historical gardens, parks and cultural landscapes and their role in cityscape development. Since 2008 she works as an assistant professor in the Landscape Art Department at the Faculty of Horticulture and Landscape Architecture in the Warsaw University of Life Sciences-SGGW.