University of Belgrade, Technical Faculty in Bor

29th International Conference Ecological Truth & Environmental Research

EcoTER'22

Proceedings

Editor
Prof. Dr Snežana Šerbula

21-24 June 2022, Hotel Sunce, Sokobanja, Serbia

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PREFACE

In today's world, the environment has been endangered by the use of outdated technology, fossil fuels and environmental law violations. Therefore, environmental and many other scientists all over the world have been concerned about finding sustainable technology in resolving these issues. That is why environmental research and ecological truth are at the focus of the 29th International Conference Ecological Truth & Environmental Research 2022 (EcoTER'22), which will be held in Sokobanja, Serbia, 21–24 June 2022. On behalf of the Organizing Committee, it is a great honor and pleasure to wish all the participants a warm welcome to the Conference.

We hope to convey the message of the conference, which is that a transformation of attitudes and behavior would bring the necessary changes. This is also an opportunity for the participants who are experts in this field to exchange their experiences, expertise and ideas, and also to consider the possibilities for their collaborative research.

The 29th International Conference Ecological Truth & Environmental Research 2022 is organized by the University of Belgrade, Technical Faculty in Bor, and co-organized by the University of Banja Luka, Faculty of Technology, the University of Montenegro, Faculty of Metallurgy and Technology – Podgorica, the University of Zagreb, Faculty of Metallurgy – Sisak, the University of Pristina, Faculty of Technical Sciences – Kosovska Mitrovica and the Association of Young Researchers, Bor.

These proceedings include 85 papers from the authors coming from the universities, research institutes and industries in 6 countries: Bulgaria, Italia, Albania, Bosnia and Herzegovina, Montenegro and Serbia.

As a part of this year's conference, the 4th Student section – EcoTERS'22 is being held. We appreciate the contribution of the students and their mentors who have also participated in the Conference.

Financial assistance provided by the Ministry of Education, Science and Technological Development of the Republic of Serbia is gratefully acknowledged by the Organizing Committee of the EcoTER'22 conference.

The support of the Platinum donor and their willingness and ability to cooperate have been of great importance for the success of EcoTER'22. The Organizing Committee would like to extend their appreciation and gratitude to the Platinum donor of the Conference for their donation and support.

We appreciate the effort of all the authors who have contributed to these Proceedings. We would also like to express our gratitude to the members of the scientific and organizing committees, reviewers, speakers, chairpersons and all the Conference participants for their support to EcoTER'22. Sincere thanks go to all the people who have contributed to the successful organization of EcoTER'22.

Prof. Snežana Šerbula,

President of the Organizing Committee

TABLE OF CONTENTS

Plenary Lectures

Conference Papers

29th International Conference Ecological Truth & Environmental Research
21 - 24 June 2022, Hotel Sunce, Sokobanja, Serbia
www.eco.tfbor.bg.ac.rs

APPLICATION OF GREEN AREAS AND GREEN ROOFS IN URBAN AREAS

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Abstract

Modern city development a large number of cars and industrial plants have led to a dramatic decline in air quality, which in some cities around the world reaches alarming parameters, which are very harmful to public health. In larger cities, during most of the year, air quality is in a moderately harmful and harmful range. Modern urban development, which introduces various new materials and sources of pollution into the urban fabric, should require an increase in the percentage of green areas, in order to maintain air quality at a level estimated to be healthy for human life. Strategic afforestation of parts of cities could have the effect of reducing the amount of harmful particles in the air, planting tall plants would in some way lead to the filtration of city air. The construction of green, vegetation, roofs would mitigate the effect of the heat island, reduce the energy needed to cool buildings, effectively manage atmospheric water, improve air quality, increase biodiversity, reduce noise, etc.

Keywords: energy efficiency, air pollution, green roofs, ecology, green areas

INTRODUCTION

With the increase of the human population, the population density in urban areas also increases. This leads to the conversion of natural, undeveloped areas into construction land, which further causes the degradation of the quality of the environment, especially in urban centers, which is reflected in changing microclimatic conditions, air pollution, noise, etc. [1]. Typical pollutants are present in every environment and in the vicinity of thermal power plants. These include: sulfur dioxide, soot, nitrogen oxides, carbon monoxide and precipitates. Today, there is an increasing tendency to reduce these particles in the air. By building green roofs and increasing vegetation in cities, the negative impact of these particles could be mitigated and thus the quality of the environment improved.

Green roofs date back to 500 BC, when they are mentioned in the hanging gardens of Babylon and ziggurats in Mesopotamia [2,3]. The term green (vegetation) roof is used to describe a roof system whose structure is covered with vegetation located on the top floor of a building or at any elevation of the building and representing its final roof surface. In scientific research, the terms are also used: roof gardens, roof gardens, living roofs and eco roots.

GREEN ROOFS

The issue of green roofs in urban areas has become increasingly important in recent years. The basic question that their application raises is the chance to adapt urban environments to the newly emerging climate change. The application of green roofs brings multiple positive effects on a better quality of life in urban areas:

- Reduces the total energy consumption for heating and cooling facilities
- Contributes to increasing the area under vegetation in urban areas
- Reduces the effect of urban heat islands in summer
- Affects the quality and quantity of atmospheric water
- The impact of their application on air, soil and water pollution is significant
- The impact on reducing elevated noise levels in urban areas is not negligible
- Contributes to the environmental and aesthetic values of urban areas
- The use of green roofs increases vegetation in urban areas

In the long run, green roofs are economically viable and sustainable. Under the green roof, the internal temperature, without additional cooling, is 3–5 degrees Celsius lower than the external temperature. Installing a green roof on the observed building saves 1–15% of annual energy consumption. Planned erection of green roofs can reduce the increase in building temperature by up to 20 degrees Celsius and save up to 80% of the energy required for cooling or heating. By applying a green roof, its lifespan is extended almost three times, roofing materials are protected from mechanical damage, ultraviolet radiation, extreme temperatures, which results in reduced maintenance and repair costs.

Figure 1 *Green roofs in urban areas*

CLASSIFICATION OF GREEN ROOFS

The most commonly used green roof construction consists of a concrete construction, a layer of thermal insulation, a drainage layer, a final layer of soil, ie a medium for growth and planted greenery. The classification of green roofs can be done according to several criteria. The most general division is according to the method of landscaping and maintenance, into:

- intensive landscaping
- extensive landscaping

Intensive landscaping can also be defined as a "roof garden" and includes, in addition to planting trees, shrubs and grasslands, and the construction of water areas and the like. This approach requires constant maintenance in terms of irrigation, plant care, construction maintenance interventions, etc. The costs of such roofs are higher and more suitable for public and commercial buildings.

Extensive landscaping is reduced mainly to grassy areas and low vegetation, which does not require special care and tolerates dry conditions. This type of greening of roofs is more suitable for residential buildings, because maintenance costs are lower.

GREEN ROOFS AND REDUCING THE EFFECT OF URBAN HEAT ISLAND

Another common problem of densely built cities are heat islands, i.e. areas in the city that heat up and reach a higher temperature than their surroundings. The temperature in urban areas rises with the increase of absorbing surfaces that retain the heat they receive during the day and emit it into the environment during the night, which creates hot urban islands. The difference in temperature between the city center and the peripheral parts of the city in the summer months can be up to 10°C, which significantly affects the health and quality of life of residents. Greenery can absorb up to 80% of excess heat energy through soil moisture and vegetation. Green roofs can reduce heat, minimize the heat-absorbing surface, and thus reduce the effects of heat islands. The positive effect is proportional to the size of the surface that the plants occupy.

A study of the impact of the green roof on the thermal islands of Toronto indicates a decrease in temperature maximums during the day from 0.4 to 0.8°C and during the night from 1.1 to 2°C. In that way, they make the steamy summer nights, when the heated asphalt and concrete radiate heat, become a little more pleasant. Green roofs have been proposed as an energy saving solution in many countries with different climatic conditions, but their cooling and heating potential strongly depends on the climate, plant choices and building characteristics [5].

Measurements on the territory of the city of Nis showed that during the summer days, the temperature on the surface of the classic flat roof varied from 35 to 60°C. While for the same period the temperature on the surface of the green roof did not exceed 25°C. This significant difference is further reflected in the air temperature in the rooms under the roof. By reducing heat gains, we also reduce the need to cool the room [5].

Takebayashi and Moriyama [4] examined the characteristics of a green roof compared to conventional flat roofs with different finishes. Experimental research was conducted on the flat roof of the Kobe University building in Japan, which is divided into several sections for this purpose. Table 1 shows the values of solar reflection for each type of roof tested, from which it can be concluded that the lowest value for the green roof. For a complete analysis and final results, it is necessary to take into account all the factors from the external environment, which, according to the authors, have been met and the importance of green roofs from this aspect of construction has been confirmed.

Table 1 *Values of solar reflection for each type of roof tested [4]*

Observed area	Bare soil (substrate)	Vegetation	Concrete	Highly reflective gray paint	Highly reflective white paint
Solar reflection	0.17	0.15	0.37	0.36	0.74

GREEN ROOFS AND MITIGATION OF THE CONSEQUENCES OF EXTREME RAINFALL IN CITIES

Green roofs also help solve the problems that arise during events with an extreme amount of precipitation, which is increasing due to climate change. They are able to absorb a certain amount of water, as well as delay the moment when the largest amount of water reaches the street sewer system. This prevents flooding of the streets and blocking of traffic, both car and pedestrian.

Reduction of runoff during heavy rains is very important for countries like England, where studies are being done on the example of London on how to distribute green roofs around the city and achieve the best effect. Green roofs regulate the largest amount of water in the summer, when the plants are active and when the warm weather promotes evaporation. Green roofs not only retain water, but also act as natural filters for the water found on them, they reduce pollutants, which are transmitted to local drainage systems and eventually flow into surface waters [5].

INFLUENCE OF GREEN ROOF ON REDUCTION OF POLLUTANTS IN AIR

The vegetative layer of the green roof affects the air pollution in the largest percentage by absorbing gaseous pollutants. Inside the plant, these gases react with water to form acids and other chemical compounds. The vegetative layer also stops the spread of solid pollutants, ie PM particles with their contact surface. PM10 carries carcinogenic particles small enough to pass defense in lung tissue and reach deep into human lungs. Some of these particles can be absorbed by the plant while the rest can be easily adhered to the surface of the plant and thus prevent further spread.

A study in Beijing showed that green roofs of 1000 m^2 can capture 160–220 kg of dust per year, reducing the concentration of dust in the atmosphere by about 25 percent. An indirect effect on reducing pollution is achieved with the help of vegetation by modifying the microclimate. By lowering the ambient temperature, the use of vegetation slows down photochemical reactions and thus reduces secondary air pollution such as ozone [5].

LARGE INITIAL INVESTMENTS AND LACK OF INSTITUTIONAL SUPPORT ARE THE REASON FOR THE LACK OF GREEN ROOFS IN SERBIA

While in the rest of Europe, "Green Building" is developing at a dizzying speed, while finding mechanisms by which ecological design will be incorporated into everyday life through do-it-yourself design, in Serbia the situation is a little different. The reason for the small number of green vegetative roofs in our country is the large initial investments, primarily due to the import of materials, as well as the lack of relevant laws and strategies. The benefits are much higher at the level of society than the individual, which is not primarily for investors. All this has the consequence that we still see green roofs in Serbia much more on conceptual projects than in construction.

CONCLUSION

Disruption of the natural environment and degradation of the quality of the environment in urban centers can be reduced by building green roofs. By increasing the area under greenery, numerous advantages are realized, some of which are exposed in the paper, and they concern the ecological aspects of construction. Users of buildings with a green roof benefit from lower outdoor and indoor temperatures in the summer, better flow and cleaner air. This means better thermal comfort and energy savings. Also, less noise and the natural environment have a positive effect on mental health. Green oases in a concrete environment calm and reduce stress levels. By increasing the area under green roofs, positive effects can be achieved at the city level. Vegetative roofs respond to the problems of existing air pollution, reduce the concentration of pollutants in the air and prevent the spread of particles, allowing our cities to breathe better. They are fighting against floods in cities and against urban islands. If we make a comparison between an area completely covered with concrete or stone in the same environment as an identical area covered with vegetation, it can be concluded that there will be a large difference in temperature. When concrete and stone slabs heat up, they emit heat back, while the green surface "absorbs" it and does not return it to the environment. "Dressing" an object in greenery means at least partially compensating for negative influences, returning part of the space to nature, but also giving the built environment an aesthetic and microclimatically more acceptable form.

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