# Assessment models of the environmental indicators at European level

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**Abstract**. According to the European Green Deal and the 2030 Agenda for Sustainable Development, the degradation of the natural environment is an actual phenomenon with a high impact on all three dimensions of sustainable development: economic, social and environmental. Thus, in order to mitigate these effects, the European Green Deal aims to transform Europe by 2030 "into a modern, competitive and resource-efficient economy". In this sense, the aim is to achieve climate neutrality by 2050, to dissociate economic growth from resource use / consumerism and, last but not least, to leave no person or place left behind. Therefore, this paper analyses a set of environmental indicators specific to the level of the EU-27 Member States for 2015 vs. 2020. The objectives of this paper are to (1) identify the trend of environmental indicators in each Member State of the European Union, and (2) to signal the risks to the states that are below the European average in terms of the indicators analysed. This paper contributes to the studies conducted in this field through models for assessing the progress of environmental indicators in the EU-27 and the unique set of indicators analysed. The countries that have made the most significant progress in terms of revenues from environmental taxes, the rate of use of materials from the circular economy and greenhouse gas emissions in 2020 are 1) Greece, 2) the Netherlands, and 3) Luxembourg.
**Key Words**: bibliometric analysis, evaluation models, environmental indicators, EU-27.

**Introduction**. Given that the natural environment is "a source of natural and economic wealth", it is essential that we contribute to its conservation and protection. In this context, the European Green Deal has as its priorities the protection of biodiversity and ecosystems, the reduction of air, water and soil pollution, the transition to the circular economy, the improvement of waste management and the sustainability of the blue economy and fisheries. Moreover, through these actions, the European Commission aims to reduce greenhouse gas emissions by 55% by 2030 (European Commission 2021). The 2030 Agenda also includes objectives that directly address environmental concerns, namely Objective 13 - Climate Action, Objective 14 - Aquatic Life and Objective 15 - Terrestrial Life (Department for Sustainable Development 2021). This paper aims to analyze a set of environmental indicators at the level of all EU-27 Member States in order to identify their trend and highlight the leaders at European level in this field, but also the countries below the European average. Thus, the work is organized in four parts. The first part corresponds to the review of the specialized literature, in which a bibliometric analysis will be performed. The research methodology section explains the set of environmental indicators chosen for the analysis. The Results and Discussions section is based on evaluation models based on the set of indicators chosen. Finally, the last section is dedicated to the Conclusions.

**Material and Method**. In the first part of the paper, a bibliometric analysis was performed on an inventory of the advertising activity in the field of environmental monitoring. In order to perform the bibliometric analysis, the VOSViewer software was used. There were analyzed 2.000 documents published between 2000 and 2020 and retrieved from the Scopus database. In the same chapter, Literature review, there were analysed other papers regarding circular economy and environmental taxes, extracted from Web of Science database. Furthermore, Table 1 presents the set of indicators chosen for the implementation of environmental assessment models at European level. The indicators, extracted from Eurostat database, are analyzed for 2015 vs 2020, in order to give complexity to the study.

Table 1

Indicators used in the analysis

| *Itm. no.* | *Eurostat code* | *Indicator name* | *Measurement unit* |
|---|---|---|---|
| 1 | ENV_AC_TAX | Environmental tax revenues | Percentage of PIB |
| 2 | ENV_AC_CUR | Circular material use rate | Percentage |
| 3 | ENV_AC_AIBRID_R2 | Air emissions accounts | Percentage |

Source: Eurostat.

It is considered that the selected indicators can provide a real picture of the environmental dimension in the EU-27 Member States, and the analysis of these variables can identify the countries that are at the top of the ranking, as well as those that are in transition to a sustainable model.

**Results and Discussion**

***Literature review***. The literature review was performed using the VOSViewer software. 2.000 articles containing the keywords "natural environment monitoring" were analyzed. Thus, Figure 1 shows the analysis of the collaboration relations between the states.

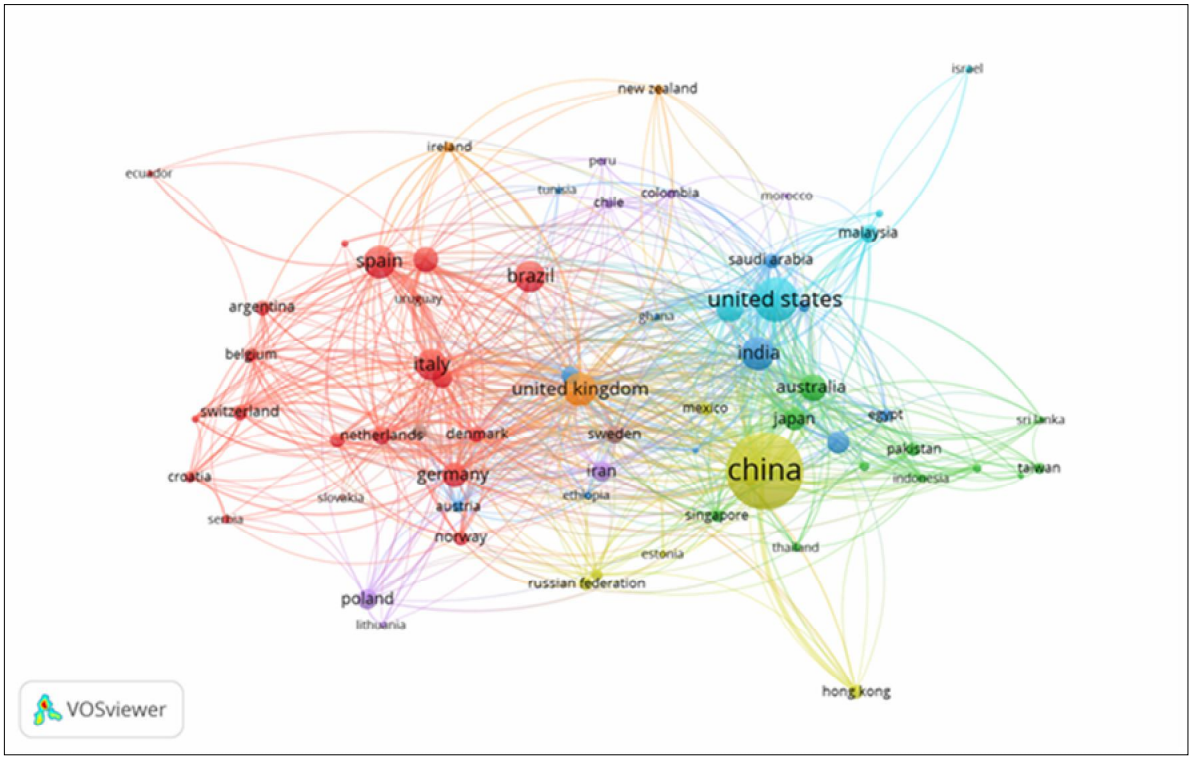


Figure 1. Analysis of the collaboration relations between states (Source: own conceptualization based on data from Scopus).

The state that ranks first in terms of collaborative relations between states for the production of scientific papers in the field of environmental monitoring is China, with 685 documents and 290 collaborative links. On second place is the United States with 234 published papers and 244 collaborative links. The analysis also identifies Romania with 7 published documents and 6 collaboration links with other states. Romania has collaborated with Argentina, Brazil, Italy, China and India to carry out scientific work in the field of environmental monitoring. Figure 2 shows the analysis of the keywords used in scientific papers.

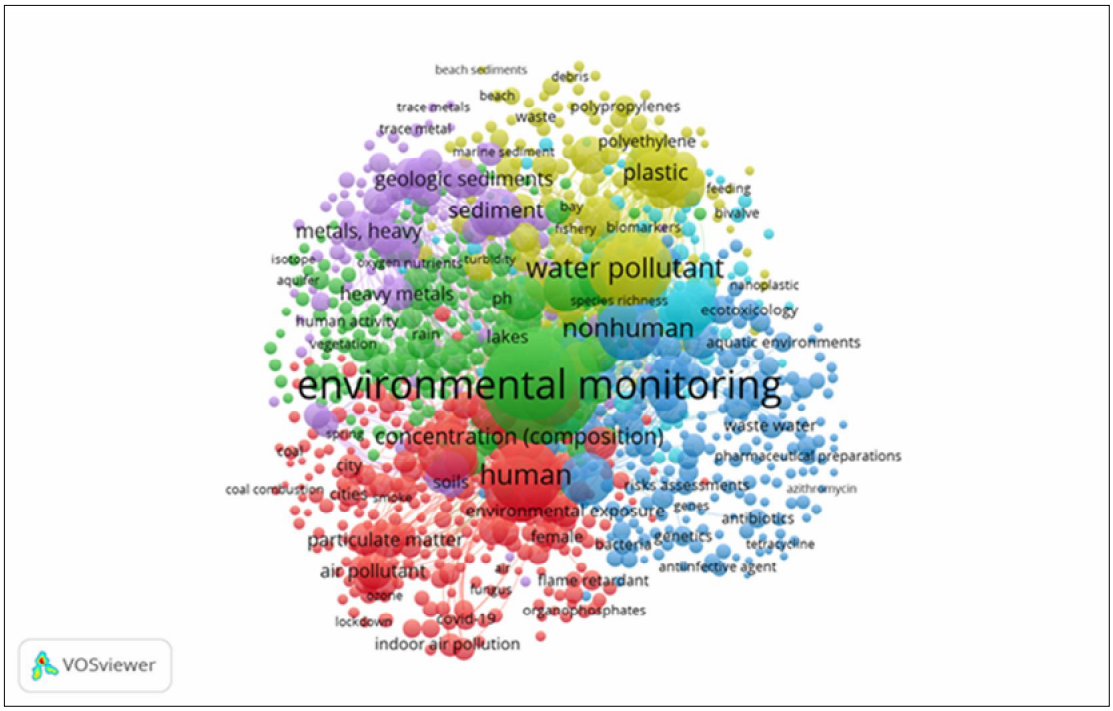


Figure 2. Keyword analysis (Source: own conceptualization based on data from Scopus).

Figure 2 shows the words that appeared most often in the 2.000 articles analyzed. The word with the most appearances is "environmental monitoring" with 2000 appearances, followed by "water pollutant" with 732 appearances and "human" with 730 appearances.

According to Tantau et al (2018), circular economy has become a global objective in the transition to the sustainable development. Thus, circular economy is based on waste integration from the beginning of the production cycle until its disposal. In this context, recycling municipal waste assures the transition to the circular economy (Tantau et al 2018). Furthermore, circular economy refers to transforming the waste into raw materials for another product, at the end of their life cycle (Van Buren et al 2016). As stated in another study, the recycling rate of municipal waste, circular material use rate, R&D expenditure, environmental tax revenues and resource productivity represent a complex set of environmental indicators that could contribute to the environmental monitoring of a country or region (Kunz et al 2018). At the same time, Yadav & Samadder (2018) consider that circular economy represent a production model which has minimum or no environmental impact. A different author suggests that circular economy refers to the 3R - reduce, reuse, recycle (Lakatos et al 2018). Although sustainability and circular economy represent a worlwide priority, there are still problems encountered when speaking about the reduction of the quantity of waste produced, as well as solutions for transforming the life cycle of a product so that it has a diminished environmental impact (Newton & Cantarello 2014). Therefore, Lewandowski (2016) claims that organic materials play an important role in waste reduction. According to his study, clients already preffer bio-based materials such as cotton, cork, wood fibre and hemp. Other author suggests that an important variable in analysing the efficiency of circular economy is the selective collection quality index. Cifrian et al (2013) claims that this indicator represents the percentage from the total amount of waste that is conditioned, taking into consideration a specific group of factors. Results of other study indicates that possible solutions for reducing waste production could be the reduction of raw materials usage, encouraging product reuse, repairing/refurbishing damaged products and repurposing an old product (Liu & Lu 2015). Bachus et al (2019) claims that approximatively 58% of the changes that occur in the recycling rate of municipal waste are influenced by the circular material use rate, R&D expenditure, resource productivity and domestic material use. The same study shows that recycling rate of municipal waste would increase at the same time with resource productivity, domestic material

consumption and, on the other hand, with a decrease in the environmental tax revenues (Bachus et al 2019). Nontheless, resource productivity and domestic material consumption have a strong statistical relationship with the recycling rate of municipal waste, which means that the two variables mentioned have a highly positive impact on the recycling rate (Cifrian et al 2013). Another important topic that should be analysed when talking about environmental monitoring is the Greenhouse Gas Emissions (GHGs) generated by the food production industry. Thus, according to Moberg et al (2021), a climate tax on food would have a beneficial impact for the mitigation of climate change, with an estimated reduction of 9% of the food-related GHGs. The same study suggests changing food prices in order to reduce consumption and modify the value-added tax system for the products that have a high enviornmental impact, at the same time with subsidising products that have a low-carbon footprint (Moberg et al 2021). Cederberg et al (2019) highlighted that GHGs emissions generated by food production also impact land and freshwater resources. Moreover, food production implies the usage of chemical substances in agriculture that affect both the environmental and human health (Lakatos et al 2018). Aleksandrowicz et al (2016) claims that plant-based diets have the potential to reduce GHG emissions and land use by 70%, as well as reducing water use by 50%. Simultaneously, other study indicates that if beef or pork would be replaced by larger shares of poultry, the consumption of water would increase (Kunz et al 2018). In addition to this, pork and chicken may have a higher impact on freshwater ecotoxicity than beef (Poore & Nemecek 2018). On the other hand, reducing consumption of beef could generate a conflict between climate mitigation and biodiversity conservation in pastures, as grazing animals play an important role in maintaining semi-natural pastures (Persson et al 2015). In the following part of the study, it will be presented the assessment models of the environmental indicators at European level. Thus, Table 2 shows the performance of Member States in terms of environmental characteristics indicators at EU level in 2015 compared to 2020. The evolution was measured as an absolute value between the values recorded in 2015 and those of 2020. Improvement ranking is calculated as the absolute difference, as mentioned above. In this context, the state with the largest differences is marked with 1, etc. The 2020 ranking was calculated taking into account the values for 2020. Performance discrepancies are calculated as the difference between the 2020 ranking and the evolution ranking.

The countries with the largest discrepancy in environmental tax revenues in 2015 vs 2020 are Slovenia (1/24), Denmark (2/24) and Ireland (3/24). On the other hand, the most insignificant difference for this indicator was reported in the case of Belgium, which ranks last in the analysis. In terms of the 2020 ranking, the highest share of environmental taxes as a percentage of GDP was recorded in Greece. Regarding the ranking made at the level of 2020, Romania ranks 20/24 in terms of the percentage of GDP allocated for environmental taxes. Furthermore, Table 3 presents the assessing progress on the utilization rate of materials obtained from the circular economy.

The countries with the largest discrepancy in the utilization rate of materials obtained from the circular economy in 2015 vs 2020 are the Czech Republic (1/21), Estonia (2/21) and Belgium (3/21). In the case of the Czech Republic, the value of the indicator increased by 6.5 p.p during the analyzed period (1.94 times). At the level of 2020, the highest value of the utilization rate of materials obtained from the circular economy corresponds to the Netherlands (1/21). Romania ranks 18/21 in 2020 vs 2015 and 26th in 2020 in the ranking on the utilization rate of materials obtained from the circular economy. Subsequently, Table 4 presents the assessment of progress on Greenhouse gas emissions.

The countries that recorded the most significant difference in terms of greenhouse gas emissions in 2015 vs 2020 are Estonia (1/26), Germany (2/26) and the Netherlands (3/26). Romania ranks 22/26 in 2020 compared to 2015 and 24/26 in 2020 in the ranking of greenhouse gas emissions. Nonetheless, Table 5 presents the assessment of the progress at national and multinational level.

Table 2

Assessing progress on environmental tax revenues

| *Country* | *Year 2015* | *Year 2020* | *2020 reported to 2015* | *Improvement ranking* | *2020 ranking* | *Performance discrepancies* |
|---|---|---|---|---|---|---|
| Belgium | 2.55 | 2.54 | -0.01 | 24 | 11 | -13 |
| Bulgaria | 2.95 | 3.03 | 0.08 | 19 | 7 | -12 |
| Czechia | 2.05 | 1.93 | -0.12 | 17 | 19 | 2 |
| Denmark | 3.97 | 3.17 | -0.8 | 2 | 3 | 1 |
| Germany | 1.92 | 1.71 | -0.21 | 12 | 22 | 10 |
| Estonia | 2.73 | 2.45 | -0.28 | 11 | 13 | 2 |
| Ireland | 1.89 | 1.21 | -0.68 | 3 | 24 | 21 |
| Greece | 3.83 | 3.77 | -0.06 | 20 | 1 | -19 |
| Spain | 1.93 | 1.75 | -0.18 | 13 | 21 | 8 |
| France | 2.16 | 2.18 | 0.02 | 23 | 16 | -7 |
| Croatia | 3.33 | 3.28 | -0.05 | 21 | 2 | -19 |
| Italy | 3.39 | 3.04 | -0.35 | 9 | 6 | -3 |
| Cyprus | 3.04 | 2.48 | -0.56 | 4 | 12 | 8 |
| Latvia | 3.5 | 3.1 | -0.4 | 7 | 5 | -2 |
| Lithuania | 1.85 | 1.93 | 0.08 | 19 | 19 | 0 |
| Luxembourg | 1.76 | 1.39 | -0.37 | 8 | 23 | 15 |
| Hungary | 2.47 | 2.18 | -0.29 | 10 | 16 | 6 |
| Malta | 2.7 | 2.27 | -0.43 | 6 | 15 | 9 |
| Netherlands | 3.32 | 3.16 | -0.16 | 14 | 4 | -10 |
| Austria | 2.38 | 2.1 | -0.28 | 11 | 17 | 6 |
| Poland | 2.65 | 2.55 | -0.1 | 18 | 10 | -8 |
| Portugal | 2.42 | 2.38 | -0.04 | 22 | 14 | -8 |
| Romania | 2.47 | 1.92 | -0.55 | 5 | 20 | 15 |
| Slovenia | 3.88 | 2.95 | -0.93 | 1 | 8 | 7 |
| Slovakia | 2.5 | 2.38 | -0.12 | 17 | 14 | -3 |
| Finland | 2.89 | 2.75 | -0.14 | 15 | 9 | -6 |
| Sweden | 2.15 | 2.02 | -0.13 | 16 | 18 | 2 |

Source: own conceptualization

Table 3

Assessing progress on the utilization rate of materials obtained from the circular economy

| *Country* | *Year 2015* | *Year 2020* | *2020 reported to 2015* | *Improvement ranking* | *2020 ranking* | *Performance discrepancies* |
|---|---|---|---|---|---|---|
| Belgium | 17.7 | 23 | 5.30 | 3 | 2 | -1 |
| Bulgaria | 3.1 | 2.6 | -0.50 | 17 | 23 | 6 |
| Czechia | 6.9 | 13.4 | 6.50 | 1 | 7 | 6 |
| Denmark | 8.3 | 7.7 | -0.60 | 16 | 14 | -2 |
| Germany | 12 | 13.4 | 1.40 | 12 | 7 | -5 |
| Estonia | 11.3 | 17.3 | 6.00 | 2 | 5 | 3 |
| Ireland | 1.9 | 1.8 | -0.10 | 21 | 25 | 4 |
| Greece | 1.9 | 5.4 | 3.50 | 8 | 18 | 10 |
| Spain | 7.5 | 11.2 | 3.70 | 7 | 10 | 3 |
| France | 18.7 | 22.2 | 3.50 | 8 | 3 | -5 |
| Croatia | 4.6 | 5.1 | 0.50 | 17 | 19 | 2 |
| Italy | 17.2 | 21.6 | 4.40 | 5 | 4 | -1 |
| Cyprus | 2.4 | 3.4 | 1.00 | 15 | 22 | 7 |
| Latvia | 5.3 | 4.2 | -1.10 | 14 | 21 | 7 |
| Lithuania | 4.1 | 4.4 | 0.30 | 19 | 20 | 1 |
| Luxembourg | 9.7 | 13.6 | 3.90 | 6 | 6 | 0 |
| Hungary | 5.8 | 8.7 | 2.90 | 10 | 12 | 2 |
| Malta | 4.6 | 7.9 | 3.30 | 9 | 13 | 4 |
| Netherlands | 25.8 | 30.9 | 5.10 | 4 | 1 | -3 |
| Austria | 10.7 | 12 | 1.30 | 13 | 9 | -4 |
| Poland | 11.6 | 9.9 | -1.70 | 11 | 11 | 0 |
| Portugal | 2.1 | 2.2 | 0.10 | 21 | 24 | 3 |
| Romania | 1.7 | 1.3 | -0.40 | 18 | 26 | 8 |
| Slovenia | 8.6 | 12.3 | 3.70 | 7 | 8 | 1 |
| Slovakia | 5.1 | 6.4 | 1.30 | 13 | 16 | 3 |
| Finland | 6.4 | 6.2 | -0.20 | 20 | 17 | -3 |
| Sweden | 6.7 | 7.1 | 0.40 | 18 | 15 | -3 |

Source:own conceptualization

Table 4

Assessment of progress on greenhouse gas emissions

| *Country* | *Year 2015* | *Year 2020* | *2020 reported to 2015* | *Improvement ranking* | *2020 ranking* | *Performance discrepancies* |
|---|---|---|---|---|---|---|
| Belgium | 10.733.019,76 | 9.555.190,94 | -1.177.828,82 | 12 | 9 | -3 |
| Bulgaria | 8.747.232,74 | 7.651.649,05 | -1.095.583,69 | 14 | 15 | 1 |
| Czechia | 11.114.474,47 | 10.233.545,22 | -880.929,25 | 17 | 6 | -11 |
| Denmark | 15.086.681,22 | 13.795.084,94 | -1.291.596,28 | 11 | 2 | -9 |
| Germany | 11.847.017,88 | 9.559.748,85 | -2.287.269,03 | 2 | 8 | 6 |
| Estonia | 14.535.548,56 | 9.075.395,43 | -5.460.153,13 | 1 | 11 | 10 |
| Ireland | 14.899.687,94 | 12.968.797,64 | -1.930.890,30 | 5 | 3 | -2 |
| Greece | 9.647.196,22 | 8.171.624,79 | -1.475.571,43 | 9 | 14 | 5 |
| Spain | 7.431.631,04 | 5.797.188,21 | -1.634.442,83 | 6 | 23 | 17 |
| France | 7.070.776,23 | 6.024.856,85 | -1.045.919,38 | 15 | 21 | 6 |
| Croatia | 5.720.274,99 | 5.758.178,11 | 37.903,12 | 26 | 25 | -1 |
| Italy | 7.474.291,69 | 6.615.829,78 | -858.461,91 | 16 | 19 | 3 |
| Cyprus | 9.762.422,41 | 9.722.757,77 | -39.664,64 | 25 | 7 | -18 |
| Latvia | 6.257.943,35 | 6.355.023,73 | 97.080,38 | 23 | 20 | -3 |
| Lithuania | 7.925.705,23 | 9.033.666,92 | 1.107.961,69 | 13 | 12 | -1 |
| Luxembourg | 17.988.192,39 | 15.765.390,08 | -2.222.802,31 | 4 | 1 | -3 |
| Hungary | 6.823.463,62 | 6.943.089,73 | 119.626,11 | 22 | 17 | -5 |
| Malta | 5.906.668,59 | 4.304.701,87 | -1.601.966,72 | 7 | 27 | 20 |
| Netherlands | 12.732.959,56 | 10.287.183,3 | -2.445.776,26 | 3 | 5 | 2 |
| Austria | 8.309.426,14 | 7.603.641,37 | -705.784,77 | 19 | 16 | -3 |
| Poland | 10.571.433,18 | 10.330.715,48 | -240.717,70 | 21 | 4 | -17 |
| Portugal | 6.792.738,98 | 5.990.020,82 | -802.718,16 | 18 | 22 | 4 |
| Romania | 5.964.916,38 | 5.769.875,96 | -195.040,42 | 22 | 24 | 2 |
| Slovenia | 8.591.120,56 | 8.537.837,66 | -53.282,90 | 24 | 13 | -11 |
| Slovakia | 7.524.426 | 6.883.429,42 | -640.996,58 | 20 | 18 | -2 |
| Finland | 10.747.234,97 | 9.201.083,52 | -1.546.151,45 | 8 | 10 | 2 |
| Sweden | 6.136.261,38 | 4.802.388,06 | -1.333.873,32 | 10 | 26 | 16 |

Source:own conceptualization

Table 5

Assessment of progress at national and multinational level

| Country | Environmental tax revenues | | Circular material use rate | | Air emissions accounts | |
|---|---|---|---|---|---|---|
| | IR* | RML* | IR* | RML* | IR* | RML* |
| Belgium | 24 | 11 | 3 | 2 | 12 | 9 |
| Bulgaria | 19 | 7 | 17 | 23 | 14 | 15 |
| Czechia | 17 | 19 | 1 | 7 | 17 | 6 |
| Denmark | 2 | 3 | 16 | 14 | 11 | 2 |
| Germany | 12 | 22 | 12 | 7 | 2 | 8 |
| Estonia | 11 | 13 | 2 | 5 | 1 | 11 |
| Ireland | 3 | 24 | 21 | 25 | 5 | 3 |
| Greece | 20 | 1 | 8 | 18 | 9 | 14 |
| Spain | 13 | 21 | 7 | 10 | 6 | 23 |
| France | 23 | 16 | 8 | 3 | 15 | 21 |
| Croatia | 21 | 2 | 17 | 19 | 26 | 25 |
| Italy | 9 | 6 | 5 | 4 | 16 | 19 |
| Cyprus | 4 | 12 | 15 | 22 | 25 | 7 |
| Latvia | 7 | 5 | 14 | 21 | 23 | 20 |
| Lithuania | 19 | 19 | 19 | 20 | 13 | 12 |
| Luxembourg | 8 | 23 | 6 | 6 | 4 | 1 |
| Hungary | 10 | 16 | 10 | 12 | 22 | 17 |
| Malta | 6 | 15 | 9 | 13 | 7 | 27 |
| Netherlands | 14 | 4 | 4 | 1 | 3 | 5 |
| Austria | 11 | 17 | 13 | 9 | 19 | 16 |
| Poland | 18 | 10 | 11 | 11 | 21 | 4 |
| Portugal | 22 | 14 | 21 | 24 | 18 | 22 |
| Romania | 5 | 20 | 18 | 26 | 22 | 24 |
| Slovenia | 1 | 8 | 7 | 8 | 24 | 13 |
| Slovakia | 17 | 14 | 13 | 16 | 20 | 18 |
| Finland | 15 | 9 | 20 | 17 | 8 | 10 |
| Sweden | 16 | 18 | 18 | 15 | 10 | 26 |

Source: own conceptualization. IR * Improvement ranking; RML ** Ranking at multinational level.

According to Table 5, the countries that have made the most significant progress in terms of revenues from environmental taxes, the rate of use of materials from the circular economy and greenhouse gas emissions in 2020 are 1) Greece , 2) The Netherlands and 3) Luxembourg.

**Conclusions**. According to the European Green Pact and the 2030 Agenda for Sustainable Development, the degradation of the natural environment is a topical phenomenon with a high impact on all three dimensions of sustainable development: economic, social and environmental. Thus, in order to mitigate these effects, the European Green Deal aims to transform Europe by 2030 "into a modern, competitive and resource-efficient economy". In this context, the aim is to achieve climate neutrality by 2050, to dissociate economic growth from resource use / consumerism and, last but not least, to leave no person or place behind. The objectives of this paper on (1) identifying the trend of environmental indicators in each Member State of the European Union and reporting the risks to countries below the European average in terms of the indicators analyzed have been met. Thus, the countries that have made the most significant progress in terms of revenues from environmental taxes, the rate of use of materials from the circular economy and greenhouse gas emissions in 2020 are 1) Greece , 2) The Netherlands and 3) Luxembourg. On the other hand, one limitation of this study may be that the data were taken from Eurostat, while other variables with a significant connotation for the study could have contributed to its study. The results of this research

contribute to future studies in this field through the methodological framework that can be easily replicated for any data set.

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