WASTE MANAGEMENT EVALUATION IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT. CASE STUDY VASILE ALECSANDRI UNIVERSITY OF BACAU

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Abstract

The sustainable development concept becomes more and more present in human society. One of its components is the waste management issues with applications in different activities. In this context, the present paper presents some modalities of waste management system implementation in public sector respectively, at "Vasile Alecsandri" University of Bacau. For the study were used reports, achieved by the Romanian Environmental Protection Agency and the data related to the waste quantities generated by the evaluated institution such as metallic waste, paper and cardboard waste, plastic waste etc.

Keywords: Waste management; Sustainable development; Antropic activities; Implementation system.

Introduction

In present it is very used the concept of sustainability application in all human activities. This concept is based on sustainable development that can be defined in different ways but, the most recognized definition is expressed by the Brundtland Commission in 1987 "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [1]. This means that the sustainable development concept is based on three directions: economic, environmental and social sustainability (Fig. 1).

Fig. 1. The interconnexion's from sustainable development concept [2]

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Romania, as a member of the United Nations (UN) and the European Union (EU), expressed its adherence to the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda, adopted by the UN General Assembly Resolution A/RES/70/1, at the UN Summit for Sustainable Development in September 2015 [3, 4]. One of these objectives is "Responsible Consumption and Production" in which it is specified that by 2030 "significant reduction of waste generation, through prevention, reduction, recycling and reuse" must be achieved in order to implement the circular economy concept [5-7].

Sustainable development has become a central element of the international agenda, considering the complex interaction between the new forms of urbanization processes, globalization and climate change [8]. In this context, municipal waste management improvement is becoming a world priority [9-18].

The proper waste management process can reduce the soil pollution and direct implications to soil properties and productivity [19-25].

The solid waste management process can be divided into two distinct parts, depending on the main responsibilities [7, 18]:

- The producer or the waste generator and in this case is analyzed the production, collection, storage and transport of the waste;
- The operators who carry out the process of waste management, respectively those who carry out the processes of sorting, treatment and storage of the waste.

In order, to put into practice, the waste management process, regardless the type of source or operator, it is necessary to implement the European regulations in Romanian legislation, by generating a series of laws with general purpose:

- EU regulations implementation in Romanian legislation;
- Legislative support for the regulation's application.

An example is represented by Law no. 132 of June 30, 2010 on "selective waste collection in public institutions" by which public institutions are obliged to collect selectively the waste generated [26]. This law, in addition to the main purpose of "increasing the degree of recycling and recovery of the waste collected selectively", also has a secondary purpose which aims to "increase the degree of information and awareness, as well as the education of employees and citizens on the selective waste collection and management" [26].

This article presents how this concept is implemented in public institutions, by take into consideration some data from "Vasile Alecsandri" University of Bacau. To highlight this waste collection system, were taken into consideration the analysis of the waste generated quantity for period 2012-2018. The used data are part from the reports analyzed by the Environmental Protection Agency (according to the Law 132 June 30, 2010).

Experimental

For the study of waste management system implementation in a public institution, the "Vasile Alecsandri" University of Bacau was chosen, an academic institution of public interest, apolitical, with non-profit character and legal personality, accredited according to law, part of the state higher education system in Romania [27].

To provide the requirements imposed by Romanian and the European legislation, respectively for the implementation of the waste management system, the following steps were performed [28]:

- The existing situation analyzes, and all types of waste were identified considering the activity field of each university structure (faculty, department, laboratory), but also of the existing university services;

- A list of wastes and the collecting methods were performed;

- The quantities of waste that will result from the didactic activities, from the student dormitories, but also from the auxiliary activities of the institution were estimate;

- Depending on the waste quantity and location of the generating source, were identified the storage areas and container type;

- Depending on the type of waste, it was analyzed how can be to dispose and/or use them.

In order to be able to implement this waste management system for the analyzed institution, the following measures were considered:

- Elaboration of internal decisions regarding the waste management;

- The way of reporting, analyzing and controlling of the waste management plan implementation;

- The immediate intervention mode was established in case of unforeseen situations;

- The way of results evaluation and the established waste management plan upgrade (if is necessary).

According to the Law 132/2010 the waste collection system in a public institution, in our case "Vasile Alecsandri" University of Bacau must be implemented by using the following conditions [28]:

a)   The containers used for the selective collection are inscribed with the name of the waste;

b)   In each compartment will be placed three containers for selective waste collection. The containers will have, depending on the type of waste collected, the colors: blue for paper and cardboard waste, yellow for metal and plastic waste and white/green for white/colored glass;

c)   The containers will be placed in some accessible places;

d)   At the entrance of each campus there must be a selective waste collection point for visitors and to ensure their information for this purpose, by exemplifying the types of waste corresponding to each container;

e)   The containers will be emptied (by the cleaning personnel's) depending on the activity intensity;

f)   The containers mark with specific colors can be done by painting, by applying stickers or by another similar process, on a minimum 20% from the total visible surface;

g)   The containers mark must be durable and visible to ensure the correct identification and containers of selective collection.

In order to implement a waste management system in a public institution, the following aspects must also be considered:

a) Waste collecting methods;

b) Containers type to favorize easy waste separation;

c) Carrying out periodic training of the institution personnel for the activity of waste collection and storage.

According to the literature, the waste collection process at source, is divided into several stages [28, 29]:

a) Primary pre-collection: the employees of the institution, each having containers in the workspace for the waste selective collection and students and visitors, in each buildings level are placed three containers of 60 liters for selective waste collection (according to Law

132/2010 art. 9), respectively: a container with yellow lid for plastic waste; a container with a green lid for glass waste and a container with blue lid for paper waste.

     b) Secondary pre-collection with administrative staff implication in the waste collection from the primary collection points and temporary storage in specially arranged locations. Within the institution there are several temporary storage points for the waste collected.

Results and discussion

     Following the analysis of the data obtained from the reports generated by the Environmental Protection Agency, a series of graphical representations were performed that aim to highlight the implementation of the waste management system.

     The variation of the waste quantity generated by the institution is presented in figure 2. From the analysis of the graphical representation it is observed that from the total waste quantity the paper and cardboard is the highest from the whole structure of waste.

     The highest annual share of waste collected is represented by the 86.9% ferrous waste collected in 2014, followed by the weight of paper waste 70.6%. However, the average value of the paper waste weight collected is 41.3%.
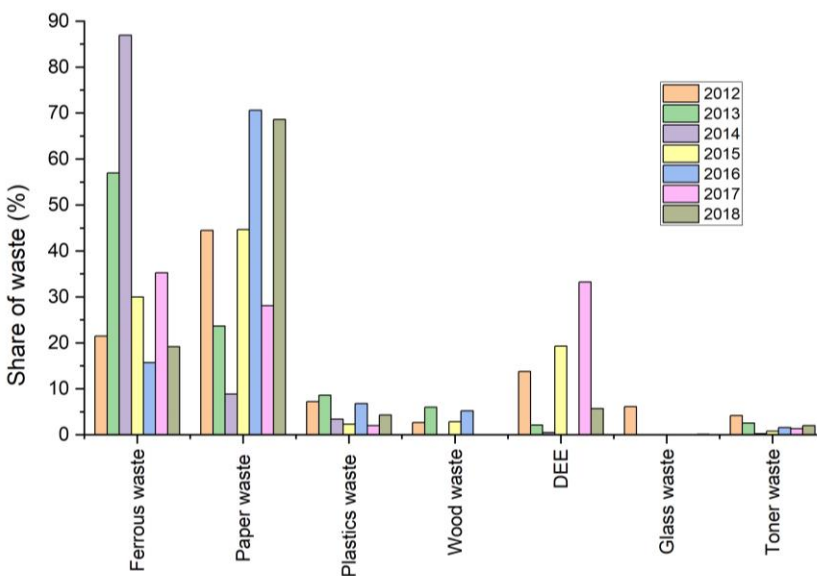

Fig. 2. Waste quantity variation for the studied period

     The largest quantity of ferrous waste, a variation that is presented in figure 3, was realized in 2014 June 2843 kg, followed by the quantity generated in July of the same year, respectively 2120 kg. Analyzing the entire period, from 2012 to 2018, it is found that the quantity of ferrous waste varied between 10 - 480 kg per month.
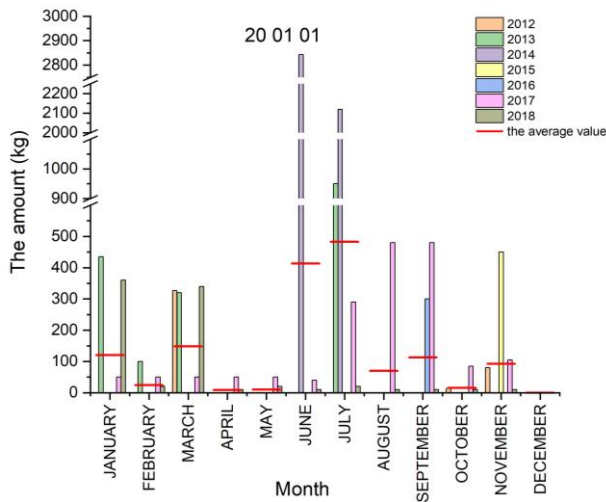
Fig. 3. Variation of the amount of metallic waste generated in the analyzed period

The largest amount of paper and cardboard waste (Fig. 4) was obtained in 2018 with 2936 kg, the year in which an amount of over 650 kg of paper and cardboard waste was generated within in three months January, July and August.

Large quantities were also identified in 2012 in November, an amount of 803 kg, in 2016 in August, an amount of 712 kg and in 2015 in November an amount of 670 kg. Analyzing the average value of paper and cardboard waste generated each month of the year, it is found that the August an average amount of 223 kg, representing the highest value, and in December an average quantity of 26 kg, being the smallest value.
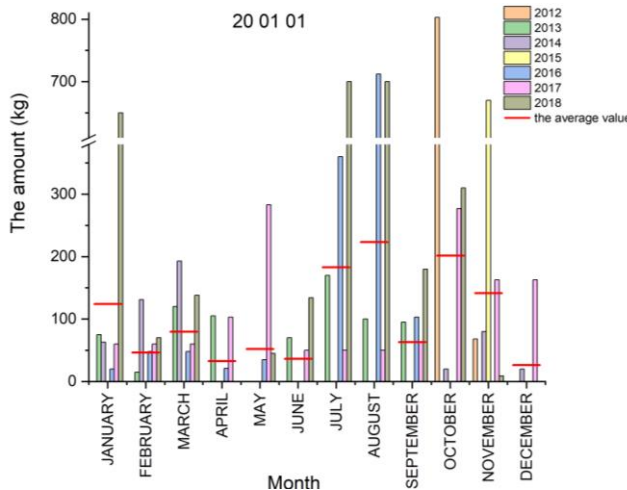

Fig. 4. Cardboard waste variation in the analyzed period

The average value of the amount plastic waste (Fig. 5) generated is in the range 7 to 27 kg, characteristic values for April, respectively for January. A large amount of plastic waste was collected in October and November of 2012, and in January 2013, where the following

quantities were generated: 80 kg, 61 kg and respectively 79 kg. The highest annual amount of plastic waste was collected in 2013, a total of 274 kg, and the smallest annual amount of plastic waste was collected in 2015, a total of 35 kg.
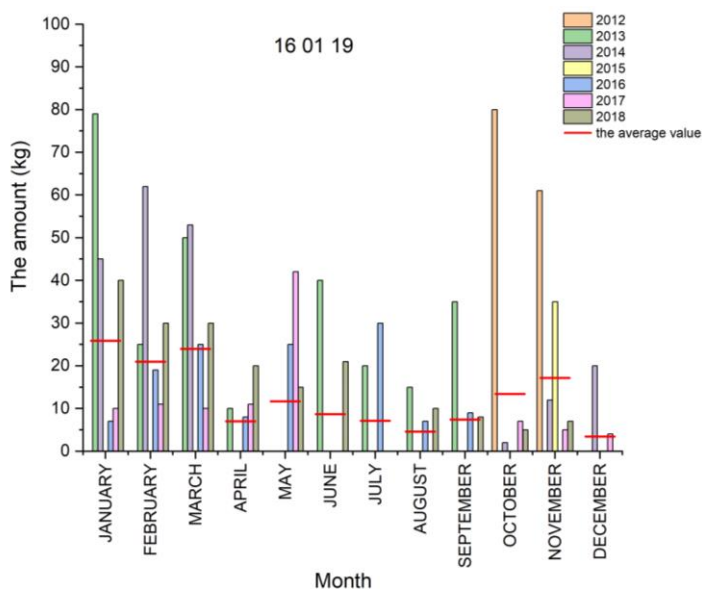

Fig. 5. Plastic waste variation of the amount of generated by the studied entity for the analyzed period

Considering the university field of activity, it is found that the source of wood waste, quantities that do not exceed 160 kg (value obtained in January 2013, Fig. 6). These types of waste are not generated every month of the year and are years when this quantity is 0.0 kg.
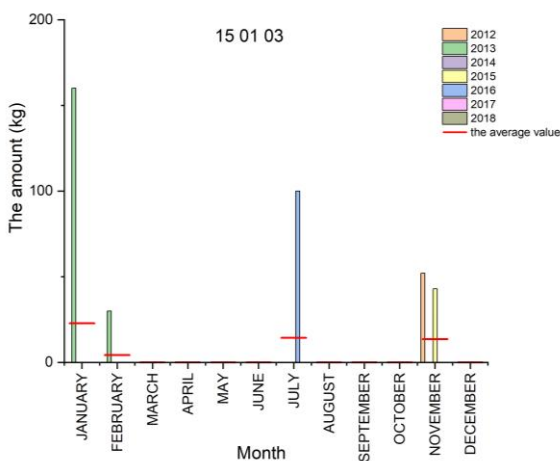

Fig. 6. Wood waste quantity variation for the analyzed period

The figure 7 presents the variation of the electrical and electronic waste (WEEE) quantity for the studied period, respectively in 2012 to 2018. From the analysis of the graphical representation it is observed that:

- There are periods when the amount of WEEE collected is 0.0 kg (for example 2016);

- During 2017, the largest quantity of WEEE was collected 1632 kg, with 866 kg in October.
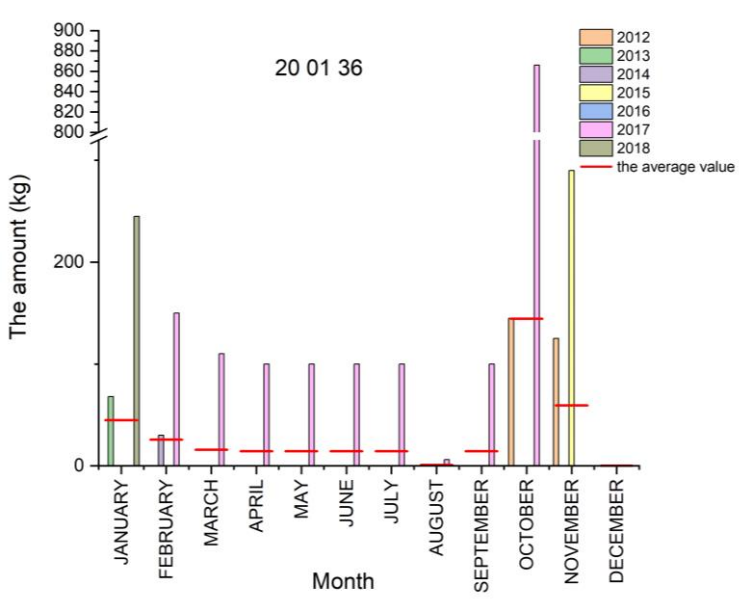

Fig. 7. WEEE quantity collected in the analyzed period

The average amount of toner waste (Fig. 8) generated per year by the unit, for the study period was 53.4 kg. Analyzing the distribution of the quantity collected per month, it is found that the largest quantity of toner waste was collected in July 2016 respectively 30 kg.
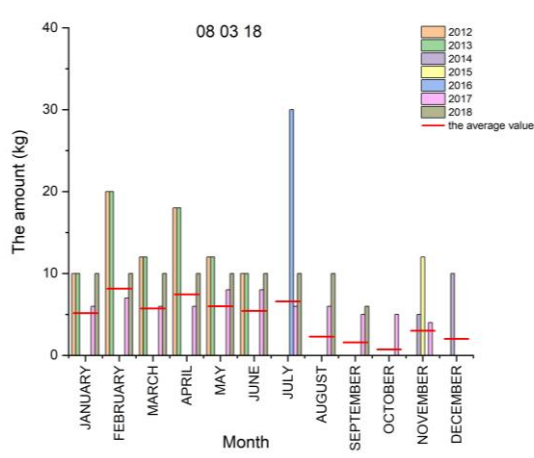

Fig. 8. Toner waste generated in the analyzed period

By analyzing the waste quantities and structure were found glass waste (Fig. 9) expressed by a significant quantity obtained in November 2012 of 120 kg. Between 2013 and 2017 we not identified glass waste, and in the year 2018 a total quantity of 5 kg was collected.
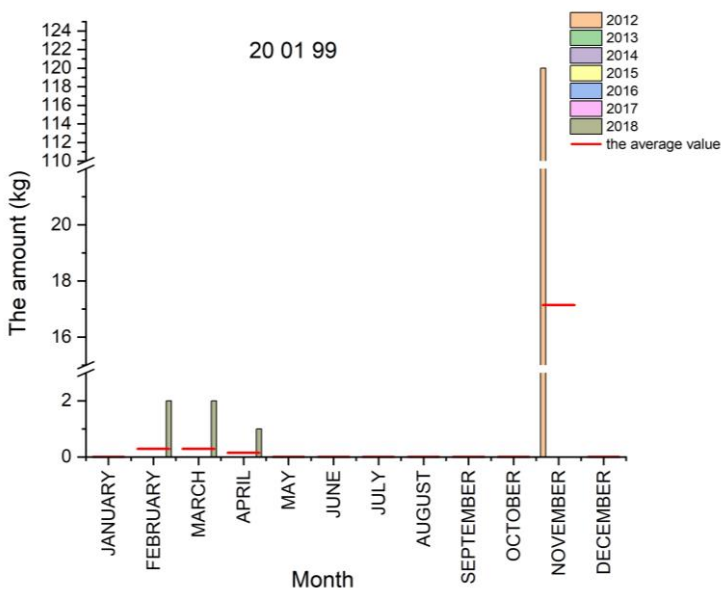
Fig. 9. Glass waste quantity variation in the analyzed period

Conclusions

The sustainable development concept application involves changes applied both to producer and consumer level. As for population, it is very important to implement this concept in as many activities are possible.

Waste management is a current activity by which the population must carry out a proper waste collection and storage.

In support of sustainable development, a series of laws have been implemented, includig Law 132 of 2010, which obliges public institutions to carry out waste management.

According to the legislation, the present study was carried out for a higher education institution, respectively the "Vasile Alecsandri" University of Bacau. Following the reports analysis, the waste category generated were metal, paper and cardboard, plastic, glass, wood, WEEE and toner.

The data reveal that the big waste quantities generated by the analyzed institution, was metal, paper and cardboard waste.

References

[1] * * *, *Introduction to environmental auditing in public sector. 1.1. Sustainable development*, https://sisu.ut.ee/env-intro/book/1-1-sustainable-development (05.11.2019).
[2] A. Kurry's, Thesis Portfolio - *International Political Economy & Sustainable Development,* http://macaulay.cuny.edu/eportfolios/akurry/files/2011/12/SDspheres.jpg (05.11.2019).

[3] * * *, *Department For Sustainable Development - Romania's national strategy for sustainable development 2030,* (in romanian), http://dezvoltaredurabila.gov.ro/web/despre/ (05.11.2019).

[4] * * *, *Welcome to the Sustainable Development Goal indicators website*, https://unstats.un.org/sdgs/?aspxerrorpath=/sdgs/indicators/indicators-list/ (5.11.2019).

[5] * * *, *Department for Sustainable Development - Objective 12: Responsible consumption and production. Ensuring sustainable consumption and production patterns, http://dezvoltaredurabila.gov.ro/web/obiective/odd12/,* (in Romanian) (10.11.2019).

[6] J. Horne, M. Recker, I. Michelfelder, J. Jay, J. Kratzer, *Exploring entrepreneurship related to the sustainable development goals - mapping new venture activities with semi-automated content analysis,* **Journal of Cleaner Production, 242**, 2020, Article Number: 118052.

[7] M. Tausova, E. Mihalikova, K. Culkova, B. Stehlikova, P. Taus, D. Kudelas, L. Strba, *Recycling of Communal Waste: Current State and Future Potential for Sustainable Development in the EU,* **Sustainability, 11**, 2019, Article Number: 2904.

[8] I. Ianos, D. Zamfir, V. Stoica, L. Cercleux, A. Schvab, G. Pascariu, *Municipal Solid Waste Management for Sustainable Development of Bucharest Metropolitan Area,* **Environmental Engineering and Management Journal**, **11**(2), 2012, pp. 359-369.

[9] P. Agamuthu, J.A. Hansen, *Universities in capacity building in sustainable development: focus on solid waste management and technology,* **Waste Management & Research, 25**(3), 2007, pp. 241-246.

[10] A.E. Cioabla, F. Popescu, G. Trif-Tordai, A.G. Dumitrel, P.D. Oprisa-Stanescu, D. Lelea, *Sustainable Development of Romanian Cities through Biogas Production from Municipal Wastes and Application in Co-Combustion Processes,* **Thermal Science, 22**(2), 2018, pp. 1071-1076.

[11] M.C. Belciu, E.F. Mosnegutu, V. Nedeff, A.D. Chitimus, N. Barsan, S. Fiore, *Production capacity of leachate from Bihor landfill,* **Environmental Engineering and Management Journal, 15**(3), 2016, p. 2057-2062.

[12] M. Nikiema, N. Barsan, M.K. Somda, D. Traore, D. Dianou, V. Nedeff, A.S. Traore, *Optimization of biogas production from organic fraction of municipal solid waste: experimental test using liquid from waste fermentation,* **Scientific Study & Research. Chemistry & Chemical Engineering, Biotechnology, Food Industry, 18**(2), 2017, pp. 213 – 224.

[13] S.S. Coulibaly, F.E. Edoukou, K.I. Kouassi, N. Barsan, V. Nedeff, I.A. Zoro Bi, *Vermicompost utilization: A way to food security in rural area,* **Helyon**, **4**(12), 2018, Article Number: e01104.

[14] L.I. Fuldauer, M.C. Ives, D., Adshead, S. Thacker, J.W. Hall, *Participatory planning of the future of waste management in small island developing states to deliver on the Sustainable Development Goals,* **Journal of Cleaner Production, 223**, 2019, pp. 147-162.

[15] M. Ikhlayel, *Development of management systems for sustainable municipal solid waste in developing countries: a systematic life cycle thinking approach,* **Journal of Cleaner Production, 180,** 2018, pp. 571-586.

[16] A. Mesjasz-Lech, P. Michelberger, *Sustainable Waste Logistics and the Development of Trade in Recyclable Raw Materials in Poland and Hungary,* **Sustainability, 11**(15), 2019, Article Number: 4159.

[17] A. Ulfik, S. Nowak, *Determinants of Municipal Waste Management in Sustainable Development of Regions in Poland,* **Polish Journal of Environmental Studies, 23**(3), 2014, pp. 1039-1044.

[18] M. Ljunggren, *Modelling national solid waste management,* **Waste Management & Research, 18**(6), 2000, pp. 525-537.

[19] A.D. Chitimus, F. M. Nedeff, I. Sandu, C. Radu, E. Mosnegutu, N. Barsan, I. G. Sandu, C. Tomozei, *Absorption Capacity of Copper and Lead in the Case of Phragmites Australis Plant Species*, **Revista de Chimie, 70**(11), 2019, pp. 4035- 4039.

[20] A.D. Chitimus,.V. Nedeff, I. Sandu, C. Radu, E. Mosnegutu, I.G. Sandu, N. Barsan, *Absorption Capacity of Heavy Metals in the Case of Typha Latifolia Plant Species,* **Revista de Chimie, 70**(8), 2019, pp. 3058-3061.

[21] Muscalu (Plescan), O.M., Nedeff, Valentin, Sandu, I.G., Partal, E., Mosnegutu, E., Barsan, N., Sandu, I., Rusu, D., *Influence of Main Works Systems on Physical and Chemical, Properties of the Soil,* **Revista de Chimie, 70**(5), 2019, pp. 1726-1730.

[22] Chitimus, A.D., Nedeff, V., Sandu, I., Radu, C., Mosnegutu, E., Sandu, I. G., Barsan, N., *Mathematical Modeling for the Absorption Capacity of Heavy Metals from the Soil in the Case of Phragmites Australis Plant Species,* **Revista de Chimie, 70**(7), 2019, pp. 2545-2551.

[23] O.M. Muscalu (Plescan), V. Nedeff, I.G. Sandu, A.D. Chitimus, E. Partal, N. Barsan, D.I. Rusu, *Influence of Soil Fertilization Systems and Crop Rotation on Soil Chemical Properties,* **Revista de Chimie, 70**(2), 2019, pp. 536-542.

[24] A.D. Chitimus, C. Radu, V. Nedeff, E. Mosnegutu, N. Barsan, *Studies and researches on typha latifolia's (bulrush) absorption capacity of heavy metals from the soil,* **Scientific Study & Research. Chemistry & Chemical Engineering, Biotechnology, Food Industry, 17**(4), 2016, pp. 381 – 393.

[25] O.M. Muscalu (Plescan), V. Nedeff, A.D. Chitimus, I.G. Sandu, E. Partal, E. Mosnegutu, I. Sandu, D.I. Rusu, *Influence of fertilization systems on physical and chemical properties of the soil,* **Revista de Chimie, 70**(11), 2018, pp. 3016-3111.

[26] * * *, *Law No. 132 of June 30, 2010 on the selective collection of waste in public institutions, published in: Official Monitor no. 461 of July 6, 2010, The Parliament of Romania*, (in Romanian).

[27] * * *, *Charter of the Vasile Alecsandri University of Bacau, (in romanian)* http://www.ub.ro/files/universitate/doc/Regulamente/R-01-01_6.0_11632.pdf.

[28] * * *, I-SSM 12 - *Waste Management from the Vasile Alecsandri University of Bacau,* (in Romanian).

[29] G. Bularda, D.C. Bularda, C. Theodor, **Domestic, Road and Industrial Waste. Collection, storage and use of reusable materials***,* (in romanian), Technical Publishing House, Bucharest, 1992.