

International environmental liability and the governance of hazardous waste: A doctrinal analysis of the 2025 chemical spill in Zambia

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Abstract

This study examines international environmental liability and hazardous-waste governance through a doctrinal analysis of the 2025 chemical spill in Zambia. The failure of a mining tailings dam released large quantities of toxic substances into the Kafue River system, causing serious ecological damage and long-term risks to human health. The research asks to what extent existing international environmental law, including the principles of prevention, no harm, polluter pays, and due diligence, provides a coherent basis for responsibility of both the Zambian state and the multinational corporate operator. Using a normative juridical method, the study analyses treaties, customary international law, soft law instruments, case law, and relevant national legislation. It finds that international rules on prevention and environmental protection are relatively clear for states; however, corporate actors remain primarily regulated through domestic law and indirect state responsibility. The Zambia spill reveals gaps in corporate accountability, transboundary risk management, access to effective remedies, and environmental rehabilitation. The article concludes with proposals to strengthen domestic liability regimes, clarify international standards on corporate due diligence and tailings management, and improve compliance and monitoring at the international level.

Keywords

Corporate due diligence, Environmental liability, Hazardous waste governance, Zambia chemical spill

Introduction

The 2025 chemical spill in Zambia following the failure of a mining tailings dam is a stark reminder that the risks of extractive industries cannot be fully contained within concession boundaries. Tailings are the residues of mineral processing and often contain mixtures of heavy metals, chemical reagents, and hazardous sediments. When a tailings storage facility collapses, the sudden release of large volumes of contaminated

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material can become an ecological disaster [1], [2]. Water quality deteriorates rapidly, aquatic life is exposed to toxic substances, food chains are disrupted, and the ecological functions of a river system are weakened. These impacts are not limited to environmental damage. They also pose long-term risks to human health through contaminated drinking water, fish consumption, irrigation, and cumulative exposure among communities that rely on the river for their daily lives and livelihoods.

As a doctrinal case, the spill highlights a persistent asymmetry: international environmental law articulates robust state duties to prevent and control hazardous activities, yet corporate accountability at the international level remains largely indirect and dependent on domestic enforcement. Tailings governance, therefore, tests not only technical standards but also regulatory oversight, transparency, emergency preparedness, and access to effective remedies and rehabilitation [3].

The urgency of this topic is reinforced by the fact that tailings governance is not merely a technical matter. It is also a governance issue involving safety standards, regulatory oversight, transparency of risk information, emergency preparedness, and access to remedies for affected populations. When a spill occurs, the public's needs extend beyond immediate containment and cleanup. Effective remedies require science-based environmental rehabilitation, compensation for social and economic losses, long-term monitoring, and measures that prevent recurrence. Yet in many environmental disaster contexts, pathways to remedy face serious barriers. Scientific causation can be difficult to prove, and affected communities often lack the resources of corporate defendants. Furthermore, legal frameworks frequently struggle to address cross-border corporate structures and enforcement challenges [4]. Accordingly, this article asks whether the principles of prevention, no harm, polluter pays, and due diligence provide a coherent legal basis for allocating responsibility between the Zambian state and the corporate operator, and what gaps the spill reveals in corporate accountability, remedies, and rehabilitation governance [5].

The objective of this study is to provide a doctrinal and normative assessment of the relevant international legal framework as it applies to the 2025 Zambia spill. Using a normative juridical method, the analysis draws on treaties, customary international law, soft law instruments, case law, and relevant national legislation. The article aims to make two contributions. The first is a systematic evaluation of the coherence and practical implications of international principles governing state responsibility for environmental harm. The second is an identification of the accountability gap for corporate actors, including the limited reach of international standards on corporate due diligence, the weakness of monitoring and compliance mechanisms, and the difficulties faced by affected communities in obtaining effective remedies.

The article's structure is as follows. The next section sets out the research method and the sources of legal materials examined. The subsequent section provides the conceptual framework and a concise account of the Zambia spill and its implications for hazardous waste governance. The following section outlines the relevant international

legal framework, encompassing treaty obligations, customary rules, and soft law standards related to prevention, environmental protection, and hazardous waste management. The analysis section then evaluates state responsibility and the limits of corporate accountability, including issues of remedies, rehabilitation, and long-term monitoring. The final section concludes by summarizing the main findings and proposing measures to strengthen domestic liability regimes, clarify international standards on corporate due diligence and tailings management, and enhance international compliance and monitoring.

Method

This research applies a normative juridical method. It analyses relevant treaties, customary international law, soft law instruments, jurisprudence, and applicable domestic legislation to assess responsibility and remedies arising from the 2025 Zambian spill. Interpretation is conducted through textual and systemic reading of norms, supported by doctrinal analysis to evaluate coherence and to formulate accountability-oriented recommendations.

Results and discussion

Conceptual framework and the Zambian case

This section develops a conceptual framework for understanding the 2025 Zambia chemical spill. In international environmental law, the term “international environmental liability” encompasses two related but distinct dimensions [6]. The second is liability in the sense of civil liability and compensation mechanisms, which are typically more developed in domestic legal systems through tort claims, administrative sanctions, or environmental criminal law. This distinction is important because many core principles of international environmental law, including prevention, precaution, and due diligence, primarily serve as standards of conduct. They require states to regulate and supervise hazardous activities in a reasonable and proportionate manner, rather than guaranteeing that accidents will never occur [7].

Hazardous waste governance in the mining sector has specific characteristics because tailings are not ordinary waste. Tailings are the residues of mineral processing, tailings can also contain heavy metals and other toxic substances. Because tailings volumes are massive and their environmental risks can be severe, they are commonly stored in tailings storage facilities retained by tailings dams. These facilities are not merely passive storage sites [8]. They are high-risk systems that require robust design standards, continuous monitoring, maintenance, emergency preparedness, and transparent risk management. A tailings dam failure, therefore, illustrates that environmental harm can result not only from deliberate dumping but also from technological failure and governance deficiencies that allow uncontrolled releases [9].

The concept of hazardous waste governance emphasizes that controlling hazardous waste requires more than general prohibitions or formal permits. It demands a chain of measures including hazard identification, standard setting for safe management, environmental impact assessment, effective compliance oversight, and credible enforcement. At this point, key international environmental law principles become analytically central. The prevention principle requires states to adopt and implement measures that reduce the probability of harm, especially where activities involve foreseeable and serious environmental risks. The no harm principle reflects the idea that a state must ensure activities within its jurisdiction do not cause significant environmental damage, and it also reinforces the normative position that severe harm should not be treated as an acceptable external cost of economic development. The polluter pays principle reinforces the expectation that the costs of prevention, control, and remediation should be borne by the polluter rather than the public. However, at the international level it often functions more as a policy guidance tool than as a direct basis for imposing responsibility on corporate actors. Due diligence then operates as a key metric for evaluating whether a state has fulfilled its obligations. It asks whether the state acted with reasonable care and took proportionate measures in light of the level of risk, available scientific and technical knowledge, and relevant best practices [10].

Within this framework, the 2025 Zambia spill can be understood as an event that tests the effectiveness of prevention and oversight systems. The failure of a mining tailings dam led to the release of tailings material and toxic substances into the Kafue River system, a river of major ecological and socio-economic importance. The movement of contamination through the river generates acute exposure impacts, such as sudden declines in water quality, fish kills and biodiversity stress, and immediate disruption to domestic water use and agricultural irrigation. At the same time, the spill creates long term risks because certain contaminants can settle into sediments, bioaccumulate in aquatic organisms, and persist in the environment. As a result, threats to human health and ecosystem integrity may continue well beyond the initial emergency phase, especially if monitoring and remediation are inadequate.

The ecological impacts associated with a spill of this nature commonly include water quality degradation, damage to habitats and biodiversity, and disruption of river ecosystem functions that provide essential services. Human health and socio-economic impacts often follow interconnected pathways, including reduced access to safe water, increased health burdens and costs, loss of livelihoods linked to fisheries and agriculture, and prolonged uncertainty caused by the need for long term monitoring and rehabilitation. For these reasons, the conceptual analysis does not focus solely on assigning blame. It also evaluates whether legal and governance systems can deliver effective prevention, clear accountability, and meaningful remedies. Effective remedies in this context encompass not only emergency response but also science based environmental rehabilitation, compensation for proven losses, long term monitoring, and guarantees of non-recurrence through improved regulation and enforcement.

Accordingly, the Zambia spill serves as a doctrinal case study to assess whether international environmental law provides a coherent basis for state responsibility while revealing the limitations of direct international regulation of corporate conduct. The case exposes structural weaknesses in corporate accountability, including the reliance on domestic law and the indirect nature of state mediated responsibility, as well as practical challenges in securing remedies and financing environmental rehabilitation. These dynamics support the broader argument that strengthening domestic liability regimes, clarifying international expectations on corporate due diligence and tailings management, and improving compliance monitoring mechanisms are necessary to close accountability gaps highlighted by the 2025 Zambia spill.

Relevant international legal framework

The relevant international legal framework for assessing the 2025 Zambia spill is not found in a single treaty or liability convention, but in a layered set of treaty obligations, customary rules, soft law instruments, and technical standards that together shape what prevention, safe management, and accountability should look like. For states, the core logic is that hazardous industrial activities must be controlled through prior regulation, ongoing supervision, and effective response capacity. For corporate actors, the framework is more indirect, operating through domestic regulation, host state enforcement, and internationally recognized expectations of responsible conduct that increasingly influence the interpretation of due diligence and the standard of care.

At treaty level, the Basel Convention provides the principal global reference point for hazardous waste governance and environmentally sound management, while the Bamako Convention strengthens this agenda in Africa. Other chemical control regimes and relevant water cooperation instruments may provide contextual guidance, particularly where downstream risks engage duties of notification and cooperation.

Customary international law provides the most direct foundation for holding states responsible for environmental harm. The no-harm rule, commonly articulated as the obligation to ensure that activities within a state's jurisdiction or control do not cause significant damage, is frequently treated as a cornerstone norm in international environmental law. This rule is closely tied to the duty of due diligence, which requires states to adopt and implement reasonable measures to prevent foreseeable harm in light of the risk profile of the activity, available knowledge, and best practicable means. Prevention is therefore understood as an obligation of conduct rather than an obligation of result, meaning that a state can breach its obligations if it fails to regulate and supervise adequately, even if the precise accident was not intended. International jurisprudence has repeatedly emphasized these themes, utilizing concepts such as foreseeability, reasonableness, and proportionality to assess whether a state's regulatory and administrative framework aligns with the scale of environmental risk. Complementing these customary obligations, the International Law Commission's work on the prevention of transboundary harm and the allocation of loss in the event of such harm is often cited as an authoritative restatement of how prevention, cooperation,

notification, contingency planning, and reparation can be conceptualized when hazardous activities pose serious risks.

Soft law instruments further clarify the normative content of prevention and environmental protection, and they are particularly influential in filling gaps where binding corporate duties remain underdeveloped at the international level. The Stockholm Declaration and the Rio Declaration articulate principles that guide state conduct, including prevention, environmental impact assessment, cooperation, access to information, and the polluter pays principle. Although polluter pays often functions as a policy principle rather than a self-executing rule of liability, it reinforces the legitimacy of requiring operators to bear the costs of risk control and remediation, and it supports the argument that states should embed such cost internalization in licensing, permitting, and enforcement systems. Soft law also matters for corporate accountability. The United Nations Guiding Principles on Business and Human Rights and the OECD Guidelines for Multinational Enterprises establish widely recognized expectations that companies conduct human rights and environmental due diligence, identify and mitigate risks, and provide or cooperate in remediation when harms occur. While these instruments are not treaties, they increasingly shape what is considered reasonable corporate conduct and can influence domestic interpretation of negligence, duty of care, and regulatory compliance.

Finally, industry standards and financial sector practices play a practical role in defining the contemporary benchmark for tailings governance and operational due diligence. Standards such as the Global Industry Standard on Tailings Management, along with lender and investor frameworks like the IFC Performance Standards and the Equator Principles, establish concrete expectations for tailings facility design, independent review, emergency preparedness, monitoring, disclosure, and stakeholder engagement. These standards are significant because they translate general legal principles into operational requirements, helping courts, regulators, and policymakers assess whether a company and its supervising authorities have met an appropriate standard of care. Taken together, treaties, customary rules, soft law, and technical standards provide a coherent basis for evaluating state prevention and due diligence, while also highlighting that corporate accountability at the international level remains largely mediated through domestic law, indirect state responsibility, and evolving but still non-binding global expectations of corporate due diligence.

Relevant international legal framework

The Zambia spill illustrates how state responsibility in international environmental law is assessed through standards of conduct, while corporate accountability remains largely filtered through domestic legal systems and indirect pathways. For the Zambian state, the prevention principle functions as a baseline obligation to establish and operate an effective regulatory system for hazardous mining activities. In practical terms, prevention requires clear permitting conditions for tailings storage facilities, mandatory safety and monitoring requirements, independent inspections, emergency

preparedness, and credible enforcement capacity. If the legal and administrative framework is weak, under-enforced, or inadequately resourced, an accident like a tailings dam failure may indicate a possible breach of the state's duty to act with reasonable care in regulating and supervising a foreseeable risk.

The no-harm principle further frames the assessment of state conduct by prohibiting significant environmental damage caused by activities within a state's jurisdiction or control. Although the Zambia spill may primarily affect domestic waters, the no harm principle remains relevant in two ways. First, it captures the general expectation that serious environmental harm is legally salient even when it is internal, reinforcing the idea that hazardous operations must not be treated as a purely private risk. Second, if contamination pathways extend downstream beyond national territory, the spill could trigger more explicit transboundary duties, including duties of cooperation, notification, and information sharing with potentially affected states. In such circumstances, a failure to take reasonable preventive measures or to provide timely notification and coordinate a response may strengthen the argument that the state did not meet the required standard of diligence.

Due diligence is the connective tissue that operationalizes prevention and no harm. It is not a guarantee against accidents, but a requirement to adopt and implement reasonable measures proportionate to the risk. In a tailings context, due diligence is assessed against the foreseeability and severity of potential risks. Tailings dams are widely recognized as high-consequence infrastructure, and their failure can cause sudden, widespread contamination [11]. A state that allows a facility to operate without robust oversight, independent review, and enforceable safety benchmarks may be viewed as falling below the due diligence threshold, even if the operator is the immediate cause of the physical failure [12].

The polluter-pays principle is often invoked to allocate costs for prevention and remediation to the actor that caused the pollution, but it has different legal effects for states and corporations. Instead, it functions mainly as a policy principle that states are expected to implement through domestic law, contractual obligations, and licensing conditions [13].

This leads to the central limitation in corporate accountability. International environmental law still primarily addresses states, and corporate actors are regulated indirectly through domestic frameworks and through the state's duty to regulate [14]. As a result, the corporate operator's responsibility for the Zambia spill is most likely to be enforced through national tort law, environmental statutes, administrative sanctions, and potentially criminal liability, depending on the applicable domestic regime. In multinational corporate settings, additional barriers arise, including complex corporate group structures, the separation between parent and subsidiary, jurisdictional obstacles, access to evidence, and uneven power between affected communities and corporate defendants. These barriers can translate into weak deterrence and incomplete compensation even when harm is severe.

The spill also exposes issues of transboundary risk management, remedies, and rehabilitation. Where downstream effects may extend beyond Zambia, effective management requires early warning systems, cross-border coordination, and shared monitoring data to support timely responses. For affected individuals and communities, effective remedies depend on practical access to justice, meaningful participation, and procedures that allow collective claims when harms are widespread. Remedies also require that compensation not be limited to immediate losses but account for long-term health risks, livelihood disruption, and ecological damage. Environmental rehabilitation raises further complexities because restoring river systems often involves multi-year sediment management, biodiversity recovery measures, and ongoing monitoring of water quality. Without reliable funding mechanisms, such as dedicated rehabilitation funds, operator-financed trust arrangements, or enforceable financial guarantees, rehabilitation can be delayed or reduced to symbolic cleanup [15].

Overall, applying the principles of prevention, no harm, polluter pays, and due diligence to the Zambia spill supports a relatively coherent basis for evaluating state responsibility, while simultaneously demonstrating that corporate accountability remains fragmented and dependent on domestic enforcement capacity. The case, therefore, highlights the need for stronger domestic liability and financial assurance tools, clearer international expectations on corporate environmental due diligence and tailings governance, and improved monitoring and compliance mechanisms to ensure that prevention and remedies are effective rather than merely aspirational.

Conclusion

The 2025 Zambian spill demonstrates that international environmental law offers a comparatively clear yardstick for assessing state responsibility through prevention, no harm, and due diligence, yet it does not provide equally firm pathways for direct multinational corporate accountability. Corporate responsibility remains largely channelled through domestic regimes and indirect state-mediated mechanisms, which may be weakened by enforcement deficits and transnational corporate structures. Accordingly, the article supports strengthening domestic liability architecture for high-hazard tailings operations through risk-based or strict liability, mandatory financial assurance for cleanup and rehabilitation, and more accessible procedures for affected communities. At the international level, clearer and more operational expectations on corporate environmental due diligence and tailings governance should be consolidated through widely accepted standards and monitoring-oriented cooperation, while remediation and long-term environmental recovery should be treated as enforceable outcomes rather than aspirational commitments.

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