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A SMALL RIVER WITHIN THE URBAN SPACE THE EVOLUTION OF THE RELATIONSHIP USING THE EXAMPLE OF ŁÓDŹ

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ABSTRACT: The aim of this article is to present the relationship between an industrial city and a small river within the last 200 years and the contemporary development and functions of rivers and valleys. The study was conducted in Łódź (currently nearly 699,000 inhabitants). In the 19th and in the early 20th century, the spatial development of the city also caused considerable transformations of rivers and their valleys. It was only at the turn of the 20th century, i.e. after the fall of the textile industry and a rise of the focus on ecological structures within a city, that the authorities decided to repair the utilisation of rivers and valleys.

KEYWORDS: small river, city, river restoration, Łódź.

MAŁA RZEKA W PRZESTRZENI MIEJSKIEJ – EWOLUCJA RELACJI NA PRZYKŁADZIE ŁODZI

ZARYS TREŚCI: Celem artykułu jest przedstawienie relacji zachodzących między miastem przemysłowym a małą rzeką w ostatnich 200 latach oraz współczesne zagospodarowanie i funkcje rzek oraz dolin. Badania przeprowadzono w Łodzi (obecnie około 699 tys. mieszkańców). W XIX i w pierwszej połowie XX wieku rozwój przestrzenny miasta był przyczyną ogromnych przekształceń rzek i ich dolin. Dopiero pod koniec XX wieku po upadku przemysłu i promowaniu ekologicznych struktur w mieście podjęto prace naprawcze w zakresie zagospodarowania rzek i dolin.

SŁOWA KLUCZOWE: mała rzeka, miasto, rewitalizacja rzek, Łódź.

1.1. Introduction

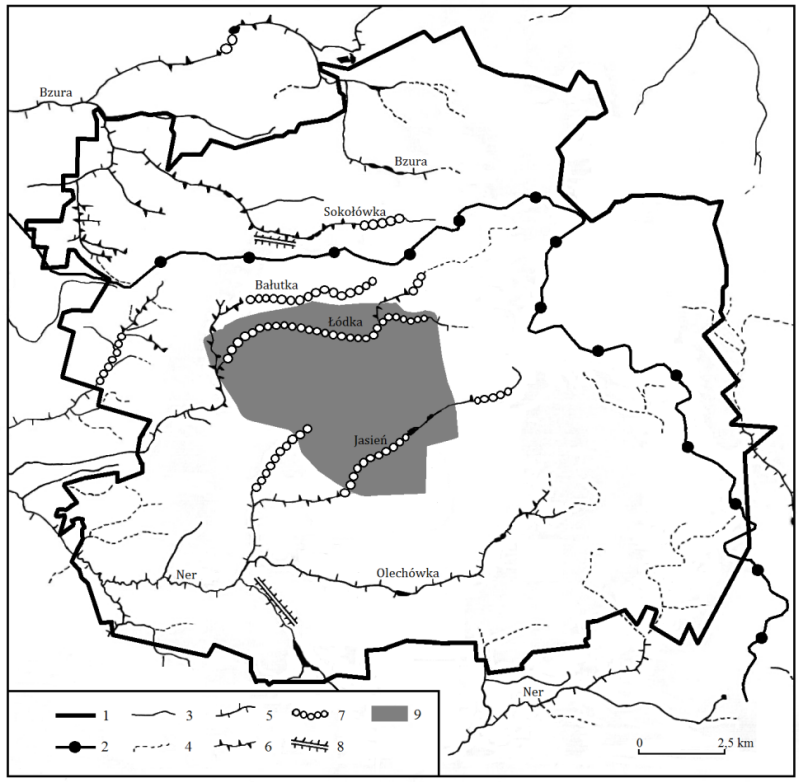
Most cities were built on rivers but the city-river relationship has always been dynamic, shifting with socio-economic and spatial changes. The biggest changes occurred in the 19th century as a result of the development of the industry and transport (Pancewicz 2004; Nyka 2013). Regardless of any anthropogenic influences, large rivers and their valleys have remained the dominant elements of the cityscape. In the case of small rivers and their valleys the situation is quite the opposite. Small rivers have been eliminated from the cityscape as a result of the spatial development of cities. They were concealed in subterranean canals or buried and their valleys were sealed and often built up. Almost throughout the 20th century, the process of designing water surface circulation systems was detached from any architectural or landscape thought (France, Martin 2002). For many years, people forgot about the importance of rivers within the urban structure. It took the second half of the 20th century for the spatial management, then in line with the notion of sustainable development, to impose a different attitude towards a river valley. It appeared that even small streams may constitute a valuable natural element in the highly-urbanised landscape and the riverain area may fulfil many ecological and socio-cultural functions. When seeking a new quality of urban space and attempting to improve the quality of life, people undertake actions aimed at restoring rivers and riverain areas, including green areas.

The aim of this chapter is to present the relationship between an industrial city and a small river within the last 200 years and the contemporary development and functions of rivers and valleys. The study was conducted in Łódź. It is a large city (currently nearly 699,000 inhabitants) located on the main watershed of the Vistula and the Oder in Central Poland – it runs through northern and eastern parts of the city (Fig. 1). That is why the layout of the hydrographic network is radiating. Most rivers and streams have their sources at the feet of the hill in the NE part of the city. The Bzura and the Moszczenica run north, the Miazga runs south. The central and south-western part of the city is drained by smaller streams: the Jasieniec, the Łódka with the Bałutka, the Jasień with the Karolewka and the Olechówka. They run SW towards the Ner.

Even in the late 18th century, Łódź was still just a small farm town. It was the 1820s, when the textile industry boom enabled the town to develop rapidly (Puś 1987; Koter 2009). Within only 50 years the town's population multiplied by almost 100, from 190 people in 1793 to 18,190 in 1851 (Flatt 1853). In the 19th century, Łódź was one of the most rapidly developing locations in Europe and in the early 20th century it became the largest industrial centre in Central and Eastern Europe. In 1914, the city's population reached 600,000. One of the major factors which lay at the foundation of the city's industrial development were

small rivers with operating water mills. The fall of the industry in the 1990s and different contemporary development priorities are the reasons behind the change of the attitude towards small rivers and their valleys.

The natural river network in Łódź and the stages of its transformations were presented based on the analysis of historical and contemporary maps and literature. During my research, I analysed maps published between the late 18th century and mid-20th century as well as studies regarding the construction of factories and industrial plants (Puś 1987; Rosin 1989; Janik et al. 2012). I have also used old photographs and designs for engineering the Łódka released by the Water and Sewage Company in Łódź. I presented the contemporary utilisation of valleys and the scope of renaturalisation works of rivers on the basis of an urban survey conducted in 2015.



1 – urban boundary, 2 – the watershed of the Vistula and the Oder, 3 – rivers, 4 – seasonal water-courses, 5 – regulated rivers, organic riverbank consolidation, 6 – regulated rivers, concrete riverbank consolidation, 7 – river in the underground canals, 8 – embankment, 9 – range of the town in 1900

Figure 1. Surface waters and river channel engineering methods in Łódź

Source: elaboration based on W. Bieżanowski (2001), P. Jokiel, Z. Maksymiuk (2011) and E. Kobojek (2013).

1.2. Utilisation of rivers and valleys in an industrial city in the 19th and 20th centuries

As a result of natural factors (relief and geological composition), rivers originated in the north-eastern part of today's Łódź and flowed mainly west- or south--westwards (Fig. 1). In the early 19th century, there were over a dozen (ca. 15) main rivers, numerous short streams and various springs within city limits. River channels were narrow (up to 1–3 m) and rather shallow 0.3–1.5 m (Koter 1988; Bieżanowski 2001). Within their main sections, valleys were very narrow and they expanded westwards along the river flow (from 50 to 200 m). Also the depth of valleys fluctuated from 40 to 5 m. River gradients decreased from around 14‰ to 2–4‰.

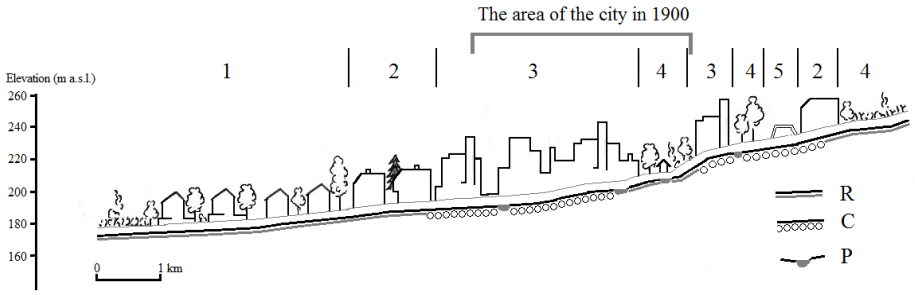
Significant water table gradients and considerable flow rates were the reason why they were used for powering water mills from very early on. Since the Middle Ages until the early 19th century, 18 water mills (all with ponds) operated on the rivers which fall within contemporary city limits.

1.2.1. Water in the development of the textile industry

In the early 19th century (1820), when the idea arose to build an industrial centre in Łódź its proponents emphasised the availability of surface waters (rivers and springs) among other advantages of the location. Rivers could not serve any communication or transport functions but they were an excellent source of water for the city and the textile industry. The industry focussed on linen and cotton and it utilised an extensive range of machinery (fulling mills, bleaching plants, mangles, dying plants) powered by water. Therefore, the factories were placed mainly on the Jasień with the highest gradient of 8‰. For a few centuries, the 3.5-kilometre-long river included three mill damings which were excellent for adapting for industrial purposes. There was a high concentration of industrial lands along the section of the river within the 1900 city limits (Fig. 2). The relationship between industrial structures and the river is clearly visible. Textile factories were also established on other rivers, but the concentration was never that high. Small streams did not pose a viable technical resource, thus, for some factories sections of river valleys were relocated.

The role of the river for the textile industry changed upon the invention of the steam engine. As early as in 1838, the first Łódź steam engine was commissioned at a factory on the Jasień. While for many years river water was used as a production resource, later it only became a recipient of waste water. In the 19th century, it was not uncommon for factories to be located directly over a river channel which enabled direct discharge of waste water.

Even in the early 20th century, rivers received waste water not only from factories but also from households and streets (including gutters). All the rivers



R – river in the open canal, C – river in the underground canal, P – ponds, 1 – areas with predominant single-family housing, 2 – areas with predominant multi-family housing, 3 – post-industrial areas, 4 – town green areas, 5 – communication areas

Figure 2. Development forms of the Jasień river valley floor
Source: author's elaboration.

that flowed through the 19th century part of the city functioned as sewers. The rapid expansion of Łódź coupled with a lack of sewerage system resulted in extensive sanitation problems. Sometimes sewage-contaminated rivers would wash out the walls of houses or factories. Water contamination that could result in an epidemic was a strong stimulus to remove rivers from the urban space.

1.2.2. Regulation of rivers and the sewerage system

A contaminated river posed a threat and was unattractive within urban space, which is why works begun to regulate them and to construct a sewerage system. First, the pond within the valley of the Łódka in the city centre was buried and the river was partly enclosed in a subterranean canal (1917). In 1925, the construction of the sewerage system began. At that time, the natural river network was included in the sewerage system. All the rivers within the industrial 19th century part of the city (today's city centre) were concealed in subterranean canals (Fig. 1). Some channel sections and many older reservoirs were buried. In the first half of the 20th century, rivers disappeared from the cityscape altogether and in the second half they even disappeared from people's memory. Rivers which flowed through younger parts of the city (created in the 20th century) were regulated in the second half of the 20th century. Their courses were straightened and their banks cast in concrete walls (Photo 1).

The sealed channels no longer performed the drainage role in relation to aquifer levels. Surface water reserves were quickly depleted as a result of the intense industrial and urban development which is why in the late 19th century new deep water wells extracting water from the Cretaceous and Jurassic geological strata were dug. A cone of depression developed within the city limits which caused upper sections of rivers to disappear. The table of the first underground water level

Photo 1. Straight canal of the Jasień river in the younger part of the city
Source: photo by E. Kobojek (2015).

disappeared entirely or dropped by a few to over a dozen metres (Jokiel, Maksymiuk 2011). Even in the northern part of the city (the most geomorphologically diverse), where rivers are still fed with underground waters, there are sections with the first level of groundwater stored deeper (1.2 m) than the channel floor is (0.5 m). There are no springs within the city limits. What remains are only names of streets (e.g. Źródłowa – Spring St.) or parks (Park Źródliska – Springs Park). As a result of nearly 200 years of human activity, rivers have been transformed into canals for discharging rainwater only.

1.2.3. Removing rivers and valleys from the urban space

The Jasień and the Łódka and other smaller streams in the city centre concealed in drainage systems and canals vanished from the cityscape. In the early 20th century, a journalist reflected that „the city of Łódź lies or rather expands over the Łódka. I write this with some reservation as no one has ever seen the river or could tell me with certainty anything about it" (Nowakowski 1931).

As a result of directing former rivers into subterranean canals new flat and low-lying areas formed. Quite soon they were all utilised. Usually, they were used for transportation infrastructure, e.g. wide streets (Photo 2), important road junctions, tram routes (Photo 3), a tram depot, but also be residential structures. Thus, the fact that there once were some rivers was soon wiped clean from the inhabitants' memory. A street that runs parallel to tram tracks and an important road is called „Nad Karolewką" which means near the Karolewka river. Very few inhabitants know that beneath the tracks there is the canal of the old river. The valley was buried and built up. This is not just one such instance. In the city centre, river

floors have been transformed to such an extent that it is impossible to indicate the scope of their elements, i.e. the former floodplains and flood fringes (Kobojek 2015). In many cases, valley floors are buried under a 2-metre-thick layer. The landscape only retains some valley slopes.

Photo 2. Section of the Milionowa Street over the Jasień river in subterranean canal

Source: photo by E. Kobojek (2015).

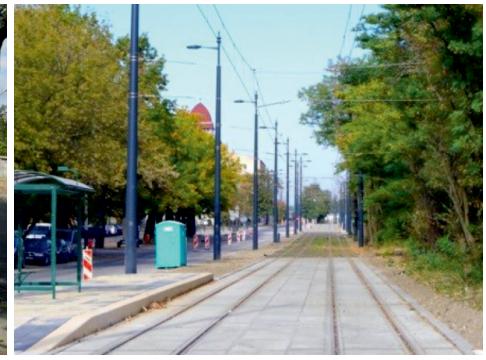


Photo 3. Tram route was built over the Karolewka river in subterranean canal

Source: photo by E. Kobojek (2015).

1.2.4. Return of water to urban space

In the late 20th century, the textile industry crashed and many post-factory structures in Łódź have been adapted to serve other functions, e.g. hotels or social utility buildings. People have also started to appreciate nature in the city. In the 1990s, the authorities began improving the condition of water resources and the living conditions of the inhabitants. In 1996, works started to restore Łódź rivers located outside the city centre. The goal was to retain as much water as possible and restore the condition of selected regulated rivers which would allow for natural processes to continue. The Sokołówka, a river outside the industrial zone, was chosen as the first one to be restored. 23% of its drainage basin is occupied by fields, 19% by forests and parks and the remaining part is urbanised (Bartnik et al. 2008). The valley development plan states that three zones are to be created. The first one includes solutions which ensure the river functions as an ecosystem and receives storm water, thus, ensuring increased water retention. The plan included the formation of 11 reservoirs of 0.1 to 2 ha and 8 meanders (Kujawa et al. 2003). Two dry reservoirs will receive flood waves during rainstorms. Many works have already been completed, mainly the formation of a series of 6 ponds. The second zone includes a buffer zone designated for recreational purposes, while the third includes space for low-rise buildings.

For urban quality of life to improve, it is necessary to have places for relaxation and recreation. The view that remaining in contact with nature has a favourable influence on people's physical and mental health is widely accepted. In Łódź, such places (green areas and reservoirs) mainly exist in river valleys. The stream network is designated as the basis for tourist routes. Rivers (developed canals), ponds and parks will create coherent relaxation and recreation areas. A guidebook entitled „Z biegiem łódzkich rzek" (Along Łódź rivers) has been published. There are folders which include newly-devised walking paths and descriptions of the most valuable locations within the routes. The presentation of the stages of river transformations served as an opportunity to remind people about the city's industrial heritage. The identity of Łódź is most profound in its 19th century spatial arrangement defined by the grid layout of the streets with the valleys of the Jasień and the Łódka (Dankowska 2009).

1.3. Contemporary utilisation of the river and its valley in the city

Contemporary functions of rivers and their valleys vary depending on their location within the city. Rivers or sections of rivers located in the city centre remain enclosed in subterranean canals (the Jasień, the Łódka, the Bałutka, and the Karolewka) while their valleys are generally sealed and built up. Rarely do artificial reservoirs or parks exist within their axes. The closer one gets to the outskirts of the city, the less built up the valleys are and more rivers flow through unregulated and uncovered canals. Sections of rivers near city limits are the most natural, e.g. the channel of the Ner meanders while its banks are overgrown with lush plant life. Also the rivers in the north of the city (e.g. the Bzura), within an area with the most diverse relief, are transformed to a lesser extent.

1.3.1. Storm water drainage

Today, small rivers mainly serve the purpose of draining excess storm water from the city. Additionally, 50% of the rivers are included in the city's sewerage system. This applies to the entire course of the Bałutka and the Karolewka and nearly the entire course of the Jasień and the Łódka. The rivers in the city centre do not flow down their own valleys but through concrete covered canals which makes ground water drainage virtually impossible. No outflow of underground water has been identified within the drainage basins of the rivers which flow through uncovered canals. Therefore, natural flows in those streams do not occur. Those are no longer natural rivers. They are fed by overland flow, storm water or even excess city sewage. The highest water levels are usually recorded during spring thaw period in February and March and in summer in July and August. The highest winter flow rate is one hundred times higher than the lowest autumn flow rate and in the case of average flow it is twenty times higher respectively. It is mainly caused by sudden overflows from the city sewerage system.

In view of their function (recipients of storm water), the rivers cannot be fully restored, e.g. the Sokołówka. The main focus is placed on establishing small reservoirs.

1.3.2. Functions of artificial reservoirs

Artificial reservoirs are an important element in the river valley landscape of Łódź. Their areas vary from 0.1 to over 11 ha. In order to retain water in the city the authorities have implemented the „Program Małej Retencji" (Small Retention Program) program within which old reservoirs are cleaned and new ones are being built. They serve various functions, however, the retentive function is predominant. They retain storm water to limit city floods. They are located in various parts of the city. One example of such a reservoir is a pond built near an important intersection located on the valley floor of the Łódka and which had been often flooded during rainstorms (Photo 4).

Photo 4. Reservoir within the floor of the Łódka river valley serves retentive and landscape functions

Source: photo by E. Kobojek (2015).

There are reservoirs serving mainly the landscape-sightseeing and decorative functions throughout the city. The ponds in the city centre are the most valuable in this respect. Parks established in the 19th century next to manors of factory owners include the most valuable reservoir systems, which had been restored in the 1990s. Small reservoirs in valley floors are currently fed by city pipe network. The ponds in the valley of the Łódka in Helenów Park, which are considered as the most beautiful ponds in Łódź, are fed by a deep water well while the river flows beneath them in an subterranean canal.

In the city centre, water systems in parks form series of ponds, usually artificially fed (Wycichowska 2012). Their floors are laced with foil since underground water level is so deep that it would result in the water seeping through the sandy base. The maintenance of old water systems within historic parks is extremely significant for the cultural and natural identity of the post-industrial Łódź, improving the landscape value and the living conditions in the city (Photo 5). The ponds serve a vital aesthetic function while the surface of the water enriches the internal layout of parks.

Photo 5. Pound in the Jasień river valley
Source: photo by E. Kobojek (2015).

Larger reservoirs located mainly in the outskirts fulfil sports and recreational functions. They are used as bathing sites and locations for practising water sports, e.g. canoeing. To encourage recreation, beaches, piers and other infrastructure have been built. For example, a 11.5 ha pond created on the Ner is a popular destination for the inhabitants of Łódź. Reservoir banks with adjacent parks are the most valued places for relaxation.

1.3.3. Green areas within river valleys

In the dynamically developing industrial city which Łódź once was there has never developed a clear-cut green complex surrounding the city centre and parks were established mainly within river valleys. Steep hills or marshy areas in some sections of the valleys made industrial or residential development difficult which is why they often remained undeveloped. In time, parks were established there. The first public park in Łódź called Źródliska Park was established in the mid-19th century in a marshy area with numerous springs. It has been drained to such an extent that today there are no springs left there and the decorative ponds are fed by the city pipe network. Park im. J. Piłsudskiego (J. Piłsudski Park), the largest park in Łódź, was established within the valley of the Łódka in the 1930s. Initially, it was located in the outskirts, but as the city expanded it was surrounded by a residential district and important thoroughfares. This is another park where initially marshy valley floor has been significantly transformed. The level of groundwater plummeted and the level of air pollution soared. In 1930, the authorities created the „Polesie Konstantynowskie" reserve, within the park in flood fringe, to protect a fir site on its border. However, in 1954, the protection focus was switched to a forest with natural features (an oak and hornbeam forest with blooming ivy). The focus was changed because firs disappeared from the reserve.

19th century parks adjacent to manors of factory owners were also established on rivers, e.g. in the valley of the Sokołówka (Park Julianowski) or of the Łódka (Park Helenów). Those are two out of fifteen parks in the city. Park Helenów has retained steep and high valley hills which surrounded the added ponds, though the river itself flows through a subterranean canal.

Parks located in one valley are often connected by series of green areas or rows of trees. Such a layout encourages the creation of walking and cycling paths within the valleys: along streams, ponds and green areas.

1.3.4. Ecological functions

Since the 1990s the need to improve the ecological aspects of people's living in cities has been signalled (Szulczewska 2002; Przewoźniak 2005). Rivers and their valleys fulfil or could fulfil those important ecological functions. They form a natural system when they include: forests, meadows, parks, rivers, reservoirs, and even allotment gardens. In Łódź valleys, there are extensive series of green areas, even in the city centre. Those are favourable locations for various species of flora and fauna.

The distribution of river valleys in the city is relief-dependant. They fall within the NE–SW line while the wind mainly blows from the west. Therefore, the valleys serve the important function of ventilating the city. The location of valleys and their utilisation (parks, reservoirs) are very important for airflow in the city. Thanks to such utilisation valley areas with greenery form ventilation corridors.

A valley and a river in a city form together opened spaces where free airflow occurs and a unique microclimate forms. Green areas and reservoirs within valleys have a favourable influence on air temperature in cities within the range of the so-called urban heat island. They decrease the maximum air temperature by 10–25% and the average daily air temperature by 7–20% (Lewińska 2000). The urban microclimate displays a rather high humidity deficiency. Bodies of water and biologically active areas store large volumes of water increasing relative air humidity.

1.4. Conclusions

The current condition of the valleys and small rivers in Łódź is a result of sudden transformations which had occurred since the early 19th century as a result of industrial development. The unique nature of the city is a result of the fact that within the lifetime of 2–3 generations, water conditions changed completely. The role of water within the cityscape was drastically limited which in turn resulted in a change of the features of the valley environment.

The approach to small rivers in Łódź was common in other Polish or European cities (Nowacka-Rejzner 2001; Kobylarczyk 2010; Schneider-Skalska 2010; Nyka 2013). In the 19th century, a river was considered first as a source of water for the industry and second as a means of discharging sewage. Water pollution was the reason why rivers were enclosed in canals in the city centre, thus, removed from the cityscape. In the early 20th century, the spatial development of the city also caused considerable transformations of rivers and their valleys. Small rivers were regulated with some sections enclosed in canals or even buried. Valleys were built up to a large extent, with the intensity of the development moving towards the centre.

The removal of rivers from the cityscape was partly a result of a broader cultural context. In the late 19th century, the contrast between nature and culture was emphasised and water was not considered when formulating architectural and urban development theories of that time (Nyka 2013). It was often the case that a free-flowing river was being treated as city limits and the area adjacent to it as the outskirts.

In the 1960s, however, people began to perceive a large river as a constituent of a city's image (Wejchert 1984; Pancewicz 2002). But it was only at the turn of the 20th century, i.e. after the fall of the textile industry and a rise of the focus on ecological structures within a city, that the authorities decided to repair the utilisation of rivers and valleys. New forms of spending free time in large cities developed, including physical activity in well-maintained green areas. Access to water became a valued asset within public space (Meyer 2001). In the case of Łódź, long series of green areas exist mainly within the valleys of former rivers which have been regulated or concealed in canals. Therefore, since the 1990s, the restoration of valleys has been perceived as an opportunity to improve the urban environment. Unfortunately the fact that rivers have been included in the city's sewerage system makes complete restoration impossible. Furthermore, a very low level of groundwater cannot ensure ground feed for rivers. The so-called "restoration" works mainly include recreation of numerous reservoirs and are aimed at shaping the cultural landscape to fit the environment as well as possible.

The course of works largely depends on the location of a valley within urban space. In the city centre instead of a river there are redeveloped or new reservoirs. The first groundwater level is too low to form a natural river. Reservoirs fed from deep water wells or city pipe network possess significant landscape and decorative value. Outside the city centre, reservoirs were established on regulated streams serving the retention and relaxation function.

Greenery and water are perceived as the main elements for renewing public space. New works help emphasise the role of rivers in the development of Łódź and offer an opportunity to come in contact with nature and create a substitute (illusion) of naturalness. This is in line with modern trends of treating a city as an ecosystem (Szulczewska 2002; Przewoźniak 2005; Zimny 2005).

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