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**ECOLOGICAL AND ECONOMIC ASPECTS OF HAZARDOUS
WASTE MANAGEMENT AND SUSTAINABLE DEVELOPMENT
IN THE REPUBLIC OF SERBIA**

This paper highlights the importance of managing less hazardous waste in accordance with the sustainable development concept, assuming that opening of several new processing sites is positioned on the territory of Northern part of the Republic of Serbia, specifically – Vojvodina. Introduction of such a planned approach would have many benefits for the ecological system of the largest cities in Vojvodina. Besides that, by processing less hazardous waste of vegetable and animal origin, products with measurable economic value are produced. The authors point out that introduction of multiple processing centres for vegetable and animal waste has shown practical readiness of Serbia to implement socially responsible behaviour. At the same time, the authors show altruism and responsibility of the Republic of Serbia, which is on its way to join the EU adopting solutions that are ecologically and economically acceptable as well as socially responsible.

Keywords: vegetable and animal waste; compost; socially responsible behaviour; sustainable development; Vojvodina.

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**Слободан Попович, Менсур Цемалович, Ранко Мійіч
ЕКОЛОГІЧНІ ТА ЕКОНОМІЧНІ АСПЕКТИ УТИЛІЗАЦІЇ
НАЙМЕНШ НЕБЕЗПЕЧНИХ ВІДХОДІВ У КОНТЕКСТІ
СТІЙКОГО РОЗВИТКУ РЕСПУБЛІКИ СЕРБІЯ**

У статті доведено важливість правильної організації навіть найменш небезпечених відходів у контексті концепції стійкого розвитку. Доведено, що відкриття декількох нових локацій з переробки таких відходів у північній частині Сербії (Автономний край Воєводина) буде сприяти кращому плануванню та отриманню нових переваг для екосистем великих міст регіону. Крім того, переробка відходів рослинного та тваринного походження може мати суттєві економічні результати. Підкреслено, що відкриття нових центрів з переробки натуральних відходів демонструє соціально відповідальну поведінку всієї країни та готовність Сербії до членства в ЄС.

Ключові слова: відходи органічного походження; компост; соціально відповідальна поведінка; стійкий розвиток; Воєводина.

Табл. 5. Літ. 22.

**Слободан Попович, Менсур Цемалович, Ранко Мийич
ЭКОЛОГИЧЕСКИЕ И ЭКОНОМИЧЕСКИЕ АСПЕКТЫ
УТИЛИЗАЦИИ НАИМЕНЕЕ ОПАСНЫХ ОТХОДОВ В КОНТЕКСТЕ
УСТОЙЧИВОГО РАЗВИТИЯ РЕСПУБЛИКИ СЕРБИЯ**

В статье доказана важность грамотной организации даже наименее вредных отходов в контексте концепции устойчивого развития. Доказано, что открытие нескольких новых локаций по переработке таких отходов в северной части Сербии (Автономный край Воєводина) будет способствовать лучшему планированию и получению новых преимуществ для эко-систем больших городов региона. Кроме того, переработка отходов растительного и животного происхождения может иметь ощутимые экономические результаты. Подчёркнуто, что открытие новых центров по переработки натуральных отходов

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демонстрирует социально ответственное поведение всей страны и готовность Сербии к членству в ЕС.

Ключевые слова: отходы органического происхождения; компост; социально ответственное поведение; устойчивое развитие; Воеводина.

Introduction. Monitoring of wastes as objects or substances that owners want to dispose or discard should always be considered from the environmental point of view too. An increasing number of laws ensures disposal of most categories of waste. Less hazardous categories should be regarded as goods, not as expenses. The objective of socially responsible behavior with less hazardous waste should include larger percentage of processing of such waste. Products which could be returned to the soil and which may have positive effects on the environment can be produced through such processing.

Through organized management of processing less hazardous animal and vegetable waste one could make products with measurable market value. For instance, waste from the slaughtering industry (bones and meat) could be processed into food for farm animals, one can further process fat and soft parts from abattoir waste which could be mixed with the remains of vegetable waste to accelerate the process of compost producing.

All products have their certain value. If they are not produced on the territory of the state, then they must be imported. Waste from the slaughtering industry, as well as vegetable waste generated in a certain areas and then deposited in landfills, requires funds for this disposal. With this study the authors point out to the fact that better organization and application of already adopted laws are the will of the state, that it is crucial for wider community to have greater benefits from the practical use of less hazardous waste management which would require opening a number of processing locations. Furthermore, this does not have to be expensive, so that investments can be repaid.

References. Preparation of this paper was based on publicly available data from the Statistical Office of the Republic of Serbia (Official Gazette of the Republic of Serbia 104, 2009; Official Gazette of the Republic of Serbia 24th, 2011), obtained in accordance with international standards and recommendations adopted by the European Parliament No 2150/2002. The authors have processed the obtained data and presented it in this paper, as well to the professional community for review. The authors point out that many solutions from this study can be used and be applied to the whole territory of the Republic of Serbia, and in other countries too.

Material and method. The authors show the total amount of generated waste in the Republic of Serbia in Table 1 (2011–2013, per ton), in order to give the public the opportunity to have insight into quantities of waste disposal in question, which is in accordance with the Waste Management Law of the Republic of Serbia (Official Gazette of the Republic of Serbia 36/2009).

In order to get a more complete overview on the problem of waste disposal in the Republic of Serbia, in addition to the amount of waste by years the authors included the overview of the amount of less hazardous waste by groups, for the years from 2011 to 2013 (Table 2).

From Table 1 it is clear that the total amount of waste generated during the observation period (2011–2013) has a constant growth, and this growth is a bit high-

er in the total amount of generated hazardous waste. The authors of this paper took into account the possibilities for the processing of animal and vegetable waste as a basis for further research. Therefore, the total amount of vegetable and animal waste in 2012 as compared to 2011 decreased by about 13%, which is noticeable, the decline continued in 2013 and it was about 54%. Another important feature of this group of waste in comparison with other categories is the extremely low level of risk and that it can be easily processed into useful products, which are commercially measurable and can be sold at open markets.

Table 1. Total waste generated by groups of waste for the period of 2011–2013, per ton, authors' calculations, based on the Statistical Yearbook of the Republic of Serbia for 2014

Groups of waste	Year of observation			
	2010	2011	2012	2013
Mineral waste	33,122,500	48,526,538	54,329,800	57,722,067
Chemical and medical waste	80,726	61,928	62,957	90,528
Recycling	147,863	155,908	273,277	338,164
Animal and vegetable waste	213,482	201,765	177,480	96,158
Mixed waste	43,879	50,422	177,363	136,109
Sludge	981	681	1,891	3,480
Electronic equipment	3,091	4,131	9,960	4,145
Total	33,612,520	49,001,373	55,032,727	58,390,651

Table 2. Total hazardous waste generated by groups for the period of 2011–2013, tons, authors' calculations, based on the Statistical Yearbook of the Republic of Serbia for 2014

Groups of waste	Year of observation			
	2010	2011	2012	2013
Mineral waste	11,082,962	12,732,526	14,329,800	16,674,243
Chemical and medical waste	76,837	57,154	56,129	85,320
Recycling waste	1,596	1,957	406	234
Animal and vegetable waste	0	0	0	0
Mixed waste	55	1,772	632	466
Sludge	0	0	0	0
Electronic equipment	622	3,381	3,385	1,960
Total	11,162,072	12,796,188	14,457,990	16,762,223

Results and discussion. The category of less hazardous waste deposited in the Republic of Serbia results from the processing of approximately 900 facilities engaged in the slaughter of animals as well as meat processing in Serbia, as well as by removal of grass and parts of plants from green areas of large cities. Processing and disposal of slaughtered animal carcasses produces annually about 28,000 t/year in Serbia. Only about 20% of this amount is covered by processing. The remaining amount of about 22,000 t/year is deposited without prior treatment to landfills, mostly in large towns. The average amount of less hazardous waste that can be easily processed into useful products such as compost in the period from 2010–2013 amounted to about 170,000 tons.

In theory, without any additional special effort, about 150,000 tons of vegetable waste and about one third of the 22,000 tons of animal waste could be processed.

Therefore, the average amount in the mentioned period, which could be processed, is about 160,000 tons, which is essentially the basis of, for example, production of compost or other products with high usability and market value.

In order to conduct such processing one must build waste treatment facilities, in particular, for processing animal waste. We think processing facilities should be built in the northern part of the Republic of Serbia in the following locations: Sombor, Zrenjanin, Backa Topola, Sremska Mitrovica and Vrbas, as well as two closed type facilities in Zitiste and Plandiste. In the rest of the Republic of Serbia there are already two processing centres in: Belgrade (currently not operating) and in Cuprija. Tabular data presentation of locations for the processing of waste from the slaughter industry in Vojvodina, i.e. in the Northern part of Serbia is given in Table 3.

Table 3. Populated areas that have the capacity for processing animal waste in the Northern part of the Republic of Serbia, i.e. the Autonomous Province of Vojvodina, authors' calculations

The place where animal waste is processed on the territory of Vojvodina	Gravitating population	% to the total population of AP Vojvodina	% in the total population of the Republic of Serbia
Sombor	90,000	4.1	1.2
Zrenjanin	130,000	6	1.7
Backa Topola	40,000	1.81	0.53
Sremska Mitrovica	90,000	4.1	1.2
Vrbas	50,000	2.27	0.66
Zitiste	5,000	0.23	0.06
Plandiste	15,000	0.68	0.2
Total population which has options for disposal of animal waste in the municipalities in which they reside	420,000	19.1	6

Note: the last column indicates the % of population in relation to the total population of Serbia which has the possibility of animal waste disposal in the city of residence, taking into account all places where they can process the waste on the territory of the Republic of Serbia.

Based on the above, we can clearly see that the situation in Serbia is extremely bad even in the part of the country where there is a possibility for processing the abattoir waste. Specifically, in the Northern part of the Republic of Serbia, even if 5 new processing facilities would be built, that would mean that about 20% of Vojvodina population would be encompassed by processing capacities in their municipalities, and in broader sense, these facilities would cover about 6% of the total population of Serbia. The situation could be improved in Vojvodina relatively easily by building another 3 processing centres, and then the picture would be quite different, as it can be seen in Table 4.

With the introduction of 3 new sites for processing animal waste on the territory of Vojvodina the situation would be much improved in that part of the Republic of Serbia because processing of animal waste would be such that it would satisfy about 50% of population needs in the region. In addition, it would improve the safety in the event of extraordinary measures, such as floods in Serbia, as occurred in 2014 when tens of thousands of animals died under the flood waters.

Table 4. After the functional establishment of 8 processing facilities for the slaughter industry in the Northern part of the Republic of Serbia, Autonomous Province of Vojvodina, authors' calculations

Locations for processing animal waste on the territory of Vojvodina	Gravitating population	% in total population of AP Vojvodina	% in total population of the Republic of Serbia
Sombor	90,000	4.1	1.2
Zrenjanin	130,000	6	1.7
Backa Topola	40,000	1.81	0.53
Sremska Mitrovica	90,000	4.1	1.2
Vrbas	50,000	2.27	0.66
Zitiste	5,000	0.23	0.06
Plandiste	15,000	0.68	0.2
Novi Sad	450,000	20.5	6
Subotica	150,000	6.8	2
Kikinda	70,000	3.18	0.93
Total population which has options for disposal of animal waste in the towns in where they reside	1,090,000	49.58	14.93

Hence, the security situation in the immediate vicinity of the EU would be improved, since Subotica is a town which is about 20 km away from Hungary and similar distance is between Kikinda from the Republic of Serbia and Romania, which, again, is the member of EU. Safety of several countries would be raised in a case of natural disasters due to prompter processing of dead animals.

Table 5. Economic effects of processing less hazardous waste into a useful products – compost, authors' calculations

The amount of processed useful waste, tons	% of average processed less hazardous waste in Serbia, in relation to total estimated amount of useful waste for the period of 2011–2013	Average retail price of compost per ton in early 2015 in Serbia	Economic effects, obtained after processing less hazardous plant and animal waste in Serbia, according to average selling retail prices as of January 2015, mln EUR
16,000	10	409	6.54
32,000	20	409	13.08
48,000	30	409	19.63

Processing of less hazardous waste of plant and animal origin into products such as compost can be extremely useful in solving the problems of land, especially those related to the erosion phenomena (Hort et al., 2013; Mihaiescu, 2013), because adding and mixing it with the layer of existing soil contributes to better conditions for planting.

During the last decades of the 20th century efforts were taken for an inter-disciplinary approach which would solve ecological problems. The eco-economic aspect began to dominate, especially in the EU. In this context, we can see an increasing number of scientific approaches that include socioeconomic studies (Popovic, 2014),

but also in marketing that is directly linked to sustainable development of areas (Eremic-Dodic and Platisa, 2010; Eremic-Dodic et al., 2011; Eremic-Dodic, 2013; Karic et al., 2013; Kotler et al., 2006; Kotler and Lee, 2007; Popovic et al., 2014; Sedlak et al., 2016). Socially responsible behaviour of company has become a must (Dib et al., 1995; Dinu, 2011), which many authors see not only as a particular situation, but as a long-term process.

The ecological approach is particularly evident in times of economic crisis, when economy has the major impact on sustainable development (Davis, 1993), especially in small and developing countries. In this paper the authors try to emphasize the importance of processing less hazardous waste into useful products, with minimal investments, adding that there is another value obtained through processing wastes, and which is measurable and which affects the ecology of areas for future generations (Manic et al., 2013; Popovic et al., 2014; Popovic et al., 2015; Popovic et al., 2016).

Introduction of three new sites for processing animal waste that could be mixed with the waste of plant origin in Serbia would significantly raise safety of less hazardous waste disposal. At the same time products would be made by processing, which would be the main raw material for production of useful products such as compost. The product of these activities could have large ecological and economical effects on the areas in the near vicinity of the EU countries, i.e. Hungary and Romania. The most important ecological and economic benefits include:

- The existing laws in Serbia are by more than 80% in compliance with the laws on ecology in the EU and EU encourages processing of all types of waste, especially if the result of such processing is useful product.
- With the opening of 3 new sites it raises the coverage area of Vojvodina with locations for processing less hazardous waste from 19.1% to 49.58%.
- The result of processing less hazardous waste is compost, a product that has value as a commodity, individually considered, and as a product incorporated into the soil it has even more value from the environmental standpoint.
- The amounts of total less hazardous waste are relatively constant they are a renewable resource that can be processed into useful products, which can be then returned to nature.

This paper provides an overview of processing less hazardous waste into compost on the basis of calculation according to average retail prices in the Republic of Serbia, according to the average rate of the National Bank of Serbia as 21/01/2015 (1 EUR = 122.07 dinars).

Conclusions. The authors claim the great importance of processing less hazardous waste and abandoning the current behaviour in terms of irreversible and inadequate depositing of less hazardous waste of plant and animal origin on the territory of Serbia. The authors gave realistic amounts of all types of waste in the Republic of Serbia during the period of 2011–2013, deposited in landfills. One of the ways to reduce unnecessary and improper depositing of less hazardous plant and animal waste is processing them into useful products that will be returned to nature.

Besides the ecological approach in this paper, the authors presented their economic valuation of the created quantities through the production of compost by processing it in the range of 10–30% of less hazardous waste. We point out that so far all the amounts of waste have been disposed in landfills unnecessarily, thus billing tax-

payers. Our results indicate economically measurable effects if this part of production would create a product such as compost in the amount of 6.54 to 19.63 mln EUR per annum, as compared to the average sale prices of compost calculated on the basis of prices as of January 2015 in the Republic of Serbia.

References:

Zakon o popisu stanovništva domaćinstva i stanova 2011 godine // Census Law of the Republic of Serbia, Official Gazette of the Republic of Serbia // www.paragraf.rs.

Zakon o upravljanju otpadom // Law on Waste Management of the Republic of Serbia, Official Gazette of the Republic of Serbia 36/2009 // www.paragraf.rs.

Davis, J. (1993). Strategies for environmental advertising. *The Journal of Consumer Marketing*, 10(2): 19–36.

Dibb, S., Simkin, L., Pride, W., Ferrell, O. (1995). *Marketing*. Mate, Zagreb.

Dinu, V. (2011). Corporate Social Responsibility – Opportunity for Reconciliation between Economic Interests and Social and Environmental Interests. *Amfiteatru Economic*, 13(29): 6–7.

Eremic-Dodic, J. (2013). Implementacija B2B modela na primeru javnog preduzeca. *Anali*: 59–67.

Eremic-Dodic, J. (2013). Revizijske procedure vrednovanja internih kontrola informacionog sistema na bazi kontrolnih ciljeva. Doktorska Disertacija. Univerzitet u Novom Sadu, Ekonomski Fakultet u Subotici, Novi Sad.

Eremic-Dodic, J., Hajder, V., Dodic, V. (2011). Pristup kontroli loga i znacaj interne kontrole metodologijom COBIT-a. XXXVIII, Simpozijum o operacionim istrazivanjima (pp. 265–268). Beograd, Serbia.

Eremic-Dodic, J., Platisa, G. (2010). Uloga i znacaj interne kontrole Informacionog sistema u preduzecu. XXXVII Simpozijum o operacionim istrazivanjima (pp. 271–274). Beograd, Serbia.

Hort, D., Cantor, M., Buta, E., Husti, A. (2013). Control of Soil Erosion on Slopes by Using Dendrological Species. *ProEnvironment*, 6: 499–502.

Karic, D., Karic, D., Zecevic, R. (2013). Znacaj medunarodnih finansijskih institucija u funkciji finansiranja zastite zivotne sredine. *Ecologica*, 20: 121–126.

Kotler, P., Lee, N. (2007). *Korporativna drustvena odgovornost*. Hesperia, Beograd.

Kotler, P., Wong, V., Saunders, J., Armstrong, G. (2006). *Osnove marketinga*. Mate, Zagreb.

Manic, M., Riznic, D., Vukovic, M. (2013). Ekonomska kriza i njen uticaj na održivi rast ekonomije pograničnih oblasti Srbije. *Ecologica*, 20: 39–44.

Mihaiescu, T. (2013). Assessment of Soil Erosion Risk in Fizes River Catchment Using USLE Model and GIS. *ProEnvironment*, 6: 595–599.

Popovic, S. (2014). Socio-ekonomski faktori ogranicenja razvoja agrara. Feljton, Novi Sad.

Popovic, S., Eremic-Dodic, J., Grubljesic, Z., Mijic, R., Novakovic, S. (2014). Unconventional marketing in agricultural enterprises. XXII International Conference Ecological Truth, Eco1st, 14 Bor (pp. 342–347). Serbia.

Popovic, S., Martinovic, B., Majstorovic, A., Ugrinovic, M., Garic, R. (2015). Development of Economy of the Republic of Serbia through processing less hazardous Waste into useful products, the case of Compost. *Bulletin UASVM Agriculture*, 72(1): 305.

Popovic, S., Popovic, V., Toskovic, J., Grubljesic, Z., Duranovic, D. (2016). Opcije i perspective pre-grade manje opasnog otpada u profitabilni proizvod: slucaj proizvodnje komposta u Republici Srbiji. In: *Agroeconomia Croatia* (pp. 17–25).

Popovic, S., Toskovic, J., Grubljesic, Z. (2014). Environmental-Economic Model of Developing Composters in Parks, Protected Areas and City Limits in the Republic of Serbia. *ProEnvironment*, 7: 213–217.

Republic Statistical Office of the Republic of Serbia. 2011 Census of Population // popis2011.stat.rs.

Sedlak, O., Jovin, S., Pejanovic, R., Ciric, Z., Eremic-Dodic, J. (2016). Access to finance mikro, small and medium business units in Serbian agribusiness. In: *Ekonomika poljoprivrede* (pp. 1219–1233).