Scientific Research Publishing

Open Journal of Soil Science, 2025, 15(8), 556-569
https://www.scirp.org/journal/ojss
ISSN Online: 2162-5379
ISSN Print: 2162-5360

Soil Policy and Governance in Lebanon: Challenges, Opportunities, and the Path Forward

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How to cite this paper: Jomaa, I., Skaff, S. and Massaad, R. (2025) Soil Policy and Governance in Lebanon: Challenges, Opportunities, and the Path Forward. *Open Journal of Soil Science*, **15**, 556-569.
https://doi.org/10.4236/ojss.2025.158024

Received: May 8, 2025
Accepted: August 4, 2025
Published: August 7, 2025

Abstract

Soil health is a fundamental factor for agricultural productivity and environmental sustainability in Lebanon. However, Lebanon faces multiple challenges related to soil degradation, including erosion, desertification, contamination, and loss of fertility. The country's governance structures remain fragmented, and policy implementation is inconsistent due to political instability, insufficient data, and weak inter-sectorial coordination. This study addresses the research question: "How can Lebanon address institutional fragmentation and data gaps to improve soil governance?" Using a qualitative methodology combining policy analysis and stakeholder mapping within the Soils4Med Project framework, this paper identifies key challenges and opportunities. It provides recommendations for improving soil protection and sustainable land management through a data-driven approach.

Keywords

Soil Governance, Lebanon, Land Degradation, Policy, Sustainability, Soils4Med, Soil Health

1. Introduction

Soil degradation is a pressing environmental and agricultural issue in Lebanon, posing significant challenges to food security, economic stability, and sustainable land management. The country's diverse topography, ranging from coastal plains to mountainous terrains and fertile valleys, makes its soils highly vulnerable to degradation processes such as erosion, desertification, and contamination. These issues originate from both natural forces, such as climate variability, and human activities, including rapid urban expansion, deforestation, unsustainable farming

practices, and industrial pollution [1] [2]. In particular, sources of soil contamination include industrial waste disposal, landfill seepage, improper chemical use, and pesticide residues, all of which have significant governance implications. The management of industrial and landfill waste remains inadequately regulated, resulting in persistent contamination hotspots that degrade soil quality and threaten public health. These contamination sources require cross-sectorial governance responses involving environmental regulations, waste management policies, and enforcement mechanisms, which currently remain fragmented in Lebanon.

Lebanon's agricultural sector, which remains a vital component of the national economy, depends on healthy soils to maintain productivity and sustainability. However, land mismanagement, excessive reliance on chemical inputs, and poor irrigation practices have led to severe soil degradation, resulting in reduced crop yields and increased soil infertility. The impacts of climate change further exacerbate these challenges, leading to intensified droughts, erratic rainfall patterns, and increased desertification, particularly in regions such as the Bekaa Valley and northern Lebanon [3] [4]. Without a structured, evidence-based approach to soil conservation, Lebanon risks further environmental degradation, which could have long-term socio-economic consequences.

Despite the urgent need for intervention, soil governance in Lebanon remains highly fragmented. Multiple governmental bodies, including the Ministry of Agriculture (MOA), the Ministry of Environment (MOE), and the Ministry of Energy and Water (MEW), manage soil-related policies and regulations, yet there is a lack of coordination among these entities [5]. This disjointed governance framework results in policy inconsistencies, ineffective enforcement mechanisms, and minimal stakeholder collaboration. Furthermore, there is an evident gap in soil monitoring initiatives, with insufficient data collection and analysis hindering policymakers from developing well-informed strategies [6].

To address these challenges, the Soils4Med Project provides a comprehensive framework for improving soil monitoring and governance in Lebanon. The project integrates methodologies such as remote sensing technologies, GIS-based mapping, and field-based soil health assessments. These methodologies offer valuable insights that Lebanon can incorporate into its governance framework to enhance policy effectiveness and soil conservation efforts. Furthermore, by establishing standardized monitoring approaches, developing a centralized national soil database, and utilizing predictive modeling and AI-driven analysis, Lebanon can ensure data-driven decision-making and improve regulatory enforcement [7]. This integrated framework will help address both current and future risks related to soil degradation and climate change, creating a more resilient and evidence-based governance structure for soil management.

Strengthening soil monitoring and integrating these methodologies into national policies will not only improve environmental sustainability but also contribute to long-term agricultural resilience and economic stability [8]. This study employs a qualitative research methodology to examine soil governance and deg-

radation in Lebanon.

2. Materials and Methods

2.1. Previous Work

A systematic review of peer-reviewed journal articles, books, and scholarly reports was conducted to explore key issues related to soil degradation, agricultural practices, and governance frameworks within Lebanon. The review aimed to synthesize existing knowledge, identify gaps, and contextualize the drivers and consequences of soil degradation in the country. Emphasis was placed on historical and current factors contributing to soil erosion, land mismanagement, and agricultural unsustainability in Lebanon [9] [10]. The review also examined the prevailing governance structures and their influence on soil degradation, providing a foundation for understanding the socio-political and environmental challenges surrounding soil management.

2.2. Policy Analysis

A critical analysis of national policies was conducted to evaluate Lebanon's approaches to soil conservation, land use, water management, and environmental protection. Primary documents reviewed included National Agricultural Strategies, policies, Lebanon's National Action Plan for Desertification (NAP), the Lebanese Environmental Policy, and environmental provisions within the Lebanese Constitution [8] [11]. This analysis aimed to assess policy coherence, effectiveness, and gaps in existing environmental policies related to soil governance, highlighting opportunities for strengthening Lebanon's soil governance framework. The roles of various institutional actors in shaping and enforcing soil-related policies were also examined.

2.3. Stakeholder Mapping

Stakeholder mapping identified the key actors in Lebanon's environmental landscape, exploring the dynamics between governmental, non-governmental, and private sector actors in shaping soil governance policies [12]. This approach offered a thorough understanding of the multi-dimensional challenges surrounding soil degradation, integrating local and international perspectives (**Table 1**).

Table 1. Stakeholder mapping.

Stakeholder	Role	Influence Level	Potential Conflicts
Ministry of Agriculture (MoA)	Policy formulation and enforcement on agricultural land	High	Conflicts with Ministry of Environment over land use priorities
Ministry of Environment (MoE)	Environmental regulation and pollution control	High	Overlaps with MoA and MEW in jurisdiction
Ministry of Energy and Water (MEW)	Water resource management impacting soil	Medium	Competes with MoA on irrigation policies

Continued

Local Municipalities	Land use planning and local enforcement	Medium	Limited capacity; conflicting priorities with national agencies
Environmental NGOs	Advocacy and community engagement	Medium	Oppose some private development projects
Private Developers	Land development and construction	High	Conflict with environmental groups and municipalities
Research Institutions	Soil data collection and analysis	Low	Limited influence on policy decisions
Farmers Associations	Agricultural practices and adoption	Medium	Diverse interests; sometimes resist regulation

2.4. Data Analysis

Data from the literature review, policy analysis, and previous studies were subjected to thematic analysis. This process identified recurring themes such as institutional fragmentation, insufficient data availability, policy enforcement challenges, and the need for greater public awareness and education on soil degradation. The thematic analysis also focused on identifying synergies and opportunities for policy improvement and effective governance mechanisms [13] [14].

2.5. Synthesis and Recommendations

Based on the findings from the literature review, policy analysis, and data gathering, a synthesis of the data was conducted to develop actionable policy recommendations. These recommendations aimed at enhancing Lebanon's soil management practices and governance framework. The final recommendations focus on enhancing institutional coordination, improving data availability, strengthening policy enforcement, and fostering public awareness and educational campaigns on soil conservation.

3. Results

The results of this study offer critical insights into the state of soil governance and degradation in Lebanon.

3.1. Fragmentation of Soil Governance

Lebanon's soil governance framework is marked by significant lack of coordination among key governmental institutions, severely delaying the effective implementation of soil-related policies. Despite involvement of ministries such as MoA, MoE, and MEW, there is no unified or comprehensive strategic approach to tackling soil degradation, including erosion, desertification, and contamination. Each ministry often works separately without clear coordination or shared vision (**Figure 1**). This fragmentation leads to inconsistent policy enforcement and overlapping mandates [15] [16].

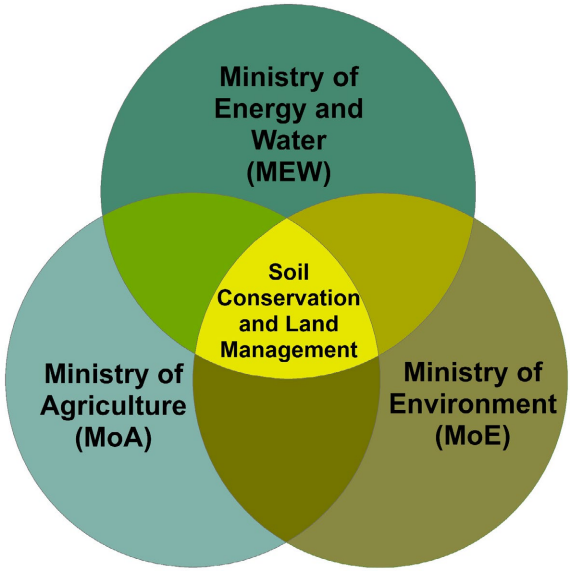

Figure 1. Responsibility fragmentation of soil governance among institutions.

Examples of successful coordination models from the Soils4Med project and Mediterranean countries illustrate pathways for Lebanon. For instance, Italy's regional soil monitoring committees foster multi-stakeholder collaboration, integrating data collection with policy enforcement. Similarly, Tunisia's national soil conservation program centralizes monitoring and incentivizes sustainable practices through coordinated institutional efforts. These examples provide practical frameworks Lebanon can adapt to improve soil governance effectiveness.

This institutional fragmentation leads to inconsistent policy enforcement and an individual approach to land management. For instance, while the MoA focuses on agricultural practices and land cultivation, the MoE addresses environmental concerns, and the MEW manages water resources. However, these ministries frequently operate independently, often duplicating efforts and leaving critical gaps in policy coherence and enforcement. There is considerable overlap in the mandates of these ministries, yet the lack of inter-ministerial collaboration and integration weakens the effectiveness of interventions [17] [18].

Lebanon's policy framework fails to adequately address the socio-political factors that exacerbate soil degradation, such as unregulated urban expansion, unsustainable agricultural practices, and deforestation [19]. This lack of integration and response coordination exacerbates the vulnerability of Lebanese soils to degradation, particularly in urbanized areas. As a result, Lebanon faces increasing challenges in mitigating soil erosion, preventing desertification, and managing contamination levels. These issues are further compounded by the absence of a national soil policy that integrates land use planning, environmental conservation, and water management [20] [21].

The absence of a cohesive, cross-sectoral strategy for soil governance not only hinders effective soil conservation efforts but also limits Lebanon's ability to meet

international environmental commitments, such as those set forth by the United Nations Convention to Combat Desertification (UNCCD) and the Sustainable Development Goals (SDGs). Addressing these challenges requires a rethinking of Lebanon's institutional framework, moving beyond fragmented mandates towards a more integrated, collaborative approach that brings together stakeholders from multiple sectors [22].

To move forward, it is essential for Lebanon to establish a unified soil governance framework that aligns the responsibilities of various ministries and fosters cross-sectoral collaboration. Such a framework would ensure that policies aimed at mitigating soil degradation are implemented in a cohesive, systematic manner, maximizing their potential to preserve the country's natural resources sustainably.

3.2. Gaps of Current Policies

The policy analysis revealed that Lebanon's existing national policies do not adequately address the root causes of soil degradation. While frameworks like the National Action Plan for Desertification (NAP) and various provisions within the Lebanese Environmental Policy provide some direction for soil conservation, they often lack clear implementation mechanisms. The objectives of these documentations are not effectively integrated into broader agricultural, environmental, and water management strategies [8] [11]. A significant gap identified in the policy landscape is the insufficient prioritization of soil protection within the context of Lebanon's overall environmental and agricultural policies. Furthermore, existing policies often fail to address the socio-economic drivers of soil degradation, such as unsustainable farming practices and rapid urbanization, and lack the necessary regulatory measures to monitor and enforce compliance [3].

In Lebanon, agricultural policies tend to focus more on production and economic goals rather than environmental sustainability. While there may be some initiatives related to sustainable agriculture, the emphasis on soil conservation is often minimal (**Figure 2**). Soil conservation is not always a core priority within agricultural policies, which tend to prioritize increasing yield, mechanization, and meeting market demands. As a result, soil governance is often overlooked.

- Lebanese National Agricultural Strategy (2010): This strategy emphasizes improving agricultural productivity to enhance food security and rural development but does not address soil conservation in a comprehensive way. It focuses more on enhancing yields through modern farming techniques and increasing market access.
- National Strategy for the Sustainable Agricultural Development (2018): This document does highlight sustainable agricultural practices, some of which could promote soil health (such as crop rotation and organic farming), but soil conservation is not a primary focus.

Lebanon's environmental policies have made great steps in recent years, particularly regarding pollution control and protected areas. However, soil conservation is still a relatively underdeveloped focus within broader environmental frame-

works. While environmental policy addresses land degradation, waste management, and biodiversity, specific soil conservation initiatives may not be fully integrated into environmental policy, which leads to a medium integration rating (Figure 2).

- Lebanese Environmental Action Plan (2011-2015): This plan targets land degradation through broader environmental protection efforts. However, the focus is on pollution and biodiversity, with soil conservation mentioned only in relation to land degradation caused by deforestation and overgrazing.
- Law 444 (2002) – Environmental Protection Law: The law outlines frameworks for environmental protection in Lebanon, including the need to combat desertification and land degradation, but it lacks specific mandates or programs focused solely on soil conservation.

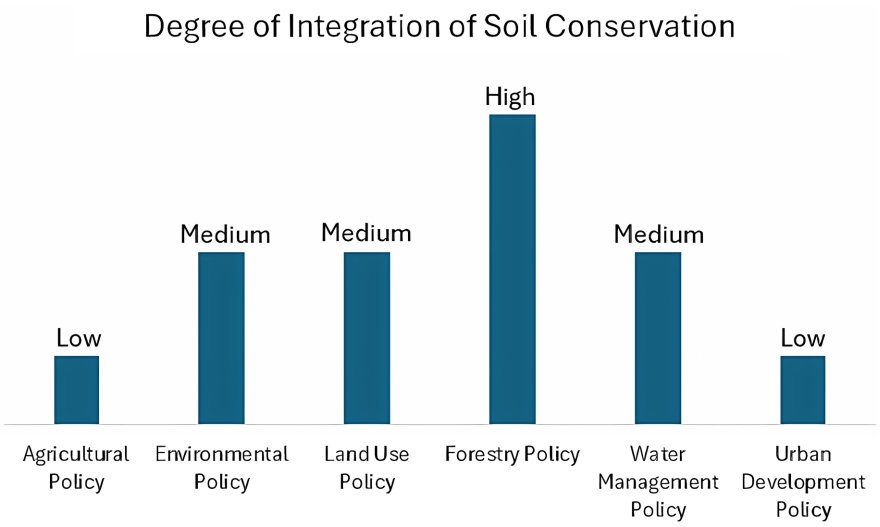

Figure 2. Gaps in policy integration for soil governance.

Lebanon's land use policy focuses on urbanization and the use of agricultural land. While there may be efforts to mitigate land degradation, these policies often prioritize urban development and infrastructure expansion over sustainable land use practices. Soil conservation is sometimes incorporated into land use policies, especially when it intersects with urbanization and agricultural expansion. However, there is often insufficient attention paid to long-term soil health and its integration into national land-use strategies.

- Lebanon National Land Use Master Plan (2004): This plan sets out a framework for land development across Lebanon, including zoning regulations for urban and rural areas. Soil conservation is recognized as part of sustainable land management, but it's overshadowed by the priorities of urban development and infrastructure expansion.
- Land and Environment Support Project (2010): This project aims to improve land and water management, with some notices for soil erosion control in agricultural regions, but the focus is broader on land use and less on soil as an

independent resource.

Forestry policies often emphasize conservation and sustainable management of forest ecosystems, which include soil protection. The roots of trees prevent soil erosion, making soil conservation a natural aspect of forestry policy. Lebanon has strong programs related to forest preservation and reforestation, and soil conservation is often an integral part of forest management strategies. Hence, this policy framework shows a higher degree of integration for soil conservation (**Figure 2**).

- National Reforestation Plan (2010): Soil conservation is a key objective of this plan. By focusing on reforestation, the policy addresses soil erosion, particularly in mountainous regions. Forests play a crucial role in protecting the soil from erosion through root systems that stabilize the land.
- Lebanese Forest Strategy (2015): This strategy focuses on forest restoration and management, incorporating soil conservation as a primary component. Sustainable forest management practices directly help prevent soil erosion, making this a highly integrated policy framework for soil health.

Water management in Lebanon involves controlling water resources, managing irrigation systems, and addressing water scarcity, which can influence soil health. However, soil conservation is not always prioritized as a key component of water policy. While soil and water are interlinked (e.g., erosion affects water quality), water policies may focus more on water distribution and infrastructure rather than soil preservation. Thus, soil conservation is only moderately integrated in this policy framework.

- National Water Sector Strategy (2012): This strategy addresses water conservation and management in Lebanon but only indirectly tackles soil issues. Soil conservation is discussed in the context of preventing water loss due to erosion, especially in agricultural regions, but it's not the central focus of the policy.
- National Irrigation Strategy (2015): This strategy aims to improve irrigation infrastructure and water efficiency in agriculture, but soil conservation is only considered in relation to reducing soil erosion and improving water retention in agricultural lands.

Urban development policies often prioritize economic growth, infrastructure development, and population expansion, with little consideration for environmental impacts such as soil conservation. Urbanization typically leads to soil degradation through construction, land sealing, and the conversion of agricultural land. Soil protection is not usually a central issue in urban planning policies, which leads to a low integration rating.

- National Physical Master Plan for the Lebanese Territory (2009): This plan focuses on urban expansion and economic development. Soil conservation is not considered, and the urbanization process typically leads to soil degradation through construction and land sealing (paving over natural soils).
- Urban Planning and Development Law (2017): This law focuses on land development for urban needs, with no specific measures for soil conservation, as the primary concern is the growth of infrastructure and housing.

Table 2. Historic and recent policies in Lebanon related to soil governance.

POLICY FRAMEWORK	EXAMPLE POLICIES (FROM 1920S ONWARD)	INTEGRATION OF SOIL CONSERVATION
AGRICULTURAL POLICY	• Lebanese Agricultural Law (1926)	Low: Focused primarily on agricultural productivity and land use, without direct emphasis on soil conservation.
	• Lebanese National Agricultural Strategy (2010)	Low to Medium: Some mention sustainable practices, but soil conservation is a secondary concern compared to productivity.
ENVIRONMENTAL POLICY	• Lebanese Environmental Protection Law (Law 444, 2002)	Medium: Environmental protection measures include addressing soil degradation in the broader context of land and water protection, but not in-depth on soil conservation.
	• Lebanese Environmental Action Plan (2011-2015)	Medium: Includes land degradation concerns, with some references to soil erosion but little focus on soil health specifically.
LAND USE POLICY	• Lebanon National Land Use Master Plan (2004)	Medium: Focuses on zoning and urban planning, with some recognition of the risks of soil erosion but limited policies targeting soil health.
	• Land and Environment Support Project (2010)	Medium: Focused on land management and reducing soil erosion, but not purely about soil conservation as a primary goal.
FORESTRY POLICY	• Forests Law (1949)	High: Established frameworks for forest conservation, with soil conservation integrated into forest management, as trees help prevent soil erosion.
	• National Reforestation Plan (2010)	High: Directly integrates soil conservation through forest restoration and reforestation efforts.
	• Lebanese Forest Strategy (2015)	High: Strong emphasis on soil protection through forest cover and sustainable forestry practices.
WATER MANAGEMENT POLICY	• National Water Sector Strategy (2012)	Medium: Soil conservation is addressed as part of water management, particularly in reducing erosion that affects water quality, but not a main focus.
	• National Irrigation Strategy (2015)	Medium: Focus on improving irrigation efficiency with some connection to preventing soil erosion in agricultural lands.
URBAN DEVELOPMENT POLICY	• National Physical Master Plan for the Lebanese Territory (2009)	Low: Primarily focused on urbanization and infrastructure development without regard for soil conservation.
	• Urban Planning and Development Law (2017)	Low: Urban growth and infrastructure development priorities often contribute to soil degradation without integrating soil conservation.

The policy landscape in Lebanon regarding soil governance has evolved over several decades, shaped by both historical events and contemporary challenges (Table 2). Historically, Lebanon's soil policies were often general rather than practical, with early efforts focusing primarily on agricultural development and land preservation. However, these initiatives were largely fragmented and lacked effective integration across different sectors. In recent years, there has been a shift to-

wards more comprehensive soil governance, with the introduction of new policies aimed at addressing soil degradation, promoting sustainable agriculture, and mitigating the impacts of climate change. Recent policies, the National Agricultural Strategies includes sustainable management of soil resources, which aims to enhance soil conservation practices and integrate soil governance into broader environmental and land use planning frameworks. Despite these efforts, implementation has been slow, largely due to political instability, inadequate enforcement mechanisms, and limited public awareness. The complexity of Lebanon's political landscape and the lack of coordination between governmental agencies have further hindered the successful integration of soil policies, resulting in persistent gaps in policy execution. This fact highlights the need for a more cohesive and strategic approach to soil governance in Lebanon.

The most recent policy which is the 2020-2025 agricultural strategy that was developed to address the key challenges facing Lebanon's agricultural sector and provide a framework for recovery and development over the next decade. The strategy places a stronger emphasis on economic resilience, food security, and the integration of sustainability into agricultural practices. Within this strategy:

- Soil conservation is mentioned as part of sustainable agricultural practices that aim to protect soil fertility and prevent erosion, particularly in hillside farming regions. The strategy also encourages the use of agroecological practices that improve soil health, including reduced tillage, use of organic fertilizers, and increasing organic farming practices that maintain soil structure and fertility.
- promotes drought-resistant crops and techniques to mitigate soil erosion due to extreme weather events. The strategy also promotes the use of water-efficient technologies, such as drip irrigation, that not only conserve water but also help prevent soil degradation.
- Soil conservation is integrated into this strategy by promoting education on sustainable land management and providing farmers with incentives to adopt these practices.
- efforts include reforestation, afforestation, and land reclamation programs that help restore soil fertility and prevent further erosion.
- The policy pushes for the modernization of agriculture through the adoption of new technologies and practices, including those that help improve soil health (e.g., precision agriculture, crop monitoring systems).
- It includes providing farmers with access to information and resources on soil conservation and sustainable farming.
- comprises the establishment of financial mechanisms (e.g., subsidies, grants) to support farmers who are transitioning to sustainable practices. This includes financial support for soil conservation efforts, such as erosion control measures and soil fertility programs.

3.3. Challenges Posed by Data Limitations

Data limitations emerged as a significant challenge in both assessing the extent of

soil degradation and formulating effective soil management strategies. Comprehensive, accurate, and up-to-date soil data are scarce, and existing data is fragmented across various agencies. The lack of a centralized, accessible database on soil health hinders the development of targeted policies and actions. Stakeholders are faced with the unavailability of reliable data on soil erosion rates, contamination levels, and desertification trends, which severely delays efforts to understand the full scope of the problem (**Figure 3**). As noted by several researchers [4] [23], without robust data, it is difficult to assess the effectiveness of existing policies and design evidence-based solutions to address Lebanon's soil degradation.

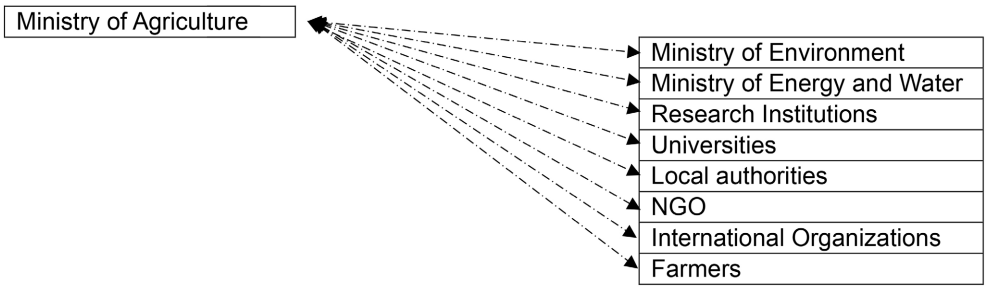

Figure 3. Fragmentation of soil data (Dashed lines: fragmented/missing connections).

3.4. Opportunities for Improved Coordination and Public Engagement

Despite these challenges, there are various opportunities to strengthen Lebanon's soil governance framework. Improving institutional coordination between key ministries and stakeholders was consistently cited as a crucial step. A more integrated approach, possibly through the establishment of a national coordinating body for soil protection, would allow for a more cohesive strategy for soil management. The establishment of such a body could enhance policy alignment across sectors and facilitate more efficient resource allocation for soil conservation efforts.

Increasing public awareness of soil health, particularly among farmers, policymakers, and local communities, is critical for promoting sustainable land management practices. Educational campaigns and capacity-building programs, especially targeting rural communities and agricultural practitioners, could help reduce the use of harmful agricultural practices and promote more sustainable alternatives. The success of similar initiatives in other countries suggests that Lebanon could benefit from such efforts [24] [25].

Enhancing the availability of comprehensive soil data through collaborative efforts among governmental, academic, and non-governmental sectors was identified as a key opportunity for improving soil governance (**Figure 4**). International partnerships and research projects could help build local capacity for soil data collection and analysis. Additionally, using remote sensing technologies and satellite imagery could provide more timely and accurate assessments of soil health across Lebanon's diverse regions [26].

Figure 4. Opportunities for strengthening soil governance.

4. Discussion

This study reveals fragmented and inefficient state of soil governance in Lebanon, with a lack of coordinated institutional efforts, inadequate policies, and significant data gaps. However, the study also points to several promising opportunities for reform. By enhancing institutional coordination, prioritizing soil protection in national policies, improving data availability, and fostering public awareness and engagement, Lebanon can develop a more effective and sustainable soil governance framework. These improvements would help address the ongoing challenges of soil degradation and support long-term environmental sustainability in the country.

The findings contribute to a deeper understanding of Lebanon's soil governance challenges and provide a foundation for the development of targeted, evidence-based recommendations aimed at improving the country's soil health and management practices.

5. Conclusions and Recommendations

Lebanon's soil governance challenges are deeply rooted in institutional fragmentation, inadequate data, and a lack of coordinated efforts across sectors. The findings of this study underscore the importance of adopting a more integrated, evidence-based approach to soil management. The lack of a unified soil policy and the fragmented governance structure have resulted in insufficient action on soil degradation despite the mounting environmental pressures. Lebanon's policymakers must prioritize the development of a comprehensive national soil policy that integrates soil health into broader environmental and agricultural strategies.

The establishment of a national soil monitoring system, as Soils4Med project performing, combined with improved coordination among stakeholders, can significantly enhance Lebanon's capacity to address soil degradation. International

collaboration, as well as capacity-building initiatives, can provide Lebanon with the tools and resources necessary to implement sustainable soil management practices and ensure the long-term sustainability of its agricultural lands. Effective soil governance will not only improve environmental sustainability but will also contribute to greater food security and resilience in the face of climate change. Key recommendations could be risen:

- Establish a Unified Soil Governance Framework.
- Develop a National Soil Policy.
- Enhance Data Collection and Monitoring Systems.
- Promote Public Engagement and Education.
- Strengthen Policy Integration.
- Foster International Collaboration.
- Encourage Sustainable Agricultural Practices.
- Develop and Implement Financial Mechanisms for Soil Protection.
- Address Urbanization's Impact on Soil.
- Strengthen Inter-Ministerial Coordination.

Acknowledgements

This research was carried out within the framework of the Soils4Med project. The Soils4Med is part of the PRIMA program supported by the European Union. Soils4Med project aims to promote sustainable soil management practices in the Mediterranean region to enhance soil health.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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