Revista de Chimie
https://revistadechimie.ro
https://doi.org/10.37358/Rev.Chim.1949

Reducing the Phenomenon of PPW (Pollution with Plastic Waste) Through Legislative and (Bio)Economic Solutions

COSTICA ROMAN, IONEL BOSTAN*
Stefan cel Mare University of Suceava, Faculty of Economics and Public Administration, 13 Universitatii Str., 720229, Suceava, Romania

Abstract: *This undertaking, starting from a global synthetic assessment of the PPW phenomenon, aims at highlighting the most important/recent coordinates regarding PPW, the risks it involves, affecting the environment and, respectively, life on Earth, but - at the same time - the solutions for preventing/fighting the respective phenomenon. Our motivation is that PPW is currently experiencing an unprecedented expansion, given that not all countries of the world, especially some in Asia, are adequately involved, protecting the consequence of the massive spill of plastics into the seas and oceans. Focusing more on this issue, as manifested in the EU and Romania, taking into account the strategies adopted here, we try to identify solutions to reduce the phenomenon of PPW, located in the circular economy. Our options are clear for the nominated area, as it is suitable for protecting the environment from plastic pollution and can also stimulate growth and innovation.*

Keywords*: Pollution with plastic waste, indicators, risks/hazards, prevention/fighting measures, legislative/institutional adaptations*

1. Introduction

Nowadays, pollution with plastic waste (PPW) is a widespread phenomenon, the consequences of which have become among the most harmful to the environment and, respectively, to life on Earth [1]. We say this because beyond the exaggerated quantities of packaging of this nature chaotically abandoned, an easily visible situation (at the level of the ground/underground, running/dead water - Figure 1), we face also - due to the persistence of this phenomenon for decades - another kind of risk.

Figure 1. Plastic waste chaotically abandoned in the environment (Authors compilation [2-4])

Specifically, we refer to those due to the appearance and spread of plastic particles (micro-plastic - particles < 5 mm, macro-plastic - particles > 5 mm [5]) following free decay, over time, of the respective waste, often under the action of natural factors.

**email: ionel_bostan@yahoo.com*

Thus, micro-plastic, which has become a major and aggressive pollutant of the ground and the underground, air and water, induces some of the highest risks to human health and to all elements of flora and fauna, at a global level. On the other hand, the fact that many of the food packaging is made of plastic (foam or Styrofoam) lead to negative effects on human health (Figure 2).

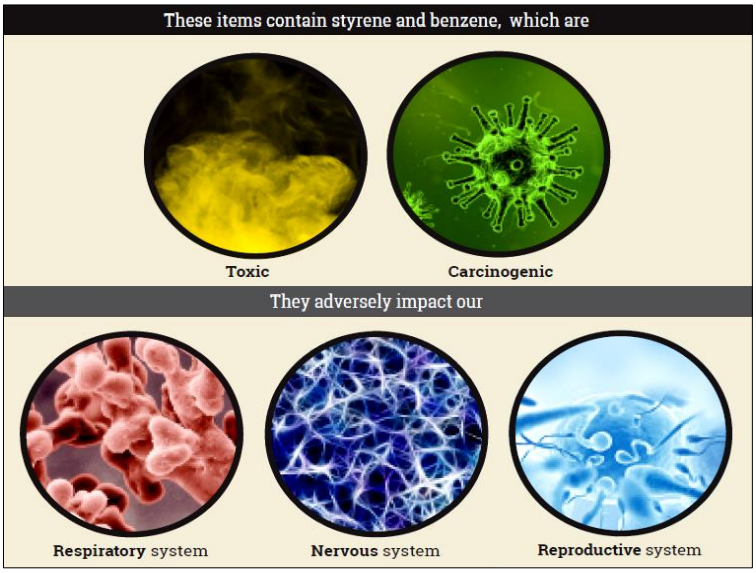

Figure 2. Negative impact of Styrofoam on our health [6]

For this reason, this work aims at highlighting some quantitative and qualitative aspects related to the phenomenon in question, international/European and national concerns about reducing PPW, insisting on institutional/legislative solutions limited to circular economy. Regarding the issue of waste management in Romania, we emphasize that an important short-term objective is the better application of the principles of sustainable management of material resources, which emphasizes the component of recycling and other elements of bio-economic relevance [7]. This goal is in line with the recent EU vision related to the new circular economy of plastic materials, which involves the creation of a smart, innovative and sustainable industrial sector. Its advantages are that it would be a definite economic growth generator, leading to the emergence of new jobs after a period of crisis [8] but also to the reduction of greenhouse gas emissions and/or the import of fossil fuels to the EU [9].

2. Materials and methods

Focusing on the means prevalently required to counteract the PPW phenomenon, we start from some quantitative assessments related to that phenomenon, based on the investigation of bibliographic sources containing indubitable data and information, developed by prestigious specialty institutions. Also, after consulting the literature, the authors resort to selecting/synthesizing the statistical content of materials recently published by institutions whose main concern is to inform all stakeholders about key issues related to the topic of our paper: the United Nations Environment Program, PlasticsEurope, Greenpeace, STATISTA, the European Commission, Eurostat, the Romanian Government, the National Institute of Statistics (RO). It is important to emphasize that certain subjects related to this topic have been addressed by us, directly or indirectly, in other papers published in prestigious scientific publications, focusing especially on the environmental components connected to the economic aspect [10-11]. The bibliographic documentation of the authors of this paper aimed at the most recent literature, but also involved the use of research methods such as analysis, comparison, logical deduction, etc. We emphasize that, as far as we are concerned, in the elaboration of this paper, we have taken into account, mainly, recent data (for the last five years), of high accuracy and maximum confidence.

3. Results and discussions

3.1. The phenomenon of PPW: a global synthetic assessment

The consumption needs of modern man have led to a growing demand for the plastics production sector. Globally, from the middle of the last century to the present day, the deliveries in this sector have showed an exclusively upward trend (Figure 2).

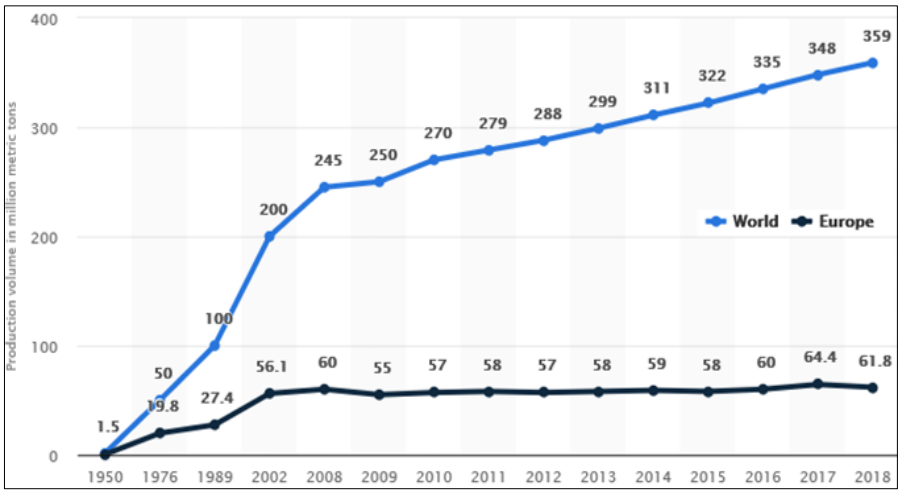

Figure 2. Global plastics production from 1950 to 2018 (in million metric tons) [12]

The uses are among the most diverse [13]: from food packaging, storage and transport containers, various items for infrastructure, construction and civil engineering, aircraft, ships/yachts, motor vehicles and rolling stock (railway), care and laboratory medicine, to sports and leisure equipment and accessories, etc. However, approx. 70% of this production goes to three sectors: packaging (39.7%), construction (19.8%) and the automotive industry (10.1%) [14]. As showed by Figure 3, the Asia-Pacific area is the one that has experienced a particular expansion of the plastics industry production capacity (approx. half of the world's production [15]).

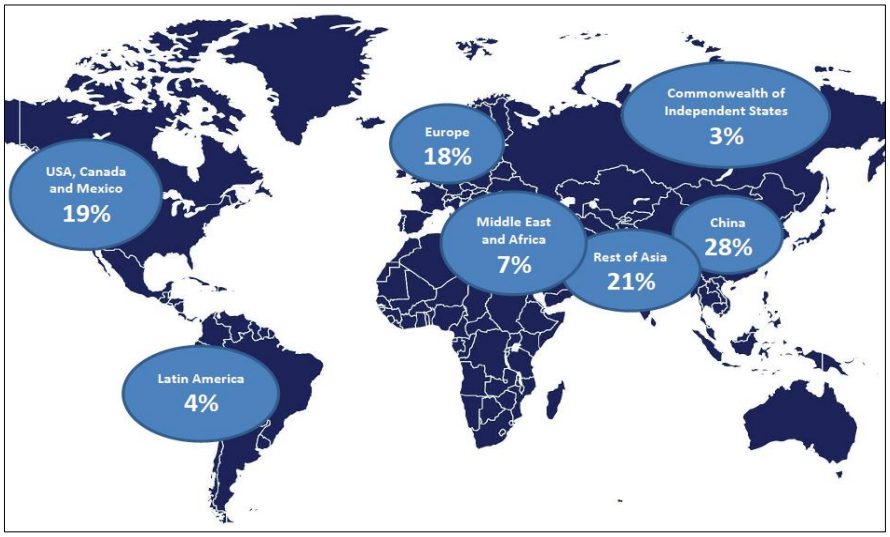

Figure 3. Global distribution of plastics production [16]

The problem that arises is that, even if approx. 40% of the plastic production is directed to packaging, and these, to a significant extent, are materialized in packaging for soft drinks, annually, less than 7% of disposable cans (PETs), intended for the packaging of those drinks, are made of recycled plastic [17]. A

study conducted by Greenpeace estimated that, in 2014, 530 billion PETs were produced globally, and since then, an annual increase of 4.7% should have been added [17]. Such studies have noted the low concern of soft drink manufacturers with reducing the use of plastic as packaging and that a low share of recycled plastic is still maintained, situations which, associated with the negligence/indiscipline of the consumer population and of the authorities, ultimately lead to the plastic ending up in nature and the oceans, polluting and affecting biodiversity for a long time to come. According to some studies, 1.15 to 2.41 million tons of plastic are transported by the world's rivers/streams to the oceans, each year [18]. The situation is worse, especially in some Asian countries, and this can be explained by deficiencies in terms of social/human behaviour but also by the poor functionality of sanitation systems. We can have an image of the situation in this area if we consider the rivers/streams which rank first in terms of the amount of plastic waste transported to the oceans (Table 1).

Table 1. The world's top 15 rivers/streams that determine the ocean's PPW [18]

Catchment	Lower mass input estimate ($t\,yr^{-1}$)	Midpoint mass input estimate ($t\,yr^{-1}$)	Upper mass input estimate ($t\,yr^{-1}$)	Total catchment surface area (km^2)	Yearly average discharge ($m^3\,s^{-1}$)
Yangtze	3.10×10^5	3.33×10^5	4.80×10^5	1.91×10^6	1.58×10^4
Ganges	1.05×10^5	1.15×10^5	1.72×10^5	1.57×10^6	2.08×10^4
Xi	6.46×10^4	7.39×10^4	1.14×10^5	3.89×10^5	5.53×10^3
Huangpu	3.35×10^4	4.08×10^4	6.73×10^4	2.62×10^4	4.04×10^2
Cross	3.38×10^4	4.03×10^4	6.5×10^4	2.38×10^3	2.40×10^2
Brantas	3.23×10^4	3.89×10^4	6.37×10^4	1.11×10^4	8.18×10^2
Amazon	3.22×10^4	3.89×10^4	6.38×10^4	5.91×10^6	1.40×10^5
Pasig	3.21×10^4	3.88×10^4	6.37×10^4	4.07×10^3	2.07×10^2
Irrawaddy	2.97×10^4	3.53×10^4	5.69×10^4	3.77×10^5	5.49×10^3
Solo	2.65×10^4	3.25×10^4	5.41×10^4	1.58×10^4	7.46×10^2
Mekong	1.88×10^4	2.28×10^4	3.76×10^4	7.74×10^5	6.01×10^3
Imo	1.75×10^4	2.15×10^4	3.61×10^4	7.92×10^3	2.79×10^2
Dong	1.57×10^4	1.91×10^4	3.17×10^4	3.33×10^4	8.54×10^2
Serayu	1.33×10^4	1.71×10^4	2.99×10^4	3.71×10^3	3.70×10^2
Magdalena	1.29×10^4	1.67×10^4	2.95×10^4	2.61×10^5	5.93×10^3

Input rate estimates (in $t\,yr^{-1}$) are representative of mismanaged plastic waste (MPW) production and catchment runoff. A lower, midpoint and upper estimate is calculated based on three regression analyses accounting for uncertainties in our field observations data set.

Obviously, the PPW of the ocean is not determined only by rivers/streams, as various coastal activities, including the daily life of the inhabitants of those areas or tourism along the beaches, also contribute to the same phenomenon. Thus, it is estimated that 5 to 13 million tons of plastics (1.5-4% of the global production) end up in the oceans each year [19], with all the resulting negative consequences.

3.2. The recent EU vision related to the new circular economy of plastics

EU Member States own a plastics sector including 60,000 companies, with 1.5 million workers. The turnover achieved is of approx. EUR 350 billion, with a profit of approx. 20% [15]. In addition to the fact that we are dealing with a top economic sector (which produces more than 67 million metric tons each year [12]), it must be said that it generates approx. 26 million tonnes of plastic waste, of which only about 8 million tonnes are recycled (the proportions being totally unsatisfactory as compared to current requirements - Figures 4-6). Therefore, a significant part of them (approx. 2/3) is incinerated or disposed of in landfills, or simply abandoned in nature [20].

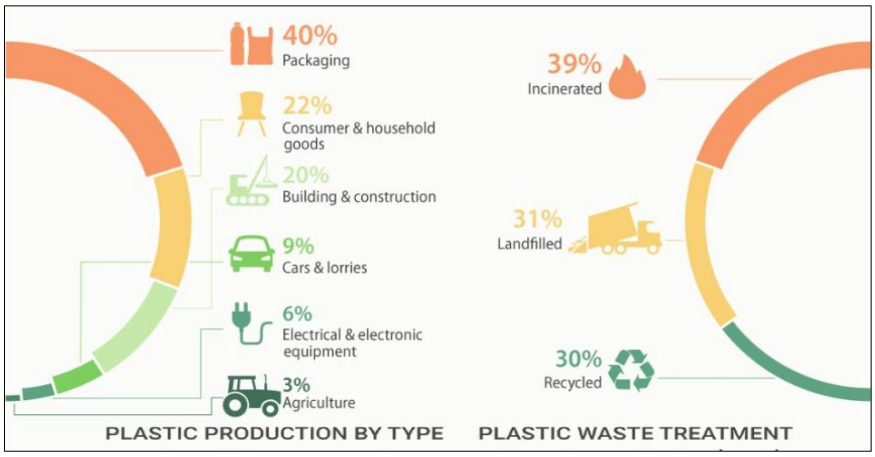

Figure 4. Destination of plastics production by category and plastic waste treatment (EU-2016) [21]

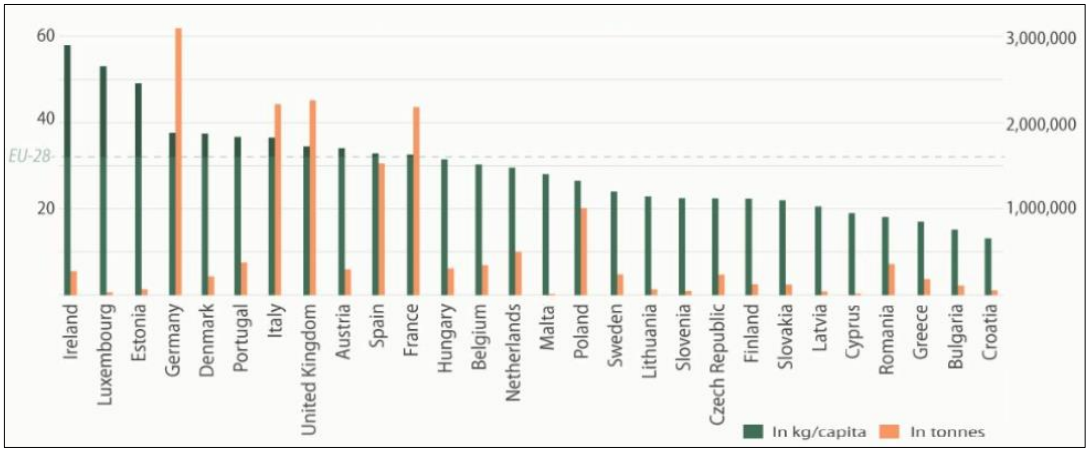

Figure 5. The amount of plastic packaging waste (EU-2016) [21]

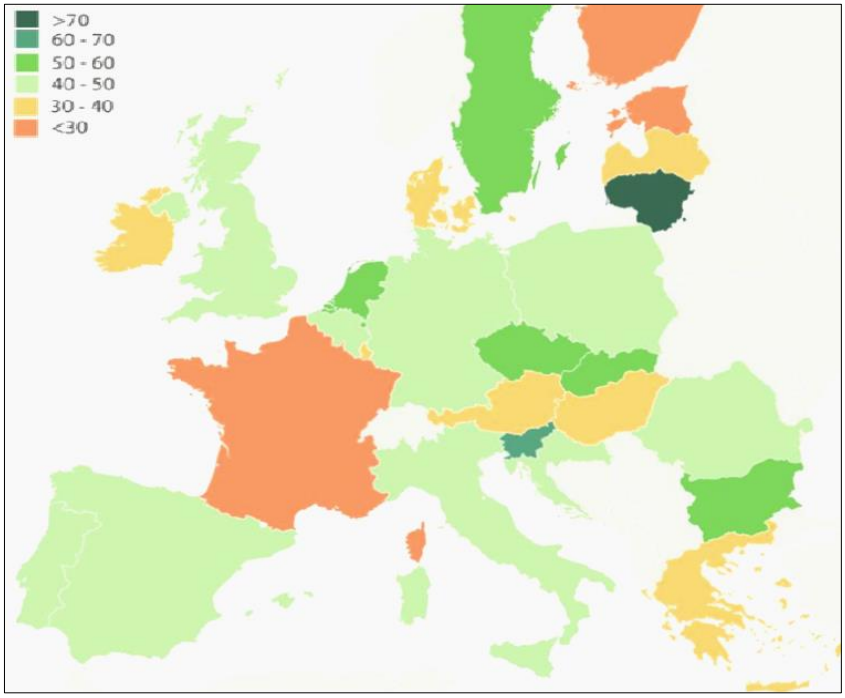

Figure 6. Plastic packaging waste recycling rate (EU-2016) [21]

The European sector in question is working to recover as much as possible and to reuse "Post-consumer" waste, in addition to the production waste collection and reuse systems. However, on the beaches of the seas in the European area, including the North-East Atlantic, plastic waste has a significant presence, along with waste of other kinds, in different proportions (Figure 7).

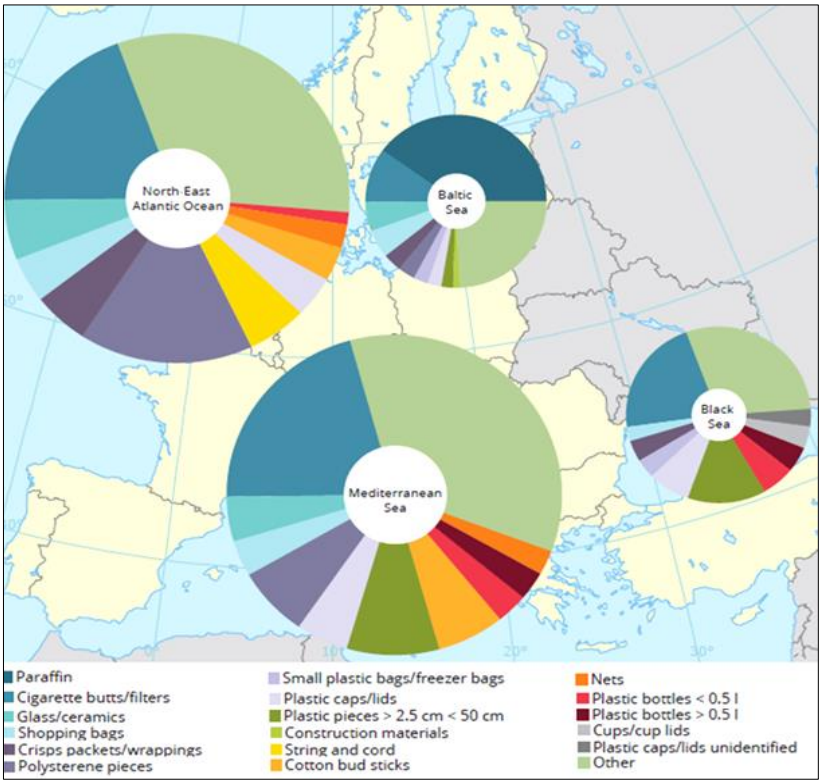

Figure 7. The presence of plastic waste, in various proportions, along with other types of waste, on the beaches of the seas in the European area, including the North-East Atlantic [22]

The adoption of strict regulations meant that in the EU28 - plus Switzerland and Norway, the recycling rate reached 73% in 2016 [15]. Here, the ways of reusing recycled plastic materialized in the production of thermal energy by combustion, 42%, and the recovery of materials and components, 31%, and 27% were classified as irrecoverable waste. The plastic packaging recycling rates exceed 20% in all European countries, half of which exceed 65% [15]. Further increase of the recycling rate means - prior to all plastic packaging in the EU being recyclable by 2030 - measures for stimulating the recycled plastic market, beyond banning certain single-use plastic (Oxo-degradable and expanded polystyrene) items (plates, cutlery, Q-tips, beverage straws, food/beverage containers [23] and limiting the number of plastic bags. These measures would include the granting of tax incentives (i.e. reduction of VAT for recycled products), the establishment of mandatory rules on the minimum recycled content in certain products, or the introduction of quality standards for secondary plastics [21], respectively the waste (more than 2/3 of what is found in the ocean) resulting from the degradation of relatively large plastic objects - fishing nets, plastic cans or bags. Moreover, the strategy adopted by the EU Commission on plastics focuses on several components of circular economy (Figure 8), aiming at protecting the environment from plastic pollution and stimulating growth and innovation.

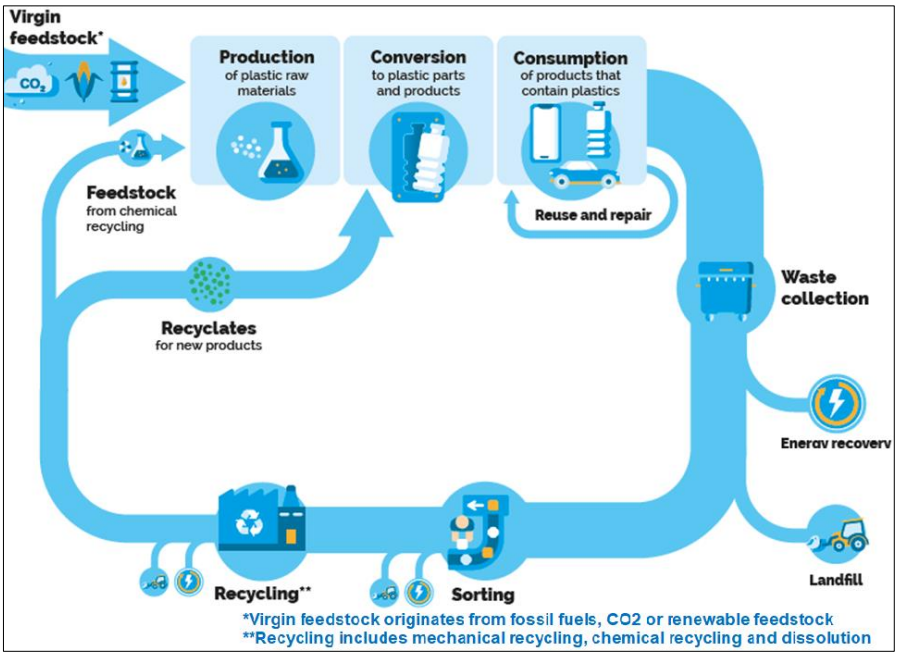

Figure 8. A model of circular economy of plastics [24]

This strategy is accompanied by a Monitoring Framework which includes ten indicators to quantify the progress in the transition towards a circular economy within the EU. Once implemented, it is expected that recycling will become much more profitable for businesses, will stimulate investments and innovation, ultimately encouraging change around the world [9].

3.3. Concerns regarding the mitigation of the phenomenon of PPW in Romania; institutional/ legislative solutions limited to the circular economy

The Integrated Waste Management Systems in Romania (objectives included in priority axis 2 of the Sectoral Operational Program Environment/SOPE 2007 - 2013), which include collection units, sorting stations, recycling facilities and compliant waste disposal storage units, have been subjected to an investment effort amounting to EURO 1.3 billion [7]. However, the projected parameters were not achieved, which can be explained by the quality deficiencies of the waste that is processed in that system. At the level of 2018, even if the legislation was imperative for the local public authorities to ensure the separate collection of municipal waste, the provisions in question have not been complied with. As a result, the percentage of recycling - for paper, metal, plastic and glass waste resulting from household waste - barely exceeded 7%. This happened, even if it had been agreed with the EU, to reach, by December, 31 2020, a level of readiness for reuse and recycling of at least 50% of the total mass generated, for the mentioned types of waste. Moreover, what is reported here also explains the fact that the EC/European Commission - Ares (2018) 2193346 warned Romania with regard to the procedure for pre-suspension of interim payments from the Cohesion Fund under axis 3. Specifically, "it did not adopt economic instruments providing for the achievement of the objectives regarding the reuse and recycling of waste by 2020 pursuant to art. 11 para. (2) of Directive 2008/98/EC" [7]. Analysing the national legal framework (Law no. 211/2011 on the waste regime, Law no. 249/2015 on the management of packaging and packaging waste, the Government Emergency Ordinance no. 196/2005 on the Environmental Fund), as recently amended [25], we appreciate that it ensures the premises for the better capitalization of the projects included in SOPE 2007-2013 and LIOP/Large Infrastructure Operational Program 2014-2020, because [7]:

- It provides for credible opportunities for converting waste management into sustainable materials management, in order to "protect, preserve and improve the quality of the environment, to protect human health, to ensure the prudent, efficient and rational use of natural resources, to promote the principles of

the circular economy, to increase energy efficiency (…), to create new economic opportunities and to stimulate long-term competitiveness".

● It establishes criteria and performance indicators for sanitation operators, sorting stations and recycling facilities.

● It details measures to ensure the achievement of the objectives regarding the recycling and recovery of recyclable waste from municipal waste.

● It introduces special economic instruments (i.e. discouraging the disposal of waste by storing it, payment schemes depending on the amount of waste generated - applying the principle "pay for what you throw away", the extended manufacturer responsibility scheme, money back guarantee scheme for the return of reusable packaging) promoting the application of the waste hierarchy formula which includes discouraging the disposal of waste through storage and incineration, etc.

● It clearly defines the extended manufacturer responsibility scheme, stating that it is "a set of measures according to which product manufacturers must bear financial or financial and organizational responsibility for the management of the waste stage of a product's life cycle".

Regarding the same legal framework, we also note that it is adequately adapted to the requirements of the EU legislation on packaging and packaging waste [26-29]. In terms of *plastic policy*, in order to ensure the mitigation of the PPW phenomenon, Romania will have to take into account the fact that all EU countries have to reach, within the next 10 years, a level of collection of 90% for plastic cans/bottles. The recycled content for the same (PETs), must reach a minimum of 25% by 2025, and to exceed the 30% threshold by 2030 [30]. If in the EU, as an average of the Member States, approx. 42% of plastic packaging waste was recycled in 2017 (Figure 9), Romania does not register significant deviations, generating 359,036 tons of plastic waste and recycling 167,554 t, tending towards a recycling rate of 50% [31].

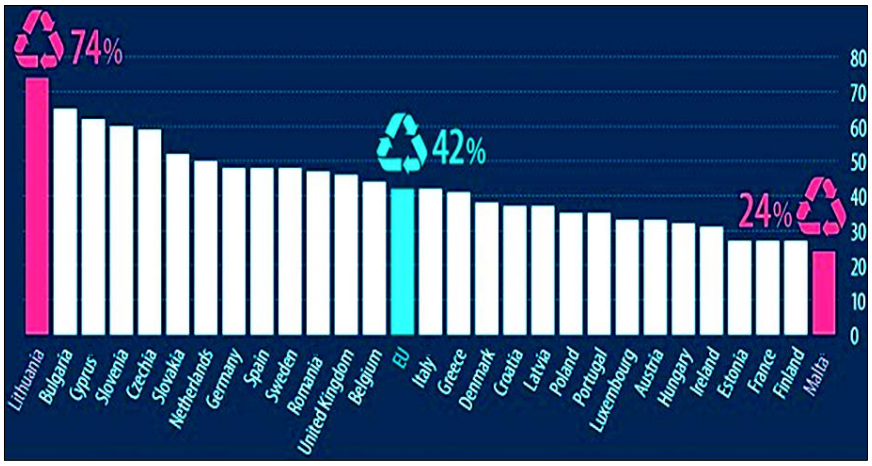

Figure 9. Plastic packaging waste recycling rate (2017)
(Source: https://ec.europa.eu/eurostat/)

In strict accordance with those provided in the Circular Economy Package [32], the amendments of Law no. 249/2015 on the management of packaging and packaging waste [25] include provisions aimed at stimulating the increase of the share of reusable packaging placed on the market. We appreciate that the establishment of a "guarantee-return system, starting with March 31, 2022, for primary non-reusable packaging of glass, plastic or metal, with volumes between 0.1 - 3 L, targeting economic operators who make available, on the national market, beer, beer mixes, mixtures of alcoholic beverages, cider, other fermented beverages, juices, nectars, soft drinks, mineral waters and drinking water of any kind", would be of great efficiency [7], added to the regulation of the "money guarantee of 0.5 lei/packaging for reusable primary packaging used for products intended for human consumption, as of March 31, 2019" [7]. We also note that, as of the beginning of 2019, it has been established that it is mandatory for companies that introduce on the national market products packaged in reusable packaging, to organize a system for taking over reusable packaging, so as to achieve a percentage of return as high as possible

(min. 90%). Thus, all these, to which we referred in here, provide for a high degree of feasibility of the objectives proposed by the National Strategy for the sustainable development of Romania (2030). We consider, for example, "a 65% recycling rate of packaging waste by 2025 (plastics 50%; wood 25%; ferrous metals 70%, aluminium 50%, glass 70%, paper and cardboard 75%) and 70% by 2030 (plastics 55%; wood 30%; ferrous metals 80%, aluminium 60%, glass 75%, paper and cardboard 85%)" [33].

Our research reveals that some quantitative aspects are able to confirm that Romania is clearly in line with the European trends related to the subject of our study. First of all, we take into account the fact that the production of plastics will increase to 164 kt in 2020, as compared to 151 kt in 2018. Then, the consumption in this respect will reach 748 kt in 2020, as compared to 698 kt in 2018. In support of this finding, we also mention the relatively satisfactory ratio between the production of plastics and the capacity to recycle plastic waste in Romania, which is approaching 285 kt/year (of which 134 kt/year - PET waste and 150 kt/year - other plastic waste) [34]. Such coordinates are meant to validate the fact that the trajectory of circular economy in the national space is congruent with the one outlined at EU level, making the Romanian contribution to the development of a sustainable European economy really significant, Romania's effort in this sense being obvious/notable.

However, we appreciate that, in relation to the topic addressed, it is important for Romania to extend the R-C-R modalities (reuse, composting and recycling) in order to bring the levels of generated waste and recycled waste as close as possible to one another.

4. Conclusions

Our research confirms the importance of reducing the PPW phenomenon, given the risks and hazards affecting human health/life and all elements of flora and fauna, on a global level. After conducting a global synthetic assessment of the PPW phenomenon, noting some alarming trends, especially with regard to the fact that 5 to 13 million tons of plastics (1.5-4% of the global production) end up in the oceans each year, with all the negative consequences arising from it, we have focused on the vision that has recently emerged at EU level related to the new circular economy of plastics. Here, as stricter discipline is imposed (incomparably higher than what we find in Asia, for example), the recycling of plastic packaging reaches rates exceeding 20%, half of the EU Member States exceeding the level of 65%. Further increase of the recycling rate in the EU means - prior to all plastic packaging in the EU being recyclable by 2030 - measures for stimulating the recycled plastic market, beyond banning certain single-use plastic items and limiting the number of plastic bags. These measures would include the granting of tax incentives, the establishment of mandatory rules on the minimum recycled content in certain products, or the introduction of quality standards for secondary plastics. Our conclusion on the EU Commission's strategy on plastics, is that it places particular emphasis on the components of circular economy, with a particular focus on protecting the environment from plastic pollution and stimulating growth and innovation. Also, after researching the concerns regarding the mitigation of the PPW phenomenon in Romania, we found that here too the institutional/legislative solutions circumscribed to the circular economy prevail. Thus, in strict accordance with those provided in the Circular Economy Package, the last amendments of Law no. 249/2015 on the management of packaging and packaging waste include provisions aimed at stimulating the increase of the share of reusable packaging placed on the market. These - highlighted in our paper - provide for a high degree of feasibility of the objectives proposed by the National Strategy for the sustainable development of Romania (2030), and if we consider the achievements so far, it is confirmed that Romania is clearly in line with the European trends related to the subject of our research. As the desire to bring the level of generated waste as close as possible to the level of recycled waste still remains, the quantitative coordinates we referred to during our approach are meant to validate the fact that the trajectory of the circular economy in the national space is congruent with the one outlined at EU level, making the Romanian contribution to the development of a sustainable European economy really significant.

References

1. BARAN B., Plastic waste as a challenge for sustainable development and circularity in the European Union. *Ekonomia i Prawo. Economics and Law*, 2020, 19(1):7–20. Doi:10.12775/EiP.2020.001.
2.SAPUTRA M., Plastic waste pollution. Meulaboh, Indonesia, 2020. Available at: https://www.shutterstock.com/editorial/image-editorial/plastic-waste-pollution-meulaboh-indonesia-02-jan-2020-10516851e
3. ***THE DYING RIVERS OF ASEAN, Villagers search for recyclable waste as they stand on top of floating garbage covering the Citarum river in Bandung, West Java province in Indonesia. The ASEAN Post Team, 23 July 2018. Available at: https://theaseanpost.com/article/dying-rivers-asean
4.*** JAPAN ENVIRONMENTAL CONSULTANT CO. Available at: http://www.vina-cues.com/cues/chi-tiet/?1168/plastic-pollution-in-the-world-s-oceans-interactive-map-reveals-wh/
5. SCHMIDT C., KRAUTH T., WAGNER S., Export of Plastic Debris by Rivers into the Sea. *Environ. Sci. Technol*, 2017, 51(21):12246-12253. Available at: http://dx.doi.org/10.1021/acs.est.7b02368
6.***UNITED NATIONS ENVIRONMENT PROGRAMME, Sıngle-use plastıcs: A Roadmap for Sustainability, UNEP, 2018, ISBN:978-92-807-3705-9, DTI/2179/JP, p.15.
7.ROMANIAN GOVERNMENT, Notă de fundamentare la OUG no. 74/2018 pentru modificarea și completarea Legii nr. 211/2011 privind regimul deșeurilor (…). Available at: https://www.gov.ro/ro/guvernul/procesul-legislativ/note-de-fundamentare/nota-de-fundamentare-oug-nr-74-17-07-2018&page=5
8. BOSTAN I., GROSU V., The social effects of the current economic crisis on the European Union labour market. *Revista de Cercetare şi Intervenţie Socială*, 2010, 31, 7-21.
9. ***COM (2018)28 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A European Strategy for Plastics in a Circular Economy {SWD(2018)16final}. Available at: https://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf
10.BOSTAN I., BURCIU A., CONDREA P., Trends of the communitarian cohesion policies and advertising for eco-investments, *Environ Eng Manag J*, 2010, **9**(6):847-851.
11. MATES D., GROSU V., HLACIUC E., BOSTAN I., BUNGET O., DOMIL A., MORARU M., ARTENE A., Biological assets and the agricultural products in the context of the implementation of the IAS 41: A case study of the Romanian agro-food system, *Arch. Biol. Sci*., 2015, **67**, 705–714. DOI:http://dx.doi.org/10.20961/jab.v19i2.449.
12. *** STATISTA, Global plastic production from 1950 to 2018. Available at: https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/
13. *** TEHNICĂ ȘI TEHNOLOGIE, Materiale plastic: Analiză de piaţă (I), July 11. 2019. Available at: https://www.ttonline.ro/revista/materiale-plastice/analiza-de-piata-materialele-plastice-si-cauciucul-trend-ascendent-la-nivel-mondial-i
14. *** PLASTICSEUROPE, Plastics – the Facts 2018. An analysis of European plastics production, demand and waste data. Available at: https://www.plasticseurope.org/application/files/6315/4510/9658/Plastics_the_facts_2018_AFweb.pdf
15. CRISTEA R., La nivel global, masele plastice și cauciucul mențin un trend ascendent, Pack-Romania, Octombrie 6, 2019. Available at: https://pack-romania.ro/la-nivel-global-masele-plastiice-si-cauciucul-mentin-un-trend-ascendent
16. BARRA R., LEONARD S., WHALE C., BIERBAUM R., Plastics and the Circular Economy - A STAP Document, Global Environment Facility and UN Environment. DOI:10.13140/RG.2.2.11515.57128.
17. BRENIUC I., Milioane de PET-uri din materiale nereciclate, aruncate anual. Ce companii sunt responsabile, *Green.ro*, 16 March 2017. Available at: https://www.green-report.ro/poluare-milioane-pet-uri-companii-responsabile/

18. LEBRETON L., van der ZWET J., DAMSTEEG J.-W., SLAT B., ANDRADY A., REISSER I., River plastic emissions to the world's oceans. *Nat Commun*, 2017, 8, 15611. Available at: https://doi.org/10.1038/ncomms15611
19. JAMBECK J.R., GEYER R., WILCOX C., SIEGLER T.R., PERRYMAN M., ANDRADY A., NARAYAN R., LAVENDER K., Plastic waste inputs from land into the ocean, *Science*, 2015, Vol. 347, Issue 6223, pp. 768-771. DOI:10.1126/science.1260352.
20. *** EUROPARL. How to reduce plastic waste: EU strategy explained. Available at: https://www.europarl.europa.eu/news/en/headlines/society/20180830STO11347/how-to-reduce-plastic-waste-eu-strategy-explained
21.*** EUROPARL, Plastic waste and recycling in the EU: facts and figures. Available at: https://www.europarl.europa.eu/news/ro/headlines/society/20181212STO21610/deseurile-din-plastic-si-reciclarea-in-ue-in-cifre
22.*** EUROPEAN ENVIRONMENT AGENCY. Marine Litter Watch, Citizens collect plastic and data to protect Europe's marine environment, Published 8 June 2018, ISSN:2467-3196, ISBN:978-92-9213-966-7. Doi:10.2800/63064.
23.*** EUROPARL, Parliament and Council agree drastic cuts to plastic pollution of environment, Press release ENVI 19-12-2018. Available at: https://www.europarl.europa.eu/news/ro/press-room/20181219IPR22301/parliament-and-council-agree-drastic-cuts-to-plastic-pollution-of-environment
24.*** PLASTICSEUROPE, The Circular Economy for Plastics. A European Overview. PlasticsEurope AISBL, Brussels – Belgium, p. 9. Available at: https://issuu.com/plasticseuropeebook/docs/plastic_europe_study_final_spread
25. *** ROMANIAN GOVERNMENT, OUG no. 74/2018 pentru modificarea și completarea Legii nr. 211/2011 privind regimul deșeurilor (…), Monitorul Oficial no. 630 din 19 iulie 2018. Available at: http://www.ecoteca.ro/wp-content/uploads/2019/01/OUG_74_2018-2.pdf
26. *** DIRECTIVE 2008/98/EC, The European Parliament and of the Council - on waste and repealing certain Directives. Available at: http://data.europa.eu/eli/dir/2008/98/oj
27.*** DIRECTIVE 94/62/EC, European Parliament and Council - on packaging and packaging waste. Available at: http://data.europa.eu/eli/dir/1994/62/oj
28.*** DIRECTIVE (EU) 2018/851, European Parliament and of the Council - amending Directive 2008/98/EC on waste. Available at: http://data.europa.eu/eli/dir/2018/851/oj
29.*** DIRECTIVE (EU) 2018/852, European Parliament and of the Council - amending Directive 94/62/EC on packaging and packaging waste. Available at: http://data.europa.eu/eli/dir/2018/852/oj
30.*** EUROPARL, Parliament and Council agree drastic cuts to plastic pollution of environment, Press release ENVI 19-12-2018. Available at: https://www.europarl.europa.eu/news/ro/press-room/20181219IPR22301/parliament-and-council-agree-drastic-cuts-to-plastic-pollution-of-environment
31. NEAGU L., Câte ambalaje din plastic reciclăm? – Date Eurostat. Deseuri, Studii, 12 November 2019. Available at: https://www.green-report.ro/cate-ambalaje-din-plastic-reciclam-date-eurostat/
32. BOURGUIGNON D., New circular economypackage, European Parliamentary Research Service, ENPE573.899. Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573899/EPRS_BRI%282016%29573899EN.pdf
33. CELAC S., VĂDINEANU A. (Coord.), Strategia națională pentru dezvoltarea durabilă a României 2030, Bucureşti: Paideia, 2018, ISBN:978-606-748-261-4, pp. 78-81. Available at: http://dezvoltaredurabila.gov.ro/web/wp-content/uploads/2018/12/Strategia-na%C8%9Bional%C4%83-pentru-dezvoltarea-durabil%C4%83-a-Rom%C3%A2niei-2030.pdf

34. TÂRȚIU V.E. (Coord.), ȘTEFĂNESCU M., PETRACHE A.M., GURĂU C.R., Tranziția catre o economie circulara. De la managementul deseurilor la o economie verde in Romania, Institutul European din Romania, Studii de Strategie si Politici SPOS-2018, 2019. Bucuresti, ISBN:978-606-8202-62-4. Available at: http://ier.gov.ro/wp-content/uploads/2019/03/Final_Studiul-3_Spos-2018_Economiecircular%C4%83-1.pdf

Manuscript received: 14.01.2020