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Major External Public Audit Topics: Combating the Effects of Climate Change on Soil

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Abstract: *This paper addresses a very important topic of external public audit in the context of soil protection and the impact of climate change, highlighting its (audit's) significance in the efficient management of natural resources. The analysis revealed a significant impact of climate change on soil health, including issues such as erosion, salinization, and loss of fertility, which underscores the urgent need to implement effective protection and conservation measures. In this context, external public audit, conducted by the Court of Accounts of Romania (and those of other EU states) and the European Court of Auditors, plays a major role in assessing the European Commission's efforts aimed at combating emerging negative effects, thereby contributing to increased transparency and accountability in the use of public funds. The paper reveals that audit activities face major challenges—limited resources, lack of complete data, etc.—and thus recommendations have been made to improve the efficiency of environmental audits.*

Keywords: *climate change; soil protection; external public audit; efficiency; sustainability; limits.*

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Nomenclature of acronyms

CAP/PAC	Common Agricultural Policy
ECA	European Court of Auditors
EC	European Commission
EEA	European Environment Agency
EU	European Union
MARD/MADR	Ministry of Agriculture and Rural Development
MEWF/MMAP	Ministry of Environment, Waters and Forests
NAEP/ANPM	National Agency for Environmental Protection
NCCDLDD/CNCSDTD	National Committee for Combating Drought, Land Degradation and Desertification
NAPCC/PNASC	National Action Plan for Climate Change
RCA/CCR	Romanian Court of Accounts
RG	Romanian Government
RP	Romanian Parliament
UNCCD	United Nations Convention to Combat Desertification

Introduction

In recent decades, the frequency of extreme weather events, such as droughts, floods, and sudden temperature fluctuations, has increased significantly, with destructive consequences for ecosystems and natural resources. At the end of 2019, the European Parliament declared a "climate and environmental emergency" highlighting the need for urgent and coordinated global actions to reduce emissions and achieve climate neutrality. The European Green Deal, the EU's new Climate Adaptation Strategy, the Horizon Europe Climate Adaptation Mission, the European Climate Law, and the European Climate Pact are important efforts by the European Union to address the complex challenges posed by climate change. Member states are required to adopt these new European guidelines to support the ambitious goal of achieving climate neutrality by 2050 (RG, 2024a,b). Soil, an indispensable resource, significantly contributes to agriculture, carbon storage, water purification, and the preservation of biodiversity. However, climate change severely impacts soil, leading to degradation, increased erosion, and reduced fertility. Studies show that climate change can compromise the soil's ability to support agriculture,

threatening global food security (Montanarella & Panagos, 2021). Thus, soil protection becomes a priority not only for environmental health but also for ensuring sustainable development. Currently, the EU and member states are implementing policies and initiatives aimed at sustainable soil management and rehabilitation, and external public audit seeks, among other objectives, to ensure transparency and accountability in resource management and the application of environmental protection measures (Bostan et al., 2013; Bostan, 2010a,b). Addressing the role of this type of audit in assessing soil protection measures in the context of climate change, we emphasize certain missions carried out by the CCR and the ECA, aiming to highlight their main findings, the challenges encountered, and the recommendations proposed to bring improvements in the field analyzed.

The structure of this paper is as follows: (1) Introduction; (2) The concept and role of external public audit in the field of the environment; (3) Climate change and its impact on soil; (4) EU initiatives and policies on soil protection in the context of climate change and the role of ECA in and evaluating their implementation; (5) Audit missions of the Court of Accounts of Romania in the field of soil protection; and (6) Conclusions.

The concept and role of external public auditing in the environmental sector

In general, we understand that external public audit is a methodical process of analyzing the financial and operational activities of public institutions, aimed at ensuring compliance, efficiency, and effectiveness in the use of public funds (Boulescu et al., 2009; Ispir, 2008). Independent institutions such as the CCR and the ECA conduct this type of audit to guarantee transparency and accountability in the management of public financial resources, as well as in the administration of public assets. In the environmental field, external public audit involves multidisciplinary approaches that include evaluating not only financial aspects but also social and environmental ones, in the spirit of sustainable development. CCR's central objective is to verify the responsible use of public funds and the efficiency of government programs, including those dedicated to the environment (RP, 1992; CCR, 2022). On the other hand, ECA examines the allocation of financial resources intended for environmental protection and climate change adaptation, assessing the impact and effectiveness of environmental policies implemented in member states (ECA, 2018a).

The audit activities carried out by the CCR and ECA encompass multiple types of evaluations (see Table 1), each with a specific goal concerning soil protection and climate adaptation.

Table 1. Main categories of audit (Information from CCR and ECA websites).

No.	Audit types	Specifications
1.	Compliance audits	They verify compliance with legislation and regulations in force regarding soil protection and measures to combat climate change, assessing whether public institutions fulfill their legal obligations and the rules set by policies.
2.	Performance audits	These missions focus on evaluating the efficiency and effectiveness of the measures adopted for soil protection, analyzing whether resources are optimally used and whether the established objectives have been achieved.
3.	Financial audits	These focus on verifying the correctness of financial reporting related to funds allocated for environmental protection projects, ensuring that public money is managed properly.
4.	Ex-post evaluations	These evaluations analyze the long-term impact of implemented soil protection measures, helping to identify lessons learned and good practices for future initiatives.

Through these types of audits, the CCR and ECA contribute to improved management of natural resources and environmental protection, promoting a more sustainable policy framework adapted to current challenges.

Climate change and its impact on soil

Maintaining soil health is vital for food security, biodiversity, and water management in the context of climate change, as healthy soil contributes to carbon capture and storage, supporting climate change mitigation. By preserving its structure and fertility, soil becomes better able to retain water, enhancing ecosystems and biodiversity and making them more resilient to extreme climate conditions. Climate change profoundly impacts soil, altering the physical, chemical, and biological processes that sustain its health (EEA, 2016). Major effects include (EC, nd,a; ANPM, 2018): (i) Soil erosion – Increased intensity and frequency of extreme weather events, such as heavy rains and storms, accelerate soil erosion, leading to the loss of the fertile top layer. This reduces agricultural capacity and ecosystem biodiversity and contributes to water pollution as sediments and nutrients are carried into water bodies; (ii) Salinization – Changes in rainfall patterns, combined with increased evaporation, lead to the accumulation of salts in soil, seriously affecting fertility. Salinization decreases soil productivity, causing economic losses for farmers and jeopardizing food security; (iii) Reduced soil fertility – Higher temperatures and changes in rainfall disrupt nutrient cycling. The limitation of soil's capacity to provide essential nutrients to plants is caused by a decrease in beneficial microorganisms and organic matter within the soil. This creates a need to increase reliance on chemical fertilizers, which can affect soil quality

in the long term. Protecting and restoring degraded soils are important adaptation measures to climate change, as well-managed soil is better prepared to withstand climate variations. This emphasizes the need for the EU and its member states to adopt effective soil conservation and restoration policies, aimed at sustainable natural resource management.

EU initiatives and policies on soil protection in the context of climate change and the role of the ECA in evaluating their implementation

The European Union has integrated soil protection into its sustainable development strategy due to its fundamental role in the context of climate change. In the Biodiversity Strategy, the EU emphasizes the importance of conserving ecosystems, including soil, and its policy proposals aim to reduce soil degradation and promote sustainable natural resource management (EC, 2020a). On the other hand, the CAP includes specific measures for sustainable agriculture that protect both soil and water resources, encouraging practices such as crop rotation, the use of organic fertilizers, and soil conservation methods (EC, n.d,b). The Water Framework Directive also includes measures to prevent soil contamination and degradation, highlighting the connection between water and soil quality (EC, 2000). Additionally, the Circular Economy Action Plan focuses on waste reduction and more efficient resource use, promoting recycling and the restoration of degraded soils (EC, 2020b). Most relevant to our topic, it should be noted that the ECA assesses whether the measures implemented by member states comply with European commitments, analyzing the efficiency and effectiveness of financial resources allocated to soil conservation projects (Bostan & Hurjui, 2014). Moreover, the ECA periodically publishes detailed reports with recommendations for improving policy implementation, supporting the adjustment of strategies and responsible management of soil resources across the EU. In this way, the ECA contributes to the transparency of European funds administration dedicated to soil protection, providing relevant information for stakeholders and the public. A relevant audit example is the one conducted by the ECA in 2023, titled "EU Efforts for Sustainable Soil Management." The audit highlighted that, although soil protection regulations are adequate, their enforcement varies significantly between member states, resulting in gaps in the effective protection of European soils (see Figure 1).

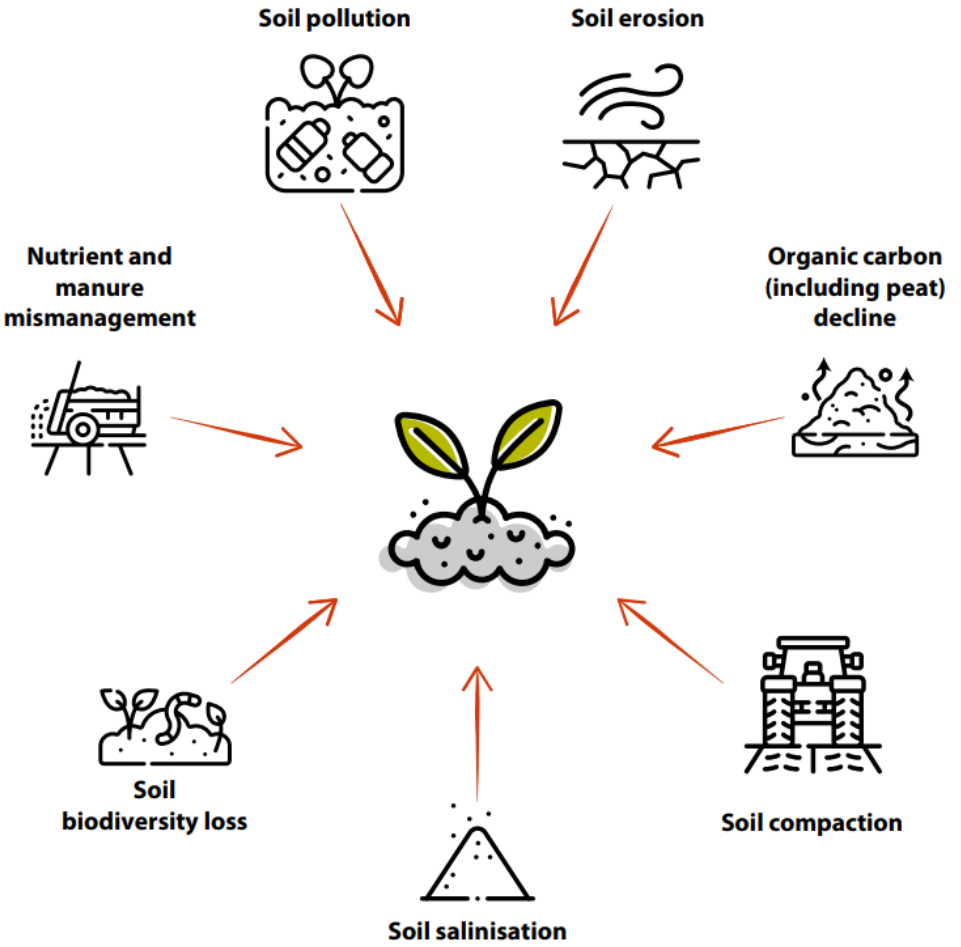


Figure 1. Pressures on European agricultural soils (ECA, 2023)

More specifically, the ECA concluded that due to insufficiently ambitious definitions and standards, combined with limited national-level implementation, the Commission and member states have not fully utilized the available tools to improve soil health, leaving substantial room for improvement. The ECA's 2023 special report highlights that, although cross-compliance standards for soil and manure management could address soil health risks by applying to 85% of utilized agricultural land, these standards often reflect existing agricultural practices and do not require significant behavioral changes from farmers. As a result, the impact on soil health remains limited. The ECA also noted that the Commission does not assess the ambition level of measures applied by member states annually to meet agricultural and environmental conditions, instead providing only a

retrospective evaluation for the 2015-2020 period. Moreover, only a few member states have analyzed the contribution of cross-compliance to sustainable soil and manure management. The ECA emphasizes that, without substantial changes in measures applied by some member states, the overall impact on sustainable soil and manure management will remain modest. In a recent mission, the ECA evaluated organic farming in the EU, based on the principle that it supports biodiversity and reduces soil, air, and water pollution (ECA, 2024). The principles of organic farming are directly linked to soil protection and health, reflected in sustainable practices that contribute to maintaining ecosystem integrity (Figure 2).

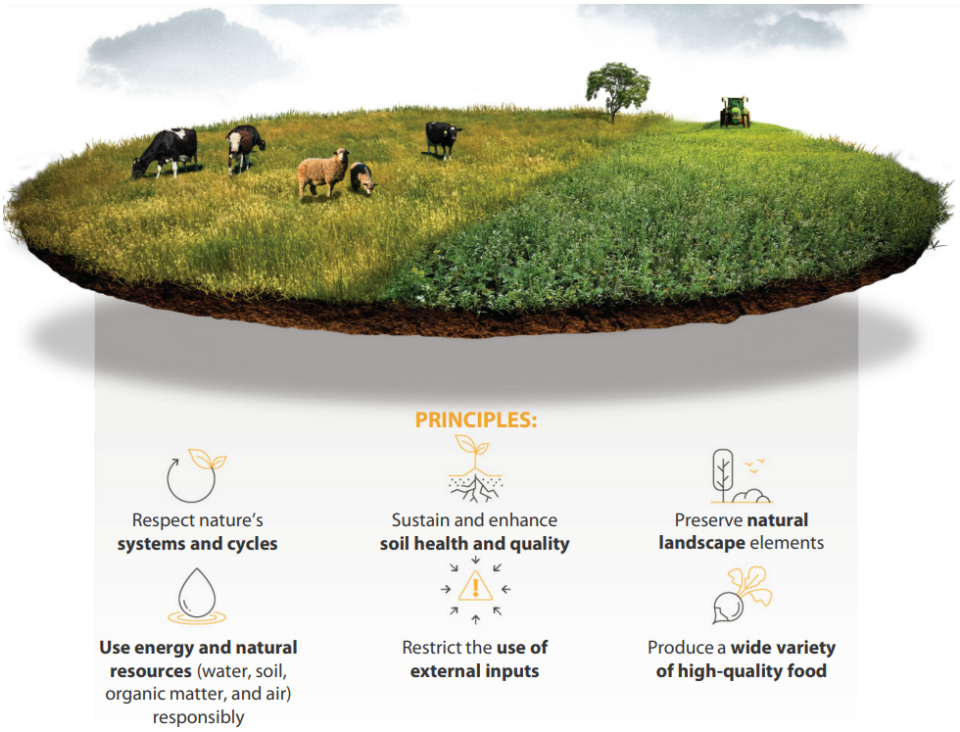


Figure 2. The principles of ecological agriculture (ECA, 2024)

The European Commission (EC) views organic farming as important to the sustainable development of the agricultural sector, proposing that by 2030, a quarter of the EU's agricultural land should be farmed organically—a notable increase from 10.5% in 2022. However, the ECA audit revealed some gaps in EU and national policies regarding organic farming. CAP funds have been used to expand organic farmland, but these investments have not been fully aligned with the EU's environmental and market objectives for organic

farming. The evaluation of this policy's impact has been limited by a lack of adequate data. Although the 2021-2027 plan represents an improvement over the previous version, its three main objectives lack quantifiable targets or clear methods for monitoring progress. Additionally, the EU's target of 25% organic farmland by 2030 is not backed by objectives covering other aspects of the sector. These issues could have been prevented, as the ECA recommended back in 2018 (ECA, 2018b): (i) developing a methodology to assess desertification and soil degradation in the EU and periodically analyzing this data; (ii) revising the legal framework on sustainable soil use, including combating desertification and degradation; (iii) detailing the EU's commitment to achieving land degradation neutrality by 2030 and reporting progress periodically; (iv) providing guidance to member states on soil conservation and achieving land degradation neutrality, including best practices; (v) offering technical support to member states requesting assistance in developing national action plans for land neutrality by 2030. At the end of 2018, the ECA warned that climate scenarios indicate increased EU vulnerability to desertification this century, with higher temperatures, extended drought periods, and reduced rainfall in southern Europe. Southern Portugal, much of Spain, southern Italy, southeastern Greece, Cyprus, and coastal areas of Bulgaria and Romania are expected to be most affected. Thirteen EU member states declared themselves affected by desertification under the UNCCD (Bulgaria, Greece, Spain, Croatia, Italy, Cyprus, Latvia, Hungary, Malta, Portugal, Romania, Slovenia, and Slovakia). These audit missions reflect the ECA's commitment to promoting effective soil management and contributing to the development of more effective climate policies.

Audit missions of the Court of Accounts of Romania in the field of soil protection

Romania's land fund includes vast areas with highly fertile soils, among the most productive in Europe, many of which remain chemically uncontaminated and ideal for organic farming. However, studies (RG, 2020) indicate a continuing deterioration in the quality of these soils, with areas exposed to drought, desertification, erosion, excess moisture, salinization, and acidification having doubled over the last 25 years. This degradation is caused by improper irrigation, compaction from heavy machinery, and depletion of organic matter through unsuitable technological practices. Eurostat's land-use studies for urban and infrastructure development have revealed a significant threat at the European level, which Romania has been tracking for over two decades. In 2004, Government Decision No. 474/2004 established the National Committee for Combating Drought, Land Degradation, and

Desertification (RG, 2004), which in 2008 adopted the „National Strategy for Reducing the Effects of Drought and Combating Land Degradation and Desertification" (CNCSDTD, 2008). The strategy aimed to reduce the vulnerability of local communities and ecosystems and to mitigate short-, medium-, and long-term social, economic, and environmental effects. The National Climate Change Strategy (2013-2020) (RG, 2013) shows that drought-affected areas have expanded considerably, with southern and southeastern Romania particularly vulnerable to soil drought. Over the last three decades, the country has experienced increasingly frequent and intense drought periods, a phenomenon many experts consider a consequence of climate change. Complex agricultural drought is a climate risk with severe impacts on agriculture, which is therefore closely monitored (Figure 3). The area affected by desertification, characterized by an arid, semi-arid, or sub-humid-dry climate, represents approximately 30% of Romania's total area.

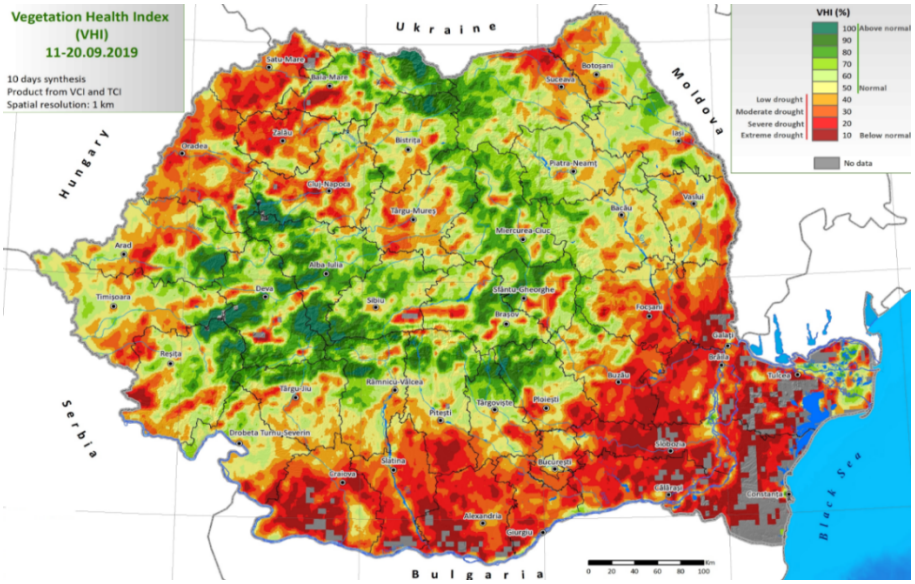


Figure 3. Drought monitoring in Romania
Source: Copernicus Global Land Service Use Case (2020).

Romania's land fund includes vast areas of highly fertile soils, some of the most productive in Europe, many of which remain uncontaminated by chemicals, making them ideal for organic farming. However, recent research (RG, 2020) shows a continued degradation in soil quality, particularly with the doubling over the last two and a half decades of areas affected by drought, erosion, desertification, excess moisture, salinization, and acidification. These effects are attributed to improper use of irrigation systems, soil compaction

from heavy machinery, and a reduction in soil organic matter due to unsuitable agricultural technologies. Eurostat investigations assessing land use for urban and infrastructural development have identified a significant threat at the EU level. Concerned with this issue for over two decades, Romania established, through Government Decision No. 474/2004, the National Committee for Combating Drought, Land Degradation, and Desertification, which formulated and adopted in 2008 the „National Strategy for Reducing the Effects of Drought, Preventing and Combating Land Degradation and Desertification". The strategy's main objective was to reduce the vulnerability of communities, natural ecosystems, and socio-economic activities to mitigate their impact in the short, medium, and long term. The National Climate Change Strategy for 2013-2020 (RG, 2013) highlights the significant expansion of drought-affected areas, particularly in southern and southeastern Romania, regions considered most vulnerable to soil drought. Over the last three decades, the entire country has felt the effects of increasingly frequent and prolonged drought periods, a phenomenon increasingly regarded as a result of climate change. Complex agricultural drought represents a climate hazard with the most severe consequences for agriculture, being constantly monitored, and the desertification-affected areas, with arid, semi-arid, or sub-humid characteristics, cover approximately 30% of Romania's total area (Figure 4).

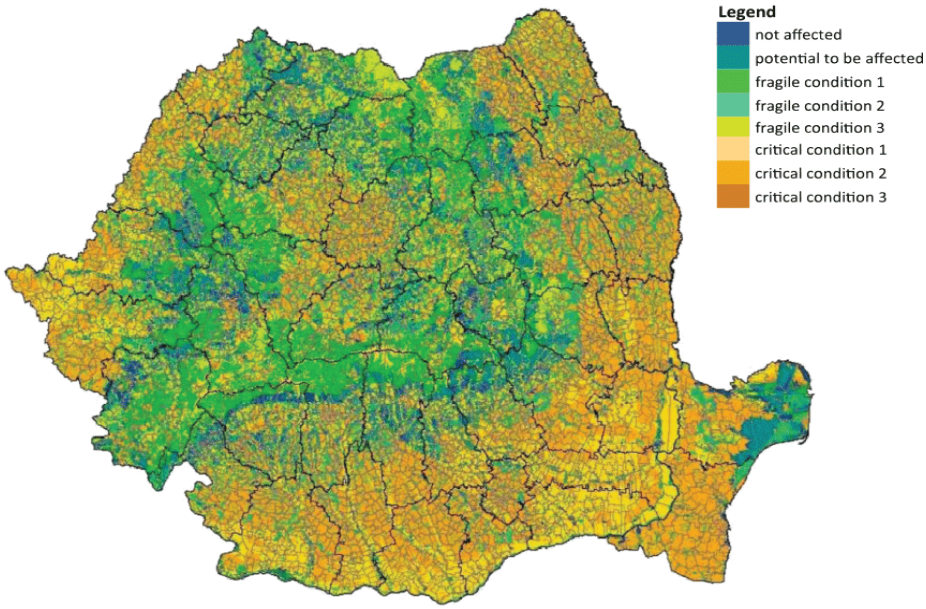


Figure 4. The desertification-affected areas, with arid, semi-arid, or sub-humid characteristics, cover approximately 30% of Romania's total area
Source: Samurović (August 24, 2020)

The audit identified various vulnerabilities and deficiencies in the evaluated activities, as well as deviations from the established objectives, based on which recommendations were made for their correction and for improving performance (CCR, 2023). These recommendations address the duties and responsibilities of the institutions involved in reducing the negative effects of climate change on national agriculture. The audit findings revealed that a national strategy had not been implemented in the agricultural and rural development sector, even though the MADR is primarily responsible for formulating, developing, and implementing sectoral strategies and policies, including those in the fields of agriculture, environmental protection, and climate change. The lack of an integrated strategy affected the coherence of policies and measures in this area, and the absence of a global vision regarding the necessary actions for implementation by all public entities with responsibilities in the field led to negative impacts on addressing the deficiencies and vulnerabilities of the agri-food sector, including those generated by climate change. Regarding the National Program for the Rehabilitation of Main Irrigation Infrastructure (RG, 2016), which aimed for resource savings (water and electricity) and increased agricultural land productivity, no evaluations or quantifications of these expected results were made. The Ministry did not ensure adequate monitoring of the program, and the necessary procedures and documents for its evaluation were not prepared. The program was only partially implemented, and the main objective, which targeted the rehabilitation of irrigation infrastructure in 89 schemes covering an area of approximately 2,004,639 ha, was not achieved by the end of 2020. Despite the significant increase in the state's financial effort for irrigation starting in 2017, through the provision of financial facilities to beneficiaries, MADR did not assess their impact. As a result, it is unknown whether these measures contributed to an increase in agricultural production. Although the irrigated area increased due to these facilities, it remains limited, representing only 12.44% of the total area designated for irrigation and 35.23% of the functional area, as recorded in 2021.

Table 2. Evolution of the irrigated area from 2014 to 2021 (CCR, 2023)

Year	Landscaped area (ha)	Functional area (ha)	Watered area (ha)	Watered area / Landscaped area	Watered area / Functional area
0	1	2	3	4=3/1	5=3/2
2021	3 011 372	1 063 187	374 544	12.44%	35.23%
2020	3 007 311	1 053 838	510 934	16.99%	48.48%
2019	2 994 746	1 200 000	283 794	9.48%	23.65%
2018	2 989 379	1 200 000	266 465	8.91%	22.21%
2017	2 989 441	823 000	217 985	7.29%	26.49%
2016	2 989 636	790 000	153 014	5.12%	19.37%
2015	2 989 706	790 000	166 484	5.57%	21.07%
2014	2 990 001	790 000	122 066	4.08%	15.45%

MADR partially implemented the Agricultural Land Monitoring Program (MADR, 2011, 2021), which aimed to track changes in land quality and propose measures to protect and improve agricultural lands. Although some activities were carried out to achieve the quantitative indicators set by the program, its implementation was hindered by ineffective cooperation among decision-makers, a lack of adequate funding, and the limited administrative capacity of the responsible authorities. Consequently, the program was only partially realized. Between 2002 and 2021, complete data from soil studies were available for only 45.2% of the country's agricultural area, although the program's goal was full national coverage of agricultural lands. MADR did not develop adequate procedures or annual plans for the implementation and monitoring of this program. Moreover, no funds were allocated for land improvement or for reintroducing lands into agricultural use. No detailed analysis of soil monitoring data was conducted to compile an inventory of necessary measures to prevent agricultural land degradation. In this context, the program's purpose was not achieved, and soil studies conducted before 2012 risk becoming outdated. The audit also highlighted the absence of methodological norms for applying the Soil Law (RP, 2020), making it impossible to effectively implement soil protection measures. At the national level, there is no centralized inventory of degraded lands, although this was a legal requirement. Additionally, no program was developed for the afforestation of degraded lands, despite a legal mandate. The Ministry of Environment, Waters, and Forests (MEWF/MMAP) and MADR were unable to identify documents to support the inventory of 2,000,000 ha of non-forested lands suitable for afforestation, as mentioned in the Forestry Code, and did not provide clear information regarding the area and location of these lands. From 2010 to 2015, only 1,021 ha of degraded lands were afforested, and between 2016 and 2022, no afforestation activities were conducted on degraded agricultural lands. Given the slow pace of afforestation, there are doubts about meeting the Forestry

Code's goal to afforest 2 million ha of non-forested lands by 2035. Furthermore, a national program for creating forest shelter belts to protect agricultural land was not implemented, although supporting studies existed. From 2011 to 2021, forest shelter belts were established on only 406 ha. Measures to reduce greenhouse gas emissions, adapt to climate change, and conserve carbon in agriculture and forestry were implemented through the CAP, but no clear emission reduction targets were defined, nor were the contributions of these measures evaluated. Reports on the implementation of sectoral and cross-sectoral actions or the achievement of the indicators established in the National Climate Change Action Plan (NCCAP/PNASC) were not published. Additionally, there were no collaboration protocols between MADR and MMAP for monitoring and evaluating progress toward these objectives.

Conclusions

Climate change has extremely negative effects on soil health/quality, leading to erosion, salinization, and reduced fertility. This underscores the urgent need for effective measures to protect and conserve soil, especially considering the importance of ensuring the long-term sustainability of agricultural and ecological resources. External public audit, conducted by institutions such as the CCR and the ECA, plays a important role in evaluating and monitoring the measures adopted to combat the effects of climate change on soil, contributing to transparency, accountability, and the efficient use of public funds. Although the situation is largely satisfactory, we have found that the audit process in the field of soil protection faces several challenges: limited resources, incomplete data, insufficient coordination between institutions, etc. Following the analysis, clear recommendations were proposed to strengthen the role of the Court of Accounts in monitoring soil protection policies, including the allocation of additional resources, the development of efficient data monitoring systems, improvement of interinstitutional coordination, and the promotion of education and awareness within communities. We have observed that the EU's policies and initiatives in soil protection provide a valuable framework that can be adapted and applied at the national level, with the audit of these initiatives helping to assess their effectiveness and formulate better strategies for the future. Our view is that to address current and future challenges, collaboration among all stakeholders and the implementation of evidence-based measures are necessary, knowing that only through an integrated and coordinated approach can sustainable results be achieved in the face of climate change.

Research limitations

Limited or inaccessible data influenced the ability to effectively evaluate the implemented programs and policies. The research focused primarily on the Romanian context and European Union initiatives, which may limit the applicability of conclusions to other regions or audit systems.

Future research directions

Future studies could adopt an interdisciplinary approach that combines economic, ecological, and social aspects to better understand the interactions between policies, soil management practices, and the impact of climate change. Additionally, research on how soil protection measures and climate change affect local communities could add an important social dimension to the analysis of these policies' effects.

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