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Water and Air Purification Technologies and Equipment in the Sustainable National Development Context

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Abstract: *The aim of this paper consists of an interdisciplinary approach to air and water environmental factors impact evaluation to eliminate the potentially adverse effects, using high-performance technologies and equipment so that the status of the ecosystems is not affected by human activities.*

This new era can be defined as the "Anthropocene Era" which impact also requires increased responsibility, conscious management, and environmental protection area-related activities.

The theoretical significance and applied value of the paper consists of highlighting the problems faced by Romania regarding the impact of pollution on the environmental factors of water and air, using performance methods and techniques.

The authors of the paper, following the risk analysis, highlight the impact generated by pollution, to reduce these effects and reach the targets assumed by Romania as a member state of the United Nations and the European Union, within the UN Summit for Sustainable Development.

Sustainable development also seeks to find a stable theoretical framework for decision-making in any situation where there is a human-environment relationship.

Sustainable development promotes the concept of reconciling economic and social progress without jeopardizing the natural balance of the planet and at the same time without compromising the ability of future generations to meet their own needs.

1. INTRODUCTION

The water and air importance for life, as components of the ecosystem, is increasingly clear in the "Anthropocene Era" whose impact requires increased responsibility too, conscious management, and related activities in the field of environmental protection.

The aim of the paper consists of an interdisciplinary approach to the evaluation of the impact on the air and water environmental factors in order to eliminate the potentially adverse effects, using high-performance technologies and equipment so that the state of the ecosystems is not affected by human activities.

The objectives of the paper were based on impact assessment and the modeling of ecological risks associated with the degree of water and air pollution. The basic method used was risk analysis in order to establish the impact on the environment.

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Environmental impact assessment methods used (Rojanschi & Grigore, 2006):

- The pollution index method – is applied for the water environmental factor (Ip). The model frames pollution indices on a creditworthiness scale with the help of which it was quantified the effects of pollutants.
- The Global Pollution Index (GPI) method – makes a synthetic assessment based on the quality indicators specific to the environmental factors, graphically correlated.
- The quality index method – allows for estimating the effects of environmental factors, transforming qualitative aspects into quantifiable quantitative quantities.

The authors of the paper, after analyzing the risks, highlight the impact of pollution, with the aim of reducing these effects and achieving the goals that Romania has taken as a member state of the United Nations and the European Union, within the framework of the UN Summit for Sustainable Development.

2. METHODS USED TO DETERMINE WATER POLLUTION

The methods used for the environmental impact assessment consisted of going through several stages of synthetic assessments based on quality indicators that reflect the state of the water environmental factors that are then correlated through graphic methods. The sources of pollution in Brăila County, of the Danube River, were identified and characterized. As a result of the Danube River monitoring, it was established that in the discharge points of wastewater from economic agents, there is a pronounced deterioration of the water quality.

The impact evaluation produced by industrial and agricultural activities was both analyzed and quantified. This assessment was also based on the ecotechnological analysis of the technological processes and the risks that can generate accidents in the environment (Amza, 2009).

Following the determinations carried out on raw water samples from the Danube, it was established that the high level that sometimes exceeds the allowed limit of pollution indicators is due to anthropogenic causes, which causes the heavy loading of the Danube River in the territory of Brăila county.

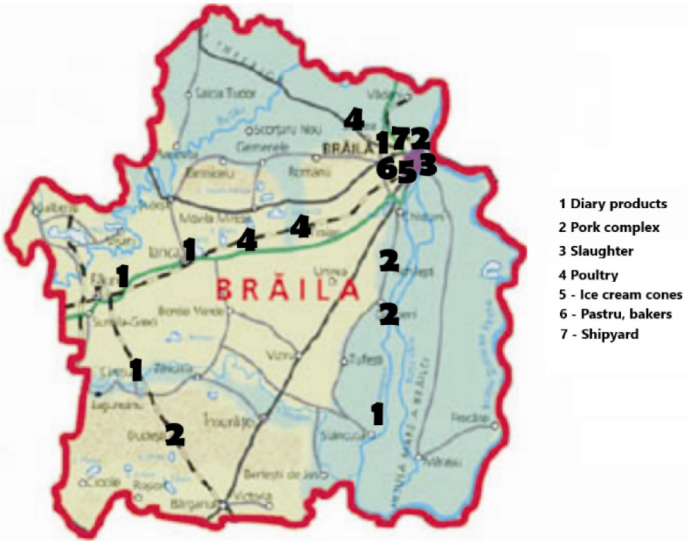

Figure 1. Location of the main pollution sources in Brăila County

Source: Own research

In order to present as explicitly as possible the impact that anthropogenic activities produce on the water environmental factor, these sources of pollution have been positioned on the map of Brăila municipality and county (Figure 1).

Environmental indicators may be used to measure both environmental performance and efforts to improve it (Avram, 2006).

The indicators may be used within the environmental management system to check how any company has reached its environmental policy targets, but they may be used by companies that have not developed such a system too.

In the zootechnical sector, pollutant emissions occur due to the high density of animals in relation to the agricultural area assigned to the zootechnical sector, the improper location of farms near-surface water, or on land with surface groundwater, near homes, the defective way of storage and drainage of effluents, the excessive use of manure accumulated in livestock farms.

The pollution index method used in assessing the impact on the environment establishes some limits between different degrees of pollution as well as general action measures on the polluting environmental factor. Pollution indices are placed on a creditworthiness scale (Rojanschi & Grigore, 2006).

The pollution index Ip is calculated for each environmental factor with the formula:

$$Ip = (CMA - CE)/(CMA + CE) \cdot 100 \quad (1)$$

CMA – maximum allowed concentration
CE – measured or estimated concentration

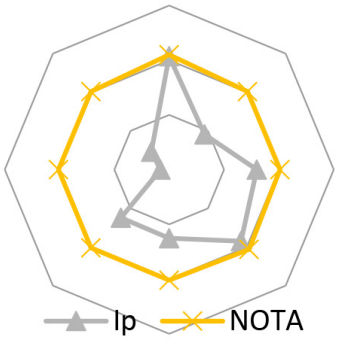

Figure 2. Graphical representation of Ip and the credit score for the pork breeding farm
Source: Own research

The global pollution index method was used as a method for evaluating the impact on the environment because it may be used to realize a synthetic assessment based on quality indicators that are then correlated graphically (Rojanschi & Grigore, 2006).

Figure 3 shows global pollution indices for a pork farm. The surface of the triangle resulting from the union of the effective credit points of each of the three environmental factors (Sr, mm^2) will represent the real state of the environment affected only by the activity proposed for analysis. The global pollution index I_{pg} is the ratio between S_i and S_r.

Figure 3. IPG Pork farm
Source: Own research

The global pollution index IPG represents the ratio between 100 and the arithmetic mean of the credit scores obtained on the assessed environmental components.

IPG = 5.35 – environment affected by human activity

The quality index method is a method that allows estimating the effects produced by a pork farm on environmental factors, it transforms the qualitative aspects into quantitative ones, that allow their aggregation and averaging on a scale of the following type (Macoveanu, 2003):

"+" → positive influence;
"0" → without influence;
"-" → negative influence.

Table 1 shows the effects of the pork farm on environmental factors.

Table 1. Effects on Environmental Factors

	Effects on environmental factors			
Sources of pollution	Water	Air	Ground	Human Health
Raw materials reception	0	0	0	0
Animal shelter	-1	0	0	0
Cleaning	-1	0	0	0
Wastewater evacuation	-1	0	0	-1
Excrement collection	-1	-1	-1	-1
Thermal plant	0	-1	0	0
Spread manure as fertilizer	-1	-1	-1	-1
Effect size	-5	-3	-2	-3

Source: Own calculations

Pork farms are characterized by a high pollution potential and a negative impact on the environment. The amount of manure, the complex chemical composition and the volume of mixture with wastewater, which is discharged from animal breeding complexes vary depending on a multitude of factors such as species, breed, size of the animals, type and the production system, system of maintenance and operation, feeding regime, technical condition and operation of installations and equipment.

The impact of livestock farms on the environment:

- the quality indicators of the discharged wastewater, except for pH, exceed the permitted limits imposed by both NTPA - 001 and NTPA 002;

- the most affected environmental factor is water because the discharged water is characterized by: high organic pollution, high fat content, high content of solid substances in the discharged water, and high content of disinfection and cleaning substances.

In conclusion, all three methods used in the assessment of the impact on the environment, lead to the same result, namely, mainly the pollution of the environmental factor water and then of the other environmental factors as well as of human health, is caused in the first place of insufficiently purified or untreated waters from animal breeding and meat processing farms, followed by dairy and pastry factories (Moater, 2006).

3. METHODS USED TO DETERMINE AIR POLLUTION

Ambient air quality is regulated in Romania by Law no. 104/2011 on ambient air quality with subsequent amendments and additions, transposing Directive 2008/50/EC of the European Parliament and of the Council on air quality and cleaner air in Europe and Directive 2004/107/EC of the European Parliament and of the Council regarding arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (Directive 2008/50/CE, Directive 2004/107/CE).

Air quality assessment, on the Romanian territory, is carried out based on common methods and criteria, established at the European level, by:

- measurements at fixed points of the pollutants regulated by law 104/2011, carried out continuously, in the automatic monitoring stations belonging to the National Air Quality Monitoring Network;
- modeling techniques;
- indicative measurements (Law no. 104/2011).

The automatic network in Braila County consists of 5 sampling points, located as follows:

- Brăila Station 1 - Traffic-type air quality monitoring station, which is located on Calea Galaţi, no. 53. Monitored pollutants NOx, SO2, CO, PM10, benzene.
- Brăila Station 2 - Urban air quality monitoring station, which is located in Piaţa Independţei no. 1. Monitored pollutants: NOx, SO2, CO, O3, PM10, PM2.5, benzene, weather parameters.
- Brăila Station 3 – Suburban air quality monitoring station, which is located in Cazasu Commune, Brăila County. Monitored pollutants: NOx, SO2, CO, O3, PM10, benzene, weather parameters.
- Brăila Station 4 – Industrial air quality monitoring station, which is located on Baldovineşti Road (North Station). Monitored pollutants: NOx, SO2, CO, O3, PM10, weather parameters.
- Brăila Station 5 – Industrial air quality monitoring station, was relocated to Ianca in December. Monitored pollutants: NOx, SO2, CO, O3, PM10, benzene, weather parameters.

Nitrogen oxides come mainly from the burning of solid, liquid and gaseous fuels in various industrial, residential, commercial, institutional and road transport installations. The concentrations of NO_2 in the surrounding air are evaluated using the hourly limit value for the protection of human health (200 µg/m^3), which can be exceeded 18 times/year, and the annual limit value for the protection of human health (40 µg/m^3), following Law no. 104/2011.

The hourly limit value for the protection of human health (200 µg/m^3) was not exceeded at any station. There were no exceedances of the alert threshold value (400 µg/mc average over 1 hour, measured 3 consecutive hours) for nitrogen dioxide.

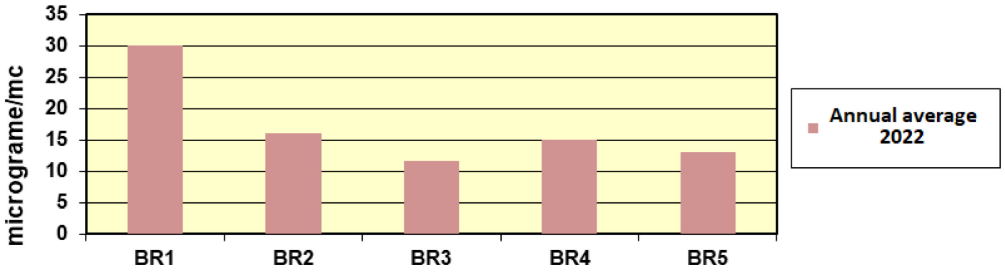

Figure 4. Average annual concentration of nitrogen dioxide in 2022

Source: Law no. 104/2011

In 2022, the average annual values according to nitrogen dioxide to the measurements are below the limit value of 40 µg/m^3 (Law no. 104/2011).

SO_2 concentrations in the surrounding air are evaluated using the hourly limit value for the protection of human health (350 µg/m^3) which must not be exceeded more than 24 times/year and the daily limit value for the protection of human health (125 µg/m^3) which must not be exceeded more than 3 times/year. Law no. 104/2011 does not establish the annual limit value for sulfur dioxide, only the hourly and daily limit value (Law no. 104/2011).

During the year 2022, there were no values higher than the daily limit value for the protection of human health (125 µg/m^3) provided for in Law no. 104/2011 for the air factor (Law no. 104/2011).

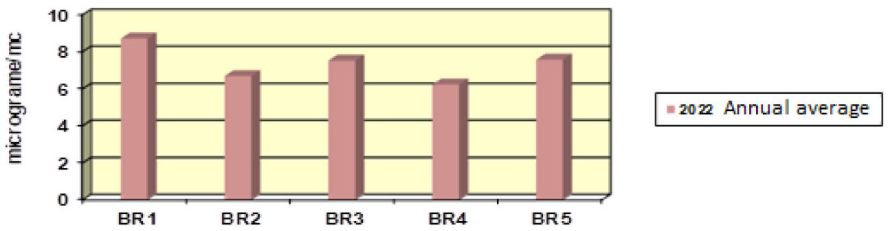

Figure 5. Average annual concentration of sulfur dioxide in 2022

Source: Law no. 104/2011

The concentrations of suspended particles PM_{10} in the surrounding air are evaluated, according to Law no. 104/2011, using the daily limit value (50 µg/m^3) which must not be exceeded more than 35 times/year and the annual limit value, determined gravimetrically (40 µg/m^3) (Law no. 104/2011).

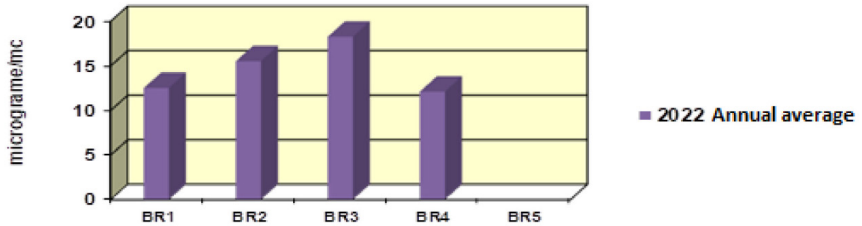

Figure 6. Average annual PM_{10} gravimetric concentration in 2022

Source: Law no. 104/2011

In 2022, benzene was monitored in BR1 - traffic station from Brăila municipality, BR2 - urban background station from Brăila municipality, BR3 - suburban background station from Cazasu commune, BR5 - industrial type station from Chiscani commune, all with captures below the minimum allowed value) (Law no. 104/2011).

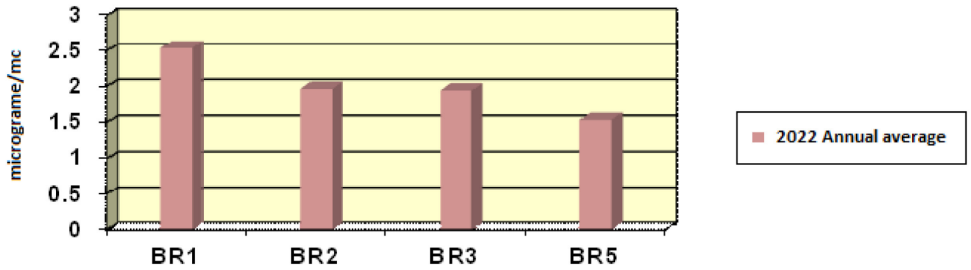

Figure 7. Average annual concentration of benzene in 2022
Source: Law no. 104/2011

The average annual values recorded were below the annual limit value established in Law no. 104/2011 on ambient air quality (5 μg/m^3) (Law no. 104/2011).

The national strategy regarding atmosphere protection has as its general objective the protection of human health and the environment (Robu & Robu, 2003).

The key objectives are:
- maintaining the quality of the surrounding air in the areas and agglomerations where it falls within the limits provided by the legal norms for the quality indicators;
- improving the quality of the surrounding air where it does not fall within the limits provided by the legal norms;
- adopting the necessary measures in order to limit or eliminate negative effects on the environment, including in a cross-border context.

4. FUTURE RESEARCH DIRECTIONS

The 2030 Agenda for Sustainable Development is a result of an international process of analysis, from which it generates that global problems may only be solved through global solutions.

Changing perceptions and awareness of the unprecedented evolution of society, the increase in the birth rate on a global scale, the acceleration of the economies of developing countries, and social disparities have highlighted the limits of planetary growth.

Rising prices of certain resources have highlighted the fact that the Earth can deplete its renewable and non-renewable physical resources, leading to a catastrophic imbalance.

As far as environmental protection is concerned, all the investments that will be made in the Danube basin must be intelligent systems based on the latest scientific and technological developments in which environmental protection is included from the design phase of the systems.

At the same time, the following should be taken into account as priorities: development and expansion of utility infrastructure (water supply, sewage network); ensuring municipal wastewater treatment for all agglomerations with over 2000 equivalent inhabitants; reduction of nitrate pollution from agricultural sources for all designated vulnerable areas on the territory of Romania and elimination of discharges of priority hazardous substances into waters.

At the Brăila county level, the Air Quality Maintenance Plan was developed, according to HG no. 257/2015 regarding the approval of the Methodology for the development of Air Quality

Plans, Short-Term Action Plans and Air Quality Maintenance Plans. This plan contains a series of measures to keep atmospheric pollutants below the permitted limits, as follows:
- Measures to reduce road traffic emissions;
- Measures to reduce emissions from the wind erosion process;
- Measures to reduce emissions from heating in the residential sector (HG no. 257/2015).

From the analysis of the effects generated by the implementation of the measures, it can be seen that the most important reductions in emissions related to mobile sources are due to the rehabilitation and modernization of traffic arteries.

Reducing the consumption of solid and liquid fuels by expanding the natural gas supply network is the main measure for reducing emissions due to institutional and residential heating.

5. CONCLUSION

Sustainable development promotes the concept of reconciliation between economic and social progress without endangering the natural balance of the planet. The idea behind this concept is to ensure a better quality of life for all the inhabitants of the planet and future generations.

Sustainable development brings to the fore a new set of values that will guide the future model of economic and social progress, values aimed mainly at man and his present and future needs, the natural environment - protecting and preserving it, as well as mitigating the current deterioration of ecosystems.

The 2030 Agenda calls for action by all countries, poor, rich and middle-income. This covers issues such as inequality, infrastructure, energy, consumption, biodiversity, oceans and industrialization. The agenda promotes the involvement of all interested parties, by democratizing the decision-making process on the topic of sustainable development. The responsibility and role of young generations to create sustainable development are emphasized.

The ecosystems' status around the world varies according to different specific characteristics and conditions. In general, there is some concern about the state of many ecosystems due to the impact of human activities such as deforestation, pollution, climate change and overexploitation of natural resources. Marine and freshwater ecosystems are also under pressure. Pollution, overfishing and destruction of natural habitats have led to declining fish populations and loss of biodiversity in these environments.

In terms of climate change, they have a significant impact on all ecosystems. Rising global temperatures, changes in precipitation patterns, and increased frequency of extreme weather events can disrupt ecological balance and lead to loss of biodiversity.

However, there are also global and local efforts to protect and conserve ecosystems. Biodiversity conservation, sustainable forest management, marine area protection and natural habitat restoration programs are being implemented.

There are also greater demands for the adoption of policies and measures that reduce the impact of human activities on ecosystems and promote sustainable development.

Only by exploiting the data from the technical and methodological point of view it will be possible to ensure coherence and objectivity in the government act, to optimize cooperation between central public institutions, but also to intensify the professionalization of skills centered on strategic planning and sustainable development.

As a conclusion, the status of the ecosystem around the world is vulnerable and under pressure due to human activities and climate change**.**

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