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PARAMETERS OF INTEREST FOR THE DESIGN OF GREEN INFRASTRUCTURE

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Abstract: The urbanization process significantly reduced the permeability of land surfaces, which had affected the changes of runoff characteristics and the relations in the hydrological cycle. In urban environments, the relationships within the hydrological cycle have changed in quantity, in particular: precipitation, air temperature, evaporation, and infiltration. Applying the green infrastructure (GI) to urban environments is beneficial for the water resources and the social community. Green infrastructure has an effect on the improvement of ecological, economic, and social conditions. Using GI into urban areas increases the permeability of land surfaces, whereby decreasing surface runoff, and thus the frequency of urban floods. It also has a significant influence on the regulation of air quality, water purification, climate change impact, and the changes in the appearance of the urban environment. When planning and designing the GI, it is necessary to identify the type of GI and determine the size and location of the selected GI. Since each urban environment has its own characteristics, it is necessary to analyze them before deciding on the GI. The paper analyzed meteorological parameters (precipitation, air temperature, insolation, air humidity) affecting the selection of GI types, using the specific example of an urban environment – the City of Osijek, Croatia. Significant parameters when designing GI are operation and maintenance. These parameters directly affect the efficiency of GI. The proper selection of GI and its location results in maximum gains: the reduction of land surface drainage - drainage of the sewage system, purification and retention of precipitation at the place of production, the improvement of air quality, and the improvement of living conditions in urban environments.

Keywords: Submission; paper sample; JUEE; instruction

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INTRODUCTION

The sudden process of urbanization is a characteristic of modern times. It is expected that the urban population will increase by 84% by 2050, from 3.4 billion in 2009 to 6.3 billion in 2050 (Abebe & Magento, 2016). Also, cities are anticipated to accommodate up to 70% of the global population by 2050 (UN DESA, 2014; Sharifi & Lehmann, 2015). Urbanization has negative impacts on the natural environment by exerting pressure on and shrinking green spaces in many cities in Europe, North America, South America, Asia and Africa with the situation in Africa being critical (Mensah, 2014; Abebe & Magento, 2016). For the first time in history more than half of the world's population resides in cities.

Some implications of urbanization include loss of aquatic ecosystems and creation of heat islands due to discharge of heat from anthropogenic activities and reduction of water pervious surfaces and vegetation (Franco *et al*., 2015). The land development and increase in urbanization affect water quantity and water quality (Gulbaz & Kazezyilmaz-Alhan, 2015).

One major change that will accompany urban growth is increased demand for energy and water. Global water demand is expected to increase by 55% by 2050, and global energy demand will increase by about 33% by 2035. Urban development significantly changes the hydrological cycle (Runde, 2015) - shown in **Fig. 1.**

Therefore, although the hydrological cycle consists of the same elements, their proportions in urban area are significantly different:

- interception of rainfall is reduced due to removal of trees;
- precipitation is usually higher than in rural areas;
- evapotranspiration is much lower;
- surface runoff is much larger;
- ground-water runoff, infiltration and recharge is small;
- water storage is much lower;
- runoff volumes and peak flows in rivers are higher;
- frequency of surface runoff is increased.

Cities expansion usually reduce green space areas. Development of green areas in cities mitigates the negative impact on the hydrological cycle and improves the quality of the environment and quality of life in cities. Increased water retentiveness of catchments improves flood protection, quality of water, the environment and aquatic ecosystems. Open water spaces and green areas improve the microclimate by providing better environment for people, increasing population health, providing recreational spaces (UNESCO, 2017).

With the introduction of green infrastructure into urban environments, the conventional urban water cycle becomes a sustainable urban water cycle.

Runoff in urban areas is different from runoff in natural areas. In urban areas, with the creation of impermeable surfaces, depending on the degree of construction in an area, the surface runoff of water increases considerably several times. The smaller part infiltrates into the underground, the groundwater level decreases, the groundwater runoff decreases, and the amount of precipitation that evaporates into the atmosphere decreases due to the lack of greenery. The surface runoff of water volume grows from 1.5 to 2 times, and the peak runoff grows from 2 to 5 times. If the flow through the canal system is added to this, the increase in the output hydrograph is even higher (Margeta, 1998).

A mixed drainage system has been built in most urban areas in the Republic of Croatia - household, industrial, precipitation, and other wastewater is drained using the same, common drainage system which has been proven to be bad for drainage systems and the urban development. Because of the different composition of domestic and other water, and due to the dependence on hydrological and geomorphological conditions in the catchment, it is preferable to solve the drainage of rainwater by using a separation system and, where possible, separate the surface water from the sewerage system as much as possible. This can be achieved in different ways: retention (bioretention or rain gardens), reduction of runoff through the use of permeable surface pavements, construction of parks, recreational areas, green areas, green roofs, construction of artificial wetlands for the retention and purification of rainwater; i.e. by building green infrastructure.

Apart from the urbanization process, we are also faced with climate changes. Climate change is visible in everyday life. In order to reduce the impact of climate change and focus on sustainable development, which is addressed in all areas of life, we need to have as much green urban areas as possible, or build green infrastructure (Obradovic, 2017). Green urban surfaces retain precipitation at the place of production, which has the effect of reducing the consequences of drought; they reduce the amount of rainfall, thus preventing urban floods.

GREEN INFRASTRUCTURES

Green infrastructure generally refers to a variety of greening strategies from rain gardens, bio-retentions, and street side vegetation to urban forests, parks, wetlands (CLEAR, 2013; Kim & Park, 2016), swales,

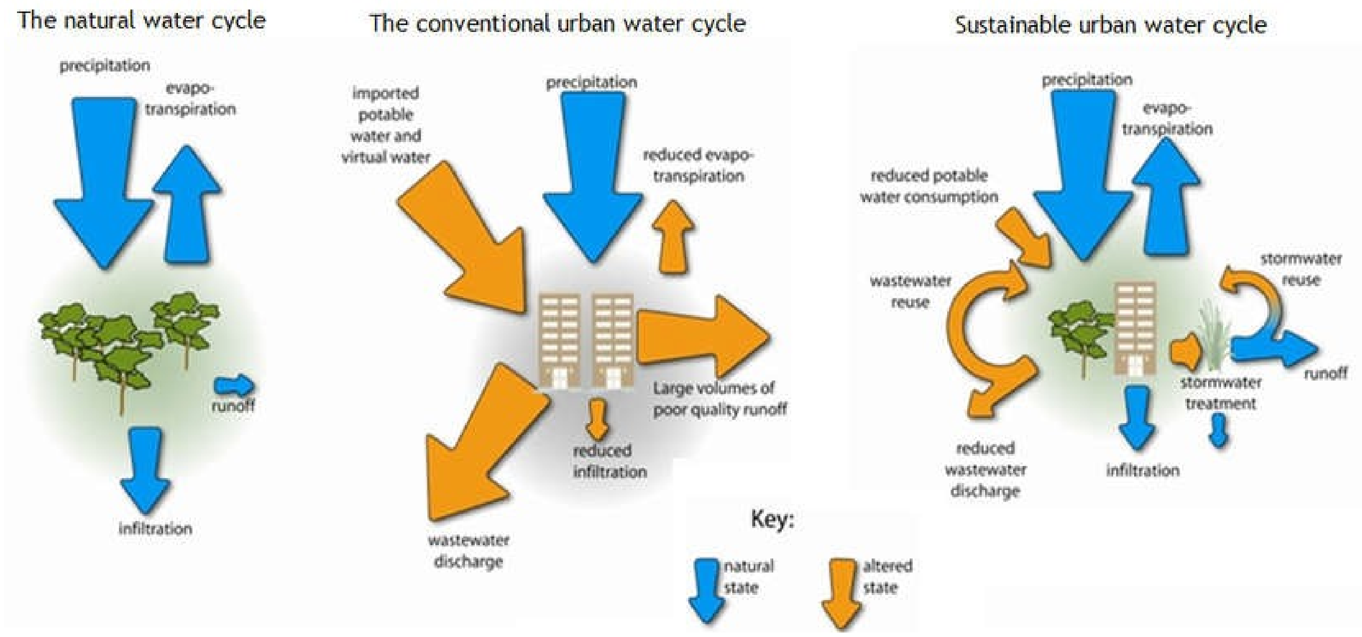

Fig. 1 Natural, conventional urban and sustainable urban water cycle. (Source: Senn & Spuhler, 2013).

bioinfiltration devices, green roofs, and permeable pavement (Zellner *et al*., 2016). Green infrastructure can facilitate stormwater management in several ways and at different scales. Runoff volume can be reduced through infiltration, evaporation, and evapotranspiration by plants (Hatt *et al.,* 2009).

The EU Commission adopted the Green Infrastructure (GI) Strategy in the form of Communication from the European Commission COM (2013) 249 final - Green Infrastructure (GI) - Enhancing Europe's Natural Capital on May 6, 2013 and proposed the implementation of systematic green infrastructure stimulation throughout the European Union. Green infrastructure represents a strategically planned network of natural and semi-natural areas, including other ecosystem features, designed and managed to provide a broad range of ecosystem services. According to the Nature Protection Act (Official Gazette of the Republic of Croatia, NN, 80/13), green infrastructure is a "multifunctional network of protected and other natural and man-made landscapes and landscapes of high ecological and environmental value that enhances ecosystem services." (Official Gazette of the Republic of Croatia, NN, 2013).

Green infrastructure represents a benefit for water resources and the community. Green infrastructure affects the improvement of ecological, economic, and social conditions. The introduction of GI to urban areas increases the permeability of land surfaces, whereby decreasing surface runoff, and thus the frequency of urban floods. It also has a significant influence on the regulation of air quality, water purification, climate change impact, and the changes in the appearance of the urban environment. Also, exposure to trees, vegetation, nature, or green space in urban areas has been connected with multiple public health benefits, including reduced mortality, morbidity, stress, and mental fatigue (Kondo *et al.*, 2015).

Green infrastructure is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits. While single- purpose gray stormwater infrastructure - conventional piped drainage and water treatment systems - is designed to move urban stormwater away from the built environment, green infrastructure reduces and treats stormwater at its source while delivering environmental, social, and economic benefits (US EPA, 2017; Sperac & Obradovic, 2017).

PROCEDURES WITH RAINWATER IN URBAN ENVIRONMENTS

Infiltration

The process of penetration of water trough the ground surface under gravity is called infiltration. Many factors influence the infiltration rate. It mainly depends on condition of soil surface, existing land cover, properties of soil beneath (UNESCO IHE DELFT, 2013). During rain infiltration loss occurs quickly almost exclusively from the water that has reached the ground surface. The water infiltrating into the soil moves downward through larger soil pores under the force of gravity. The smaller surface pores take in water by capillarity (Sen, 2017).

Infiltration components are used to capture surface water runoff and allow it to infiltrate (soak) and filter through to the subsoil layer, before returning it to the water table below. Due to its ability to purify water, the natural layer of soil functions as a long term and effective groundwater protection during the infiltration of rainfall through the vegetated layer of soil. Soil retains harmful substances from stormwater and removes them from the water through various chemical and biological processes. A revitalized layer of soil is an excellent stormwater filter. Buildings should have specific spacing on the boundary with adjacent lots. In addition, the rules regulating construction should require that a small section of land be set aside for a green area and some additional space, both in populated and in unpopulated areas. These green areas are used not only to beautify the space around the building; they can also be used as an ideal space for the infiltration of stormwater from the roofs (Kovačević & Agić, 2012).

The most rational way is to drain the water over solid soil, through surface channels, or through shallow wells, to a vegetated surface where infiltration is possible. In this way, vegetated surfaces can be useful in two ways - as elements of urban zone design, and for the infiltration of stormwater (Kovačević & Agić, 2012).

A rain garden (**Fig. 2**) is primarily used to manage runoff from roofs (and relatively unpolluted areas). Plants in a rain garden should be able to withstand periods of ponding and dry periods and, ideally, maintain or enhance the pore space in the underlying soils via deep rooting systems (Susdrain, 2012).

In industrial areas, all usable areas are usually paved or banked with some other material, thus preventing the possibility of infiltration of rainwater through the soil. The aggravating circumstance in this case is that it is also necessary to build a set of stormwater drains or stormwater treatment facilities. The simplest, most cost effective and most efficient way to drain stormwater is through green areas (Kovačević & Agić, 2012). Some of infiltration type devices are: infiltration trenches, grass filter strips, grass swales and pervious pavements. Infiltration trenches are provided to enhance the infiltration of storm water into the ground. Grass filter strips are stripes of grassed soil surfaces introduced between the urban impervious surfaces and the storm drains to slow down and partially infiltrate runoff. Grass swales are depressions in the grassed terrain designed to function as small unlined channels in which a stormwater runoff is slowed down and partially infiltrated along their course. Pervious pavements are permeable surfaces where the runoff can pass and infiltrate into the ground. Pervious pavements facilitate peak flow reduction, ground recharge and pollution filtering. There are three types of pervious pavements: porous asphalt pavements, porous concrete pavements, and garden blocks (UNESCO IHE DELFT, 2013).

Fig. 2 Rain garden. (Source: Hofmann, 2016).

Retention

Retention is the reservation of water in case of heavy rainfall and its gradual release to the ground or sewerage. In this way, large water waves and floods can be prevented and there is no need to dimension the drainage system with large cross section pipes. A retention pond (**Fig. 3**), sometimes called a “wet pond”, has a permanent pool of water with a capacity above the permanent pool designed to capture and slowly release the water quality capture volume over 12 hours (UDFCD, 2015). The design of capacity is based on the runoff generated from the basin due to a design storm (UNESCO IHE DELFT, 2013). The permanent pool is replaced, in part, with stormwater during each runoff event so stormwater runoff mixes with the permanent pool water (UDFCD, 2015). A retention basin can also provide water quality benefits by reducing sediments and attached pollutants (Stormwater, 2009). Retention ponds can be very effective in removing suspended solids, organic matter and metals through sedimentation, as well as removing soluble pollutants like dissolved metals and nutrients through biological processes (UDFCD, 2015). A retention basin can also provide water quality benefits by reducing sediments and attached pollutants (Stormwater, 2009). Additionally, sunlight and oxygen break down greases and oils (SWFWMD, 2003). Retention ponds are one of the most effective stormwater management installations for removing stormwater pollutants. Sedimentation of solids occurs in the open water and wetland bench. Nutrients are removed from the open water by photosynthesis and by bacteria attached to wetland plants. Since retention ponds have the capability of removing soluble pollutants, they are suitable for sites where nutrient loadings are expected to be high (DCC, 2017).

Fig. 3 Stormwater retention pond. (Source: Lapin Services, 2015).

Fig. 4 Stormwater detention pond. (Source: Metrolina Landscape, 2015).

Maintenance activities include repairing erosion, removing sediment, and managing the vegetation. Repairing erosion early can save significant costs, both in the erosion and the resulting sedimentation that can end up needing to be removed from the basin (Stormwater, 2009). Retention ponds provide two primary services. First, they retain the runoff before releasing it into streams. They release the water at flow rates and frequencies similar to those that existed under natural conditions. The flood volume held in a retaining pond reduces the impact on downstream stormwater systems. The second benefit of the retaining ponds is that they provide pollutant removal through settling and biological uptake. Ponds remove 30-80% of certain pollutants from water before it enters nearby streams. Common pollutants reduced are sediments, bacteria, greases, oils, metals, total suspended solids, phosphorous, nitrogen, and trash. Ponds are one of the most effective tools at providing channel protection and pollutant removal in urban streams. Essentially, retention ponds provide water quality and quantity control (Jordan, 2017).

Aquatic vegetation is often associated with wet ponds. Vegetation such as grasses and plants are able to establish themselves in the permanent pool of wet ponds thus providing extra pollutant removal. The aquatic plants and grasses serve as an extra filter in the pond. They assimilate dissolved pollutants and, by biological uptake, transform pollutants into less toxic materials. Microorganisms often establish themselves in wet ponds and aid in the breakdown of pollutants (Jordan, 2017). Some benefits are water quality control, water quantity control, amenity value, habitat creation value and biological treatment (DCC, 2017).

Detention

Detention ponds, also called dry detention ponds (**Fig. 4**), are basins that receive and hold runoff for release at a predetermined rate, thereby reducing the peak runoff delivered to storm sewers and streams. The ponds generally are earthen structures constructed either by impoundment of a natural depression or an excavation of existing soil. Captured runoff is released through multi-level outlet structures consisting of weirs, risers, orifices or pipes, which provide increased discharge as water levels in the basin increase. They help prevent localized flooding and, if designed to do so, provide some water quality benefits and reduce streambank erosion downstream (DCCCD, 2013).

Detention ponds serve as important flood control features. They are usually dry except during or after rain or snow have melted. Their purpose is to slow down water flow and hold it for a short period of time such as 24 hours. Urban areas rely on these structures to reduce peak runoff rates associated with storms, decreasing flood damage (LCCD, 2011). Detention ponds have been one of the most widely used stormwater management practices.

However, they should not be used as a one size fits all solution. If pollutant removal efficiency is an important consideration, detention ponds may not be the most appropriate choice. Detention ponds require a large amount of space to build (MDEQ, 2011).

Detention ponds can be designed for a variety of storm events and purposes. The land area available for construction, slope of the site and contributing area are all factors to be considered. Also, an emergency spillway is usually required to allow for safety during flood events. Although detention ponds can vary in size and shape, they all function to settle stormwater particles and reduce peak flows. All of the ponds are designed to be separate from local groundwater supplies to prevent movement of dissolved pollutants from surface water to groundwater sources (LCCD, 2011).

Dry ponds, detention ponds, do not have dead storage and dry out between storms (Jordan, 2017). Properly maintained detention ponds can be very

effective at removing certain pollutants and providing necessary storage volumes during larger storm events.

Improperly maintained ponds can increase the discharge of pollutants downstream, increase the risk of flooding downstream, increase the instability of downstream channels, and lead to aesthetic and nuisance problems (SEMSWA, 2017). Some benefits of detention ponds are: reduction of peak rate of runoff, alleviation of flooding, cost effective, can be designed to address water quality, the space surrounding the pond can be landscaped to enhance and provide habitat for wildlife (DCCCD, 2013).

Detention ponds are best used in areas where there is four or more hectares of land. On smaller sites, it is difficult to control water quality and other options may be more appropriate. Detention ponds generally use a very small slope to divert water. The system works by allowing a large collection area, or basin, for the water.

The water then slowly drains out through the outlet at the bottom of the structure. Sometimes concrete blocks and other structures act as a deterrent to slow the water flow and collect extra debris (Leber, 2015).

STUDY AREA

Osijek is the fourth largest city in Croatia with a population of 108 048 according to the 2011 Census. It is the largest city and the economic and cultural centre of the eastern Croatian region of Slavonia, as well as the administrative centre of the Osijek-Baranja County. Osijek is located on the right bank of the river Drava, 25 kilometres upstream of its confluence with the Danube, at an elevation of 94 metres (REC, 2018).

The City of Osijek is located in the eastern part of the Republic of Croatia. It has a very good geographical position in relation to the major European transport corridors. The city has developed in a location where the crossing over the Drava River would be the most suitable for connecting Central and South-Eastern Europe. The transport importance of the city is primarily due to the Podravina and Podunavlje transport corridors, which is also closely linked to the Posavina transport corridor. These corridors include the road, rail, and river transport routes. The City of Osijek covers an area of 17 371 ha (173.71 km²).

According to the territorial bases for water management - organization of water management, Osijek, with its related suburbs, belongs to the water area of the Drava and Danube catchment. The City of Osijek is located on the right and the left bank of the Drava River, with its centre 21 km upstream from the place where the Drava River enters into the Danube (Official Gazette of the City of Osijek, 2012). Osijek is the city with the most greenery and green areas in Croatia, considering there are 19 parks in the city, with a total surface area of 286 000 m² (**Table 1**).

Table 1. Public green areas (Source: Croatian Bureau of Statistics, 2009, edited).

Purpose	Number	Surface area (km²)
Parks	19	0,28
Lawns	-	2,59
Zoological gardens	1	0,10
Tree-lined streets	47	0,08
Public children's playgrounds	65	0,03

Table 2. Streets, roadway surface area, squares (circuses) and public parking places (Source: Croatian Bureau of Statistics, 2009, edited).

Purpose	Number	Surface area (km²)
Street	455	8,52
Roadway	-	2,49
Squares (circuses)	15	0,01
Public parking places	4	0,16

The river Drava is the only watercourse passing through the City of Osijek and it is among the most significant watercourses in Croatia (Official Gazette of the City of Osijek, 2012). In **Table 2** are presented the number of streets, roadway surface area, squares (circuses) and public parking places with their's belonging areas.

PARAMETERS ANALYSIS

Relief and climate parameters

The City of Osijek is a part of a wider area, which, according to its relief, belongs to the northeast, predominantly lowland, flat part of the geographical unit of Eastern Croatia, i.e. the Republic of Croatia. The watercourse of the Drava was a crucial part of the modelling and appearance of today's relief. In the area of a typical accumulation plain, the type of relief characteristic for this area, in this seemingly uniform and geologically young relief, different geomorphological forms in the lowland relief can be distinguished: flood (alluvial) plains and river terraces.

The climatic features of the City of Osijek are a part of the wider climate of Eastern Croatia, where the moderate continental climate is predominant. The main characteristics of this type of climate are the average monthly temperature of more than 10°C for more than four months a year, the mean temperature of the hottest month below 22°C, and the mean temperature of the coldest month between -3°C and +18°C. A characteristic of this climate is the absence of extremely dry months; precipitation is more frequent in the warm part of the year, and the average annual precipitation volumes range from 700 to 800 mm.

Winds that are the most common are light winds and wind calm, while wind directions are very variable. The average air temperature according to the measurements is

10.7°C. Mean monthly temperatures increase up to July, when they reach their maximum, with mean monthly temperatures at observed stations from 19.5°C to 21.9°C. The coldest month is January, with a mean temperature of -1.4°C (Official Gazette of the City of Osijek, 2012). In **Fig. 5**, the deviations in the average daily air temperatures for the year 2016 compared to the mean daily air temperature for the period 1961-1990 show the fluctuation of the climate change expressed by the rise in the air temperature. **Figure 6** shows the increase in sunshine in 2016 compared to the period from 1961 to 1990. The distribution of precipitation in the vegetation period (390.4 mm - Osijek) is of great importance for the City of Osijek. In this area, it is possible to expect an average of 1800-1900 hours of sunshine annually, and 1290-1350 hours in the vegetation period. The impact of climate change through increasing rainfall is shown in **Fig. 7**.

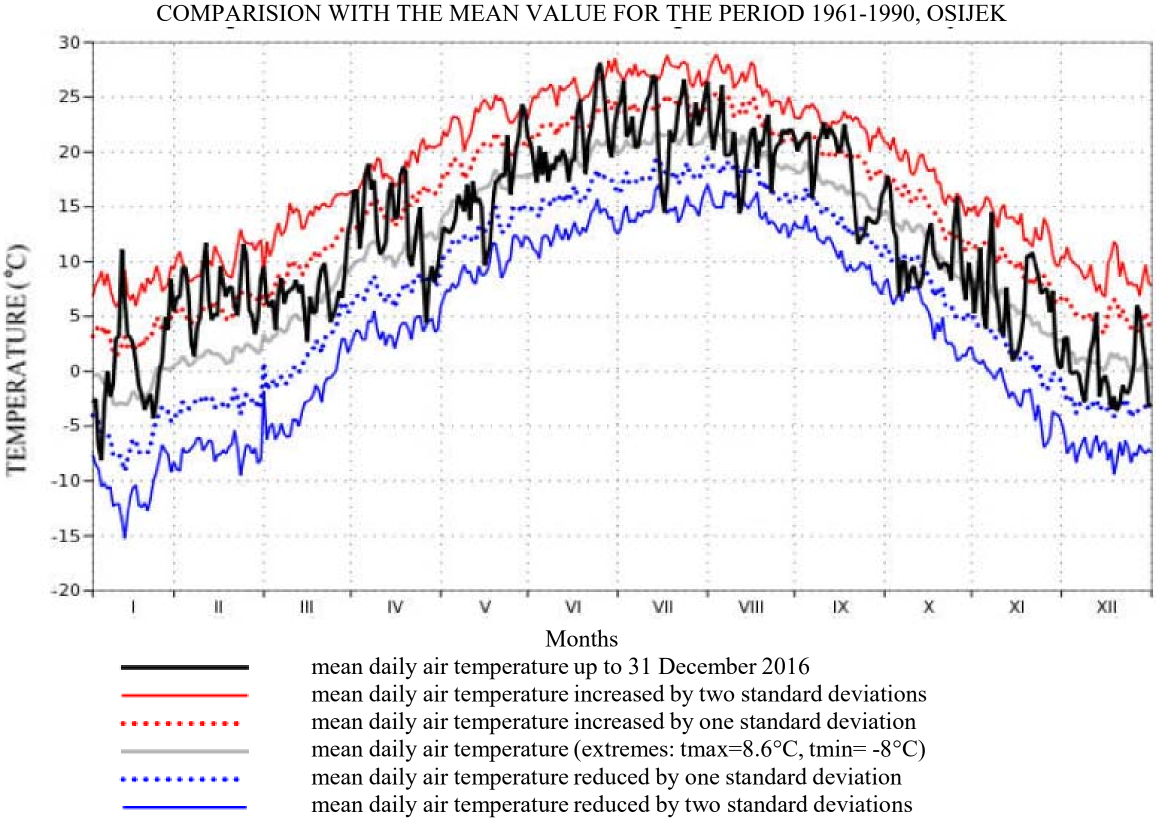

Fig. 5 Analysis of average air temperature. (Source: Croatian Meteorological and Hydrological Service, edited).

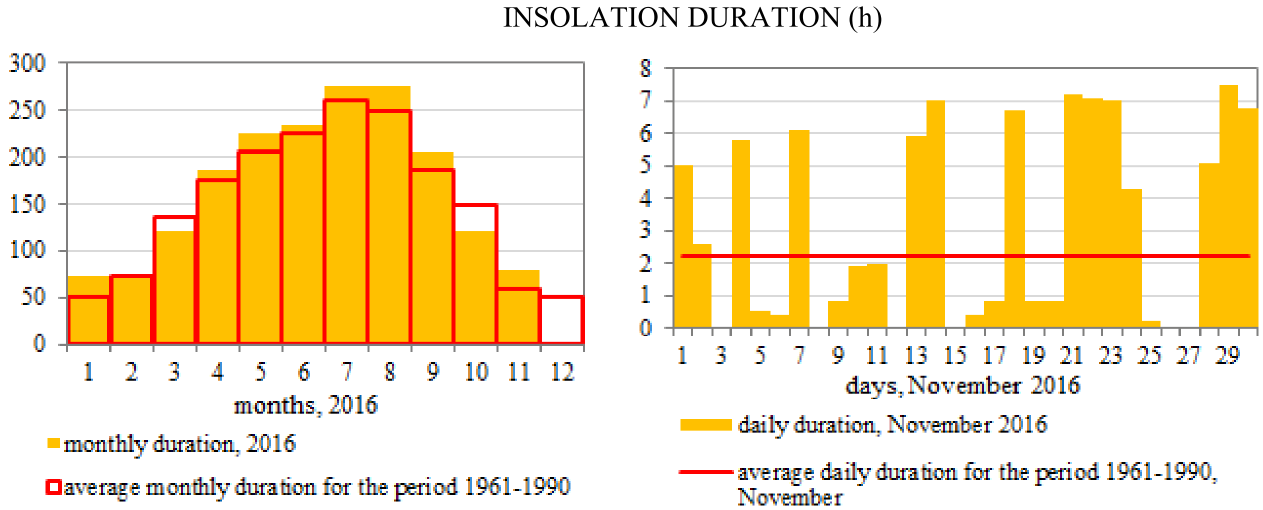

Fig. 6 Decreases of insolation for 2016 in relation to the period 1961-1990. (Source: Croatian Meteorological and Hydrological Service, edited).

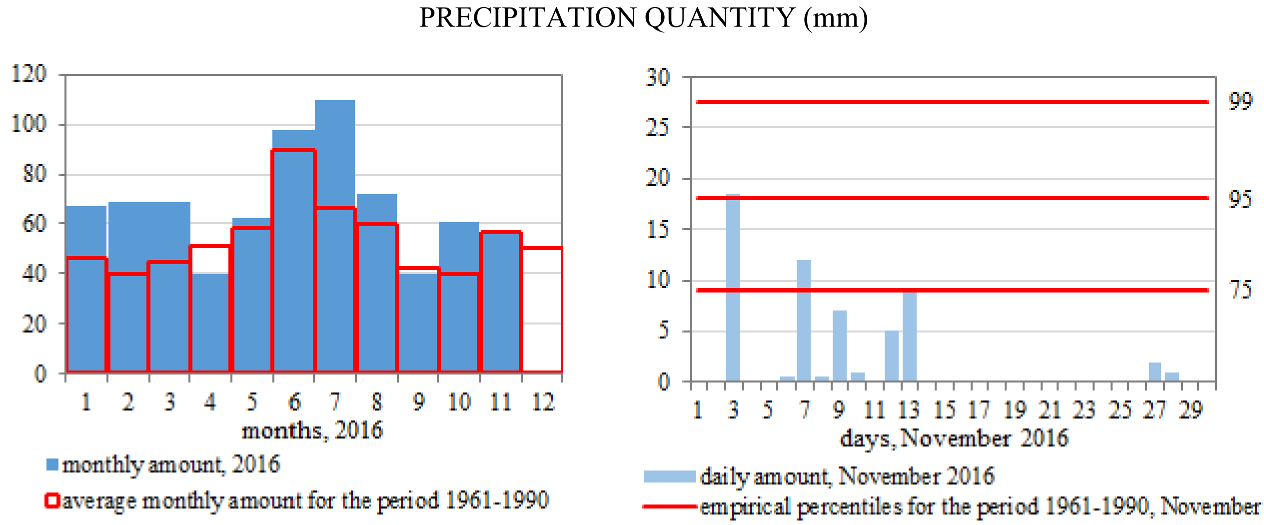

Fig. 7 Decreases of average precipitation for 2016 in relation to the period 1961-1990. (Source: Croatian Meteorological and Hydrological Service, edited)

According to the annual wind rose (Osijek station), the most common winds are from the northwest, west, and even north and southeast winds. In the winter, the most common wind is from the southeast, and in the summer from the north-western direction. Wind calm is associated with summer and autumn. The number of days with fog amounts to an average of 30 to 50 a year. The highest number of fogs in the lowlands is of radiation origin, i.e., ground-based fogs that are generated by the radiation of the soil during clear nights. The appearance of frost occurs during 30-50 days a year on average. Most days with frost are during the winter, especially in December (8 days) (Official Gazette of the City of Osijek, 2012).

Condition of wastewater drainage

In the City of Osijek there is a water supply and sewage company "Vodovod-Osijek d.o.o." There is a built-in sewerage network of mixed type in the length of about 250 km, with 15 347 home connections, which collect municipal wastewater along with industrial water and rainwater. Channels and collectors are made with a minimal drop, so currently there are 26 pumping stations in the wider area of Osijek. In the present situation, wastewater is discharged without treatment into the Drava River, partly through the discharge near Nemetin, and partly through the existing rainfall overflows (8), some of which are active even in the dry season. The old North collector, built in 1912, has a length of 6 633 m and is still in operation. In addition, a connecting North collector which is 3 218 m long and has a diameter of 280 cm, an industrial collector with the length of 930 m and diameter 150 cm, as well as approximately 10 700 m of the planned 10 812 m of the Southern collector have been built and are in operation. The dimensions of the South collector range from diameter 420 cm, 320 cm, 280 cm, and diameter d=200 cm for the connection to the existing collector (Official Gazette of the City of Osijek, 2012).

OPERATION AND MAINTENANCE

Operation and maintenance represent a key element of efficiency, and therefore justifiability of green infrastructure utilization. Already in the design phase of green infrastructures, the ways of operations and maintenance of certain species should be considered.

Some of the important maintenance elements that need to be considered before the implementation of the project include: maintenance type to be applied, maintenance frequency and available maintenance personnel, cost of replacing components, e.g. plants, shrubs, porous surfaces, sufficient resources to cover maintenance activities, including costs replacement components. The basic elements required for strategic planning of operation and maintenance are: maintenance activities - focuses on the proper maintenance of a particular type with the required maintenance frequency as well as the necessary equipment; training - ensures that all potential entities responsible for green infrastructure from individuals to landscape designers have the expertise required to carry out maintenance activities; checking - field control of green infrastructure functionality and maintenance needs; monitoring - effective maintenance of green infrastructure requires comprehensive knowledge of the type, location and needs of green infrastructure maintenance. Already in the design and planning phase, consideration should be given to choosing the type of green infrastructure, the way and the possibilities for their maintenance.

Maintenance is largely affected by the climatic conditions of an area, the arrangement of existing infrastructure, urban plans and population awareness of the need and benefits of green infrastructure. The need to maintain different types of green infrastructure varies greatly depending on the type and design.

APPLICATION OF GREEN INFRASTRUCTURE IN THE REPUBLIC OF CROATIA

In Croatia, precipitation waters are collected and drained by a conventional sewage system, which includes collecting pipes connected to the wastewater treatment plant or direct discharge into the recipient. Due to such solutions, urban floods are common occurrences in Croatia, resulting from a high rainfall intensity and the inability of the sewage system to absorb large amounts of precipitation in a short time.

These phenomena are more apparent in urban environments, especially in the cities on the Adriatic coast (Sperac & Obradovic, 2017). One of the solutions to this problem is the integrated approach of drainage, i.e. the application of green infrastructure. Such a way of controlling precipitation waters almost does not use pipes or canals for rainwater. Precipitation water is naturally treated, part infiltrates underground, and part evapotranspirates.

In the Republic of Croatia, through the Croatian Council for Green Building, there are initiatives aimed at the popularization of green infrastructures and on education related to the possibilities of their application.

Wider involvement is needed, based on the inclusion of the overall professional and scientific public (Cosic-Flajsig, 2015). Croatia has been a member of the European Union since 2013, and the European Commission (2013) recommendation for the implementation of green infrastructure has triggered interest in city institutions and spatial planning (Uzelac, 2012).

CONCLUSION

Green infrastructures represent an innovative approach to the management of surface and precipitation waters that relies on the ecological principle that needs to be planned and designed for drainage according to natural runoff: to manage source precipitation using evenly distributed decentralized micro-drainage systems, using design techniques that predict retention, infiltration in the underground, evaporation, and filtration and plant purification.

Creating meteorological backgrounds for the selection and design of certain types of green infrastructures is a comprehensive work and can be realized only in the close cooperation of meteorological experts and designers - users. Ensuring that green infrastructure projects are planned and designed with maintenance in mind can help maximize environmental benefits and reduce the cost of the project over its lifespan (US EPA, 2013). The management of rainwater in Croatia is far from sustainable and the use of GI is at it's beginning.

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