Environmental engineering education - waste management in Romania

Valentin Petrescu, Rodica Ciudin, Claudiu Isarie & Victor Nederita

Lucian Blaga University of Sibiu
Sibiu, Romania

ABSTRACT: The current situation and conditions of waste management in Romania, as well as the identification of their problems and priorities, are presented and discussed in this article. Waste management is a difficult and complex problem in Romania, and the education sector, especially students from environmental engineering, should be aware of the issues and ideas concerning the environment and the impact of new developments. Waste management is also a difficult and complex problem in Romania, which is far from being solved, according to the environment rules of the European Union. The focus in this article is on the experience in the field of waste management and environmental engineering education in Romania.

INTRODUCTION

Romania's Environmental Problems

Currently, Romania faces acute problems concerning air, water and soil pollution, which require large investments in the short- and long-term, as well as the participation of both the public and private sectors. Essential measures are needed in the fields of waste management, the improvement of water quality, and the enforcement of integrated pollution prevention and control. It should be also noted that Romania will require massive environmental investment by both the government and industries to comply with EU standards.

Rapid industrialisation since World War II has caused widespread water and air pollution, particularly in Prahova County, an oil refining region. The nation has 49 km^3 of renewable water sources, with about 59% used to support farming and 33% used for industrial purposes. Romania's cities produce on average 3.0 million tons of solid waste per year. Air pollution is heaviest in the nation's cities, where industry produces hazardous levels of sulphur dioxide. In 1992, Romania had the world's 28^{th} highest level of industrial carbon dioxide emissions, which totalled 122.1 million metric tons with per capita level of 5.24 metric tons. In 1996, the total level dropped to 119 million metric tons [1].

An analysis of the current situation reflects the condition of waste management in Romania, and it is based on viable statistical data. It leads to the identification of the problems, and to prioritising, and ensuring a sufficient basis for an analysis of strengths, weaknesses, opportunities and threats (SWOT). The SWOT analysis is a synthesis of the current situation in the field of waste management that presents the internal factors on which to concentrate (the strengths) or which must be annulled (the weaknesses), as well as favourable external factors (opportunities) or unfavourable (threats) [2].

The SWOT analysis confirms the fact that implementing an integrated waste management can have a significant impact on improving the quality of life, and of the environment in Romania. Improvements in the field of waste management in Romania will lead to the promotion of sustainable development.

In Romania, present research in the field of waste management is concentrated on the strategies, action plans, and the strategic planning of urban systems for waste management.

THE STATUS OF WASTE MANAGEMENT IN ROMANIA

A large level of waste is generated in Romania, and this represents one of the biggest and most difficult problems of environment protection. It is of highest importance that waste management is adequately managed to avoid potential

environmental risk. Waste management methods and practices produce pollutant emissions that lead to soil contamination, water contamination and, subsequently, human health problems.

It should be pointed out that ecologic priorities for Romania are waste management, followed by water and air pollution. Waste management in Romania is characterised by:

- Continuing growth of the amount of waste and its relevant storage;
- Waste transportation and collection are insufficient;
- Economic benefit of waste is insufficiently developed.

There are technical solutions and concepts, which are not possible to develop because of financial constraints. The needed capital for such investments is too costly for communities, cities and society. The SWOT analysis of waste management in Romania is presented in Table 1.

Table 1: SWOT analysis for waste management in Romania.

Strengths	Weaknesses
• National Strategy for Waste Management and National Plan for Waste Management established. • The elaboration of regional plans for waste management. • Legal framework for waste management is too complex at this moment. • Establishing the guides for waste management systems. • The experience acquired by local authorities in developing investment projects financed through European programmes. • Setting up organisations orientated towards promoting efficient and lasting solutions for the waste management process.	• Huge quantity of waste is generated with no controlled storage. • Rate of valorising the useful fractions is highly reduced. • Reduced quality of soil and water because of waste pollution that is not stored appropriately. • Precarious infrastructure for collecting, transporting and eliminating waste. • Low level of awareness and responsibility by the population and the economic agents of adequate waste management. • Lack of competent staff for waste management activities. • The existence of a huge number of historically polluted sites as a consequence of past economic activities. • Low degree of implementation of environmental legislation. • Bureaucracy in obtaining finance for waste management projects.
Opportunities	**Threats**
• To access EU funds for improving the quality of the environment in Romania. • To develop waste management systems for tourist areas. • To attract foreign investors by improving the sanitation services. • To develop long-term investment projects in sustainable development conditions. • To develop a viable market for recycling waste and, respectively, a market for valorising the products from waste processing. • To encourage *clean technologies*, which are less polluting. • To develop partnerships with other city authorities for waste management; and • To promote renewable energy sources.	• Pressures exercised by domestic waste on the quality of environmental factors. • Unstable legal frameworks. • A mentality of indifference concerning environmental protection. • High cost of implementing *clean technology* and best available techniques for waste management. • Irrational exploitation of natural resources. • Inappropriate use of EU funds. • Delays in approving waste management projects. • Difficulties encountered in financing income-generating projects; and • Difficulties in choosing the right place for building the waste infrastructure.

The exact amount of waste generated is not known because of a lack of measurement equipment. The data below represent the volume estimation of generated waste. That is why waste record and management are just partially reflecting the current situation. However, the rough percentage of the composition of household waste in urban and rural areas in 2008 is presented in Figure 1.

According to Regional Plan for Waste Management (RPWM), the amount of household waste for the region is 0.9 kg/person per day for urban areas and 0.4 kg/person per day in rural areas. The amount of household waste generated in 2007 was approximately 953,000 t [3].

According to the environmental rules of the European Union, Romania has to change the way in which waste is managed. The population must be educated on how to separate waste; the entire amount of generated waste must be

collected efficiently, all the uncontrolled storage deposits must be closed, and there is a need for building new conformed deposits for waste, as well as recycling and composting areas.

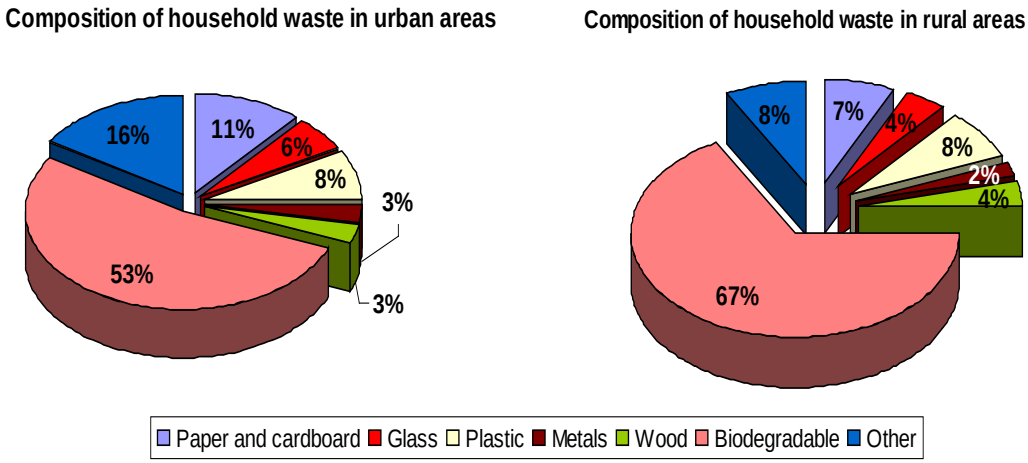

Figure 1: Composition of household waste in urban and rural areas in 2008.

WASTE MANAGEMENT IN ROMANIA'S CURRICULA

Education is an essential tool for achieving sustainability. People now recognise that current economic development trends are not sustainable and that public awareness, education and training are the key to moving society towards sustainability [4]. Now, environmental issues affect almost all commercial and industrial sectors, and are a central concern for the public, governments, and even international relations. There are several universities in Romania that are offering different programmes related to environmental science and engineering (Table 2). On the other hand, the environmental engineering education programmes at most universities in Romania are quite traditional.

Table 2: Environmental educational programmes in Romania.

No	Main Universities	Name of Department Schools/Faculties
1	*Lucian Blaga* University of Sibiu	Faculty of Engineering - Department of Science and Technology of Materials - Engineering and Environmental Protection in Industry
2	University *Politehnica* of Bucharest	The Hydraulics, Hydraulic Machines and Environmental Engineering Department
3	University *Politehnica* of Bucharest	Faculty of Materials Science and Engineering - Engineering and Environmental Protection in Industry
4	University of Ecology Bucharest	Faculty of Managerial Engineering - Environmental Engineering
5	University of Agronomic Science and Veterinary Medicine – Bucharest	Faculty of Landscape Improvement and Environmental Engineering
6	*Babeş-Bolyai* University, Cluj-Napoca	Faculty of Environmental Sciences
7	Technical University of Cluj-Napoca	Faculty of Materials Science and Engineering - Department of Environmental Engineering
8	University *Politehnica* Timişoara	Faculty of Industrial Chemistry and Environmental Engineering
9	Technical University *Gh.Asachi* Iasi	Faculty of Hydromechanics, Geodesy and Environmental Engineering
10	Transylvania University of Brasov	Faculty of Science and Engineering of Materials - Engineering and Environmental Protection in Industry; Engineering of Waste Valorification
11	The University *Dunarea de Jos* Galati	Faculty of Mechanics and Environmental Engineering
12	University of North Baia Mare	Faculty of Mineral Resources and Environment
13	University of Oradea	Faculty of Environmental Engineering
14	*Constantin Brancusi* University of Targu Jiu	Faculty of Engineering - Engineering and Environmental Protection in Industry
15	*Aurel Vlaicu* University of Arad	Faculty of Food Engineering, Tourism and Environmental Protection
16	University of Craiova	Faculty of Engineering and Technological Management - Industrial Environmental Protection
17	University Valahia Targoviste	Faculty of Environmental Engineering and Biology
18	University of Petrosani	Faculty of Mining Engineering
19	*Sapientia* University of Miercurea Ciuc	Faculty of Sciences - Engineering and Environmental Protection in Industry

Students should be made aware of the issues and ideas concerning the environment and the impact of new developments on it as early as possible in their education, with the objective of raising their interest in, and appreciation for, the environment and its protection. Through industrial visits and practical terms spent in industry, students should be encouraged to make themselves familiar with new approaches to sustainable development and environmental protection undertaken by industrial organisations. It should be stressed that industry recognises its responsibility for the environment and is keen to be involved in environmental education and training [5].

A new way in which issues, topics and ideas concerning environmental engineering and sustainable development are addressed and treated, in individual subjects, is urgently needed. Engineering faculties should give more support to those colleagues across all engineering disciplines, who are willing to include and address such issues and topics in their courses.

Romanian research in the waste management field is gradually making progress in supporting the actions of local and central authorities, so as to adopt and put into practise waste management systems that are similar to most European practices. Thus, at the level of central authorities, there are two national research institutes subordinated to the Ministry of Environment (The National Institute of Research and Development for Environment Protection - ICIM Bucharest and The National Institute of Research and Development for Industrial Ecology - ECOIND), which include laboratories and special sections for research in the field of technologies for waste management.

The role of these institutes is to undertake fundamental scientific research, using national statistics and national reference databases. Further, the institutions take note of governmental and locally adopted strategies, as well as monitoring the implementation of them, under the accepted treaty for joining the European Union.

More emphasis is required on education and a particular awareness of the issue, but including such programmes at school level requires substantial effort. It is believed by community motivators that any form of education is more effective than mass awareness-raising campaigns. Introducing a new course at school level is a must for Romania. So far, there are no such programmes and only a few universities are offering education in the field of environmental engineering.

Waste management is a difficult and complex problem in Romania, which is far from being solved in accordance with the environmental rules and regulations of the European Union. The worsening of the waste problem, especially of domestic waste, is further aggravated by the significant increase of its quantity, as well as by the inappropriate way of solving different stages of waste processing.

Education and awareness in the area of waste and waste management are also increasingly important from a global perspective.

CONCLUSIONS

Environmental engineering education is only just beginning in Romania, and there are many obstacles to promoting this field of study. The main obstacles are summarised as follows:

- The budget limitation for the establishment of environmental engineering programmes;
- Lack of academic staff in the new field of environmental engineering;
- Lack of professional jobs for environmental engineering graduates.

Clearly, up to now, the environmental problems that Romania is currently facing have not been addressed. The main obstacle to implementing environmental projects is still the lack of necessary funding. The low amount of environment investment is primarily due to a lack of environmental financing instruments.

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