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Soil governance in Greece: A snapshot

Spyros Schismenos [a,d,*], Dimitrios Emmanouloudis [b,d], Garry J. Stevens [a], Nikolaos D. Katopodes [c,d], Assefa M. Melesse [e]

[a] School of Social Sciences, Humanitarian and Development Research Initiative (HADRI), Western Sydney University, Sydney, Australia
[b] Department of Forestry and Natural Environment, International Hellenic University, Kavala, Greece
[c] Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, United States
[d] UNESCO Chair on Conservation and Ecotourism of Riparian and Deltaic Ecosystems, International Hellenic University, Drama, Greece
[e] Institute of Environment, Department of Earth and Environment, Florida International University, Miami, United States

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ABSTRACT

For thousands of years, soil resources in Greece have been a critical underpinning of local socio-economies. However, soil threats are increasing rapidly, primarily due to human activity and the impacts of climate change. Greek and other European state governments have established legal frameworks to protect soil, but there is a great need for centralization and harmonization with European Law. This chapter highlights the importance of integrated soil governance frameworks that could be applied at the regional or international level while also supporting public engagement and local focus. It also considers the urgent need to address erosion - a major threat to soil resources in Greece that affects local well-being, environmental sustainability and heritage sites.

1. Introduction

Greece is situated in southeastern Europe and belongs to the Mediterranean zone of the Palaearctic bio-geographical region. It occupies approximately 132,000 km^2, has a large coastline (about 18,400 km), and about 6000 diverse islands and islets. It is the crossroad between Europe, Asia and Africa (MoEE, 2016). Some regions of Greece are in the Mediterranean Basin, which is the second largest basin and third richest hotspot for flora diversity worldwide. Greece has a unique soil and aquatic biodiversity profile, and hosts a plethora of endangered species with several of its natural ecosystems included in the Natura 2020 Network. (MoEE, 2016; OECD, 2020). However, like most other countries in the Mediterranean region, Greece has been inhabited by humans for thousands of years and this has impacted its natural resources, including water and soil (Schismenos et al., 2019; Zaimes et al., 2016).

Agriculture has been one of the major economic activities in Greece for the past millennia, but poor soil management practices have resulted in degradation in this resource over time (Intergovernmental Technical Panel on Soils, 2015 p. 44). At present, agricultural land covers about 50 percent of the land area (OECD, 2020) and contributes substantially to the country's economy with an estimated total annual production value of approximately US$ 12 billion (Paschalidis et al., 2020). However, a growing body of research suggests this percentage of arable land may decrease in coming decades due to soil threats such as erosion and land take for urbanization (Simonis, 1993; Stefanidis et al., 2021; Panagos et al., 2015; Paschalidis et al., 2020; Zaimes et al., 2016).

Soil threats are common in most countries around the world, but their level and type differ by region. Greece tends to face threats also observed in other countries in southern Europe (e.g. Spain, Portugal) and eastern Mediterranean region (e.g. Cyprus, Turkey). In the 'Status of the World's Soil Resources: Technical Summary', it is reported that there are ten soil threats for Europe and Eurasia; with Greece sharing many of these (Intergovernmental Technical Panel on Soils, 2015 p. 46):

1 **Soil sealing and land take**: An increasing threat in Europe related particularly to rising population densities and planning laws.
2 **Salinization and sodification**: Issues particularly affecting Hungary, Spain and Turkey.
3 **Contamination**: Heavy metals and mineral oils are key soil pollutants in Europe, although efforts are being made to minimize this threat.
4 **Organic carbon change**: The reduction of organic carbon levels is a common issue in agricultural lands.
5 **Nutrient imbalance**: Principally associated with both the overuse and underuse of fertilizers.

* Corresponding author.
E-mail address: s.schismenos@westernsydney.edu.au (S. Schismenos).

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6 **Soil erosion:** Mountainous and sloping areas are highly affected by erosion. The geomorphology of Greece means that it is particularly affected (Koutalakis et al., 2015; Paschalidis et al., 2020; Zaimes et al., 2016).
7 **Loss of soil biodiversity**: Ecosystems that are urbanized or contaminated typically experience substantial loss of local biodiversity.
8 **Soil acidification**: Acid rain is the main factor in this threat. Although most European countries took early action against soil acidification, it will take years for soil to recover.
9 **Waterlogging**: This is primarily observed in Central Asia; it is associated with irrigation.
10 **Compaction:** This threat occurs when heavy machinery is used.

Most of the above threats are exacerbated not only by the over-exploitation of humans but also the effects of climate change. As the 'Intergovernmental Panel on Climate Change's Fifth Assessment Report' indicates, the Mediterranean Basin will continue becoming warmer and dryer by 2100 (Stocker, 2014). For Greece, this translates to increased soil erosion (Koutalakis et al., 2015; Stefanidis and Stathis, 2018). Erosion is a key risk to soil resources and is intensified by climate-related natural hazards, notably droughts, wildfires, and floods. These affect soil functions, remove topsoil and reduce vegetation coverage (Hamidov et al., 2018; Qian et al., 2020). Greece's mountainous topography, steep slopes, soil type and low levels of soil organic matter content compound these effects (Simonis, 1993; Stefanidis et al., 2021; Panagos et al., 2015; Paschalidis et al., 2020; Zaimes et al., 2016).

Since there is substantial evidence that soil erosion is affected by climate change (Borrelli et al., 2020; Nearing et al., 2004) any policy or program response to erosion must be informed by relevant climatic science. A timely example of the urgency of a climate-focused response can be seen in the recent multiple disaster events experienced in Evia. Evia is the second largest island in Greece and was significantly damaged by wildfires in August 2021. In October of the same year, it was also hit by torrential floods and mudslides. These hazards, and particularly their interactive effects, caused serious soil erosion which affected community livelihoods and biodiversity (ABC News,2021).

In this chapter, we examine Greek soil governance, with a particular focus on erosion and recommendations to address this issue.

2. Soil legislation and regulations in Greece

The Food and Agriculture Organization of the United Nations (UN FAO) Global Soil Partnership identifies soil as a vital component of sustainable agriculture and healthy ecosystem services. Soil is also a critical resource that directly supports most of the United Nations Sustainable Development Goals (Keesstra et al., 2018). Yet, due to the variety and complexity of soil resources, and the numerous stakeholders involved, countries' soil governance is spread across a range of different international and national legislative instruments including often 'siloed' environmental, urban planning, and agricultural portfolios (UN FAO, 2021). Greece is no exception to this trend. Table 1 details SoiLEX - Soil related legal instruments and soil governance. It summarizes important soil themes and related laws, decrees, decisions, and action plans in Greece.

As detailed in Table 1, the relevant legislation is dispersed across agricultural, biodiversity protection, environmental protection, soil management, urban planning, waste and waste-water management themes. Soil conservation, erosion and pollution generally see the most concentrated regulation, indicating a critical awareness of damage to the country's soil resources and its ramifications. While existing soil legislation (Table 1) provides important legal provisions and preventive measures for sustainable soil management, a number of its instruments were developed more than 30 years ago and need to be updated or modified to better address current needs and integrated practice (Charalampidou, 2018; WWF, 2014).

Table 1
Soil-related themes, legislations and regulations in Greece.

SOIL THEMES	LAWS, DECREES, DECISIONS & ACTION PLANS	DATE OF TEXT
SOIL CONSERVATION	Law for the protection of the environment	01/01/1986
	Ministerial Decision No.80568/4225/91 on methods, conditions and restrictions for the use in agriculture of sludge from domestic and municipal waste-water treatment	22/03/1991
	Law No.2508 on sustainable urban planning	13/06/1997
	Law on the protection and management of water resources	09/12/2003
	Ministerial Joint Decree No.107017 on the assessment of the effects of certain plans and programmes on the environment in compliance with Directive 2001/42/EC of the European Parliament and of the Council	28/08/2006
	Joint ministerial decision on criteria for agricultural land quality	07/09/2010
	Law on Conservation of Biodiversity	29/03/2011
	Law No.4014 on the environmental licensing of works and activities, regulation of illegal constructions in connection with environmental stability and other provisions falling under the competence of the Ministry of Environment	20/09/2011
SOIL EROSION	Law for the protection of the environment	01/01/1986
	National action plan for combating desertification	01/01/2001
	Law on conservation of biodiversity	29/03/2011
NUTRIENT IMBALANCE	Joint ministerial decision on criteria for agricultural land quality	07/09/2010
SOIL ORGANIC CARBON LOSS	National action plan for combating desertification	01/01/2001
SOIL POLLUTION	Ministerial Decision No.80568/4225/91 on methods, conditions and restrictions for the use in agriculture of sludge from domestic and municipal waste-water treatment	22/03/1991
	Presidential Decree No.148 on environmental liability with regard to the prevention and remedying of environmental damage - Compliance with Directive 2004/35/CE of the European Parliament and of the Council	28/09/2009
	Law No.4042 on the protection of the environment through criminal law, on waste management and other provisions, in compliance with EU Directives 2008/99/EC and 2008/98/EC	13/02/2012
SOIL QUALITY	Joint ministerial decision on criteria for agricultural land quality	07/09/2010
SOIL RESTORATION	Presidential Decree No.148 on environmental liability with regard to the prevention and remedying of environmental damage - Compliance with Directive 2004/35/CE of the European Parliament and of the Council	28/09/2009
SALINISATION / SODIFICATION	Law for the protection of the environment	01/01/1986
	National action plan for combating desertification	01/01/2001
SOIL SEALING	Law No.2508 on sustainable urban planning	13/06/1997

Source: UN FAO SOILS PORTAL - SoiLEX - Soil related legal instruments and soil governance. Available at: http://www.fao.org/soils-portal/soilex/country-profiles/details/en/?iso3=GRC&tx_dynafef_search=1&rec_uid=&submit=Submit&form_build_id=form-5ae4f3e17f332a3d1530f9613588df674c9854dddf474b0fa82c90b97b7fd7e7.

The 'OECD Environmental Performance Reviews: Greece 2020' details the efforts of the Greek government to increase transparency and accountability in environmental and soil-focused laws, but also highlights the institutional capacity limits which constrain effective implementation of the current legislation or its further development (OECD, 2020). For example, the existing environmental laws regarding soil resources and waste management do not reflect recent data regarding climate change and the more stringent protections needed to address this issue (Charalampidou, 2018; WWF, 2014).

To support a more transparent and pragmatic soil legislation framework, Charalampidou (2018) identified key technical and governance issues that frequently undermine application of existing soil laws in Greece: i) the interpretation and application of these laws by controlling authorities can differ widely. The controlling authorities include citation of different soil laws that focus on the same or overlapping themes (e.g. soil conservation and pollution) and often causes confusion; ii) the complexity in principles and operating protocols regarding soil-pollution and soil-waste management also cause confusion; iii) the failure of controlling authorities to ensure legal compliance in a timely manner, iv) and the gaps that exist regarding governance and oversight of entities that knowingly damage soil resources or do so unintentionally (e.g. escaped substances) and limits to remediation options when such actors declare bankruptcy. These issues highlight some of the practical limits of the existing soil protection arrangements in Greece. These could be addressed through further legislative changes or updates, particularly changes that are able to centralize, integrate and harmonize these legislative instruments and support common understandings, goals and implementation frameworks (Morvan et al., 2008).

3. Soil erosion management and monitoring

The European Commission identifies soil protection against erosion and other soil threats as a key priority. This has been highlighted in the Soil Thematic Strategy (EC, 2012). Another important step forward is the compilation of the soil erosion risk map of Europe (Morvan et al., 2008). The map provides an important baseline to document the extent of the problem in Europe, and a reference against which soil erosion monitoring and evaluation could be conducted (Zaimes et al., 2016).

Despite the seriousness of erosion, only limited research has been conducted to address this threat in Greece (Yassoglou, 2005). Koutalakis et al. (2015) reviewed the available literature regarding erosion in Greece and found that most relevant studies focused on the land type, physical and anthropogenic factors, and assessment tools. It should be noted that soil erosion is not just a threat to human agricultural staples or the environment, but also our heritage. Polykretis et al. (2021) proved that archeological sites of worldwide importance in Crete were highly affected by soil erosion. Cuca and Agapiou (2018) presented their findings regarding the impacts of soil erosion and land-use changes in two archeological areas in Cyprus, with one case being a UNESCO protected site.

Currently in Greece, the most commonly used soil erosion monitoring methods investigate changes in surface level or volume using erosion pins, catchpits, etc. Although these methods are cost-effective, they are not practical for frequent measurements (Zaimes et al., 2011, 2016). To effectively monitor soil resources, approaches that provide accuracy and frequent testing are preferred. However, such methods are costly, timely and focus on smaller scales.

To improve research on erosion, Zaimes et al. (2016) suggested the use of two tools, the Automated Soil Erosion Monitoring System (ASEMS) for continuous and accurate measurements, and the Soil Erosion Integrated Information System (SEI^2S) for larger areas. Stefanidis et al. (2021) tested the Revised Universal Soil Loss Equation - RUSLE (Renard et al., 1991) in Kassandra Peninsula, Northern Greece, and found that appropriate erosion mitigation strategies are essential to minimize erosion.

As there is a greater need for more and better research on soil, the investigation of optimal research approaches based on the available resources, open data and emerging technologies should be a priority for state and local governments, universities and the private sector.

4. Lessons from Portugal and the eco-holistic soil conservation framework

Portugal is another European country that faces similar soil threats to Greece and also lacks a centralized soil framework for policies, administration infrastructure and capacity. Their soil regulation law was approved in the 1970's and while there have since been notable efforts to update and expand soil-related regulations in accordance with the European Law, the country still lacks a comprehensive soil protection regulatory framework. Notably, a recent comparative analysis of existing Portuguese soil management legislation and related legislative documents within the European Union, highlighted that, compared with the longer-term preventive approaches underpinning EU policy and programming, Portuguese laws focused more often on the management of emergent issues such that they were often 'reacting' to threats rather than preventing them (Castelo-Grande et al., 2018). At the time of writing (2018), the review concluded that the progress for soil protection in Portugal is slow, and that the development of a soil framework that links local and national governance structures and articulates with European regional strategies such as the Soil Thematic Strategy (EU, 2012) offers the best strategy to address soil protection in Portugal. It also emphasized the that European citizens, in general, are not well informed regarding the limits of soil legislation and how these currently affect soil protection in their respective countries. A similar review process is needed regarding soil legislation in Greece, as well as other European countries. This could potentially identify those laws requiring revision and/or harmonization with European Law and priority areas for protection, particularly in view of actions needed to manage climate impacts (Charalampidou, 2018) .

The need for a regional and international soil governance frameworks that actively promotes local engagement is also raised by Albaladejo et al. (2021) who conducted an extensive review on soil conservation programs. They introduced the Eco-Holistic Soil Conservation framework which is based on a detailed analysis of success and failure indicators for soil conversation projects. They argue that in order for soil legislation to work, societies need to perceive soil resources as living systems and develop soil behavior that enshrines ethical use. This could begin with raising community awareness of the critical role of soil conservation in the preservation of vital ecosystems that sustain all life and in the battle against climate change. To implement these effectively, they suggest a trans-disciplinary approach of three stages: i) diagnosis of the causes for soil threats; ii) synergy between the different stakeholders to integrate the related assessments; and iii) active evaluation and monitoring of the impacts on soils. At the program level, such a framework must support consistent oversight and delivery across a range of diverse government portfolios and legislation, and non-government actors, essentially as a 'cross-cutting' issue.

5. Discussion

For thousands of years, soil resources in Greece have been critical for the local socio-economy. However, the continuous use of land for agricultural purposes, deforestation and urbanization, combined with increasing climate change impacts, have affected the quality of the soil.

Greek governments have established a series of laws for the protection of soil resources, primarily against erosion and pollution. Soil erosion is one of the more pressing environmental threats for many Mediterranean countries and needs comprehensive assessment and remediation (van der Knijff et al., 2000). In the case of Greece, a land with numerous protected natural and archeological sites, there should be a greater interest to investigate this threat more effectively in coordination with the European Commission.

The protection of soil resources is not just a national matter, but a global priority. Soil, and its health, are elements essential to achieving, and often linking, the Sustainable Development Goals. As such, it should be treated with the same focus and urgency afforded to more 'championed' natural resources such as water, air, and clean energy media. At present, soil governance is not under a specific framework, but spread across different themes and portfolios. The UN FAO Global Soil Partnership is pushing to increase global awareness of soil conservation. This could be achieved by developing integrated soil governance strategies that minimize current threats, and protect livelihoods, heritage and the environment. For example, a centralized soil framework with the oversight of the European Union could better coordinate European state responses, while minimizing any state political or internal issues with the potential to delay effective action. The European Soil Health Law which will be introduced in 2023, aims to improve Europe's soil status by 2050 and is another step to this direction (Foote, 2021). This law could also align with and strengthen current policies to address climate change and human-induced activities that harm the natural resources upon which we rely. At the national level, countries such as Greece could develop frameworks that support soil protection, public engagement and local focus. The Eco-Holistic Soil Conservation framework that suggests developing a societal narrative, ethos and soil behaviors for managing soil resources could be the basis for such frameworks.

6. Limitations and future work

This chapter was largely based on soil-themed literature available in English. Future research investigating soil erosion threats, governance and management initiatives in Greece should also include literature written in the Greek language. It could also identify other areas of soil threat at a national level (e.g. soil contamination and loss of soil biodiversity), particularly after the megafires that currently occur across the country (Kitsantonis and Specia, 2021).

7. Conclusion

Soil resources are essential for mankind. In Greece, soil resources particularly underpin agriculture, a sector vital to the financial well-being and development of the country. However, natural and human-induced factors increasingly threaten soil health. As erosion is one of the most serious soil threats in the Mediterranean Basin, Greece has established legal frameworks to protect against this hazard. While efforts are being made to decrease erosion and find innovative solutions, a constellation of factors threaten profound impacts to soil resources and the socio-economy more broadly in the decades to come. Integrated soil legislation informing national and regional management frameworks may be the 'game changer' needed to protect this critical resource at all levels.

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