ENVIRONMENTAL CRIME AS A BARRIER TO SUSTAINABILITY TRANSITIONS

Jelena Dimovski[1], Darko Dimovski[2]

[1]University of Niš, Innovation Center, Univerzitetski trg 2, 18 000 Niš, Serbia, jelena.dimovski@icun.ni.ac.rs
[2]University of Niš, Faculty of Law, Trg kralja Aleksandra 11, 18 000 Niš, Serbia, darko@prafak.ni.ac.rs

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Corresponding Author: Darko Dimovski, University of Niš, Faculty of Law, Trg kralja Aleksandra 11, 18 000 Niš, Serbia, darko@prafak.ni.ac.rs

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ABSTRACT

Environmental crime represents a significant barrier to the global sustainability transition by compromising environmental integrity, economic stability, and social well-being. The study assesses the multifaceted impacts of illegal activities, including wildlife trafficking, illegal logging, pollution, and illicit waste disposal, on sustainable development pathways. Utilizing interdisciplinary perspectives from environmental economics, criminology, and sustainability science, the analysis explores how environmental crime disrupts resource efficiency, weakens institutional frameworks, and erodes public trust in governance systems. Drawing on case studies from the European Union, the analysis places particular emphasis on regulatory gaps, corruption, and transnational networks that enable these activities, thereby complicating enforcement and policy implementation. The study highlights the economic consequences of environmental degradation, including biodiversity loss, diminished ecosystem services, and long-term financial burdens on governments and communities. The research findings indicate that addressing environmental crime is essential for effective and equitable sustainable development, necessitating coordinated action among policymakers, businesses, and civil society to mitigate risks and strengthen resilience. Strengthening institutional capacity, enhancing cross-border cooperation, and leveraging technological innovations such as environmental monitoring systems are essential for effective prevention and enforcement. Furthermore, integrating anti-crime measures into sustainability strategies can enhance policy coherence and reinforce long-term economic and environmental resilience.

Keywords: Environmental crime, sustainable development, transition, European Union, prevention.

INTRODUCTION

The transition to sustainable development is a central policy objective of the twenty-first century, shaping international agreements, national strategies, and corporate governance frameworks. However, environmental crime increasingly threatens the pursuit of sustainability and remains underrepresented in mainstream economic and policy discourse [1]. Encompassing wildlife trafficking, illegal logging, unauthorized pollution, and illicit waste disposal, environmental crime is among the most profitable and rapidly expanding forms of transnational criminal activity. It generates illicit proceeds estimated at tens of billions of euros annually and impacts nearly every ecosystem and economic sector [2].

Unlike conventional crime, environmental crime rarely produces an immediately identifiable individual victim. Its harms are diffuse, cumulative, and often irreversible, including biodiversity loss, soil and water contamination, depleted fish stocks, and degraded carbon sinks [3]. Considering that these harms develop gradually and span jurisdictions and generations, environmental crime has historically received less priority than other forms of organized crime, despite having equally severe consequences for sustainable development. Environmental crime should therefore be recognized as a structural barrier to sustainability transitions, as it interacts with and exacerbates weaknesses in institutional governance, economic incentives, and international cooperation mechanisms [1], [3].

This study employs an interdisciplinary approach, integrating environmental economics, criminology, and sustainability science. Environmental economics provides tools to analyze how environmental crime distorts markets, externalizes costs, and undermines the valuation of natural capital. Criminology offers frameworks for examining the actors, networks, and enforcement dynamics that enable environmental harm to persist despite formal prohibitions. Sustainability science introduces a systems perspective, positioning environmental crime within the broader context of the Sustainable Development Goals (SDGs) and the European Green Deal. This approach facilitates tracing how localized illegal acts evolve into systemic barriers to climate, biodiversity, and social equity objectives. The study seeks to demonstrate that environmental crime is a structural barrier to sustainability transitions and to identify necessary institutional, economic, and cooperative changes to remove this barrier, using the EU as a case study.

The remainder of the article is structured as follows. Section 2 develops a conceptual framework situating environmental crime within sustainability transition theory and examines the main typologies of environmental crime. Section 3 analyzes the institutional and governance conditions, regulatory gaps, corruption, transnational criminal networks that facilitate environmental crime, as well as assesses the economic consequences of environmental degradation linked to criminal activity. Section 4 presents case studies from the European Union (EU). Section 5 discusses policy responses and prevention strategies and concludes with recommendations for coordinated action among policymakers, businesses, and civil society.

THEORETICAL BACKGROUND OF ENVIRONMENTAL CRIME WITHIN SUSTAINABILITY TRANSITIONS

Sustainability transitions are long-term, multidimensional processes in which societies shift from unsustainable production and consumption patterns toward systems that protect ecological integrity, economic viability, and social equity. Transition theory, particularly the multi-level perspective, conceptualizes these shifts as resulting from interactions among niche innovations, dominant socio-technical regimes, and broader landscape pressures [4]. Environmental crime disrupts each of these levels. At the regime level, it reinforces unsustainable practices, such as illegal logging that supplies informal timber markets, by making these products cheaper and more accessible than legally compliant alternatives, thereby hindering the adoption of sustainable substitutes. At the landscape level, the cumulative ecological damage from environmental crime, including biodiversity loss and greenhouse gas emissions from illegal deforestation, intensifies the very pressures that sustainability transitions seek to address [5].

A critical distinction must be made between environmental crime and broader environmental harm. Not all ecologically damaging activities are criminalized, and not all environmental crimes result in catastrophic or visible harm. Environmental crime is characterized by the intentional violation of legal prohibitions, domestic or international, governing the protection of species, habitats, air, water, or waste management, typically for financial gain [6]. This legal-economic dimension is significant for sustainability analysis, given that environmental crime often reflects a rational response to misaligned incentives: when the expected profit from illegal exploitation exceeds the anticipated costs of detection and sanctions, actors are structurally incentivized to offend [7]. Sustainability transitions that fail to address this incentive imbalance will continue to permit opportunities for criminal exploitation, regardless of the ambition of their formal targets.

Institutional erosion is fundamental to understanding why environmental crime constitutes a barrier, rather than a mere side effect, to sustainability transitions. Effective sustainability governance depends on robust regulatory institutions, credible enforcement, and public trust in the fairness and efficacy of environmental regulations. Environmental crime undermines each of these pillars. It exposes regulatory gaps and enforcement deficiencies, diminishing the perceived legitimacy of environmental law among both compliant and non-compliant actors. When legally operating firms observe competitors profiting by evading environmental obligations with minimal risk of sanction, their incentives to invest in genuine sustainability practices are reduced [8]. As a result, environmental crime creates a corrosive feedback loop: it exploits existing institutional weaknesses while simultaneously intensifying them, making each subsequent policy intervention more difficult to implement effectively.

Environmental crime comprises various illegal activities, each characterized by specific actors, market structures, and sustainability impacts. The primary categories of environmental crime include wildlife trafficking, illegal logging and deforestation, pollution, and illicit waste disposal [5], [6], [9], [10].

Wildlife trafficking, which includes the illegal trade in live animals, plants, and derivative products such as ivory, timber species, and traditional medicine ingredients, is among the most profitable forms of environmental crime and clearly illustrates its impact on biodiversity-related sustainability targets. The depletion of keystone and endangered species through poaching and illegal trade destabilizes ecosystems, reduces genetic diversity, and can trigger cascading effects throughout food webs. Beyond ecological harm, wildlife trafficking undermines local livelihoods dependent on legal ecotourism and sustainable resource use, and it has increasingly been linked to public health risks, including the transmission of zoonotic pathogens through unregulated wildlife markets.

Illegal logging encompasses the harvesting, transportation, processing, or trading of timber in violation of national or international laws, including breaches of harvesting quotas, encroachment into protected areas, falsification of permits, and mislabeling of species. The sustainability consequences are substantial: deforestation resulting from illegal logging is a major driver of biodiversity loss, disrupts hydrological cycles, and is one of the largest anthropogenic sources of carbon emissions from land-use change, directly undermining climate mitigation objectives. Illegally sourced timber frequently enters legal supply chains through document fraud and complex intermediary networks, a process known as timber laundering, which allows it to reach EU markets despite due-diligence regulations. Economically, the persistent influx of illegal timber undercuts legally and sustainably managed forestry operations, whose compliance costs place them at a competitive disadvantage compared to illegally sourced, artificially cheaper timber.

Illicit waste disposal and unauthorized pollution, including the dumping of hazardous, electronic, and municipal waste, illegal shipment of waste to jurisdictions with weaker enforcement, and unpermitted industrial emissions, constitute also the major typology of environmental crime. These activities are primarily driven by cost avoidance: legal waste treatment and emissions abatement are expensive, and illegal disposal allows firms to externalize

these costs onto surrounding communities and ecosystems. The consequences include soil and groundwater contamination, air quality degradation, and, in the case of illegal transboundary waste shipments, the transfer of environmental burdens from wealthier to less-resourced regions, directly contradicting the principles of environmental justice central to sustainability frameworks. Within the EU, illegal waste shipment networks have been documented moving materials labeled as recyclable but effectively unprocessable to destination countries with limited capacity for safe treatment, creating long-term contamination liabilities beyond the point of origin.

Across these main typologies, a consistent structural pattern emerges: environmental crime systematically shifts environmental costs that legitimate market participants and public budgets are intended to internalize onto ecosystems and communities least able to resist or recover from the resulting harm. This cost-shifting function is the primary reason environmental crime constitutes a barrier to sustainability transitions, rather than merely representing a limited category of illegal activity. It actively undermines the internalization of environmental externalities that sustainable development strategies require [11].

INSTITUTIONAL, GOVERNANCE, AND ECONOMIC DIMENSIONS

The persistent prevalence of environmental crime, despite comprehensive legal prohibitions, indicates underlying governance deficiencies that generate high economic costs. This section examines four interconnected dimensions: regulatory gaps, corruption, transnational criminal networks, and the broader economic consequences resulting from their persistence.

Regulatory frameworks for environmental protection are frequently fragmented across jurisdictions, sectors, and levels of government, creating exploitable gaps for criminal actors. Inconsistent definitions between national legal systems regarding what constitutes a criminal environmental offense, as opposed to an administrative infraction, impede cross-border investigations and prosecutions. In many jurisdictions, sanctions for environmental crime remain disproportionately low relative to the financial gains, resulting in inadequate deterrence. Monitoring and inspection capacities are often under-resourced compared to the scale of regulated activities, particularly in sectors such as waste management and maritime transport, where shipment volumes far exceed the capacity of customs and environmental authorities to conduct comprehensive inspections [12], [13].

Corruption is a key enabling factor for environmental crime, particularly within permitting, customs clearance, and law enforcement processes. Bribery of officials responsible for issuing extraction permits, certifying legal timber or wildlife products, or inspecting waste shipments allows illegal activities to appear legitimate and enter formal supply chains and markets. Corruption further undermines prosecutorial and judicial processes, resulting in low conviction rates and lenient sentencing even when investigations are successful. The relationship between corruption and environmental crime is mutually reinforcing: environmental crime generates substantial illicit profits that sustain corrupt networks, while corruption reduces the operational risks and costs of continued offenses, creating a self-perpetuating cycle that is difficult to disrupt through enforcement alone [12], [14], [15].

Environmental crime increasingly operates through sophisticated *transnational networks* that resemble the organizational structures of other serious and organized crimes. These networks include compartmentalized supply chains, the use of shell companies and complex ownership structures, and integration with money-laundering mechanisms. They exploit jurisdictional fragmentation by routing goods through countries with weaker enforcement or lower detection risks before reaching final destination markets [16]. The transnational nature of these networks renders unilateral enforcement by a single state insufficient. Without coordinated cross-border cooperation, criminal networks can reroute activities through jurisdictions with minimal resistance. This dynamic demonstrates that environmental crime cannot be addressed solely as a domestic law enforcement issue and presents a unique challenge for sustainability governance frameworks, which are often designed and implemented at national or regional levels.

The economic costs of environmental crime extend beyond the immediate value of illegally extracted or traded resources, imposing long-term and diffuse burdens on public budgets, ecosystem services, and future economic productivity [17]. Biodiversity loss from wildlife trafficking and habitat destruction associated with illegal logging reduces the availability of ecosystem services such as pollination, water purification, and climate regulation, which are essential for agricultural and broader economic activity. Considering that these services are often unpriced or undervalued in conventional economic accounting, their degradation is not immediately reflected in standard economic performance measures, even though it undermines the natural capital base critical for sustained productivity [18], [19]. Governments and communities face significant direct financial burdens due to environmental crime, including costs for remediating contaminated sites from illegal waste disposal, restoring degraded forest and marine ecosystems, and strengthening infrastructure and public health systems affected by pollution. Remediation costs typically exceed those associated with prevention, indicating that insufficient investment in enforcement capacity often results in a net economic loss, even when considered solely in fiscal terms [20], [21], [22]. Additionally, environmental crime distorts competition within legitimate industries, as firms adhering to legal and sustainability standards incur higher operating costs than non-compliant competitors. This disparity can discourage investment in sustainable production methods and hinder the broader transition of affected sectors. At the macroeconomic level, persistent environmental crime generates reputational and market-access risks, particularly as international trade increasingly requires sustainability-linked conditions such as due diligence and traceability for commodities associated with deforestation or illegal extraction. Regions or supply chains with high levels of environmental crime may be excluded from markets enforcing these requirements, resulting in long-term competitiveness costs that compound the immediate fiscal and ecological burdens previously described [23].

CASE STUDIES FROM THE EU

Environmental crime poses a significant obstacle to sustainability transitions by undermining environmental protection, public health, institutional trust, and the implementation of circular economy principles. The EU offers a valuable context for analyzing environmental crime as a barrier to sustainability transitions, given its advanced regulatory framework. Key instruments include the Environmental Crime Directive, the Timber Regulation and its successor deforestation-related due-diligence framework, and the Waste Shipment Regulation [24], [25]. Despite these measures, persistent enforcement challenges underscore the limitations of formal legal harmonization.

One of the most prominent examples of environmental crime in Europe, based on the European Union Action to Fight Environmental Crime – EFFACE [26] is the illegal disposal and burning of hazardous waste in the Campania region of southern Italy, commonly referred to as the "Land of Fires" (Terra dei Fuochi). For decades, organized criminal networks, particularly the Camorra mafia, illegally transported and disposed of industrial and hazardous waste originating from various Italian regions. Waste was frequently buried on agricultural land or openly burned, releasing toxic substances into the air, soil, and groundwater. The environmental consequences have been severe, including widespread soil contamination, groundwater pollution, biodiversity degradation, and reduced agricultural productivity. Numerous epidemiological studies have also suggested increased incidences of cancer and other health problems among local populations. Economically, the contamination damaged the reputation of agricultural products from Campania, reducing market competitiveness and affecting rural livelihoods. From a sustainability perspective, this case demonstrates how environmental crime directly contradicts the objectives of the circular economy by replacing regulated waste management with illegal disposal practices. It also illustrates the importance of strong environmental governance, effective monitoring systems, and coordinated law enforcement. The case highlights that sustainability transitions cannot succeed

where organized crime exploits weaknesses in environmental regulation and institutional capacity [27].

Another significant EU case study on environmental crime concerns the illegal shipment of electronic waste (e-waste) from EU Member States to China despite international regulations prohibiting the export of hazardous waste [28]. Large quantities of discarded computers, televisions, mobile phones, and other electronic devices were falsely declared as reusable second-hand products to circumvent customs controls and avoid the higher costs associated with environmentally sound recycling within Europe. Once transported to informal recycling centers in China, electronic waste was dismantled using primitive techniques, including open burning of cables and acid extraction of valuable metals. These practices generated substantial environmental pollution and exposed workers and local communities to toxic substances such as lead, mercury, cadmium, and brominated flame retardants. The case demonstrates the global dimension of environmental crime and reveals how illegal international waste trade undermines the EU's circular economy ambitions. Instead of recovering valuable secondary raw materials within Europe, criminal networks externalized environmental costs to countries with weaker enforcement capacity.

The ILVA steel plant in Taranto represents one of Europe's largest examples of corporate environmental non-compliance [29]. For many years, industrial operations emitted excessive quantities of dioxins, heavy metals, particulate matter, and other hazardous pollutants into the surrounding environment. Investigations revealed repeated failures to comply with environmental regulations despite the known risks to human health and ecosystems. The environmental impacts included extensive air, soil, and marine pollution, while nearby residents experienced elevated rates of respiratory diseases and certain cancers. The case generated significant legal proceedings concerning corporate criminal liability, environmental accountability, and the balance between industrial production and environmental protection. Unlike environmental crimes committed by organized criminal groups, the ILVA case illustrates that environmental crime may also result from systematic corporate negligence and regulatory failures. It demonstrates that sustainable industrial transformation requires not only technological innovation but also effective environmental compliance mechanisms, transparent monitoring, and credible sanctions. The case has become an important example in discussions regarding corporate environmental responsibility within the European Green Deal framework.

Illegal logging remains one of the most profitable forms of environmental crime affecting global forest ecosystems while also challenging European regulatory systems. This case study examined how illegally harvested timber entered European markets through complex supply chains involving document fraud, money laundering, and insufficient coordination between enforcement authorities responsible for the EU Timber Regulation (EUTR), the Convention on International Trade in Endangered Species (CITES), and financial crime investigations [30]. Illegal logging contributes to deforestation, biodiversity loss, carbon emissions, and ecosystem degradation, directly conflicting with climate neutrality objectives and sustainable forest management principles. The economic consequences include unfair competition against legally operating forestry companies and substantial losses of public revenues in producing countries. This case highlights that sustainability transitions depend not only on environmental legislation but also on integrated enforcement across customs, environmental authorities, financial intelligence units, and judicial institutions. The study recommends stronger due diligence requirements, improved international information exchange, and enhanced financial investigations targeting organized criminal networks involved in timber trafficking.

The Aznalcóllar tailings dam failure in Spain (1998) and the Kolontár red mud spill in Hungary (2010) are examples of environmental harm linked to failures in industrial risk management and corporate responsibility [31]. Although differing in legal circumstances, both incidents raised important questions regarding criminal liability for environmental damage. In Spain, the collapse of a mining waste reservoir released millions of cubic meters of toxic sludge

into the Guadiamar River, threatening the nearby Doñana National Park. Similarly, the failure of a red mud reservoir in Hungary released highly alkaline industrial waste that caused fatalities, injuries, widespread ecological damage, and long-term contamination of rivers and agricultural land. These cases demonstrate that environmental crime extends beyond deliberate illegal acts and includes serious breaches of environmental safety obligations where negligence results in catastrophic environmental harm. They illustrate the necessity of rigorous environmental risk assessment, continuous monitoring of industrial facilities, effective inspection systems, and criminal accountability where operators fail to prevent foreseeable environmental disasters. Such governance mechanisms are essential for ensuring that industrial development remains compatible with sustainability transitions and environmental resilience.

DISCUSSION AND CONCLUSION

The evidence presented in the preceding sections substantiates the central argument that environmental crime constitutes a structural, rather than incidental, barrier to sustainability transitions. Environmental crime operates at multiple levels: ecologically, by directly depleting biodiversity and natural resources; economically, by externalizing costs and distorting competitive dynamics; and institutionally, by eroding regulatory legitimacy and diminishing public trust in governance systems. These dimensions are mutually reinforcing. Institutional weaknesses enable the proliferation of environmental crime, which in turn generates economic distortions that undermine incentives for compliance. The resulting ecological degradation further increases the challenges and costs associated with achieving sustainability transitions.

Another significant implication is the distributional impact of environmental crime. Its ecological and economic costs are often shifted onto communities and regions with limited capacity to resist or recover, such as through the illegal shipment of waste to under-resourced countries or the depletion of resources vital to local livelihoods. Consequently, environmental crime raises environmental justice concerns that intersect directly with the equity dimension of sustainable development. Transitions that overlook these distributional effects risk perpetuating the very inequities they aim to resolve. Evidence from the EU indicates that the primary constraint on progress is not legislative ambition, given the extensive regulatory framework, but rather the capacity for implementation and effective cross-border coordination. This finding underscores a broader lesson for sustainability governance: comprehensive legal commitments to environmental protection are insufficient unless accompanied by adequate investment in enforcement capacity, anti-corruption measures, and international cooperation mechanisms capable of addressing the transnational nature of environmental crime networks.

Addressing these challenges requires coordinated, multi-layered responses. Strengthening institutional capacity involves increasing resources for environmental regulatory and enforcement authorities and enhancing the coherence of legal definitions and sanctioning regimes across jurisdictions. Penalties must be proportionate to the financial scale and ecological harm of offenses to restore deterrence. Additional measures include investing in specialized training for judicial and law enforcement personnel and embedding anti-corruption safeguards, transparency requirements, and independent audit mechanisms within permitting and inspection processes to reduce regulatory capture. Given the transnational nature of environmental crime, domestic reforms must be complemented by enhanced cooperation among national enforcement agencies, customs authorities, and international organizations. This includes shared intelligence systems, harmonized data standards for tracking shipments and supply chains, and joint operational task forces capable of intercepting criminal activity across borders. Within the EU, deeper integration of national environmental crime units with shared enforcement infrastructure would help close jurisdictional gaps exploited by transnational networks.

Technological innovation provides an additional, complementary means of prevention at a scale beyond the capacity of manual inspection. Satellite-based remote sensing enables near real-time identification of illegal deforestation and land-use change. Blockchain-based supply-chain verification increases the difficulty of falsifying origin documentation. Automated monitoring

networks for air, water, and waste facilities enhance detection of unauthorized pollution and illegal disposal while reducing dependence on resource-intensive physical inspections. However, these measures will not be effective unless anti-crime strategies are explicitly integrated into broader sustainability policies rather than pursued separately. Incorporating environmental crime risk assessments into sustainability-linked trade agreements, corporate due diligence requirements, and development finance conditions helps ensure that resources allocated to sustainability transitions are not undermined by unaddressed criminal exploitation of the same resources and ecosystems.

In summary, environmental crime represents a significant and often overlooked barrier to global sustainability transitions, undermining environmental integrity, economic stability, and social well-being through activities such as wildlife trafficking, illegal logging, pollution, and illicit waste disposal. The persistence of environmental crime reflects deeper governance weaknesses, regulatory gaps, corruption, and transnational criminal networks, which complicate enforcement and policy implementation even in jurisdictions with advanced legal frameworks, as demonstrated by case studies from the EU. Effective responses require coordinated action among policymakers, businesses, and civil society, including strengthened institutional capacity, enhanced cross-border cooperation, and the integration of technological innovations such as environmental monitoring systems directly into sustainability strategies. As sustainability transitions accelerate in response to climate and biodiversity imperatives, safeguarding the resources and ecosystems central to these transitions from criminal exploitation will be essential to achieving equitable and lasting sustainable development outcomes.

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DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

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