Rainwater Management in relation to Water Bodies and Flows in Urbanized Areas

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Abstract. The paper deals mainly with relations of water between urbanized area and public space of settlements and their mutual influence. The article defines basic parameters and specifics of watercourses and water areas with a link to the built-up area, including evaluation of the current state of watercourses and areas in settlements and their interconnection.

1. Introduction

Despite the improving situation, the urbanized areas of settlements in the Czech Republic are in many respects far behind those of developed countries. In many larger cities, the revitalization of watercourses and areas began, but the treatment of watercourses and water areas is rarely and very slowly entering the environment of smaller municipalities and rural areas. It depends on a number of circumstances and parameters, such as awareness of the possibility of adjustments (whether between residents or municipal representatives), the financial capacity of the municipality, the availability of appropriate reference examples, fear of changing public space, location of development (sufficient space or built in close proximity), etc.

The settlements, which grow mainly around watercourses or water bodies, first adapted to the water with their construction and urban concept. Such adaptation can be seen in the ground plans of the historical centres of various towns and villages, where streets, squares, rows of houses follow the shape of the terrain and the bank of the watercourse (e.g. Figure 1). Although the establishment of settlements near the watercourse was difficult, for example if it was a settlement on a meandering stream, a difficult headland or on islands, such a settlement had a strategic role. Many cities are based on not easily accessible places with well-controlled access roads close to waterways or areas for defences and protection. A good example of a defence and defence strategy in this case are castles around which a moat was built if it was not possible to use the natural watercourse. The built-up towns or the layout of the castles and chateaux are adapted to the shape of the banks of the watercourse. With the gradual increase of population and expansion of the built-up area, better technical skills and resources, the development began to expand and grow on both banks of the watercourse and the watercourses were also gradually absorbed into the built-up area of settlements [1].

Watercourses passing through the built-up area, especially through the dense development of historical cores and city centres, could not usually remain in their natural form. The free space with the potential of lucrative building plots around the streams was too expensive for settlements if it remained undeveloped and logically built up. The dense development got close to the river where regular and natural floods would have devastating consequences for it. The solution was the regulation of
watercourses, when a solid flat stone trough with high banks was built, which was able to mostly catch the flood wave [4].

Figure 1. Cesky Krumlov - ground plan arrangement of the historical center influenced by the Vltava River.

2. Water management in urbanized area

Working with watercourses in urbanized areas of settlements is quite different from water management in the open countryside. In particular, the nature of the space being worked on and its size, which is often very limited in an urbanized area, are different, whether by built-up areas, traffic situations or, for example, more complex ownership relationships. In addition, the space in the built-up area of settlements is much more valuable and in many ways more attractive.

The watercourses in the urbanized area must provide sufficient flow capacity and be stable. However, this does not mean that the trough in a town or city must always have the character of a technically hardened canal, ecologically completely degraded and unsightly. On the contrary, in most situations, the basic requirements of capacity and stability can be met by creating a trough that retains at least a part of the nature close to nature, well fitting into the system of urban park and recreational areas. Such a trough should then promote a favourable habitat environment in the urbanized area of settlements and at least partially preserve ecological functions, in particular to allow the migration of aquatic organisms in both aquatic and contiguous terrestrial environments, the continued existence of fish and other aquatic organisms. Another type of nature-related flood control measures in an urbanized area may be to increase the flood flow rate by reducing the level of terrain around watercourses into flood areas. Parks or sports grounds can also operate in these flood plains [6].

In contrast to the open landscape, there is an effort to restore naturally small, rugged channels, supporting the suppressive floods of floods into the surrounding floodplains. In urbanized environment of settlements, spatial conditions are usually much more limited and it is necessary to respect the priority requirement of sufficiently large flow capacity and usually also of channel stability. There may be very diverse solutions in this area that require a special approach for each individual case and may result in varying degrees of approximation to nature. It opens up space for imaginative architectural and artistic treatises of the urban landscape that takes into account the basic environmental requirements. Basically, flood and revitalization solutions can be used in two situations. In confined conditions, especially in the historical centres of settlements, where the watercourse is delimited by an existing trough and cannot be extended, passive flood protection measures of
individual buildings and neighbourhoods (partial building modifications of buildings, fixed and mobile flood walls) are combined with some sort of “ecological minimum “trough [3].

Figure 2. Bad Staffelstein - close to nature, but the flood capacity solution of the stream.

3. Watercourses and urbanized areas
Watercourses in municipalities can be divided by size (amount of water, flow rate, channel width, etc.), according to the degree of flow regulation (treatment of banks, riverbed, riverbed bottom, tubing), eventually according to the place in the middle of the village, in a closed area, in an open space). Furthermore, the flows can be divided according to the risk of possible floods and the consequential damage that any floods could cause. General principles of watercourse revitalization:

- making the flow accessible to the public and creating a recreation area / resort,
- design of landscaping around the watercourse
- improvement / maintenance of the current state of flood protection of the municipality, its surroundings,
- improvement of the technical condition of the stream bed and of structures near and on the stream,
- where possible, uncover and make available piped flows [7].

In more relaxed conditions, usually peripheral parts of buildings, more generous solutions can be used, in which increasing the flow capacity of corridors of watercourses by expanding or doubling of river beds or reshaping the terrain of floodplain areas appears as an active element of flood protection. In the preceding Figure 2 it is possible to observe the nature-friendly but flood-resolving solution of the brook in the built-up area. Approaches to the revitalization of watercourses in urbanized areas can be found in particular in the following areas:

- look for all and partial opportunities to increase the area of the watercourse. The aim is to increase flood flow and slow down flood flow,
- to choose, as far as possible, naturally close river basins and to carry out these activities even at the expense of mining larger volumes of soils,
- in places where flood barriers were situated in the past, to look up for opportunities to expand the nature-like river area by indenting these dams,
- the flood area of the watercourse should be designed as multifunctional, ie to enable the development of natural elements in this area or open it for the movement and recreation,
- in cramped conditions, reconcile with the technical solution of the banks (in the worst case, the bank walls), but insist on the nature close to the bottom, which is the basis of the ecological functions of the watercourse,
- trough bottoms, be resolved as close to nature, shape-shaped (do not forget the possibility of deep subdivision of the bottom and thus create systems of depressions and pools),
4. Water areas and urbanized areas

Similarly to watercourses, water areas in urbanized areas can be divided into several categories. Depending on size, technical condition, area with drainage, inflow or runoff, purpose of use (retention tanks, fire tanks, breeding ponds, etc.).

**Figure 3.** Biotope swimming pool Lhotka Prague 4 - incorporation of water element into functional, recreational areas of the city.

In the case of water bodies, the possibilities of revitalization and subsequent use are somewhat greater than in watercourses. The general principles of water surface revitalization are generally as follows:

- making the water area accessible to the public,
- design of landscaping in the vicinity of the water surface, supplemented with furniture,
- cleaning up the water surface and its banks,
- improvement of technical condition of banks, embankments and elements on the water surface.

As a rule, it is not possible to revitalize only one particular element without linking to the surroundings. It is therefore advisable to combine the revitalization of the water area with landscaping (mainly landscaping with the addition of urban furniture). Eventually with the extension to a larger area of the village and in a similar spirit to adjust the remaining public areas (park landscaping, unified style furniture, navigation and information system, etc.). There is also the possibility of using the possibilities of self-cleaning of water surfaces (eg on the principle of biotope ponds), similarly as in Figure 3.

5. Conclusion

Water management, whether water courses or areas, is one of the key parts of urban planning and urbanization. It has an unquestionable impact on the environment and the standard of living of the population. The need to address the relationship between urbanized areas and water management is currently respected in developed countries, especially in the European Union. However, not
everywhere the approach to this issue is active and responsible. Effective solutions to this neglected problem require an active approach not only by the authorities but also by increased interest from the population.

The issue of watercourses and areas in the public space of urbanized areas of settlements and the possibility of their revitalization and reconstruction is currently a very thorny topic, mainly due to climate change. At the same time, it is necessary to point out the current, often unsatisfactory, state of most of our urbanized areas of settlements and their public spaces. Technically designed troughs, designed for large flood flows, are often very poorly adapted for ecologically acceptable operation at small and normal flow rates that prevail in the trough most of the time. This may be related to the question of the functional usability of the trough space - technical troughs often create spaces and surfaces, usually without water, which do not serve anything and anyone during periods of heavy rain and at most raise maintenance problems [2].

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