

INTERNATIONAL LEGAL FRAMEWORK FOR SOIL PROTECTION: NORMATIVE GAPS AND ECONOMIC IMPLICATIONS

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Abstract. Protecting soils from degradation is a significant area of research in international environmental law. Almost all states face soil degradation problems and are striving to solve them at a national level. The quality of soils is decreasing worldwide, which affects states' ability to ensure food security and protect biodiversity. The different approaches adopted by various states to this problem result in insufficient legal regulation of soil protection at a national level. It is therefore imperative that effective international legal regulation of soil protection and international co-operation in this sphere be established. The *purpose of this article* is twofold: firstly, to analyse the international legal regulation of soil protection, and secondly, to identify existing problems and propose solutions. An analysis was conducted of statistical data pertaining to the deterioration of soils, in addition to the economic consequences thereof. *Methodology.* General theoretical methods were mainly used when writing the article. The sufficiency of international legal regulation of the protection of soils from deterioration was assessed using analysis and synthesis, theoretical generalisation and systematic interpretation. *Results.* The article examined the content of the UN Convention to Combat Desertification, the FAO's Voluntary Guidelines for Sustainable Soil Management and national strategies aimed at combating desertification and protecting soils, identifying their shortcomings. *Practical implications.* Drawing on doctrinal principles and the provisions of current international law, the authors have identified the main challenges facing the international legal framework for the protection of soils against degradation and have proposed possible solutions. *Value/Originality.* It has been determined that a significant step in enhancing the international legal regulation of soil protection is the adoption of international standards for climate-resilient agricultural practices and soil protection.

Keywords: climate change, economic consequences of soil degradation, international environmental law, environmental safety.

JEL Classification: K00, K10, K30, K33

1. Introduction

A significant global problem that endangers both the right to food and biodiversity is the deterioration of soil quality. It is estimated that 3.2 billion people, representing approximately one third of the global population, are affected by this problem. The preservation of soil integrity is a pivotal component in the pursuit of sustainable development objectives. Despite the fact that none of the objectives are exclusively dedicated to the protection of soils, it is imperative to recognise the significance of soil protection in the context of the eradication of hunger, the mitigation of climate change, and the preservation of life on land. Furthermore,

military actions have been shown to exacerbate the problem, thus necessitating enhanced legal regulation of soil protection and its monitoring.

In the course of the present study, particular attention was paid to the economic consequences of soil degradation, as well as to the provisions of international legal instruments for the protection of soils from degradation. It is evident that proposals were made *de lege ferenda*. In the composition of this article, the authors partially relied on the scientific achievements of scholars such as I. Kovalchuk, A. Pakhomova, V. Melnyk, T. Novak, O. Tymoshchuk, O. Gulac and K. Yemelianenko, among others.

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The objective of this scholarly endeavour is to undertake a comprehensive analysis of prevailing international documents that are oriented towards the preservation of soil integrity. This analysis aims to identify existing deficiencies and formulate recommendations for enhancing the efficacy of these documents.

2. The State of the World's Soils and its Economic Implications

In the contemporary era, the degradation of soil has become a matter of significant global concern, representing one of the most pressing environmental challenges currently facing the world. Degradation of soil is intensifying in all regions globally due to climate change, intensive land use and unsustainable agricultural practices. Soils are losing their capacity to ensure sustainable food production and to enable protection of biodiversity. Recent global evaluations indicate that soil degradation is a pervasive phenomenon affecting all regions of the world. Degradation of the soil is a key factor in the weakening of ecosystem resilience, with the result that the livelihoods of billions of people are threatened. In order to enhance the situation, it is imperative to cultivate a comprehensive understanding of the scale, the underlying causes, and the ramifications of soil degradation. It is imperative for the formulation of efficacious national policies and strategies that are oriented towards the rehabilitation of soil resources and the enhancement of international legal frameworks for soil protection.

According to United Nations statistics, up to 40% of the planet's land area is now degraded, meaning its ecological or economic productivity has declined. This pervasive deterioration carries severe ramifications for the climate, biodiversity, and human economic development. Concurrently, droughts are becoming both more prevalent and more intense, having increased by 29% since 2000 as a consequence of climate change and unsustainable land-use practices (United Nations, 2024). The states report that 1.56 billion hectares of land are degraded. Land degradation is increasing at a steady rate. 15.4% of reported land is degraded, representing a 4% increase in four years. As a result, 1.3 billion people (25% of the reported population) are affected by land degradation and 1.84 billion people are affected by drought. A total of 98 countries are affected by drought, with 15 experiencing severe or extreme conditions (UNCCD Data Dashboard, 2025).

According to the European Environment Agency, projections for the EU-27 suggest that there are 2.8 million potentially contaminated sites in total. Although the situation varies from country to country, it is clear that cleaning up contaminated land remains

a significant challenge. Waste disposal and industrial operations are the main causes of soil pollution in Europe, with heavy metals and mineral oils being the most common pollutants (European Environmental Agency, 2025).

Land resources deteriorate not only due to global warming, which causes droughts. Human activity has the greatest impact on this deterioration. According to data from the State of Food and Agriculture (SOFA) report, prepared by the UN Food and Agriculture Organization (FAO), 1.7 billion people are living in areas where crop yields are failing due to land degradation caused by humans (FAO, 2025). Scientists warn that 24 billion tonnes of fertile soil are lost each year, primarily due to unsustainable agricultural practices. Intensive farming is the main cause of soil degradation, which results in low levels of "organic matter". This phenomenon impedes the soil's capacity to retain water effectively, thereby rendering populations vulnerable to adverse climate events such as droughts, wildfires, and water shortages (Earth org, 2024).

Soil pollution incurs direct costs for remediation and management. Some states have indicated that they spend an average of tens of thousands of US dollars annually, as reported by countries such as Ecuador and Eswatini. Others spend tens or even hundreds of millions of dollars each year, including Germany, Finland, the Netherlands and Belgium. It is estimated that the cost of remediating all polluted soils in China could run into hundreds of billions of dollars (FAO, 2024).

The data presented indicates that soil degradation has become a significant global environmental issue, affecting more than a third of the world's land. The resulting decline in soil quality undermines food production, accelerates biodiversity loss and reduces the land's capacity to store carbon. As droughts intensify and pressure on land use grows, soil systems are becoming increasingly fragile, proving the urgent need for coordinated restoration efforts. To address the aforementioned problems, adequate national legislation is needed to prevent the deterioration of land resources due to climate change and human activity. Additionally, high-quality international legislation is required in this area. The next part of the article will consider whether the current level of international legal regulation is sufficient.

3. Economic Consequences of Soil Degradation

Climate-related extremes cause huge economic losses. For instance, the European Environment Agency (2025) estimates that economic losses to assets in the European Union will total 822 billion EUR between 1980 and 2024, with over 208 billion EUR (25%) occurring between 2021 and 2024.

According to the FAO, annual production losses by income group are 96,060 tonnes in low-income countries (primarily in Africa), 19,995.76 tonnes in upper-middle-income countries, 1,336.5 tonnes in lower-middle-income countries and 97,517 tonnes in high-income countries. The average production loss per hectare by income group is 0.002 tonnes in low-income countries, 0.003 tonnes in lower-middle-income countries, 0.004 tonnes in upper-middle-income countries and 0.004 tonnes in high-income countries (FAO, 2025).

While the specific effects on markets vary by crop and region, the impact on the global food market is well documented. Reduced yields tighten the global supply and make markets more vulnerable to shocks such as weather events, conflicts and energy price changes. Higher production costs, such as those associated with fertilisers, soil restoration and irrigation, push prices up across the supply chain. Import dependence also increases in regions where severe degradation has occurred, raising their exposure to global price fluctuations. There are also long-term risks: feeding a projected population of 9.8 billion by 2050 will be more difficult as soil productivity declines (Soliman, 2026). Soil degradation has far-reaching consequences for agricultural productivity, ecosystem health and global food security (Adugna Bayata, 2024; Pérez-Aguilar, 2026).

The quality of land resources is also reduced by military action (Yemelianenko, 2024). According to the Kyiv School of Economics' analytical centre, Ukraine's agricultural sector has incurred indirect financial losses of 81.9 billion USD in lost revenue and 33.5 billion USD in added value due to the full-scale invasion of the Russian Federation. These indirect losses include loss of crop production, loss of crops, loss of production, loss of exports, increased production costs, and reclamation costs. These indicators are evaluated using indirect methods that combine state and regional statistics with survey data from agricultural producers. Thus, losses from crop production amounted to 47.18 billion USD in revenue and 19.17 billion USD in value added; losses from disruption to logistics and falling prices amounted to 24.78 billion USD in revenue and 10.07 billion USD in value added; losses in the livestock, beekeeping and fishing sectors amounted to 4.61 billion USD and

1.87 billion USD respectively; and losses due to the increase in the price of MTP amounted to 4.53 billion USD in profit and 1.84 billion USD in value added. Reclamation and dismantling are estimated to cost 0.822 billion USD and 0.506 billion USD, respectively. Total indirect losses to the sector amounted to 81.929 billion USD in revenue and 33.461 billion USD in value added. The largest proportion of indirect losses for farmers was due to a reduction in crop production, amounting to 47.2 billion USD across the four production cycles from 2022 to 2026. The decline in the yield of main crops during this period was due to a reduction in the area under cultivation and a change in production technologies, both of which led to a fall in yield (Interfax-Ukraine, 2026).

Almost a third of Ukraine's territory is now contaminated with unexploded ordnance, including artillery shells, grenades, mortar rounds, cluster munitions, rockets, missiles and improvised explosive devices. Many of these weapons have high failure rates, meaning those that do not detonate on impact can explode unpredictably long after they were deployed. Once the war ends, it could take as long as half a century to fully clear the country of landmines and unexploded munitions (Hryhorczuk, 2024).

The preceding statistics substantiate the necessity for efficacious international legal regulation of the struggle against desertification. The provisions of the aforementioned act will be analysed in the fifth part of this article.

4. Increasing of Costs for Land Restoration Because of Climate Change

It is becoming increasingly evident that climate change is rapidly intensifying the financial and technical demands associated with the restoration of degraded land. Rising temperatures, prolonged droughts, erratic precipitation patterns, and more frequent extreme weather events accelerate soil erosion, salinization, waterlogging, and the decline of vegetation cover. These processes are influenced by climate change, resulting in an expansion of the total land area requiring restoration and a significant increase in the cost of land restoration.

As the impact of climate change intensifies, degraded soils lose their natural regenerative capacity. Land restoration requires more water and increased irrigation infrastructure due to prolonged droughts

Table 1

Distribution of soil and land degradation processes in Ukraine

Indicator	% of country's territory	Regions of Ukraine effected the most
Soil erosion caused by water and wind	57 %	Southern and eastern steppe (Kherson, Zaporizhzhia, Mykolaiv, Odesa)
Waterlogging of land	12 %	Polissya region, the Carpathion region
Acidification	18 %	Polissya region
Salinisation and alkalisation of soil	6 %	Black Sea and Azov Sea regions

Source: <http://www.fao.org/3/a-i3905e.pdf>

and declining soil moisture, as well as more intensive fertilisers and microbial treatments to rebuild fertility. Advanced technologies such as climate-resilient seeds, erosion-control engineering and better land management tools are also needed. These factors increase the cost per hectare of restoration and reduce the cost-effectiveness of traditional rehabilitation methods (IPCC, 2026).

The analysis shows that the cost of land restoration can range from approximately 185 USD per hectare for basic forest management to around 3,012 USD per hectare for more complex methods. Overall, global land restoration would require an estimated 311 billion USD to 2.1 trillion USD over ten years, depending on the methods chosen and their scale. Although this represents just 0.04% to 0.27% of the global GDP each year, the investment is still modest compared to the far greater economic and ecological losses caused by land degradation. These losses are estimated to be worth 6.3 trillion USD each year in diminished ecosystem services (Bell, 2025).

Between 2001 and 2020, the economic damage caused by land degradation and subsequent loss of ecosystems amounted to nearly 2 trillion USD. Restoring these areas is crucial for tackling climate change and preserving biodiversity. The restoration of degraded ecosystems (such as forests and grasslands) is an economically effective solution. It provides significant carbon sequestration benefits at an average global cost of around 50 USD per tonne of carbon. The restoration of ecosystems that were degraded between 2001 and 2020 would require an investment of around 6.9 trillion USD. At the same time, it is projected that each dollar invested would generate 2.39 USD in returns over 30 years while enabling the sequestration of 138 gigatonnes of carbon (Mirzabaev, 2024).

The full-scale invasion of Ukraine has created unprecedented risks for land resources, particularly through the widespread contamination of territory with explosive remnants of war. The magnitude of this contamination poses long-term threats to agricultural productivity, environmental safety, and regional development. Current assessments illustrate the seriousness of the challenge and the extensive efforts required to monitor and restore affected lands.

It is estimated that 17.4 million hectares of land in Ukraine have been contaminated with explosive remnants of war, including areas where active hostilities have occurred, territories under temporary occupation, and regions subjected to military actions. It was estimated that approximately 2.59 million hectares of agricultural land required inspection. It is anticipated that a further 2.91 million hectares will require monitoring upon the cessation of active hostilities. In order to address this challenge, the National Mine Action Authority of Ukraine has

adopted an action plan for demining 470.9 thousand hectares of agricultural land in 2023. The plan delineates a coordinated effort among state institutions, accredited mine-action operators, local authorities, and private sector stakeholders. It is reported that pyrotechnic units of the State Emergency Service of Ukraine have thus far neutralised more than 319,000 explosive devices and cleared 79.1 thousand hectares of contaminated territory. In order to promote transparency and public safety, the Mine Action Service has also developed an interactive map. This map is intended to identify areas that may be contaminated with explosives (Tykhenko, 2025).

The aforementioned figures illustrate the scale of Ukraine's landmine contamination problem and its long-term implications for land use, agricultural recovery and national security. Despite the significant progress made by the national authorities and specialised demining activities, the scope of the problem requires sustained coordination, substantial resources and continued international support. Effective demining is crucial not only for restoring safe living conditions, but also for enabling Ukraine to restore its most valuable economic and environmental asset: its land.

The data presented demonstrate that land degradation, caused by both climate change and armed conflict, has become one of the most pressing environmental and economic challenges of our time. The consequences of climate change, such as rising temperatures, prolonged droughts and extreme weather events, increase soil erosion, salinisation and the loss of vegetation cover. This increases the scale of degraded areas and significantly raises the cost of land restoration. However, the long-term benefits of restoration, including enhanced carbon sequestration, improved biodiversity and food security, far outweigh the costs.

4. International Legal Regulation of Protection of Soils

The interlinked problems of climate change and unsustainable agricultural practices are exacerbating the already fragile state of land resources (Kovalchuk, 2025; Gulac, 2022), which in turn has a detrimental effect on the protection of environmental human rights (Vashchenko, 2021). This predicament is a pervasive one, manifesting across diverse geographical regions. This is why, at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil, the UN General Assembly was called upon to establish an Intergovernmental Negotiating Committee to prepare a UN convention to combat desertification in countries experiencing serious drought and/or desertification, particularly in Africa. This convention is known as the UNCCD. The UNCCD was adopted and opened for signature on June 17, 1994, in Paris,

France. Its goal is to protect and restore land resources, ensuring a safer, fairer and more sustainable future. It is the only legally binding multilateral environmental agreement established to address desertification and land degradation. However, the question arises as to whether its provisions are sufficient to adequately protect land resources.

According to the United Nations Convention to Combat Desertification (UNCCD, 1994), "desertification" refers to land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. In order to combat the deterioration of soil resources, states must prioritise the fight against desertification and the mitigation of the effects of drought. They must also allocate adequate resources in accordance with their circumstances and capabilities, and establish strategies and priorities within the framework of sustainable development plans and/or policies to combat desertification and mitigate the effects of drought. Furthermore, they must address the underlying causes of desertification, paying special attention to the socio-economic factors contributing to desertification processes. Finally, they must provide an enabling environment by strengthening relevant existing legislation where appropriate, and enacting new laws and establishing long-term policies and action programmes where they do not exist. However, the Convention requires the participation of local communities in decisions concerning the adoption and implementation of programmes aimed at combating desertification (Article 9). According to Article 10(2)(f) of the UNCCD, national action programmes should allow for the effective participation of non-governmental organisations and local populations, including women and men, particularly resource users such as farmers and pastoralists, and their representative organisations, at the local, national and regional levels in the planning, decision-making, implementation and review of national action programmes. The participation of the general public in the adoption of action plans is, of course, a positive aspect, providing more opportunities for their improvement and ensuring that the interests of local communities are taken into account.

As is apparent, the Convention dedicates considerable attention to the development of national legislation, national action plans and strategies in the field of preventing the deterioration of the quality of land resources. However, it is regrettable that the convention does not provide more detailed requirements for national legislation, necessary elements of action plans and strategies.

In 2017, the Food and Agriculture Organization (FAO) of the United Nations adopted Voluntary Guidelines for Sustainable Soil Management. The objective of

the guidelines is to provide recommendations on sustainable soil management, with a view to preventing soil degradation. The guidelines are principally concerned with agriculture, which is broadly defined as the production of food, fibre, feed, timber and fuel. This approach is comprehensible, given that agriculture exerts the most significant influence on soil quality. The guidelines recommend concrete practices for protecting soils, such as establishing or strengthening inclusive, sustainable soil management, agricultural and environmental policies; increasing responsible investment; and fostering and strengthening targeted soil research. They also recommend preventing or minimising soil degradation and restoring or rehabilitating degraded soils (Voluntary Guidelines for Sustainable Soil Management, 2017). The biggest disadvantage is that the guidelines are voluntary, so their implementation by states depends on political will and national priorities. Secondly, the provisions of the guidelines are very general and do not define minimum standards. Thirdly, the guidelines do not address the shortcomings of the UN Convention to Combat Desertification in countries experiencing serious drought and/or desertification, particularly in Africa, with regard to the detailed requirements of national legislation and the necessary elements of action plans and strategies. This leads to different countries approaching the issue in different ways. Here are some examples.

Spain's 2022 National Strategy to Combat Desertification is one of the most ambitious national frameworks for soil protection. Its strengths include a systemic and interdisciplinary approach; the precautionary principle; cross-cutting and multi-sectoral integration; shared governance and multi-scale co-operation; the development of mechanisms that facilitate stakeholder involvement; adaptive management; inclusivity; and a gender perspective. The Strategy recognises that desertification is a structural challenge affecting ecosystems, economies and communities, not merely an environmental issue (National Strategy to Combat Desertification, 2022). New inventories, mapping tools, governance bodies and restoration mechanisms were introduced. Spain's approach could serve as an example to other states when developing national strategies for soil protection (Golovko, 2025).

The National Strategy and Action Plan for Combating Desertification 2024-2030 in Turkey led to the establishment of the Directorate General of Combating Desertification and Erosion within the Ministry of Environment, Urbanisation and Climate Change. Its duties and authorities include: combatting desertification and erosion with a focus on river basin integrity; developing integrated rehabilitation plans and projects to control avalanches, landslides and

floods; conducting the necessary studies and project work for these initiatives; implementing the projects; monitoring their progress; providing project support to relevant institutions; facilitating co-operation and coordination among organisations to establish policies and strategies related to these actions and operations; planning the enhancement of watersheds at national and regional levels to address desertification and erosion; and defining corresponding policies and strategies. It also oversees the launch of satellites and the provision of satellite data to combat desertification and erosion, as well as for climate and environmental action purposes (National action programme to combat drought and desertification of Turkey, 1999). The establishment of the Directorate strengthens the co-operation between the various bodies whose activities are aimed at protecting the soil.

The National Action Programme to Combat Drought and Desertification in Italy emphasised the importance of integrating soil protection into sectoral policies. It promotes monitoring systems for land degradation and early warning systems, as well as preventive measures over restorative ones (National action programme, 1999). Although it establishes the principles of soil protection, it lacks concrete action plans.

As is evident, the strategies employed by different states with regard to the protection of land resources and the combating of desertification focus on different aspects. This discordance in opinion is indicative of the absence of a consensus on this matter. The development of an international standard for adapting agricultural practices to climate change, in addition to the growing necessity of soil protection, would be required to improve the situation. It is for this reason that the adoption of international standards in this sphere is considered necessary.

5. Conclusions

Statistical data indicates that soil degradation has become one of the most pressing environmental issues of the twenty-first century. According to recent analyses by the UNCCD and the FAO, more than one-third of the world's land is already degraded. This weakens the ecological and economic functions of soils. Soil degradation affects an estimated three billion people and contributes to declining crop yields worldwide. Furthermore, 1.7 billion people depend on increasingly fragile soils. Degraded soils also intensify climate risks by reducing their carbon storage capacity and increasing biodiversity loss. Droughts, which have become both more frequent and severe in recent decades due to climate change and unsustainable land use, have a further deleterious effect on soil vulnerability. These trends demonstrate the necessity for coordinated global action

to restore soil resources and ensure sustainable food production.

Degradation of soil and land has been demonstrated to result in economic, environmental and social losses on both national and global levels. The impact of climate change on soil fertility and land productivity has already resulted in significant economic losses, with estimates reaching hundreds of billions of euros in Europe and trillions of dollars worldwide. The burden of this situation is felt most acutely in low-income countries, where reduced yields and production losses have a detrimental effect on food security and economic stability. Concurrently, global food markets are becoming increasingly vulnerable due to the diminution of agricultural resilience caused by degraded soils.

The quality of land resources in Ukraine is also affected by military actions. The large-scale degradation of soil, caused by military destruction, unexploded ordnance, and disrupted agricultural systems, has resulted in indirect losses amounting to tens of billions of dollars. The contamination of almost a third of the country's territory with explosive remnants of war poses a significant threat to long-term land productivity and has a considerable impact on the cost and duration of restoration efforts.

Against this backdrop, the rising global costs of land restoration, ranging from hundreds of billions to several trillion dollars, must be understood as essential investments, not optional expenditures. The restoration of degraded ecosystems is economically profitable. It generates high returns on investment and substantial carbon sequestration benefits. Every dollar spent on restoration generates long-term profits while simultaneously strengthening climate mitigation, biodiversity conservation and food security.

Although the FAO's 2017 Voluntary Guidelines for Sustainable Soil Management offer an important global framework for soil protection, they have a number of shortcomings. They are voluntary, their provisions are too general, and they do not define minimum standards for soil protection. The UN Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, particularly in Africa, also fails to provide more detailed requirements for national legislation, as well as the necessary elements of action plans and strategies.

The strategies adopted by different states to protect land resources and combat desertification differ not only in the details, but also in their approach. They focus on different aspects. This fragmentation limits the effectiveness of global efforts to combat land degradation. This is why it is necessary to adopt international standards for climate-resilient agricultural practices and soil protection. They would help to create coherence on this issue.

International standards could guide states in developing their national policies and encourage the adoption of sustainable agricultural practices that have been proven effective.

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