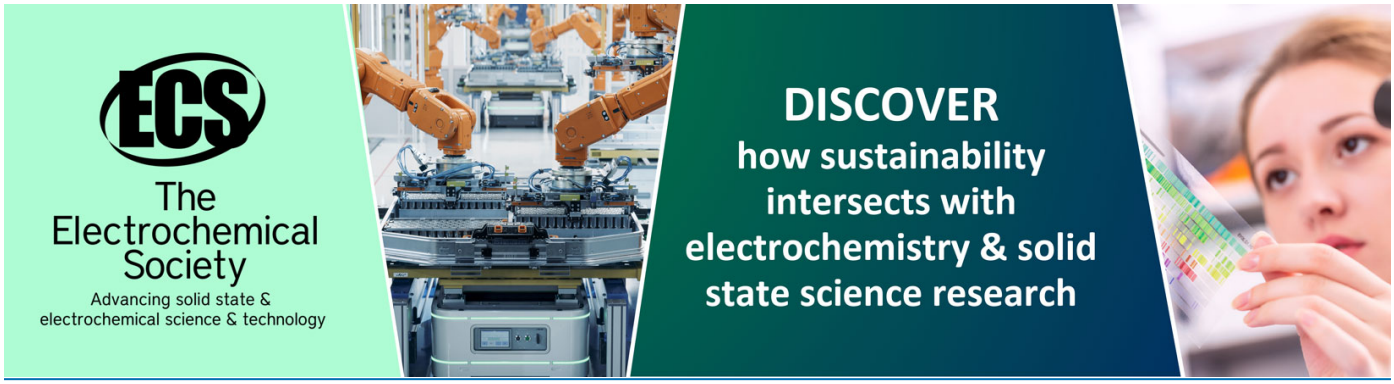
Environmental Engineering in the Slovak Republic



Environmental Engineering in the Slovak Republic

N Stevulova[1], M Balintova[1], M Zelenakova[1], A Estokova[1] and S Vilcekova[1]

[1]Technical University of Kosice, Faculty of Civil Engineering, Institute of Environmental Engineering, Kosice, Slovakia

E-mail: nadezda.stevulova@tuke.sk

Abstract. The fundamental role of environmental engineering is to protect human population and environment from impacts of human activities and to ensure environmental quality. It relates to achieving the environmental sustainability goals through advanced technologies for pollutants removing from air, water and soil in order to minimize risk in ecosystem and ensuring favourable conditions for life of humans and organisms. Nowadays, a critical analysis of the environment quality and innovative approaches to problem solving in order to achieve sustainability in environmental engineering, are necessary. This article presents an overview of the quality of the environment and progress in environmental engineering in Slovakia and gives information regarding the environmental engineering education at Faculty of Civil Engineering at Technical University in Kosice.

1. Introduction

The fundamental role of environmental engineering is to protect human population and environment from impacts of human activities and to ensure environmental quality. It relates to achieving the environmental sustainability goals through advanced technologies for pollutants removing from air, water and soil in order to minimize risk in ecosystems and ensuring favourable conditions for life of humans and organisms [1,2,3,4]. Sustainability in environment focuses on practical experience of a wide range of research areas within the general field of environment which covers mainly the following areas: waste water management, air and soil pollution control, waste disposal and recycling strategies, radiation protection, industrial hygiene, environmental technologies, processes linking environments, urban planning and development, environmental economics, policy and legislation [5,6,7,8]. It also includes management of environmental risk and safety, mainly assessment of environmental risks from climate changes and anthropogenic activities in the catchments of water bodies. Studying the impact of construction systems in buildings in terms of harmful substances emissions release into indoor environment is very important. Environmental engineering realizes a wide variety of ecological activities for creating appropriate living and technological conditions to maintain the right parameters with regard to the human environment; provides environmental technologies for cleaner production allowing to reduce emissions and waste production, the usage of non renewable resources, recycling the waste, mitigates the effects of natural disasters (floods, droughts, pollution in water, air and soil) [7,8,9].

Nowadays, a critical analysis of the environment quality and innovative approaches to problem solving in order to achieve sustainability in environmental engineering, are necessary. The aim of this paper is to give the information of the quality of the environment in a clear and concise form, to show progress of the Slovak Republic (SR) in the transition to a low-carbon and green economy. Ensuring improved environmental sustainability is linked to the education of environmental experts having a

broad knowledge base and skills to solving the actual environmental problems. Further part of this article brings information of environmental engineering education at Faculty of Civil Engineering of Technical University of Kosice.

2. The environment quality of the Slovak Republic

A cross-cutting source of information on the status of the environment in the SR presents the environmental regionalization of Slovakia (ERS). Over 20 year's period, environmental protection and risk factors: air, water, rock environment, soil, biota and landscape, wastes, as well as criteria for their mutual evaluation have been gradually profiled. The Slovakia territory is in terms of the environmental regionalization divided into three categories. About 51% of its territory is included into the 1st category – the highest environmental quality where classified regions with undistorted environment were. A decrease of 18 % of the regions with heavily distorted environment was recorded in 2015 in comparison with 1992.

The decline in the size of agricultural land and increase in the size of forest and urban areas have been long-recorded. Agricultural land is of high quality from point of view of its contamination; more than 99% is hygienically suited. Soils monitoring has been showed that the most apparent is the physical degradation of soils – especially by erosion and compaction. Regarding the chemical degradation of soils there has been observed the decrease of accessible nutrients - particularly phosphorus and potassium. The area of acidic soils has been decreasing together with the decrease of acidic air pollutants. Average organic carbon content in arable land is significantly lower than on permanent grassland. The soils contaminated in the past are contaminated also at present. The evaluation of agricultural lands according to quality level in 2014 confirmed that 35% share is of the highest quality (1-5 levels). Improving the air quality and reducing atmospheric deposition have led to improved forest health, but it is still assessed as negative.

The water resources are distributed unequally, not only regarding the quantity but also quality.

A very good and good environmental status of surface water bodies was recorded at 56.2% with a length of 8,073.43 km. The average environmental status was 34.8% of water bodies, which represents 7,565.46 km. The bad and very bad state was set in 9% of water bodies with a length of 2,159.41 km. The assessment of chemical status of surface water bodies in the period 2009 - 2012 was carried out in 1,510 water bodies. Good chemical status reached 1,473 (97.6%) of water bodies of the SR and 37 (2.4%) of water bodies did not achieve good chemical status.

The contamination of territory by harmful pollutants coming from human activities poses a significant risk to human health or environment, groundwater and soil. In Slovakia 902 probable and 281 contaminated sites were recorded. It includes a wide range of areas contaminated by industrial, military, mining, transport and agricultural activities, but also by inappropriate waste handling. Despite a lower production of municipal waste per capita than the average in the European Union countries, low poor separation of its components and recycling still persists and land filling in high share prevails. Ratio of Gross Domestic Product (GDP) to quantity of waste generated (excluding municipal waste) shows a positive trend, the so-called absolute decoupling.

The energy consumption of the Slovak economy is declining; however, when compared to the EU average, it is still high. The share of renewable sources in gross final energy consumption of energy is increasing. In 2014, it amounted to 23.0% in electricity production, 10.4% in heat and cold production, and 6.6% in transport.

Emissions of air pollutants such as NO_x, SO_2, CO, $PM_{2.5}$, PM_{10} and non methane volatile organic compounds (NMVOC) have been declining in the long term, but after 2000 the rate of their decline slowed down significantly. The total volume of emissions of persistent organic pollutants (POPs) is increasing. A positive trend in produced greenhouse gas emissions quantity was recorded. The 45% decline in 2014 has been found in comparison to 1990. Problematic sectors where the effective regulation of greenhouse gas emissions increase is not successful are the road transport and energy production by the burning of fossil fuels in households. The limit values for selected pollutants have been exceeded in some air quality monitoring stations, but air pollutant limit values to protect

vegetation were not exceeded. However, ground level ozone remains a serious problem, where limit values for the protection of vegetation and forest are long term and regularly exceeded.

As people spend more than 2/3 of days in buildings, focusing on monitoring indoor air quality is very important from the point of view of ensuring healthy housing. The assessment of indoor air quality in schools in Europe and ambient air in the vicinity of schools (projects SEARCH a SINPHONIE**)** resulted in worsening the indoor air quality related to outdoor air pollution, design errors of buildings and poor building maintenance, poor cleaning and lack of ventilation. The proposed recommendations were aimed at preventing and improving indoor air quality in schools.

Drinking water quality has been showing high levels for a long time, the domestic consumption has been declining in the long term. The number of inhabitants supplied with water from public water supplies is increasing. Amount of waste water and water pollution has been declining in the longer term. The connection of population to public sewerage system has been also increasing in the long term; however, it lags far behind the public water supply.

Weather in the Slovak Republic has become more extreme in recent decades. One of the most significant negative effects of climate change is the more frequent occurrence of very strong local storms with high total rainfall causing unexpected floods and huge flood damages. On the other hand, it is the occurrence of long-lasting heat and droughts. The alternation of these extreme phenomena has negative impacts on ecosystems, economic and social spheres what is the most pressing environmental problems at present.

The GDP of the Slovak Republic since 2000, with the exception of 2009, records an annual year-on-year increase. Industrial production has the greatest share (about one-fifth) in its creating among others of industrial sectors. Resource productivity in the Slovak economy, measured as the ratio of GDP at constant prices as at 2010 to the domestic material consumption (DMC), increased by 42% compared to 2000 but Slovakia still significantly lags behind the average resource productivity in the EU.

CO_2 productivity expressed as a ratio of GDP at constant prices to the total quantity of CO_2 emissions shows a long-term positive development. On the other hand, thus the carbon intensity of the SR economy is decreasing.

The most important voluntary tools of the care for environment include environmental labelling, the application of environmental management systems, green public procurement and environmental innovation. The Slovak Republic is among the EU countries with low eco-innovation performance. Within the „Eco-innovation Scoreboard“ in 2013, Slovakia ranked 25^{th} from all EU countries (Slovakia is followed only by Cyprus, Poland and Bulgaria). The most important instruments of financial support of the care for the environment are the Environmental fund and programs for receiving the aid from the EU funds - for the years 2007–2013 the Operational Programme Environment (OPE), and for the years 2014-2020 the Operational Programme Quality of Environment [10].

3. Education in Environmental Engineering

Environmental engineering programmes are offered at either faculties/departments of civil engineering or the departments of chemical engineering at the technical universities. Significant efforts in shaping the environmental science field and application of the principles of sustainable development in education at the Faculty of Civil Engineering of the Technical University in Košice (FCE TUK) resulted from the global trend in higher education in the field of ecology and environmental science in the early 1990s. There was a need to solve the interactions of technical activities with the environment in terms of the complex protection of human and environment and to live in a healthy environment. This was linked with the need for education and training of environmental experts. Education in Environmental Engineering as a discipline in the field of technical sciences is directed to utilization of engineering methods for preserving, rational shaping and using external natural environment (e.g. water resources, waste management, air protection, soil protection), for preserving and creating indoor environment in rooms, buildings and constructions. The first accredited master study branch Ecology

in Construction (1993) was followed the accreditation of bachelor, master and doctoral studies in the field of Environmentalistics (2001). The three level study in environmental engineering was provided within the programme Environmental Structures since 2004. Nowadays, the FCE TUK provides 4 interdisciplinary study programmes accredited in the combination of two field of study - Environmental Engineering and Construction/Structural Engineering at bachelor and master level of the university study. Doctoral study program is provided in the field of study of Environmental Engineering. The study programmes are created in accordance with the concept of sustainable development in environmental engineering and construction and it is defined by the needs for industrial, engineering, design, municipal and state spheres associated with the design and making of environmental structures, with the assessment and solution building interactive relationships with the environment.

Bachelor study programme: Environmental Structures
Programme graduates are proficient in using environmental and civil engineering knowledge to develop technologies of air, water and soil protection, waste processing and recycling. The graduated students are able to assess environmental impacts of activities and buildings, and to solve simple engineering projects in the field of landscape design, protection and revitalisation based on new legal regulations and state environmental policy.

Bachelor study programme: Structures for Sustainable Water Management in the Landscape
Graduated students will acquire basic knowledge of water management in urbanized areas and in the landscape; monitoring and analyzing the state of pollution of environmental components; design, construction and operating of water structures; protection and restoration of the landscape and legislation in force in the addressing areas. The graduated students are able to use the acquired knowledge, practical procedures and tools for solving simple engineering projects from the field of environmental protection, water management, and design of simple constructions and fragments of complex constructions and are able to assess the impacts of activities and constructions on the environment.

Master study programme: Environmental Structures
Graduates can work in the design, operation and management of civil engineering and environmental structures with emphasis on the protection, creation and restoration of the environment and can find applying in state administration and in the area of environmental impact assessment and evaluation of environmental performance of materials and buildings during their whole life cycle. Graduates are also able to carry out all the activities in the preparation, implementation, reconstruction, rehabilitation and use of all types of structures.

Master study programme: Structures for Sustainable Water Management in the Landscape
Graduated students gain comprehensive knowledge and can solve engineering problems of water management, water structures and environmental protection. They will acquire modern methods of experimental research, computerized data processing, environmental monitoring of the quality of environmental components with an emphasis on the aquatic environment and evaluation of extreme hydro-climatological events - floods and droughts. Graduates can analyze, design, operate, as well as prepare and manage the construction of various types of water structures. They are able to implement new technical solutions and the best available technologies to the operating systems, to introduce new legislative regulations and standards. They can perform research with a high degree of creativity and autonomy.

Doctoral study programme: Environmental Engineering
The programme is suitable for engineers who wish to prepare for their future scientific research career. Programme graduates are able to clearly formulate scientific research problems, target objects and

goals of research and progress in the field of environmental engineering; they are able to solve formulated problem with respect to social, ethical, legal and economic impact of their research.

4. Conclusion

This paper presents information on the status of the environment in the SR. Innovative approaches to achieve sustainability in environmental engineering are still necessary nowadays. Solving the interactions of technical activities with the environment in terms of the complex protection of human and environment is linked with the need for education and training of environmental experts. Study programmes in the field of the environmental engineering at FCE TUK are oriented on education of multidisciplinary graduates - environmental "civil" engineers focusing on environmental chemistry, advanced air, soil and water treatment technologies, bioremediation, separation processes, recycling, water treatment plant design, hydrology, water resources management and environmental assessment of technological activities, building products as well as environment components.

Acknowledgments

The paper was created as part of the NFP 26220120037 project solution.

References

[1] Engh E D and Smith B F 2002 *Environmental Science: A study of interrelationships* Mc Graw-Hill Higher Education
[2] Chiras D D 2006 *Environmental Science*. Jones and Bartlett Publishers
[3] Singh Y K 2006 *Environmental Science*. New Age International Publishers
[4] Corbitt R A 1989 *Standard Handbook of Environmental Engineering* McGraw-Hill Publishing
[5] Duggal K N 2008 *Elements of Environmental Engineering* S. Chand Publishing
[6] Mackenzie L D and Masten S 2003 *Principles of Environmental Engineering and Science.* McGraw-Hill Higher Education
[7] Mihelcic J R and Zimmerman J B 2014 *Environmental Engineering: Fundamentals, Sustainability, Design* Wiley
[8] Mines R O 2014 *Environmental Engineering:Principles and Practice.* John Wiley & Sons
[9] Gilbert M M and Wendell E 2008 *Introduction to Environmental Engineering and Science.* Prentice Hall
[10] Lieskovska Z 2017 *Environment of the Slovak Republic in Focus*. Ministry of Environment of the SR; Slovak Environment Agency