

URBAN STORM WATER MANAGEMENT AND ITS CHALLENGES

Tucan Laura-Elena

University of Architecture and Urban Planning 'Ion Mincu', Bucharest (ROMANIA)

laura.tucan [at] gmail.com

Abstract. Considering the climate change and the global issue in which human capacity to control floods is exceeded, this article is an approach to the topic of international concern "urban storm water management". Thus, in this paper it will be presented measures which the public and local governments should adopt in order to prevent the catastrophic effect that climate change may have both on the anthropic space and on the natural space in urban areas. Being a recent attitude for planning the city of the future, this approach presents an initiation of specialists (engineers, architects, town planners, landscape architects, etc.) in an interdisciplinary research, provided by the interrelation of urban dimension with engineering size.

Keywords: Climate change, floods, storm water management, interdisciplinary research.

1. INTRODUCTION

Cities are dynamic systems, with constant transformation and change, both in terms of size and urban structure and interacting with the environment. In this context, increasing urbanization, the overall trend of extensive development of current cities and enclosing the adjacent territories, wasteful use of land and climate change have had a significant negative impact on local environmental conditions and especially they created major problems with the capacity level of the centralized system for collecting rainwater in urban areas.

2. THE CURRENT STATE OF URBAN DEVELOPMENT

Cities from all continents are currently facing several problems, such as:

- Reducing natural resources, including water;
- Environmental degradation;
- High level of CO₂;
- Demographic and social changes associated with the phenomenon of urbanization and population growth;
- Increased frequency and magnitude of urban floods;
- Increased intensity of rainfall in short periods of time.

Urban flooding manifested in urban areas is of two types [1]:

- Flooding inside the locality, generated by the inability of centralised systems to collect large flow of rainwater. Rainwater collection systems no longer meet current environmental conditions and needs of the urban population. Thus, sewer systems cannot efficiently take water flows that do not fit the reference indices to which they were designed.
- Flooding caused by the increase of surface water volume and overcoming the main riverbed, into which flow the centralized systems of wastewater and storm water collection. Damage of topsoil surface and building rainwater collection network has generated increased volume of water coming from rain or melting snow, which flows along the ground and discharges into surface waterways. Consequently, increased the frequency of floods caused by emissaries out of the main riverbed, thus affecting urban areas in close proximity. This takes place when discharge of large amounts of rainwater occurs in a very short period of time.

The causes of the problems the city is currently facing are:

Rapid urban expansion (urbanisation): Urbanisation is the process of intensive development of existing cities and fast and stressed growing of their number and therefore, the number of urban population.

Urbanisation effects are felt both in urban environment and in its immediate vicinity, as follows:

- Increased consumption in urban areas;
- Expanding city territory – emphasizing discrepancies between urban and rural areas;
- Urban population growth;
- Long-term and irreversible consequences in terms of non-renewable resources and support capacity to the natural capital.

To analyse the impact that urbanization and urban development have on surface water that are emissaries for river basins related to urban areas, international studies were carried to monitor rural and urban areas with different percentages of area occupied. Thus, it was found that with river with 5% impermeability, emissary is stable and with a good structure of banks, has good quality water and large areas of wetlands and associated vegetation. When analysing river basins with 8-10% Impervious surface, was observed that the emissary is still stable, but are visible erosion of riverbanks and wetlands and vegetation are less visible. Active erosions of rivers serving as an emissary for urban areas become very evident in the river basin impermeability of 20% and are obvious materials and pollutants floating on the surface. Also, the water quality drops significantly in this case.

Inefficient and wasteful use of resources, but especially of land: Urban development and occupation of the lands with constructions directly affect the characteristics of freshwater. Interventions that occur on land on which are built new constructions can have a major negative impact on the natural water cycle, on the mode of transport and its natural storage. The new developed residential and commercial areas generate Impervious surfaces and compact soil infiltrating a small percentage

of rainwater. Therefore, flow coefficient increases and decreases the volume of water that seeps directly into the ground. These phenomena have implications in increasing the frequency, intensity and severity of urban flooding.

3. THE CURRENT COLLECTION OF RAINWATER: THE CENTRALISED SYSTEM

Currently, sewage and rainwater in urban areas are collected through a centralized sewer system. This includes all objects to collect and transport sewage water (wastewater and storm water) to the emissary in an orderly way.

There are three types of centralised collection system of urban waters [2]:

- **Unitary system.** The advantage of using the unitary system is economic, due to lower costs of building. The disadvantages of this system are twofold: firstly because of the costs of treatment of large quantities of wastewater and secondly because of outdated channel capacity to take on large debts on rainfall with increased intensities.
- **Separate system:** The biggest advantage of this system is primarily economic, since the implementation of this system can be done in several stages, and secondly an advantage due to lower treatment costs. The shortcoming is the high cost of investment, caused by doubling the number of channels. Another disadvantage is the increased risk of polluting the emissary in the first part of the rainy event, because in urban localities meteoric water washes the streets, parking lots etc. and therefore it is very dirty.
- Mixed System.

4. CAUSES AND MANAGEMENT ISSUES OF STORM WATER

4.1 Climate Change After the Year 2000

According to the World Meteorological Organization Report, globally, the decade 2001-2010 was the warmest period of the first temperature monitoring since 1850. This has been identified including in Bucharest.

Also, the average rainfall recorded globally in the continent, in the decade 2001-2010, exceeded the 1961-1990 average. Analysing the variation in precipitation in the same decade, in Bucharest, it can be seen that extreme events manifest such as increase in precipitation in autumn and spring and of the intensity of rain and reduced falling time.

4.2 Increasing Impervious Surfaces

With the growth and development of cities, the landscape is replaced by streets and sidewalks, parking lots, paved public spaces, residential buildings, administrative offices, etc.

Thus, the impervious surfaces increase to the detriment of natural lands, a phenomenon that affects the natural water cycle. Impervious surfaces thus

contribute to decreasing the ratio of water to leach into the soil and increase the runoff coefficient [3].

5. FUTURE CHALLENGES

5.1 Change Scenarios of Climate Phenomena

The US Intergovernmental Panel on Climate Change warns that the current rate of greenhouse gas emissions will lead until 2030 to a 4°C increase in global temperature, a point where capacity of specialists to predict the effects of these changes is exceeded. Cities will feel most strongly these climate changes, whereas currently they gather more than half of the world's population and most of the urban population is located in the most vulnerable areas, along rivers and coastal areas. At the same time, cities generate 60-70% of greenhouse gases worldwide. For this reason, urban areas can contribute significantly to mitigating and adapting to climate change [4].

5.2 Future Trends of City Development

Worldwide, the world's urban population is growing and changing. If current trends are seen in the future also, it is estimated that in 2050, world population will reach 16 billion, almost double than that of 2010. Given this scenario, it appears that more than 50% of future urban areas are still undeveloped.

Compared to 1950 – 1975, when population growth was located equally in urban and rural areas, estimates for 2030 mainly locates future population growth in urban areas. Unlike general expectation, of locating future population growth in large cities, metropolitan areas with a population over 1 million inhabitants, U.S. studies and researches 2002 presented a viable hypothesis, stating that the urban population explosion will be located specifically in small cities (with a population registered at present to 100,000 inhabitants) and medium cities (population between 100,000 and 250,000 inhabitants), which will witness a rapid urban expansion, compared to the big cities, that will have a slower rate of growth. Thus, to prevent small and medium cities confrontation with the current problems of the big cities, it is necessary to pay specific attention to spatial planning and urban management, with coherent and balanced reservation of lands to reduce the impact of urban development on the natural environment [5].

6. NEW PRINCIPLES UNDERLYING THE SUSTAINABLE MANAGEMENT OF URBAN WATER

The principles underlying the sustainable management of urban water are:

- Respect for water resources;
- Management of storm water on site as much as possible to the ground surface;
- Restoring river basin and emissary;
- The inclusion of rivers in the planning and development of cities;

- Multifunctional management of public spaces;
- Increasing public awareness;
- Economic motivation.

The new concept of sustainable urban management and urban water use efficiency, taken globally is 'Green Infrastructure'.

The concept of 'Green Infrastructure' was first used in Florida in 1994 in a report submitted to the Governor of strategies for land conservation and intended to convey that natural systems are even more important than the other infrastructure components. Since it is generally accepted that we must plan 'the Grey Infrastructure', the idea of planning the conservation and restoration of natural resources has helped the population in areas where it has been applied this concept to recognize the importance of the 'Green Infrastructure' in the planning process. This change in the mentality of the population was produced by the recognition that people's needs are inseparable from the natural environment needs as humans are part of nature.

The concept of 'Green infrastructure' is used and applied both on a regional scale, and on the scale of the city and is based on the use of the properties of green spaces to improve the current problems of the urban environment as they (the green spaces of urban park or square type, green roofs, land plots in residential areas, etc.) contribute to climate change mitigation in three ways [6]:

- Green spaces can store a significant amount of carbon, store rainwater and help its infiltration, reduce pollution levels. A larger amount of vegetation means a greater amount of the absorbed carbon;
- Trees can indirectly contribute to climate change mitigation through the cooling and shading they produce and thus reduce energy consumption;
- The green areas can contribute significantly to the reduction of greenhouse gas produced over the city.

7. CONCLUSIONS

In the context of global warming and the recent transformation of the urban environment, traditional rainwater management is facing increasing challenges, as evidenced by frequent floods as a result of exceeding the capacity of existing sewage systems of collecting large water flows.

The initial design of the centralized systems for collecting rainwater targeted one aspect, namely to carry in the shortest time possible water draining on impervious surfaces. For a long time, this process has proven its efficiency, and local flooding has been prevented. However, with changes in the rainfall due to climate change and increasing land occupancy, negative effects manifested such as flooding and erosion of riverbanks in areas of rainwater drain.

In this context, future storm water management must consider long-term forecasts of both environmental conditions, particularly rainfall and of the increase in urban population and hence impervious surfaces. Thus, the adaptability of future systems

must become an essential pillar in the long-term planning of storm water management in accordance with the principles of sustainability.

For an effective adaptation to urban and rainfall parameters forecasted for the future, we may adopt the concept of great interest – ‘Green Infrastructure’ – which involves local collecting from the place of fall of rain water.

Multidisciplinary approach to sustainable management of rainwater is thus a necessity, given the complexities of actual problem: implementation in urban areas of decentralized systems of collection and infiltration of rainwater, which will be located and distributed efficiently, be integrated in the urban landscape (in terms of landscape), but also to meet the current and future technical requirements and needs.

REFERENCES

- [1] Booth, D., B., Konrad, C., P., (2002), Hydrologic Trends Associated with Urban Development for Selected Streams in the Puget Sound Basin, Western Washington, Water-Resources Investigations Report 02-4040, U.S. Geological Survey, Tacoma, Washington (DC).
- [2] Blitz, E. (2012), Sewer Systems, Didactic and Pedagogical Publisher, Bucharest.
- [3] Water Environment Federation and the American Society of Civil Engineers (1998), Urban Runoff Quality Management, WEF Manual of Practice No.23, U.S.A.
- [4] Bates, B., Kundzewicz, Palutikof, J., Z., Wu, S., (2008), Climate Change and Water, Intergovernmental Panel on Climate Change, Geneva.
- [5] Cohen, B., Montgomery, M., Reed, H., Stren, R., (2003), Cities Transformed – Demographic Change and Its Implication in the Developing World, National Academy of Science, Washington (DC).
- [6] Convention of Biological Diversity, Stockholm University – Stockholm Resilience Centre – Research for Governance of Social-Ecological Systems, I.C.L.E.I. Local Governments for Sustainability (2012), Cities and Biodiversity – Outlook, Action and Policy, A global Assessment of the Links between Urbanization, Biodiversity and Ecosystem Services, Secretariat of the Convention on Biological Diversity, Montreal.
- [7] Bica, I., Tucan, L., (2014), Using the Green Infrastructure Concept in Adapting Cities to Climate Change, Romaqua.

Article distributed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND).