

Historical Pollution in the Polluter Pays Principle: Who Pays When the Polluter Is No Longer There?

Davilla Prawidya Azaria¹, Anni Alvionita Simanjuntak²

¹Faculty of Law, Universitas Pembangunan Nasional "Veteran" Jakarta, e-mail: dp.azaria@upnvj.ac.id

²Faculty of Law, Universitas Pembangunan Nasional "Veteran" Jakarta, e-mail: annialvionita@upnvj.ac.id

ARTICLE INFO

Keywords:

Historical pollution,
polluter pays principle,
state responsibility,
developing country.

How to cite:

Azaria, Davilla
Prawidya &
Simanjuntak, Anni
Alvionita. (2026).
Historical Pollution in
the Polluter Pays
Principle: Who Pays
When the Polluter Is No
Longer There?. *Veteran
Law Review*. 9(1). 127-
140.

Received:2026-06-19

Revised:2026-06-22

Accepted:2026-06-30

ABSTRACT

The conventional Polluter Pays Principle encounters jurisdictional paralysis when confronted with historical pollution, particularly when responsible corporations escape liability through liquidation or strategic bankruptcy, leaving behind severely deteriorated environments as orphan sites. This normative legal research aims to formulate a policy reconstruction to bridge this intertemporal liability gap by analyzing successful environmental policy frameworks from various developing countries. Grounded in the protective function of state authority, governments possess an inherent responsibility and institutional capacity to proactively intervene in long-standing ecological crises. The analysis indicates that transferring remediation liability to the state can be effectively operationalized through adaptable instruments tested in the Global South, including state-led emergency restoration mechanisms, collective industry-funded environmental pools, and property-attached ecological obligations. In conclusion, the state must act as the primary executor of physical remediation upfront, subsequently utilizing its sovereign right to reclaim restoration costs from successor entities or parent companies to guarantee intergenerational ecological justice.

1. Introduction

Global economic development which driven by industrial and extractive sectors, has historically left a trail of massive environmental degradation. A critical challenge facing modern environmental law is historical pollution, where industrial activities from past decades released hazardous substances into the biosphere (Rotolo, 2017). Contemporary legal discourse has shifted focus from the historical activities themselves to their resulting legacy pollution: the accumulation of toxic substances that remain deposited in soil, sediment, and groundwater today. A defining characteristic of this pollution is the long time lag between initial waste disposal and the manifestation of severe ecological impacts. These contaminated areas are frequently neglected, remaining unresolved without necessary remedial action.

In recent decades, localized land and groundwater contamination from historical activities has evolved from an isolated domestic issue into a pervasive global crisis. Scientific and regulatory attention intensified during the 1960s following several high-profile incidents, including arsenic contamination of groundwater in Western Europe, chemical waste burial in Dutch residential developments, and extensive soil and groundwater degradation from mining in the Swansea Valley (Prokop et al., 2000). Over subsequent decades, historical pollution cases increasingly commanded international concern. Notable examples include catastrophic mercury poisoning in Minamata Bay, Japan (Funabashi, 2006); fifty years of systemic oil industry pollution in Ogoniland, Nigeria (Percival et al., 2012); diffuse mercury contamination from legacy gold mining in South America (Pestana & Formoso, 2003); widespread acid mine drainage in South Africa (Feris, 2012); and the dissolving DDT stockpiles in Old Korogwe, Tanzania, which continuously threaten the Pangani River ecosystem (Percival et al., 2012).

Conceptually, defining the precise boundaries between historical pollution, legacy pollution, and general contamination remains a persistent challenge for legal authorities worldwide. The temporal dimension is particularly disruptive, as the multi-generational time lag between initial disposal and damage manifestation inherently obscures legal evidence (Rotolo, 2017). Time acts as a distorting factor that complicates the establishment of legal causation; over decades, environmental landscapes shift, a multiplicity of new actors intervene, and regulatory frameworks themselves evolve. This absence of rigid statutory boundaries is frequently exploited by industrial actors seeking to evade ecological liability, ultimately transforming past industrial externalities into an enduring contemporary environmental burden.

In environmental law discourse, the polluter pays principle (PPP) is a globally recognized doctrine that shapes environmental policy at both national and international levels. The principle orders that polluters must bear the costs of pollution prevention and control measures mandated by public authorities, including preventive actions, ecological restoration, or a combination of both (Organisation for Economic Co-operation and Development (OECD), 1975). Legally internalizing these costs incentivizes industrial actors to implement the precautionary principle throughout their operations. However, the operational effectiveness of the PPP relies heavily on the assumption that an active, identifiable legal entity exists, can be prosecuted, and possesses the financial capacity to compensate for the environmental legacy it leaves behind (Vozza, 2017).

Legal deadlocks arise when PPP is confronted with the reality of an absent or nonexistent polluter. Corporate entities responsible for historical pollution have frequently been liquidated, declared bankrupt, or deliberately dissolved to evade legal liability. This orphan site phenomenon exposes a fundamental

gap in traditional liability frameworks; when the primary legal subject disappears, the chain of causation under the PPP is broken. This rupture leaves a critical regulatory dilemma regarding who should fund the physical remediation of the neglected environment. This situation is further compounded in developing countries, where ecosystems are already severely deteriorated by accumulated exploitative damage. In these jurisdictions, the problem is often exacerbated by weak institutional enforcement and a systemic prioritization of short-term economic growth, which tends to limit remedies for environmental damage to narrow, ineffective civil law mechanisms.

2. Method

This study employs normative legal research methods, focusing on the analysis of core legal tenets, specifically the polluter pays principle and the principle of intergenerational equity. The research utilizes secondary legal data, analyzing primary legal materials from international environmental law instruments such as the 1972 Stockholm Declaration, the 1992 Rio Declaration, and OECD recommendations on polluter-pays guidelines alongside relevant domestic state regulations. Secondary legal materials comprise pertinent books and peer-reviewed scientific articles, while tertiary sources consist of legal dictionaries and encyclopedias. Data collection was conducted through structured library research, involving the systematic identification, classification, and inventorying of these materials. The data were evaluated using descriptive-analytical techniques and systematic interpretation to assess the application of environmental law frameworks when the original legal subjects have ceased to exist.

3. Analysis

3.1. The need for an adequate concept of polluter pays principle in developing countries

Formal recommendations by the OECD in the 1970s are widely considered the normative basis for the polluter pays principle (PPP). However, an early jurisprudence of this concept can be traced to the landmark Trail Smelter Arbitration of 1938 and 1941. In that dispute, the tribunal awarded monetary compensation to rectify damage caused to transboundary agricultural land, reinforcing the foundational idea that a polluting entity must bear the financial consequences of its externalities (International Arbitration Tribunal, 1941). Decades later, the OECD formalized the PPP, initially introducing it as an economic efficiency principle before it transitioned into an established legal doctrine (Organization for Economic Co-operation and Development, 1992). A definitive milestone occurred when the principle was enshrined in Principle 16 of the 1992 Rio Declaration on Environment and Development, solidifying

the PPP as a cornerstone of both international and domestic environmental law.

The PPP functions simultaneously as an environmental economic tool and an environmental legal doctrine. In environmental economics, it promotes market efficiency by internalizing environmental externalities. As a legal principle, it governs the allocation of preventive costs, civil liability, and compensation for ecological damage (Bugge, 1996). Consequently, the PPP stands as a foundational pillar of environmental protection, operating alongside complementary tenets such as the precautionary and prevention principles. In domestic jurisdictions, the implementation of the PPP varies significantly, reflecting diverse legal systems and local conditions. Most commonly, it is operationalized through statutory frameworks that impose direct liability, requiring polluters to bear the full cost of the environmental remediation necessitated by their operations.

Principle 16 of the Rio Declaration provides the normative foundation for integrating environmental economic and legal frameworks when allocating ecological costs to polluters. From an economic perspective, these costs inevitably influence production overheads and product pricing. Hence, consumers often bear a dual burden, ultimately absorbing the shifted financial costs of pollution prevention while simultaneously experiencing the physical impacts of environmental degradation (Bugge, 1996). Therefore, the PPP is best understood as a mechanism for allocating primary financial risk; it forces polluters to internalize costs to the extent that they cannot be transferred to consumers, insurers, or other third parties. Ultimately, the PPP remains a multifaceted doctrine whose interpretation and enforcement must dynamically adapt to varying legal, economic, and institutional contexts.

The scope of PPP must be evaluated beyond simple cost-allocation models for emission prevention; it inherently encompasses broader environmental costs, civil liability, and ecological restoration (Bugge, 2009). Economically, when environmental degradation is assessed through property valuation, the associated financial liabilities fluctuate, yielding higher cost projections in affluent areas and significantly lower metrics in lower-income regions. Even when considering other regulatory variables, such as environmental quality standards, threshold limits, and public health impacts, the calculated social cost of pollution frequently appears higher in pristine areas than in already degraded landscapes. Market-driven cost-benefit analyses can perversely suggest that environmental degradation is less financially burdensome when concentrated in impoverished regions, a structural vulnerability that disproportionately impacts most developing countries.

The OECD's formulation of PPP as an instrument of economic efficiency assumes a relatively stable baseline environment, enabling external costs to be calculated and proportionally charged to active industrial actors. However, adopting this framework into the legal systems of developing countries

reveals a profound conceptual gap, as it ignores the severely deteriorated state of local ecosystems (Singh, 2023). In these regions, historical pollution from past industrial activities has already exceeded ecological carrying capacities, a crisis further exacerbated by modern, export-driven extractive industries that fail to perform commensurate restoration (Apergis et al., 2021). Thus, conventional applications of the PPP become structurally biased and inequitable; under these conditions, it is virtually impossible to isolate new contamination generated by current corporations from the pervasive legacy of past pollution.

Conventional PPP often falter in developing countries due to a fundamental misalignment between their market-centric origins and the actual demands of environmental protection. Conceived primarily as an economic cost-allocation tool to optimize market efficiency, the traditional PPP was not designed to uphold ecological justice or remediate historical degradation. When mechanically applied to heavily strained ecosystems in the Global South, it fails to provide preventive incentives and instead risks commodifying the environment by establishing a de facto "right to pollute." Furthermore, historical pollution introduces an acute temporal justice dilemma that undermines the principle's core logic. The standard economic definition of a polluter presumes an active, identifiable entity currently generating revenue from its operations. When an ecosystem has been degraded by a succession of past industrial activities and the responsible legal subjects have ceased to exist, this market-based framework loses its foundational utility. The resulting impasse creates a severe conflict between corrective justice, which demands retrospective accountability from past actors, and contemporary distributive justice, wherein the financial and ecological burdens of restoring a deteriorated environment are ultimately shifted onto the public and future generations.

In developing countries, the implementation of PPP has historically focused on securing immediate compensation for affected victims. Under this framework, strict liability regimes are designed to channel financial restitution directly toward local environmental institutions responsible for monitoring high-risk industrial activities (Luppi et al., 2012). This decentralization rests on the premise that municipal and regional authorities can offer localized, highly responsive enforcement through administrative and litigation mechanisms. Such an approach leverages the proximity of local governments to manage immediate interventions, oversight, and enforcement actions, including issuing permits, conducting inspections, imposing administrative fines, suspending operations, or revoking licenses. However, when systemic structural failures occur, the PPP frequently devolves into a government-pays principle, wherein public authorities end up absorbing remediation costs within nations where rapid economic development heavily compromises environmental integrity

The application of PPP in developing jurisdictions faces significant critique, primarily due to a conceptual paralysis that occurs when transferring the model from ideal institutional settings in developed nations to the contrasting realities of developing countries. In these regions, weak institutional capacity, pre-existing environmental degradation, and regulatory systems that exist largely on paper inadvertently incentivize corporations to manipulate ecological compliance to evade exorbitant remediation costs (Larson, 2014). Because the cumulative cost of restoring lands impacted by historical pollution is massive, corporations frequently pursue strategic insolvency – opting for bankruptcy or the liquidation of local assets to escape statutory restoration liabilities. This pattern underscores a fundamental critique of the PPP: relying solely on ex-post (after-the-fact) civil liability is inherently insufficient to protect or restore severely degraded ecosystems (Bugge, 2009).

This dilemma is further compounded by a systemic misalignment between environmental regulations and corporate bankruptcy laws in developing countries, which frequently fail to accommodate ecological protection (Gatoto, 2025). When a polluting company operating in a severely degraded area enters insolvency, its remaining assets are almost invariably allocated to conventional preferred creditors, such as tax authorities, financial institutions, and labor claims. Hence, the massive costs required to remediate land or groundwater contaminated by historical waste are marginalized. This neglect leaves degraded areas permanently abandoned as orphan sites that continuously release toxins into the surrounding environment (Larson, 2014). Moreover, this situation introduces an acute retroactive liability impasse; even when the original polluters are successfully identified, establishing their legal responsibility remains profoundly difficult if the contaminating activities were carried out before modern environmental statutory frameworks were enacted (Munir, 2013).

Within the judicial system, liability lawsuits targeting historical pollution face formidable obstacles. Although modern environmental frameworks can bypass the requirement to prove fault by invoking strict liability, institutional enforcement remains practically elusive. The weak capacity of regulatory authorities to respond to multi-decadal environmental degradation severely hinders their ability to establish legal causation in court. The absence of historical environmental baseline data allows corporate defendants to easily shift liability to previous actors or attribute the degradation to natural phenomena. Thus, judiciaries remain reluctant to impose stringent physical remediation penalties, an impasse that becomes absolute when the original polluters are completely untraceable.

These statutory challenges are compounded by the socio-economic realities of developing nations, where extensive, informal small-scale economies accelerate ecological decline. Prototypical examples include

unregulated artisanal gold mining utilizing mercury and decentralized textile clusters discharging untreated chemical effluents directly into river systems, effectively converting aquatic ecosystems into ecological dead zones. When this fragmented informal sector generates massive, cumulative legacy pollution, the state lacks a formal corporate entity to hold financially accountable under PPP. As a result, the public is forced to independently bear the severe health and environmental externalities.

This systemic degradation demonstrates that the accumulation of historical pollution necessitates a radical reconstruction of the PPP within developing jurisdictions. Mechanically equating the operational dynamics of the PPP in developing countries with those in developed nations where environmental baselines were historically more secure, constitutes a theoretical fallacy. Developing countries must urgently pivot from an ex-post (after-the-fact) pursuit of individual, often non-existent corporate entities toward the establishment of collective financial guarantee systems capable of sustainably mitigating environmental degradation.

3.2. Bridging the missing gaps in historical pollution liability

The polluter pays principle (PPP) is fundamentally understood as a doctrine of strict liability and compensation for environmental damage, operating independently of culpa (fault). Legally, a polluter is defined as any entity that introduces deleterious emissions, thereby instigating ecological degradation. Under this framework, PPP functions as a clear mechanism of corrective justice and carries distinct ethical imperatives. However, conventional formulations of the PPP fail to address the realities of historical pollution in developing nations, leaving profound regulatory gaps. When a corporate entity responsible for historical pollution is legally dissolved or declared bankrupt, traditional civil liability frameworks lose their necessary legal subject. This disappearance of the polluter effectively paralyzes the operational utility of environmental law, necessitating an innovative jurisprudential bridge to overcome the resulting liability vacuum.

Within international environmental law, the concept of sustainable development introduced a forward-looking paradigm of justice designed to bridge temporal inequities: the principle of intergenerational equity. Promoted by Edith Brown Weiss, this principle advocates for equitable environmental management that explicitly accounts for the needs of future generations (Weiss, 1989). It rests on the philosophical foundation that each human generation receives a natural and cultural legacy in trust from its predecessors, holding it in fiduciary stewardship for its successors. Therefore, this framework imposes distinct planetary obligations upon the present generation to conserve the quality, integrity, and diversity of the natural resource base, while simultaneously granting specific planetary rights to sustainably utilize this shared heritage (Sohn & Weiss, 1987). To ensure that

these reciprocal rights and obligations are systematically upheld, the principle of intergenerational equity must be integrated comprehensively within both international and domestic legal frameworks.

When applied to historical pollution, the principle of intergenerational equity serves as a temporal bridge that resolves the vacancy of legal subjects. It shifts the jurisprudential focus from the retrospective identification of defunct or defunct perpetrators toward the proactive protection of the rights of present and future generations. This forward-looking paradigm directly addresses the temporal challenges inherent in defining and regulating legacy pollution. Traditionally, the protracted time lag between the initial act of contamination and the ultimate manifestation of ecological damage distorts legal causality, acting as a procedural hurdle (Rotolo, 2017). Through the lens of intergenerational equity, however, this temporal dimension is transformed from an evidentiary obstacle into a normative justification; it establishes that the obligation to restore a degraded environment is perpetual, inherent to the state, and independent of individual corporate longevity.

The conceptualization of intergenerational equity serves as a critical instrument to resolve the economic-environmental justice dilemma articulated by Bugge. It critiques conventional formulations of PPP for operating merely as contemporary cost-allocation tools designed to optimize short-term market efficiency. When past polluters evade liability through insolvency, a profound intertemporal distributive inequality occurs: preceding generations enjoy exclusive economic rents and profits, while future generations inherit severe ecosystem degradation devoid of financial or ecological compensation. To transform this intergenerational moral obligation into a concrete, binding legal doctrine, the framework must be integrated with the principle of state responsibility. This synthesis establishes the state as a public trustee, providing the constitutional authority and mandate to actively intervene in and remediate systemic environmental crises (Bosselmann, 2017).

State responsibility principle rooted from absolute state sovereignty within traditional international law, can no longer be interpreted merely as a territorial right to exploit natural resources for economic gain. As states face multi-generational environmental crises, this classical paradigm must shift to reconstruct both the meaning of sovereignty and the scope of state responsibility. Under this modern framework, the state functions not as an absolute owner, but as a public trustee mandated to manage natural resources for the benefit of citizens and future generations. Therefore, when a past industry degrades the environment and subsequently dissolves, this fiduciary duty prohibits the state from remaining passive. Instead, it obligates the state to assume residual liability, because the duty to protect its territory is permanent and inherent to sovereign authority itself. Furthermore, while corporations are structurally ephemeral, constrained by the lifespans of their owners or the legal finality of bankruptcy, the state serves as a temporal bridge

that transcends these corporate life cycles, ensuring long-term ecological continuity and institutional accountability.

Under the 2001 Draft Articles on State Responsibility, state accountability arises not only from affirmative actions but also from omissions or negligence in preventing and mitigating environmental degradation within a state's jurisdiction (Crawford, 2002). In perspective of environmental law, proving fault under a traditional fault-based liability framework is secondary; the primary threshold is establishing either a direct causalities to the ecological damage or invoking a standard of strict liability. In its capacity as an environmental trustee, the state holds an *erga omnes* fiduciary duty to maintain environmental quality, which directly conditions the public's right to health. Thus, a state's legal obligation to undertake environmental remediation is not a discretionary political policy choice that an administration may opt out of, but rather an binding public law obligation burdened by past regulatory omissions (Bosselmann, 2017).

Tangible manifestations of state responsibility include executing environmental decontamination programs, remediating toxic sediments in groundwater reservoirs, and restoring the hydrological functions of degraded ecosystems to ensure human habitability. Under international human rights law, the state is obligated to maintain an environmental baseline that safeguards individual public health rights (Shelton, 2006). In cases of historical pollution, a state's failure to undertake ecological restoration constitutes a severe regulatory omission, directly compounding its liability and precipitating widespread human rights violations. This health guarantee further requires the state to provide long-term, specialized medical infrastructure for communities suffering from chronic diseases induced by prolonged exposure to legacy toxins.

The state's status as an environmental trustee grants it the sovereign authority to implement preventive measures by restricting private property rights and corporate freedom of contract in the public interest. Under this framework, the economic interests of industry must remain subordinate to the principle of environmental sustainability. When a civil impasse occurs regarding the identification of liable polluters, the legal discourse must shift away from standard liability assignment toward the state's functional role as the ultimate custodian of territorial sovereignty. This custodial role authorizes the state to undertake coercive remediation actions under the doctrine of subrogation, effectively transferring the legal claims and restoration duties to specialized state-owned institutions or enterprises. Beyond physical remediation obligations, several developing countries have progressively adapted their national laws to address the structural limitations of PPP. These domestic innovations offer valuable regulatory and practical benchmarks for jurisdictions facing a widening normative gap between the environmental realities of developed and developing nations.

India pioneered the doctrine of absolute liability through its prominent Supreme Court jurisprudence, effectively eliminating traditional common law exceptions, such as natural disasters or third-party interventions, in environmental pollution cases (*Supreme Court of India Decision M.C. Mehta vs Union of India 1988 AIR 1115, 1988*). A subsequent institutional breakthrough occurred with the enactment of the National Green Tribunal (NGT) Act in 2010, which established a specialized forum for the expeditious and effective adjudication of environmental disputes (National Green Tribunal, 2010). Operating independently of the standard Code of Civil Procedure, the NGT utilizes its own streamlined procedures guided by the principles of natural justice. This decoupling of environmental disputes from conventional civil procedures represents a highly progressive approach capable of addressing the multidimensional complexities of ecological harm (Gill, 2017). Within this framework, India implements a proactive interpretation of PPP. If a corporate polluter becomes insolvent or untraceable, the NGT possesses the statutory authority to mandate that the state government immediately remediate the contaminated area using public emergency funds. Under the doctrine of subrogation, the NGT can then grant the state the right to pierce the corporate veil and pursue the personal assets of company directors, even across transnational jurisdictions.

Another innovative approach to resolving the financial impasse of legacy contamination – particularly regarding abandoned corporate mining sites – is found in Chile’s deployment of ecological fiscal policy instruments. Alongside establishing specialized Environmental Tribunals and reforming its core environmental regulations, Chile enacted a regulatory framework dictating that if a legacy mining site is toxic and its original owner cannot be identified, the state assumes custodianship of the site (Ley No. 19.300 de Bases Generales Del Medio Ambiente, 1994). Crucially, by institutionalizing the *Fondo de Protección Ambiental* (FPA) or Environmental Protection Fund, Chile avoids burdening the state budget alone with the total cost of restoring these orphan sites. Instead, the fund is heavily capitalized by green taxes levied on active extractive operations (Simon et al., 2023). Through this mechanism, contemporary industries collectively finance the remediation of historical pollution left by their predecessors. This progressive step provides a viable model for developing economies that are heavily dependent on extractive industries and frequently burdened by legacy environmental liabilities.

In contrast, the Brazilian Superior Court of Justice expanded the scope of environmental restoration by classifying the obligation as *propter rem*, meaning the liability attaches directly to the property or land rather than the legal subject. Under this doctrine, the obligation to remediate contaminated land follows the property title to its current owner, even if the land ultimately reverts to state control (*Superior Tribunal de Justiça República Federativa Do Brasil Súmula 613-STJ, 2018*). This jurisprudential breakthrough provides an effective

solution when a polluting corporation dissolves, leaving behind an orphan site that is subsequently repossessed by the state. Grounded in this *propter rem* principle, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) can safely assume management of the property, financing necessary remediation efforts through a combination of public funds and active environmental trust funds (Oliveira & Costa, 2025).

This series of progressive state interventions across developing jurisdictions confirms that when confronting the "missing polluter" phenomenon, the state cannot remain a passive spectator. Because financing remains the primary obstacle to remediation, establishing specialized public funding schemes is critical. A foundational model for this approach is the United States Superfund program, established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Superfund trust ensures the remediation of highly contaminated hazardous waste sites even when the responsible parties are insolvent or untraceable (Cilluffo & Larson, 2025). This trust fund is capitalized through targeted sectoral taxes levied on high-risk chemical, petroleum, and extractive industries, and is managed directly by federal regulatory agencies. For developing nations, a similar framework allows the state to pre-fund ecological restoration, thereby immediately breaking the chain of toxic exposure and accelerating physical environmental recovery. Such state-led interventions do not absolve corporate actors of their ecological liabilities. Instead, they manifest functional sovereignty as a necessary exercise of state authority to prevent cumulative environmental degradation from being externalized onto local communities and future generations.

By theoretically integrating intergenerational justice, state responsibility, and environmental trusteeship with the operational instruments utilized in both developed and developing jurisdictions, this framework resolves the intertemporal liability vacuum surrounding historical pollution. Transferring the responsibility for physical remediation to the state via an absolute liability standard supported by preventive and corrective public funding schemes effectively breaks the conventional PPP standoff. This intervention is particularly vital for the severely degraded environmental conditions commonly found across the Global South. Eventually, this structural reconstruction of public legal policy is essential to fortifying the state's role as a sovereign actor capable of upholding sustainable environmental justice across generations.

4. Conclusion

The impasse in applying the conventional polluter pays principle (PPP) to historical contamination stems from the inherent limitations of civil law, which is structurally unequipped to resolve multi-generational ecological disputes. When a past corporate polluter dissolves, linear frameworks of civil

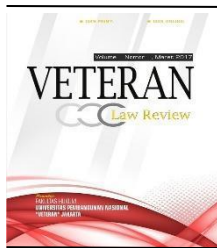
accountability collapse, leaving behind orphan sites that continuously deteriorate local environments. This regulatory failure is acutely exacerbated in developing nations, where cumulative ecological damage originates from legacy activities that can no longer be mapped or traced. To resolve this gridlock, the legal paradigm must shift from private liability to the realm of public law, integrating the principles of intergenerational equity and state responsibility. Under this approach, the state acts as a public trustee with a constitutional mandate to execute environmental remediation, thereby safeguarding the right to a healthy life for both present and future generations.

This state-led assumption of liability has been progressively exercised through successful legal frameworks across the Global South. These statutory reforms directly address international normative disparities, legal fragmentation, and severe domestic ecological conditions, advancing the development of a multidisciplinary Global South legal doctrine. Key institutional breakthroughs include enforcing absolute liability through specialized environmental tribunals, capitalizing environmental trust funds via collective green taxes on extractive industries, and transforming traditional liability into a proper rem doctrine where the obligation to remediate attaches directly to the damaged property. Through these integrated mechanisms, the state serves as the primary executor of environmental restoration, fulfilling its highest sovereign function and fiduciary duty.

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Veteran Law Review

Volume: 9

Issue: 1

P-ISSN: 2655-1594

E-ISSN: 2655-1608

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