ENVIRONMENTAL ENGINEERING

The 8th International Conference
May 19–20, 2011, Vilnius, Lithuania
Selected papers

ISSN 2029-7106 print / ISSN 2029-7092 online
ISBN 978-9955-28-828-2 (2 Volume)
ISBN 978-9955-28-827-5 (3 Volume)
http://enviro.vgtu.lt

THE CONCEPT OF RAINWATER MANAGMENT IN KOŠICE CITY

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Abstract. In many parts of Europe water use is unsustainable and therefore is desirable to provide recommendations for a new approach to managing water resources in practise. Overexploitation has a heavy impact on the quality and quantity of the remaining water as well as the ecosystems which depend on it. Enlargements of settled areas, in consequence of urbanization and industrial activities, instead of greenery prevent from rainwater infiltration and temperature around the countryside is increasing. A problem of settled areas is to sustain comfortable microclimate especially in the summer. Dense urbanization change nature water regime of the natural ecosystem. Settled areas prevent rainwater infiltration and resupply of groundwater. Sewage systems of residential units were constructed as a single system in the past. There are strong pressures to limit the runoff of rainwater from the newly constructed buildings at the edges of cities. Therefore the sophisticated use of alternative supplies of water, such as the purified waste water from households and capture rainwater is essential, to help reduce water consumption. The purpose of the paper is to solve possibilities of rainwater management and about what can be done to reduce the construction of water runoff from the territory to avoid compromising the building's own water. The concept of drainage in cities, which aims to mitigate the impact of urbanization on the hydrological regime of the country and on aquatic ecosystems, come from our experiences and knowledge of current method of sewerage. New concept of capture and use water from surface run-off provides a platform for a new technical and non-technical measures, both in drained on each property, as well as the public part of urban drainage area.

Keywords: drainage, rainwater, infiltration, drainage wells, percolation shaft

1. Introduction

"We are living beyond our means when it comes to water. The short-term solution to water scarcity has been to extract evergreater amounts of water from our surface and groundwater assets" said Professor Jacqueline McGlade, Executive Director of EEA (European Environmental Agency).

In many countries, water is used in unsustainable way, and therefore it is desirable to put into practise the recommendations for a new approach to managing water resources. According to (Žabička 2005) the increasing power of hard surface at the expense of the green prevents infiltration of rainwater from surface runoff and the temperature increases around the built up areas of settlements. The preservation of pleasant microclimate especially in summer is a major problem of urban development. Dense urban development has changed the natural water regime of the original ecosystem. Reinforced and built-up areas prevent resupply of ground water. It is necessary to think about what the building industry can do to reduce water runoff from territory in order to avoid flood danger of the own buildings.

Sewer network of residential units were set up in the past as a unified system. Sewers of most cities are congested today. New urban development penetrates to larger distance from the historic centre. Reconstruction of the sewers is cost demanding. Thus, there is a strong pressure to reduce rainwater runoff from newly constructed buildings in the surroundings edge of the cities. A sophisticated use of alternative water supplies such as cleaned waste water from the households and collecting rain water would be useful with the aim to help reduce water consumption.

The concept of urban drainage, which aim is to reduce urbanization impact on hydrological regime of the country and water ecosystem is based on the experience and knowledge of former method of sewage. The new concept of capture and use of water from surface runoff provides space for new technical and non-technical measures for the drainage of the property, as well as in the public part of urban drainage area. The common denominator is seeking high energy and material efficiency. There are some examples that were fully put into practice. Such a concept of urban drainage has been documented in case studies from Switzerland, Japan and Germany (Krejčí 2002). Although in recent years realization of several different types of infiltration facilities have occurred in Europe and overseas, there are some errors caused by underestimating of the

professional claims at their planning and operation. In areas where the impervious or poorly permeable rocks are, it is necessary to proceed very carefully at the infiltration of the subsurface water. At its fulfilment of requirements for rainwater capture on the land property should be exercised with due care in order not to damage the objects (Žabička 2005). A great worldwide attention is given to the harmony of capture and use of water from surface runoff with the principles of the sustainable development.

Water scarcity is an increasingly severe problem worldwide due to factors such excessive consumption of raw water, climate change, water pollution and unsustainable water resource consumption. Under these conditions, traditional or alternative forms of water resource such as rainwater are being considered as attractive options to reduce potable water consumption. Roof water harvested onsite from buildings is usually the cleanest alternative water source available, requiring little treatment before being suitable for a wide variety of uses (Apostolidis and Hutton 2006)

The potential benefits that accrue from rainwater harvesting are a decrease in demand for potable water from centralized water sources, reduction in runoff into to urban stormwater system and a reduced risk of overflow strom events (Zhang *et al*. 2009).

2. Drainage in Tokyo City

Experimental Sewer System (ESS) is the most systematically studied drainage system. The essence of this system is the most possible infiltration (permeable communications, infiltration pits, ditches, etc.) and retention of the rain runoff (retention in infiltration devices, route choice and link sewers and sewer retention). The rain runoff from the roofs and roads is firstly reduced in infiltration pits (2). These pits are interconnected through infiltration channels (3) and infiltration pipes (4). The rain runoff is fallen from infiltration pits (6), ended in a single sewer (1) for the lack of rate infiltration. The permeable surface communications (5) contribute to the reduction of rain runoff. Wastewater from the households (7) is as usually connected to the single sewer (Fig 1).

In 1980, this system was implemented in own plot of the urban drainage administration in Tokyo and since then it has been continuously distributed mainly in the north-eastern part of Tokyo, in river basins Shakujii and Shirako.

For the first six years, 450 ha with more than 56 000 inhabitants have been drained in this way, and in 1987 its future expansion was estimated at 100 ha per year. Gradually, 33 294 infiltration objects, 285 km of infiltration galleries and 49.4 ha of permeable surface roads and other communications were built (Krejčí 2002).

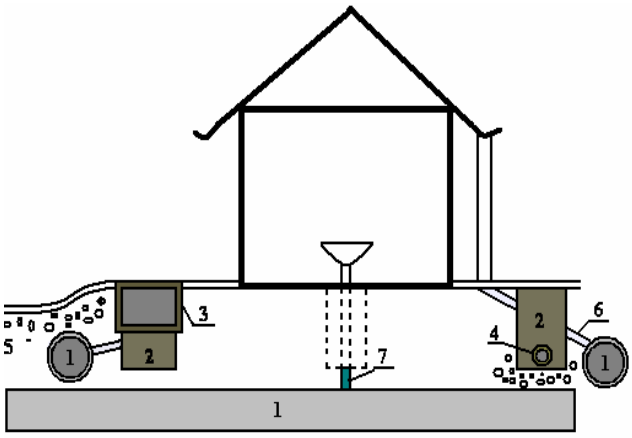

Fig 1. Experimental Sewer System (ESS) in Tokyo (Fujita, 1987)

3. Objectives of the planned drainage project in Košice City, Slovakia

At Civil Engineering Faculty, Technical University of Košice has been established Centre of collaboration TechAqua - in 2009. The Centre solve the project supported by the Slovak Research and Development Agency in program Support of collaboration between universities and private sector SUSPP-0007-09 with title - Increasing of the rainwater management efficiency for the purpose of energy demand minimization. The role of the Centre is to stimulate research collaboration by business environment and encourage investments from the private sector to research and education.
Main targets are the following.

3.1. Target - Monitoring of rainfall intensities and precipitations and derived realistic calculation of values for the conditions of the region

Solution methodology will be based on analysis and evaluation of the current state of discharges of sewage systems during rain in Slovakia and abroad, as well as specific knowledge of measuring the qualitative and quantitative indicators of rain water. When planning a rain water drainage system it is necessary to determine the volume of rainfall, depending on the duration of rainfall and its intensity. For practical use there is available statistical data of the rain intensity from period of about ten years. There are large discrepancies between the intensity of rainfall for the drainage design of buildings and intensity of rainfall values for the dimensions of the public sewer system. Precipitation is monitored at the area of Technical University of Košice (Fig 2) since 2010 by rain gauge.

Fig 2. Placement of the rain gauge on the roof of the building of Library of the Technical University in Košice

3.2. Target - Establish rules for the design of rain water infiltration. Create a national rule which would take over certain procedures for the experimental verification of in-situ from German AVT, or from other European national legislation

The issue of water from surface runoff is not explicitly addressed in the legislation at all. The European standards describe mainly wastewater from population industry, but not so specifically the water from surface runoff. Water in SR is protected under the Water Act No. 364/2004 Z.z. and wastewater law under the Water Supply and Sewerage No. 442/2002 Z.z.. Treatment with the surface water runoff is governed by different regulations. In case of rainfall infiltration is law interpretation ambiguous - regarding groundwater management - the artificial enrichment of underground water resources by surface water, for which is necessary an authorization of the competent bureau.

We increasingly need to address problem of overloading sewage systems with urban development in large cities and their surroundings. Operators are reluctant to do it and allow only the construction of sewage water connections so they need to address the management of rainwater separately, mainly by infiltration. Result of this is that it is proposed by various designers in completely different ways, indicating different amounts of water. An important prerequisite for infiltration is hydro-geological survey, which is often restricted to a minimum or only to the reading data from maps and hydrological data in Slovak republic. To tackle rainfall infiltration from surface runoff into the soil, there should be a new standard / technical advice, which would take care of setting the conditions of rain water infiltration. Infiltration of rain water is not addressed in any standard or regulation in Slovakia.

3.3. Target - Modelling and validation of the results obtained on selected objects in practice

At the beginning of the year 2011, devices for measuring fluctuations of groundwater (Levelogger) and for pressure measurement (Barologger) (Fig 3.) were placed in percolation shaft in the figure 4, which is located in area of Technical University in Košice. The measuring channel is also placed there with the aim of monitoring quantity and quality of rainwater. Unit M4016 with modem with UZV sensor is used for subtraction of values. The final results from this unit will measure the level [mm], flow rate [l/s], flow rate [m^3], temperature [°C] (Fig 5.). The values of precipitation measured by rain gauge which is located on the roof of the building of Library of the University in Košice will be used for the design of drainage of infiltration system in the area.

We will find out how the groundwater moves by means of measured values and we will be able to determine the status of groundwater based on processed results by the program HYDRUS (Pc-progress) where a geological profile is needed. HYDRUS-1D numerically solves moisture transport for a given soil. The study system will be simulated based on measured or estimated parameters. Input requirements for HYDRUS included rainfall and soil properties including field capacity, wilting point, density, and sand, silt, and clay fractions (Hilten *et al*. 2008).

The design of drainage and the establishment of national regulations are the results at which the specific procedures would be taken from the German AVT or other European regulations are the expected results.

Fig 3. Levelogger, Barologger

Fig 4. Percolation shaft in the area of the Technical University in Košice

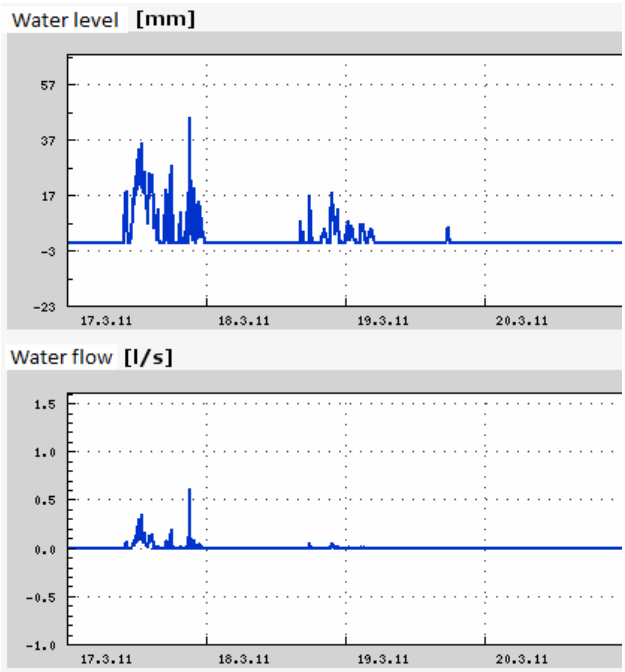

Fig 5. Output data with unit M4016

Addressing issues of design and assessment of infiltration systems and follow this rain water and pollution of urban river basin is the most important part of achieving the objectives of the project. The results of a study of several methods of surface runoff will be coordinated and used the possibilities to reduce runoff and pollution through unpolluted rain water infiltration directly to the basin. This part of the solution will include detailed description of infiltration systems, their advantages and disadvantages, criteria for the framework design, as well as guidance on the detailed design of concentric diffuse of infiltration systems. Project team will focus on forecasting and concept development of advanced methods of drainage and disposal of wastewater from urban catchments. The study will serve as a conceptual focus for the widening of Slovak standards in the field of sewage management. Implementation of selected proposals will enable in situ monitoring of the proposed theoretical solutions in real terms.

4. Conclusion

Best management practises that reflect the natural process of infiltration can be found in not urban basins. Infiltration practises belong to one of the best management practises that are able to effectively reduce the overloading sewage systems in case of rainwater drainage. If local conditions allow, part of urban runoff will be controlled by infiltration.

A new challenge for management of rainwater and groundwater requires a fundamental change in the way we think about it. Rainwater should be regarded as alternative, sustainable strategies and as rehabilitation of rural and urban settlements in aspect of environmental, economic and social criteria.

Percolation shaft is one of the possible alternatives that are able to reduce the risk of floods, regulate groundwater quantity and quality.

The Centre was supported by the Slovak Research and Development Agency under the contract No. SUSPP-0007-09.

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