Waste management in rural communities.

Legal Requirements and Recommendations

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Content

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Policies and recommendations on sustainable solid waste management practices in rural communities

Characteristics of the rural environment and perspectives on its development

Rural areas and/or communities located far from urban centers, are still vital to today's society because they support primary food production and the extraction of raw materials, constitute an appropiate recreational environment and contribute to the overall well-being of the population and to restoration of ecosystems. Rural areas cover 83% of the European territory, while rural communities include 30% of Europe's population. Approximately 45% of communities in Europe can be classified as remote in terms of distance from urban centers (European Commission, 2022).

The rural population is at increased risk of poverty and social exclusion, has limited access to essential infrastructure and services and fewer opportunities in terms of education, jobs, medical services, public transportation and cultural activities. For decades, rural areas are experiencing demographic decline as the population settles more in communities where access to various services is available. The remaining rural population is aging, with a small percentage of them having completed some form of tertiary education and lacking completely or having less digital skills.

Among the advantages of rural communities we can mention: a strong perception of the individual’s identification with the community in which he belongs to, higher trust in local authorities, greater openness to collaborative and voluntary activities for the wellbeing of the community. In this sense, the opportunities created for the development of the rural environment, in general, were identified in areas such as: bioeconomy, renewable resources, mobility (transport) and tourism.

The specialized literature shows that rural development (i) includes actions aimed at improving the quality of life of the population, preserving the natural and cultural landscape and (ii) ensures the sustainable development of rural areas (Brînzan, 2006, p.19), iii) is carried out on the basis of a program for rural development. Rural development programs, in order to be balanced, must ensure the simultaneous development of the rural community in several directions. One of the directions of rural development, along with the social and economic component, is represented by the protection of the environment, its natural resources, and the reduction of pollution, taking into account and applying the principle of sustainable development.

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The rural development programs are closely related to the policies adopted at this level but also in accordance with the general and sectoral policies at the regional, national or European Union (EU) level. In order to ensure the sustainable development of rural communities, plans and strategies will have to be developed at the regional level that explicitly include the rural environment in the fields of socio-economic development, agricultural policies, strategies for the bioeconomy, policies for energy sources and policies related to mobility (transport). Importantly, each community and rural area, in a region, is unique. This is more reason why a specific and analysis of available resources, ecosystems, existing economic activities is necessary. The establishment of local rural policies requires an integrated vision of governance, close cooperation between public authorities, civil society and the private sector. Rural policy represents the set of political initiatives aimed at promoting opportunities and providing integrated solutions to economic, social and environmental problems in rural areas (Profiroiu & Radulescu, 2019, p.311).

Environmental governance includes, in addition to the previously mentioned cooperation, the obligation of public authorities to verify and ensure that, within the given administrative limits, the legislation is respected. But, at the same time, public information campaigns are needed in order to raise awareness and help them understand the policy in the field of waste, stimulating a change in behavior in this regard (Decision, 2013). Local stakeholders will need to analyze and decide for their community in a participatory and collaborative way, taking into account the funds available at regional, national and European level. The development of rural and local policies cannot be carried out without knowing the context of general and sectoral policies, starting from the most comprehensive set, that of the EU, and continuing with the national one and, from the perspective of Romania's 8 regions, with regional policies and county.

EU environmental policy has been oriented since 1970 by establishing environmental action programs (EAPs) that defined priority objectives and targets to be achieved in a certain number of years. With regard to waste management, among the multiannual environmental policies stand out:

- PAM 6 (2001-2010), which supported the sustainable development strategy introduced through PAM 5 (1993-1999) and emphasizes the responsibility involved in decisions affecting the environment. Within the PAM 6, among the 4 priority policy areas are the conservation of natural resources and waste management (Decision, 2002). During this program, Directive 2008/98/EC on waste was developed, the current basis of waste legislation in all EU member states (Directive, 2008).

- PAM 7 (2013-2020), through which "The Union agreed to protect the environment and human health by preventing or reducing the negative impacts of waste generation and management, as well as by reducing the global impact of resource use and improving the efficiency

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of their use, by applying the following waste hierarchy: prevention, preparation for reuse, recycling, other ways of recovery and disposal" (Decision, 2013).

- PAM 8 (2022-2030) which is consistent with the UN 2030 Agenda and its Sustainable Development Goals (SDGs) and which "underpins the achievement of the environmental and climate goals defined under the UN 2030 Agenda and its SDGs, as well as those targeted by multilateral agreements in the field of environment and climate" (Decision, 2022, art.1. paragraph 3). Through its priority objectives of GAP 8 it sets "a direction for Union policy-making, building on the commitments made under the European Green Deal strategies and initiatives, such as the EU Biodiversity Strategy for 2030, the new Economic Action Plan circular, the Strategy for promoting sustainability in the field of chemicals and the Action Plan on reducing pollution to zero, without being limited to these" (Decision, 2022, pc.11).

The most important European initiative for rural areas is the Long-Term Vision for Rural Areas, launched in 2021 (A Vision for Rural Areas Towards 2040), accompanied by 2 other framework documents, namely the Rural Pact (2021) and the Rural Action Plan (EU Rural Action Plan, 2021). The challenges of rural areas are specific in relation to economic development and resource use and are a result of demographic variability. These challenges should not be treated in the same way as those in urban areas, using the same strategies and tools.Rural areas need specific policies and strategies.

The implementation of environmental policies, regardless of the level at which they were developed, requires the development of a legal framework that determines behaviors that will have the effect of achieving the established objectives and targets. The link between policies, strategies, action programs and implementing legislation is indispensable. This aspect is very well highlighted even at the EU level, where MAP 7, within the priority objective 2, shows that the full implementation of the Union legislation in the field of waste is necessary. Among all the policies, those developed at the APL level have the highest degree of concordance and subordination with higher public and sectoral policies (EU national and county) and with the legislation that implements them. In practice, the policies and strategies must take into account all these but also the local conditions (Figure 1).

Among the sectorial policies and strategies and action plans developed at the EU level and which have an impact on waste management, we mention:

- EU Biodiversity Strategy for 2030 (Strategy, 2020a),
- Strategy for promoting sustainability in the field of chemicals – Towards a toxic-free environment (Strategy, 2020c),
- The new EU Soil Strategy (Strategy, 2021),

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- Strategy "From farm to consumer" (Strategy, 2020b),
- March 2020 Circular Economy Action Plan (Plan, 2020)
- The action plan "Towards zero air, water and soil pollution" (Plan, 2021).

Although there are many such policies, strategies and plans at the EU level, "the insufficient integration of environmental objectives in the processes of development and application of national and local public policies with a significant environmental footprint, the ineffectiveness of environmental governance, observed including to the people responsible for ensuring compliance on the ground, and the lack of transparency regarding information about the environment, information that would allow those interested, regardless of whether they are authorities or ordinary people, to mobilize and act" (Communication, 2022), constitutes reasons for not meeting the environmental objectives.

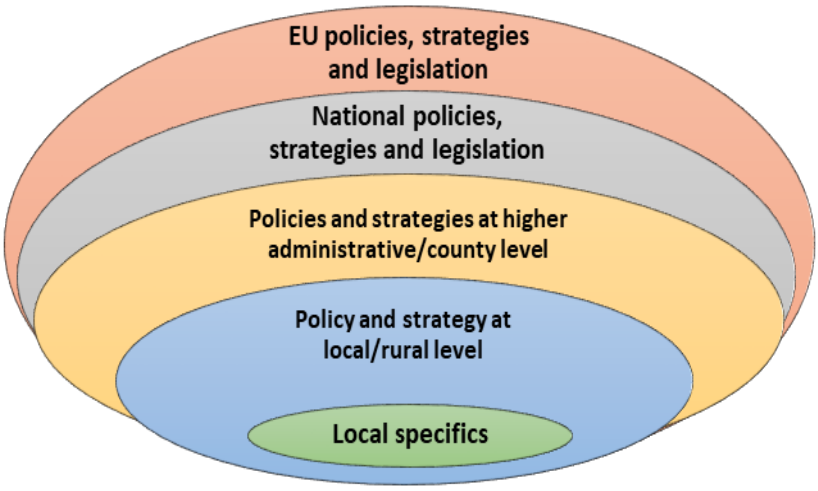

Figure 1. Integration of policies and local specificity in local rural policies

European Union legislation on waste management has undergone changes in recent years to meet the objectives of the circular economy (The Zero Waste MasterPlan, 2020). In the context of the changes made, member states must include separate collection schemes for the following categories of waste with specific deadlines:

- bio-waste until 31.12.2023;
- textiles until 01.01.2025;
- hazardous waste until 01.01.2025;
- used oils until 01.01.2025;
- paper and cardboard, separate collection is mandatory since 2015;
- metal, separate collection is mandatory since 2015;

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- plastic, separate collection is mandatory since 2015;
- glass, separate collection is mandatory since 2015.

Simultaneously with the establishment of mandatory separate collection schemes, a number of targets at European level have been set in relation to packaging waste and waste treatment options:

Table 1. Targets established at the level of the European Union for different categories of waste and types of treatment operations

Waste type	**2025**	**2030**	**2035**
Municipal solid waste Preparation for reuse+recycling, min.	55%	60%	65%
Municipal solid waste Lanfilling max.	-	-	10%
Packaging waste Recycling min.	65%	70%	-
Plastic, min.	50%	55%	-
Wood, min.	25%	30%	-
Ferrous metals, min.	70%	80%	-
Aluminum, min.	50%	60%	-
Glass, min.	70%	75%	-
Paper and cardboard, min.	75%	85%	-

In the coming years, the policies and strategies of the European Union will be directed even more towards the concept of resource management, where an important place will be played by waste as a source of materials, raw materials and energy. Waste management policies intersect with policies for the development of local renewable energy resources from bio-based sources, as well as transition policies towards rural economies with low greenhouse gas emissions, also known as "low- carbon".

Overview of policies and strategies, national waste action plan and main legislation

The First National Waste Management Strategy (SNGD for the period 2014-2020), approved by H.G. no. 870 of 2013 had among its main points: (i) prioritizing efforts in the field of waste management in line with the waste hierarchy, (ii) increasing the recycling rate and improving the

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quality of recycled materials and (iii) implementing the concept of "life cycle analysis" in waste management policy (Decision, 2013). This strategy, although out of date, is still in force.

The current national waste management plan, valid until 2025, is approved by Government Decision no. 942 of December 20, 2017 (PNGD, 2017). This plan includes important information regarding APL's obligations in establishing its own waste management policies and action plans in Chapter III.6 Governance measures for waste management. Other information contained in the national waste management plan:

- covers 18 categories of waste, some clearly identified, such as: food waste, waste batteries and accumulators, municipal waste, used oils and others presented generically, such as: hazardous industrial waste or waste from agriculture, forestry and fishing
- presents alternatives to waste management planning
- presents the waste policy instruments: economic, regulatory, administrative and informational.

The national waste management plan also includes, in chapter III, the National Program for the Prevention of Waste Generation (PNPGD) with 3 main objectives 1. 10% reduction of waste households per capita, 2. decoupling the increase in the amount of packaging waste from economic growth and 3. promoting the prevention of waste generation from wood processing and from the chemical, metallurgical and steel industry. Based on the national waste management plan, the County Waste Management Plans - PJGD were developed, which can be accessed at: http://www.mmediu.ro/categorie/documente-de-planificare-pngd-pjgd/239.

In the European Commission's document entitled "The 2022 evaluation of the implementation of environmental policies. Country report - Romania"- SWD (2022) 271, it is mentioned that in terms of waste management at the national level, in Romania there has been limited progress, the degree of waste recycling and composting varying insignificantly.

The national context in which waste management related activities are carried out, either in the urban or in the rural environment, is based on:

1. The full implementation of European Union legislation in the field of waste, following the hierarchy of waste management options, ensuring separate collection and assuming the objectives of reducing the amount of waste that reaches the landfill;
2. Reducing the amount of waste generated in total and the amount of waste generated per capita;
3. In the case of non-recyclable but combustible materials, energy recovery should be preferred to landfilling, together with alandfill ban in the case of recyclable or recoverable (recyclable) waste.

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The waste hierarchy is provided for in OUG 92 of 2021 on the waste regime (Ordinance, 2021) and in accordance with the Framework Directive 98 of 2008 on waste (Directive, 2008). It is also necessary to take into account all the normative acts that challenge specific targets to be achieved in waste management.

The current situation and forecasts in the field of waste management, in the rural environment, is presented in the 41 county-level waste management plans (PJDGs) and the Waste Management Plan for the Municipality of Bucharest (PMGD) adopted in 2021.

At the national level, the situation regarding waste management can be summarized as follows:

- the amount of municipal solid waste has increased in the last 5 years, 2016-2020, for which there are statistical data validated at the level of the European Union, up to the value of 287 kg/capita/year, significantly lower than the European average of 505 kg/place/year, but the economic development is directly proportional to waste generation rates;

- in terms of material recovery, estimated by recycling rates, this is far below the European average (48%), with the observation that in the decade 2010-2020, no significant progress was recorded, the values remaining between 11-15% ;

- landfilling, although it is the last option in the hierarchy of waste management practices, is the most widely used. A significant problem that remains unsolved is the situation of 42 landfills that should have been closed, because they do not comply with the current standards regarding the uncontrolled disposal of waste, but to receive waste. In this regard, 2 actions to the European Court of Justice were registered for non-compliance with the Court's Decision of October 18, 2018, in which it was found that Romania had not fulfilled its obligations set out in the Directive on landfills (Directive, 1999).

Through the National Recovery and Resilience Plan, Romania has requested funding for the development, modernization and completion of integrated municipal waste management systems at county or city/municipal level, which should be in accordance with the PNGD and PJGD.

In the same document SWD (2022) 271, the priority actions in waste management are the following:

- Ensuring the closure and rehabilitation of non-compliant landfills and taking action against illegal landfills. Those responsible for waste management in rural areas can contribute to the achievement of this action by eliminating illegal storage practices within the territory for which they are responsible and by delegating contracts to authorized operators to collect and transport waste only to compliant landfills.

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- Ensuring the existence of a National Waste Management Plan and a national waste prevention program, compliant with the revised Waste Framework Directive, and their coherence with the 41 county-level waste management plans plus the plan for the municipality of Bucharest. Those responsible for rural waste management can provide data on socio-economic indicators and waste generation, as well as on waste composition generated by the population and commercial activities found in their territory, to contribute to the realization of plans counties based on updated official information;

- Improving and expanding the separate collection of waste, including bio-waste. In this context actions may include: establishing minimum service standards for separate collection (e.g. collection frequency, types of containers, etc.) in municipalities to ensure high rates of collection of recyclable waste; the use of economic instruments, such as the „ pay as you throw" scheme, and the establishment of mandatory recycling targets for municipalities and sanctions for non-compliance (eg fines). These actions are implemented locally, therefore it is up to each person in charge of waste management to contribute to the efficiency of the separate waste collection system. In packaging waste management, more ambitious targets have been setted out on 2019, an ction that will support the achievement of 2025 and 2030 targets.

Table 2. Targets for the recovery of packaging waste in Romania

Packaging waste	**2019**
Recovery	65%
Recycling min.	60%
Plastic, min.	45%
Wood	50%
Ferrous metals	70%
Aluminum	30%
Glass	65%
Paper and cardboard	70%

- The development and implementation of programs for municipalities, through which actions such as organizing separate collection and improving recycling rates are supported. The training programs for local authorities from the rural and urban areas as well as the population awareness campaigns can serve as support tools for carrying out these actions.

- Improving the functioning of extended producer responsibility (EPR) systems, in line with the general minimum requirements. Those responsible for waste management in the rural

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environment have the role of ensuring an adequate framework for the functioning of extended producer liability systems. Considering that in most cases the producers are located at an appreciable distance from the countryside, the role of these responsibles is to ensure that there is an efficient waste collection service and that the population uses it adequately.

Binding obligations of local public authorities in the development of environmental policy regarding waste

Starting from the general normative act that regulates the role and attributions of the local public authorities (LPA), namely the Administrative Code (Ordinance, 2019), we find the following:

- The local council (LC) has duties regarding the economic-social and environmental development of the commune and the management of services of local interest (art. 129, paragraph 2), in which sense it approves the strategies regarding the economic, social and environmental development of the administrative unit- territorial and ensuring the completion of the works and takes the necessary measures to implement and comply with the provisions of the commitments assumed by Romania as a member state of the EU in the field of environmental protection and water management for the services provided to citizens (art. 129, paragraph 4). Moreover, LC ensures the protection and restoration of the environment and community services of public utilities of local interest (art. 129 paragraph 7).
- the mayor elaborates, following public consultations, the draft strategies regarding the economic, social and environmental condition of the administrative-territorial unit, publishes them on the website of the administrative-territorial unit and submits them to the local council for approval.

In continuation of these provisions, GEO 92 of 2021 comes and points to art. 26 that "when drawing up local strategic documents and approving investments in the field of waste management, local public authorities take into account the principle of autonomy and proximity, without violating the provisions of the national waste management plan and the national waste management strategy". Even if LPA must follow and ensure the fulfillment of the provisions of the PJGD and PPGD, they have the obligation to develop "other own strategies and programs to ensure the prevention of waste generation and sustainable waste management" (Law, 2021, art. 60).

LPA's obligation to develop and implement specific policies for certain categories of waste can also be found in other normative acts, among which we mention:

- Law 101 of 2006 regarding the sanitation service of localities (Law, 2006) points to art. 5 para. (1) that "The local public administration authorities develop, approve and control the application of

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local strategies regarding the development and operation of the sanitation service in the medium and long term, taking into account the provisions of the legislation in force, the urban planning documents, the planning of the territory and the protection the environment, as well as the economic-social development programs of the administrative-territorial units".
- Law 181/2020 on the management of non-hazardous compostable waste (Law, 2020), in art. 4 para. (3) shows that local LPAs have the obligation to develop their own strategies and programs for the management of biodegradable waste.

We remind that each of the obligations to achieve certain specific results (targets, objectives) of certain categories of waste, found in the normative acts that regulate them, can be the subject of local policies and strategies.

Recommendations regarding waste valorization in rural areas

Referring to waste management, strictly in the rural context, we can say that obtaining energy from biomass such as agricultural waste, food and vegetable waste (forestry), as well as from other organic waste, can contribute both to the achievement of objectives and targets with regarding waste management, as well as ensuring a sustainable source of energy, which leads to the development of the rural community.

An example of good practices from the Romanian countryside is in Filipeștii de Pădure, a village in Prahova county, with approximately 11,000 inhabitants, where an anaerobic digestion plant was built. This plant uses organic waste from the agro-food sector as fuel to produce electricity and thermal energy, being located in the vicinity of Cris-Tim meat processing factory. Wastes such as animal manure, agricultural waste and meat processing waste are treated by anaerobic digestion, a process by which biogas (a gas containing methane) and digestate (a mixture of solid organic fraction and water) are obtained. The biogas is treated to remove unwanted compounds (through filtration and cooling) and sent to the plant. The thermal energy recovered from the biogas is used by the factory of meat products and preparations, the electricity produced is supplied to the national grid, and the resulting digestate is used as fertilizer. The anaerobic digestion waste treatment facility is capable of processing 23,000 tons of waste/year. The anaerobic digestion process produces 4 million Nm^3 of biogas per year. Methane is converted in 8000 MWh of electricity and 7000 MWh of thermal energy annually. Operating the digestion plant needs 5 full time emplyees. From the activities of ecological agriculture, using digestate as fertilizer, 15 jobs resulted in the area. This example of good practice is in line with the principles of the circular economy, the principles of obtaining energy from renewable resources and the principles of sustainable

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development. As key recommendations emerging from this example, it can be mentionioned the fact that agricultural activities and the agri-food sector are important employers in the rural environment, with a significant potential in waste management and their utilization in obtaining sustainable energy. When reviewing local/regional policies, decision-makers have the role of raising awareness and providing training to stakeholders, highlighting the local benefits. Local public authorities play a leading role in ensuring the separate collection of waste from different sources and in setting the conditions for the installation and operation of waste fuel cogeneration plants. Local farmers as beneficiaries of digestate used as fertilizing product are also trained on digestate properties and use.

In rural areas, synergies should be sought between programs and plans on waste management and those related to energy obtained from renewable sources, where technologies based on energy recovery can be the solution to correctly manage organic waste.

Another example of rural waste recovery comes from Told, a commune in Hungary with 300 inhabitants and challenges in combating poverty. Thanks to an initiative to obtain cheap fuels and improve living conditions, the production of bio briquettes has started. Through the project coordinated by an NGO, 20 families in Told are supplied with briquettes to heat their homes, at a price 30% cheaper than the price of conventional fuel. The NGO also trained the participants on collecting biomass waste from local farms and converting it into briquettes. The initial investment, made by the NGO, was 2.000 euros involving manual methods of briquette production. In the second phase, an investment of 10. 000 euros was needed to purchase an automated production line, which allows the shredding and drying of biomass waste. In this way, biomass waste was recycled, a cheaper alternative source of heating was found and 2 permanent jobs were created.

The main recommendation for rural communities that emerges from this example concerns the role of waste management in solving other local challenges: obtaining energy, fighting poverty, creating jobs. Through such initiatives members of the local community will acquire new (technical and administrative) skills, thus social development is also ensured (Policy brief: Local bioenergy development, 2020).

Recommendations regarding bio-waste management in rural areas

In Casalgrande, Italy, home composting is encouraged through financial instruments. Casalgrande Town Hall provides a 20% reduction in the waste collection fee if citizens use home composting to treat food and garden waste. In 2021, 200 locals were composting at home, the equivalent to 26.8 tons of composted material annually. Good communication and the training

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programs offered by the Environmental Education Center in Casalgrande should be mentioned as an important success factor (Policy Brief: The biowaste management challenge, 2021).

Key recommendations for an effective management of bio-waste generated in rural communities:

- implementing compulsory separate collection schemes of bio-waste for canteens, restaurants, boarding houses, accommodation units, local shops and agro-industrial units;

- informing and raising awareness of household bio-waste generators in favor of separate bio-waste collection, offering training programs with explanations and instructions in all the languages spoken locally;

-encouraging home composting in small communities and ensuring collection services frequency appropriate to the amount and composition of biowaste generated; for larger communities or closer to bio-waste treatment infrastructure, anaerobic digestion can be considered a viable bio-waste treatment option, additionally biogas can be used as fuel for public transport;

-monitoring citizens' behavior and encouraging desirable behaviors and sanctioning undesirable ones.

Recommendations regarding the collection of special categories of waste

Current European legislation also refers to the separate collection of used oils by domestic consumers. An example of good practice in increasing the degree of separate collection of waste oil is in Rubiera, Italy, a town with 14,882 inhabitants. Citizens can place bottles/containers of used vegetable oil in yellow containers with a capacity of 800 L, which are replaced when they fill ¾ of the volume of the container. The costs of installing and emptying the container are covered by the revenues from the sale of the collected oil. The amount of used oil collected separately increased from 366 kg in 2018 to 11460 kg collected in 2019 (Policy Brief: The biowaste management challenge, 2021).

Recommendations on the separate collection, reduction, reuse and recycling of waste in rural areas

Together with the legislative obligations regarding waste management, in the context of the European Union's strategies with reference to the circular economy, the concept of "Zero Waste" (Zero Waste) has appeared. The concept is defined as follows: the conservation of all resources through responsible production and consumption, reuse and recovery of products, packaging and materials without incineration and disposal in environmental compartments: soil, water, air, emissions that can affect the environment or human health. The hierarchy of waste management

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options is modified accordingly, by eliminating incineration and landfilling and with an emphasis on (starting with the most desirable): redesign (rethinking production and consumption models), reduction and reuse, preparation for reuse, recycling/composting/anaerobic digestion, material and chemical recovery, stabilization for disposal (The Zero Waste MasterPlan, 2020). The "Zero Waste" concept can be considered as part of the principles of the circular economy and can be applied at the individual level, at the business or community level.

Applied at the community level, either in the urban or in the rural environment, the "Zero Waste" concept means, in addition to reducing the amount of waste generated/collected/ transported and the achievement of mandatory local objectives regarding waste management, less greenhouse gas emissions; economic benefits materialized in the reduction spending from the local budget with waste management, lower taxes or tariffs for citizens; and social benefits such as: social integration, local innovation, new local jobs, financial capital that remains in the community, (The Zero Waste Master Plan, 2020).

A synthetic comparative analysis of traditional waste management and waste management under the "Zero Waste" concept can be seen in Table 3:

Table 3. Comparison between traditional waste management and waste management under "Zero Waste" conditions

Traditional waste management	**Waste management - "Zero waste"**	**Remarks**
Centralized	Decentralized	A decentralized system is appropriate for rural communities located far from an urban center
It consumes capital	It creates new jobs	With greater importance for socio-economic conditions in remote rural communities
Waste is incinerated or landfilled	Waste is reduced from the design or production phase	Remote and small rural communities can significantly reduce incineration/landfill rates by separate treatment of bio-waste through composting and by setting local recovery and recycling centers Rural communities closer to urban centers and larger in size can significantly reduce

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Traditional waste management	Waste management - "Zero waste"	Remarks
		incineration/landfill rates by separate treatment of biowaste through anaerobic digestion (especially if there are also economic units), and by setting local recovery and recycling centers
It is based on increasing waste generation rates	It allows the implementation of policies to prevent and reduce the amount of waste	Rural communities have the opportunity to reduce amounts of waste through local decisions, to ban or to encourage the use of only certain types of materials proven to be sustainable by comparison

The "Zero Waste" concept was also implemented in Romania, in 12 villagies and cities and 2 communities, representing a population of 0.8 million inhabitants or 4.1% of Romania's population. The rural areas where the "Zero Waste" concept was implemented are summarized in Table 4. Other cities in Romania that have adopted or intend to adopt this concept are: Făgăraș, Mizil, Comănești, Roman with a population of less than 70,000 inhabitants and Tulcea, Oradea, Iași with a population of over 70,000 inhabitants.

"Zero waste" localities in the countryside have implemented the separate collection of waste by 5 fractions of waste, the "door-to-door" collection method and the "pay as you throw" principle. In addition, repair centers for waste that can be reused have been created or local initiatives for such activities or centers for recycling/recovery of materials from waste have been supported. It was up to the local authorities to prohibit the construction of incinerators or landfills.

Usually, for the Romanian cases, the main person responsible for the success of the implementation of the "Zero Waste" concept is the representative of the local political authorities (mayor), who through determination and motivation managed to achieve the assumed targets regarding waste management. The biggest challenge was the residents' resistance to change. The solution came from better communication between the authorities, the implementation team (collection operators, waste management specialists, other stakeholders) and residents (The State of Zero Waste Municipalities Report, 2021).

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Table 4. Rural villages that have adopted the practices of the "Zero Waste" concept

No. crt.	Ref. year	City/ Population (loc. no.)	Municipal solid waste generated, local value, kg/capita /year	Municipal solid waste generated, national average, kg/capita /year	Selective collection rate,%	Household waste generated, kg/capita
1	2014	Târgu Lăpus/ 11744	80	282	75	20
2	2018	Sălacea/ 3036	77	282	70	23.1
3	2019	Cociuba Mare/ 2798	70	282	60	28
4	2020	Valea lui Mihai/ 9686	89	282	50	44.5
5	2020	Brănești/ 8531	252	282	17	209.2

Following the analysis of the data, especially in small rural towns, it was found that most citizens are actively involved at the community level when they have access to adequate infrastructure, there is political will at the local administration level, a prevention system is used, awareness, education, sanctioning of undesirable practices or bonuses to encourage desirable practices. It is not necessarily necessary for a community to officially want to implement the concept of "Zero Waste" in order to go through the stages of the initial analysis proposed by the Zero Waste Alliance (Annex 1) in order to have a clear picture of the current situation of waste management in their town. Moreover, the data collected through the analysis can be used to develop local waste management plans.

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Table 5. Rural villages that have adopted the practices of the "Zero Waste" concept - achievements and future targets

No. crt.	Ref. year	City/ Population (loc. no.)	Municipal solid waste generated, local value, kg/capita /year	Reduction % of the waste generated	Targets assumed in the future
1	2014	Târgu Lăpus/ 11744	80	20%	90% waste diverted from landfill 0% incineration 70 kg waste/capita /year
2	2018	Sălacea/ 3036	77	55%	90% waste diverted from landfill 0% incineration 40 kg waste/capita/year
3	2019	Cociuba Mare/ 2798	70	30%	90% waste diverted from landfill 0% incineration 40 kg waste/capita/year
4	2020	Valea lui Mihai/ 9686	89	20%	90% waste diverted from landfill 0% incineration 40 kg waste/capita/year
5	2020	Brănești/ 8531	252	-	90% waste diverted from landfill 0% incineration 100 kg waste/capita/year

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Policies and recommendations in the assessment and management of contaminated sites

The **general objective** of the policies, strategies, and norms for the investigation of potentially contaminated and contaminated sites is to address in a unitary and coherent manner the actions to prevent contamination of the geological environment, of actions to identify, inventory, preliminary investigate and thoroughly investigate and assess the risk posed by potentially contaminated and contaminated sites. Thus, at the national level, within the Ministry of Environment, Water and Forests, the Contaminated Sites Office was established with the following attributions:

a) implements the governance strategy and program in order to promote environmental policies in the field of soil, subsoil protection, and management of contaminated sites and ensures their implementation according to the directions of action;
b) develops environmental strategies and policies regarding the protection of soil, subsoil, and management of contaminated sites in order to guarantee and implement the right to a clean and healthy environment in compliance with the European principles of sustainable development in urban communities, as well as with the European and international requirements and standards in the field;
c) develops and promotes the National Strategy and the National Action Plan on the Management of Contaminated Sites, as well as the subsequent normative acts for its implementation;
d) elaborates and promotes, according to the law, draft normative acts, regulations, instructions, and technical norms specific to the protection of soil, subsoil, and management of contaminated sites;
e) coordinates and supervises the compliance with the provisions on soil and subsoil protection, and management of contaminated sites, in collaboration with the other competent authorities, according to the law;
f) follows the implementation of the provisions of the legislation specific to the field of soil protection, subsoil, and management of contaminated sites;
g) promotes and participates in specific training actions, elaboration of brochures, and manuals for public information, and ensuring the right of citizens to access environmental information and participate in environmental decision-making;
h) monitors the application of the provisions and recommendations of international agreements and conventions or other EU documents in the field of soil protection, subsoil, and management of contaminated sites;

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i) collaborates with internal and/or subordinated structures, coordination of the MMSC, or other central and local public authorities, institutions, economic organizations, and NGOs in the field of soil protection, subsoil, and management of contaminated sites;
j) proposes scientific research topics and necessary studies in the field of soil protection, subsoil, and management of contaminated sites;
k) formulates views in the field of soil protection, subsoil and management of contaminated sites, as well as in related areas;
l) ensures the implementation of the recommendations formulated by the Public Policy and Quality Management Unit and through the audit report.

The main regulations underlying the officials of the control and management structures of contaminated sites, as well as for the implementation of the methodology for the evaluation and management of contaminated sites are:

- Law nr. 74/2019 on the management of potentially contaminated and contaminated sites, (Law, 2019),
- MO no. 184/1997 for the approval of the Procedure for carrying out the environmental balances (Order, 1997a),
- MO no. 756/1997 for the approval of the Regulation on the assessment of environmental pollution (Order, 1997b),
- MO no. 1.423/3.687/2020 on the approval of the methodology for investigating contaminated/potentially contaminated sites (Order, 2020),
- MO no. 267/346/2021 on the methodology for remediation of contaminated sites (Order, 2021),
- MO no. 2012/2022 for the designation of the Romanian Environmental Association 1998 as a national body for the certification of specialists carrying out activities in the field of management of contaminated sites (Order, 2022).

For example, within the National Strategy and the National Action Plan for the Management of Contaminated Sites in Romania and the Methodology for the investigation of potentially contaminated and contaminated sites, approved by Governmental Decision no. 683 from 2015 for approval of the National Strategy and the National Plan for the Management of Contaminated Sites in Romania (Governmental Decision, 2015), respectively Ministerial Order no. 1.423/3.687/2020 (Order 2020), the framework, methodology and criteria for the identification and inventory of potentially contaminated or contaminated sites are regulated. The preliminary investigation of potentially contaminated/contaminated sites is carried out by elaborating the preliminary

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investigation report and carrying out the conceptual model of the potentially contaminated site (CMS). The elaboration of the preliminary investigation report must consider the provisions and criteria of Annex no. 2 of Law no.74 of 2019 and it is drawn up in such a way as to detail the conceptual model of the site in order to highlight it easily (Governmental Decision, 2015; Order, 2020; Order, 2021). The processing and interpretation of the information in the preliminary investigation report leads to the preparation of its final chapter, i.e. conclusions and recommendations. The information and conclusions of this stage lead to the substantiation of the decision of the EPA to impose additional actions and/or to conclude it. The preliminary investigation must lead to conclusions as to the sufficiency of the evidence showing that the site is or may be contaminated, summarise all the circumstances (including the conceptual model) as well as the potentially unacceptable risks so that the steps and measures applicable to the situation of the site can be defined at a later date. The results of the preliminary investigation shall determine whether it is necessary to carry out the detailed investigation and risk assessment phase (Governmental Decision, 2015; Order, 2020; Order, 2021).

The contaminated sites conceptual model (CMS) is the primary planning tool that establishes and characterizes potentially contaminating sources, receptors, as well as migration pathways that may exist between sources and receptors (Governmental Decision, 2015; Order, 2020; Order, 2021). The CMS is carried out already at the preliminary investigation stage and is updated at the stage of detailed investigation and risk assessment, as well as in the remediation project and in the post-remediation monitoring phase. The potentially contaminated/contaminated CMS provides available information about the site in a clear and transparent manner, facilitates the identification of data and information gaps, and it is useful in making decisions on potentially contaminated/ contaminated sites, and is used to provide an overview of the conditions of the site, to identify additional data necessary for further investigation, to integrate information on contaminants, migration routes, and different receptors and to serve as a support at all stages of the investigation, in the framework of the risk assessment, the feasibility study and the remediation project of the contaminated site (Governmental Decision, 2015; Order, 2020; Order, 2021).

In developing a conceptual model, according to the methodology, the following are considered:

a) the sources of contamination, the types and quantities (volume) of pollutants resulting from the proposed activity, the type and characteristics of the raw materials used in the proposed activities, and the finished products obtained,
b) possible routes of migration of contaminants and their effects on receptors;

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c) identification of the receiver(s) starting from the environmental characteristics of the area where the activity is carried out (land use in the area of activity and in its vicinity, identification of protected natural areas and residential areas, geological, hydrogeological, and hydrological characteristics).

CMS is considering establishing the source-pathway-receptor relationship and starts by identifying and analysing the source, and the next action is to determine the route of transfer/migration of contaminants to the receptors, and eventually, the receptors must be identified (who or what could be affected). The risk associated with the degree of contamination of the geological environment is treated by a phased approach to risk assessment: preliminary investigation; detailed investigation and risk assessment; prioritizing remedial actions (Governmental Decision, 2015; Order, 2020; Order, 2021).

The can be presented as a descriptive conceptual model or graphic/ chart or in map or cross-section format, schema or flow diagram, presenting the main properties of the source-path-receiver link; this graphic representation must illustrate the surface of the land, the geological/hydrogeological framework, the extent of the affected environment, the definition of the source area, the mutual relations between different factors, etc., on an appropriate scale.

Regarding the detailed investigation and the risk assessment, it envisages the detailed investigation, followed by the elaboration of the conceptual model and the actual evaluation of the risk, taking into account the following steps (Governmental Decision, 2015; Order, 2020; Order, 2021):

a) the collection and processing of additional data and information;
b) reconsideration of the conceptual model;
c) clarification of the objectives of the risk assessment, depending on the local objectives (local context) of environmental protection.

Quantitative risk assessment refers to the process of quantifying the impact that contaminants can have on human health and the environment and provides a clear picture of the intensity of contamination in relation to alert and intervention values.

The qualitative risk assessment refers to the general conditions for the protection of the site and is based on a comparative assessment of the concentrations of contaminants relevant to the site with the limit values/alert and intervention values/reference values for the present and future use of the site established by the legal provisions in force.

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Simplified (qualitative) risk assessment - Level I –

Within level I of risk assessment, alert thresholds and intervention thresholds are used to determine whether certain concentrations of pollutants are above or below their values as defined in the legislation in force and include (Governmental Decision, 2015; Order, 2020; Order, 2021):

a) reassessment of sources of contamination, migration and exposure pathways as well as receptors (CMS);
b) comparison of the concentrations of the identified contaminants with the alert thresholds and intervention thresholds established by the legislation in force.

In the Level I risk assessment, the concentrations of contaminants in the samples taken in the vicinity of the contamination source are considered and the following conclusions are drawn:

a) where the concentration of pollutants is below the alert threshold values for sensitive land use, no special measures shall be established, and the potentially contaminated site is classified as a 'site suitable for any use';
b) where the concentration of one or more pollutants exceeds the alert threshold values for sensitive land use, and where the concentration of one or more pollutants exceeds the alert threshold values for less sensitive use of the land but does not reach the values of the intervention threshold for less sensitive land use, a Level II risk assessment is carried out;
c) if the concentration of pollutants exceeds the intervention threshold values for less sensitive land use, the potentially contaminated site is classified as a 'contaminated site'.

Exposure assessment (quantitative) - Level II –

The purpose of the Level II risk assessment is to characterize the nature and extent of the risks to human receptors and ecological receptors due to the intensity of the degree of contamination under site-specific conditions (Governmental Decision, 2015; Order, 2020; Order, 2021). Level II risk assessment uses analytical models to estimate the concentration at the point of exposure, considering it to be a homogeneous and isotropic means. The Quantitative Level II risk assessment verifies whether the acceptable risk levels for the use of the site in question (which may be sensitive or less sensitive) are exceeded, solely based on the factual situation found (site-specific situation at the time of the assessment).

The risks to human health and the environment depend on the following four factors:

a) the concentration of the chemical present in the geological environment;
b) the duration of the exposure of a human recipient or ecological receiver to contamination;

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c) the duration of the exposure of a human recipient or ecological receiver to contamination;
d) the potential for environmental recovery.

The steps to be taken in the Level II quantitative risk assessment shall concern:

a) CMS re-analysis and receptor/receptor characterization;
b) collecting data and carrying out measurements in order to be able to characterise the nature and intensity of the contamination of environmental factors, as well as other information necessary to assess the behaviour of contaminants at present and to estimate their future behaviour;
c) the assessment of the toxicity as well as of the frequency and extent of human and ecological exposures to the contaminated environment, both now and in the future;
d) risk characterisation;
e) description and presentation of uncertainties;
f) Decision making.

For risk characterisation, experts shall analyse each type of contaminant and make comparisons with the reference values for determining the acceptability of the risk. Based on the most used options from other Member States of the European Union, it is recommended to use the following acceptance criteria (Governmental Decision, 2015; Order, 2020; Order, 2021):

a) acceptable incremental carcinogenic risk for a single compound: Ri = 10-5;
b) acceptable cumulative carcinogenic risk for a single compound: Rcum = ∑Ri = 10-5;
c) risk of acceptable toxicity related to exposure to a single toxic agent j (hazard coefficient): HQj = 1;
d) acceptable cumulative toxicity risk for exposure to a multitude of toxic agents (hazard index) HI = ∑HQj = 1,
e) the hazard coefficient (HQ) may be in the following two situations: if the HQ value is less than 1 (HQ<1), the contaminant does not present a risk of adverse health effects; exposure can be considered acceptable because it does not give rise to adverse effects and if the HQ value is HQ>1, the contaminant is hazardous to human health but the extent of the adverse effects cannot be determined/predicted.
f) the hazard index (HI) may be in the following two situations: if the HI value is less than 1 (HI<1), exposure to the studied contaminants does not present a risk of adverse health effects, and if the HI value is HI>1, the contaminants are hazardous to human health but the extent of the negative effects cannot be determined/estimated.

For carcinogenic risk, an acceptable value of 10-5 indicates an acceptable risk of 0.00001 during life, compared to a natural background which, for people living in Europe, is about 0.257 (this

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means that, for an exposed recipient, a maximum increase in the possibility of acquiring cancer over the course of a lifetime has been assumed from 0.257 to 0.25701).

A number of computer applications use simplified analytical transport models to calculate specific assessment indicators for the protection of human health and must include at least the following information:

a) estimation/modelling of contaminant transport routes for each environmental factor;
b) the mathematical model applied;
c) identification of input data used in the equations/formulas applied.

The risk assessment grid shall be carried out according to the criteria of Annex no. 1 and Annex no. 2 from the Methodology for investigating potentially contaminated and contaminated sites. The calculated risk score for each potentially contaminated/contaminated site is useful for:

a) a national record of contaminated sites classified as priority categories;
b) prioritising the remediation in the case of orphan contaminated sites with priority at remediation the site with the highest score, where the funds available for remediation projects are limited;
c) carrying out remedial projects financed on the basis of the selection criteria considering their eligibility and relevance.

Depending on the risk score obtained, the contaminated sites are classified as follows (Governmental Decision, 2015; Order, 2020; Order, 2021):

a) priority of urgent remediation (score 80 - 100);
b) high remediation priority (score 60 – 79);
c) average remediation priority (score 30 – 59);
d) low fix priority (score < 30).

Measurement of exposure - Level III of risk assessment –

Level III is to a large extent achieved based on the exposure measured using the same risk analysis as described above for Level II. The application of level III of risk requires site-specific investigations tailored to local conditions and requires a greater amount of site-specific data and information that allows for a detailed site assessment. The results of the activities within the detailed investigation and risk assessment phase as well as the results of the analyses carried out in the laboratory may be presented in tabular form, summarizing the analytical data, and highlighting contaminants that exceed the evaluation indicators/threshold values. The result of the evaluation of the analytical data must identify those contaminants that exceed the assessment

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indicators/baselines and must be taken into account for the modification and updating of the CMS. The results of the detailed investigation work must also be accompanied by graphic and cartographic representations (Governmental Decision, 2015; Order, 2020; Order, 2021):

a) situation plan with the location of the sources of contamination;
b) plan with the location of the investigations carried out and of the sampling points;
c) piezometric maps;
d) drilling profiles (lithological sections along the length of the boreholes);
e) map of the distribution of contaminants at zonal level or in a vertical plane (sections);
f) various graphs and possibly maps representing the temporal variation of contamination (contamination history based on data).

In Romania, over 1000 potentially contaminated sites and over 200 contaminated sites are registered in the National Inventory. It is recommended to monitor and continuously update the National Inventory, to create a platform to ensure transparency in the process of evaluation and classification of potentially contaminated or contaminated sites (Governmental Decision, 2015; Order, 2020; Order, 2021).

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Annex 1. "Zero waste" implementation initial analysis at city level

Waste generation

1. What amount of waste is generated?-total and -kg/capita/year

Competence

2. Who is responsible for waste collection?

The composition of the waste

3. What is the typical composition of a household waste container?
4. What is the amount of recyclables in it?
5. What is the proportion of recyclable materials in it?

Separate collection

6. What is the separate collection rate?
7. What happens to waste that is not collected separately?
8. What happens to the collected waste?
9. Is data available on quantities/volumes of waste recycled?

Biodegradable organic waste management

10. Is organic waste collected separately?
11. If so, what is the level of contamination with other waste? % impurities in the amount of organic waste?
12. Is there a composting facility in the city?
13. Is there an individual or shared composting system supported at local authority level?

Waste prevention

14. Is there a waste prevention plan?
15. How does the local authority introduce waste prevention measures?
16. Does the local authority have the power to introduce certain products or materials on the market?

Repair, reuse

17. How many repair or reuse centers are there in the city?
18. How many businesses related to repair and reuse are there in the city?

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Contractual obligations

19. Is there a long-term contract between the local authority and the waste collector/treatment operator?

Treatment costs

20. What is the fee for the treatment of mixed municipal waste?
21. Can local authorities change it?

Contractual obligations

22. What is the cost of waste management per capita? Euro/capita/year
23. Are there fees for incineration or landfilling?

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These documents are made with the financial support of the EEA Financial Mechanism 2014 - 2021. Its content (text, photos) do not reflect the official opinion of the Program Operator, the National Contact Point or the Office of the Financial Mechanism. The information and opinions expressed are the sole responsibility of the author(s).