Environmental Law: The Living Handbook

A Student-Authored Critical Handbook for International & EU Environmental Governance

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Finally, thanks to the readers who will take this work seriously enough to question it: your scrutiny is part of the pedagogy.

INTRODUCTION

This book is the outcome of a teaching-innovation project carried out in the Environmental Law course of the Law Degree at the Autonomous University of Barcelona (UAB) in the academic year 2025–2026. It is offered not as a perfect handbook or a single, authoritative voice, but as a collective exploration—an open notebook where we learn by doing, think together, and test legal ideas against ecological realities that overflow the usual channels of law.

At its core, the project embraces challenge-based learning. Instead of assigning chapters that simply summarize doctrine, we posed open questions that have no tidy answers and that require students to integrate positive law, scientific evidence, political economy, and ethical reflection. Working in teams, students researched, drafted, peer-reviewed, and edited their own chapters under a shared editorial framework: milestones, feedback cycles, workshops on sources and methodology, and a shared set of quality standards. Assessment focused on three axes: (1) legal rigor and source literacy; (2) clarity and synthesis in communication; and (3) creativity—the courage to think outside the box and to connect contemporary theoretical lenses with the black letter law.

The result is a polyphonic book. It revisits the historical foundations and principles of environmental law; examines the architecture of international and European Union environmental governance; and then stress-tests those frameworks through case studies—from the Doñana wetlands to nuclear tests in the Pacific, from climate change and air pollution to waste and the promises and limits of the circular economy. Throughout, the chapters converse with theoretical tools that help us name and navigate complexity: Risk Society, Post-Normal Science, hyperobjects (to think phenomena massively distributed in time and space), Object-Oriented Ontology, and ecosystemic thinking. These lenses do not replace law; they make it more reflexive about its limits and, paradoxically, more useful.

Why this approach now? Because environmental law increasingly operates where facts are uncertain, values are contested, stakes are high, and decisions cannot be postponed. In that terrain, jurists need competencies that cannot be found in any code: to reason under uncertainty, to weigh intergenerational justice, to collaborate across disciplines, and to design institutions that learn. Thinking of climate change as a hyperobject, for example, prevents us from reducing it to a single tort or a discrete emission; it forces us to confront dispersed causation, delayed harm, and polycentric responsibility. Post-Normal Science reminds us that precaution and adaptation are not signs of weakness but forms of responsibility when definitive proof arrives too late. And Risk Society helps explain why modern law grapples with manufactured, systemic risks that do not fit comfortably in traditional doctrines of causation and liability.

We worked with clear commitments to academic integrity and responsible use of digital tools. Students used generative AI to enhance writing quality—for grammar, clarity, style, and coherence—and, where appropriate, for brainstorming and outlining. AI was never a substitute for legal analysis or original argumentation: all AI-assisted passages were reviewed, edited, and verified by humans, sources were checked, and any assistance was transparently disclosed in each chapter's methodological note. Learning law in the automation age requires exactly that: learning to ask better questions, verify better, and explain better.

What this book is not: it is not exhaustive, it is not uniform, and it does not pretend to close debates. It is intentionally heterogeneous—voices, styles, and angles diverge—because the goal was not only to transmit knowledge but to form judgment. Any remaining imperfections are part of the learning process. We chose to make the process visible rather than sand it down, on the conviction that showing how law is built in real controversies is a pedagogical good in itself.

How to read it? Linearly, if you wish; but it also works as a map for moving between theory, doctrine, and case. A reader may start with principles and foundations, jump to the EU as governance software, and then test these claims in Doñana or in the law of transboundary harm; or begin from waste and circular economy and work backward to the structural logics of enforcement and compliance. A legally trained reader will, we hope, find invitations to look beyond habitual categories; readers from other disciplines will find a gentle bridge into legal reasoning without sacrificing the world's complexity.

If this book helps one student ask a harder question, one lawyer reconsider the scope of a principle, or one public official redesign an instrument with greater reflexivity and fairness, it will have served its purpose. Environmental law cannot be a mere technology of control. It is, at its best, a collective effort to align human institutions with ecological limits and demands of justice that precede and will outlast us. May these pages contribute, however modestly, to that common task.

CHAPTER ONE. THE FOUNDATIONS OF ENVIRONMENTAL LAW

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1. THESIS

Environmental law has evolved from its early inception as a purely reactive, state-centred body of regulations to a global governance system shaped by uncertainty, complexity, and the competing ethical and economic imperatives of ecological preservation.

2. INTRODUCTION

This development and evolution was driven by the necessary demands of regulating consecutive ecological crises driven by a human race now totally dominant over global resource gathering and distribution. Human activity now profoundly shapes the planet, and the law could no longer treat systemic issues such as pollution and biodiversity loss as isolated, local problems, but rather manufactured risks borne from a totally industrial society that are global, uncertain, and often invisible.

Environmental law poses a significant theoretical and political challenge to the established legal system, making it more than just a specialized area of regulation. It has become a revolutionary field that challenges the philosophical, economic, and social foundations of the majority of contemporary legal systems, which are primarily based on ideas of property, contracts, and national authority. Therefore, the foundations of this discipline are not merely technical guidelines for controlling pollution, but rather a sophisticated and essential solution to the most pressing issue facing humanity: our transformation into a geological force. This chapter argues that environmental law has fundamentally evolved from a system of reactive, human-centered rules to a global governance mechanism shaped by widespread unpredictability, ethical duties to future generations, and the significant scale of the Anthropocene crisis.

2.1 New epoch of human influence

Early environmental regulation was largely reactive and local. (Ackerman, 1985) ‘During the early days of [federal] environmental concern, perhaps it was plausible … to suppose only a few pollution problems were out of hand’, and general consensus stood that these themselves could be ‘solved in a short time’. (Ackerman, 1985) Environmental law has become one of the most relevant fields of modern regulation as a consequence of the increasing influence of humans on the natural world, as well as the rising awareness of that. Legal systems around the world are continuously presented with challenges connected to pollution, the loss of biodiversity etc and are forced to adapt and cooperate.

The object of study of environmental law is the set of various globally relevant environmental issues which require an efficient system of regulation. The key issue to have in mind is the conflict between two fundamental realities—the established legal and economic model of continuous, rapid growth—and Earth’s unavoidable natural, physical limits, which need to function in harmony. This dysfunction is the cause of this complete, planetary crisis rather than a collection of minor, regional or local dangers to nature.

The scientific term "Anthropocene" best describes the extent of this conflict. This term, which refers to a new epoch of human development, reflects the new understanding that, since the middle of the 20th century, industrialization, population growth, and global resource use have been the main drivers of global ecological change. Humans are now more than just creatures that inhabit ecological systems; they also have the power to determine the planet's future.

Due to this significant historical shift, the nature of the environmental issues that the law addresses has fundamentally changed. Damage is no longer limited by local or national boundaries. The potential dangers have inherently become cross-border, as well as irreversible—requiring proactive and forward-thinking action. Due to the intricacy of Earth systems, environmental decisions frequently have to be made in situations where the facts are unclear, the stakes are high, and the possible outcomes are disastrous (Funtowicz &

Ravetz, 1993). It is precisely because of this high level of scientific uncertainty that novel legal principles like precaution have to be developed.

For these reasons and circumstances, the Anthropocene acts as the foundational temporal and spatial context for environmental law. The law's function is to harmonize human behavior with the ecological constraints of planetary boundaries, a task which the existing legal structure was never designed to perform.

2.2 The Social and Political Nature of the Environmental Problem

The environmental issue is also a social and political issue rather than just a technical one that can be resolved by better engineering. Due to the fact that structural inequality, power dynamics, and political decisions are the main causes of environmental degradation, legal intervention is necessary (Beck, 1992). For these reasons, managing environmental issues needs to be done taking into account principles such as intergenerational justice, procedural justice etc. which will be discussed hereafter.

2.3 The Central Problem - The Struggles of Traditional Law

To build a legal system that can tackle the challenges of the Anthropocene, environmental law first needed to address the main weaknesses of the previously mentioned approach, which focused mainly on humans. This approach is the core of the study. The historical legal tradition that humans have used is completely human-centered. Nature, including forests, rivers, species, and the atmosphere, was seen only as an object or property for human use, and not as a legal subject with its own inherent value or rights. This bias led to a legal framework created solely to handle disputes between people over natural resource use.

As it will be discussed in the remainder of the chapter, the common law principles of property and nuisance were the first tools used to tackle and manage environmental harm (Fitzmaurice, 2012). However, these tools have limitations because they require a human property owner to show a direct, localized damage. They cannot address some global issues like climate change or harms that impact entities that aren’t in private possession like the deep ocean or wild species. Furthermore, non-human entities often do not have the right

to sue in court, making it hard to address harms that mainly affect the environment. The rise of legal concepts like the "Rights of Nature" in countries such as New Zealand is a significant effort by environmental law to overcome this focus solely on humans.

2.4 Chapter Structure and Methodology

As previously outlined, this chapter argues that environmental law has become a necessary global governance system. We will explore this claim using a method that combines history, regulation, and theory. We will look at the historical development of legal responses, review the new legal rules created to tackle modern risks, and identify the current gaps in legal control through the lens of contemporary theory.

3. HISTORICAL ROOTS OF ENVIRONMENTAL LAW

Environmental law has evolved from a reactive, state-centric set of controls over localized harms into a fragmented but increasingly global governance system that operates under conditions of scientific uncertainty, systemic complexity, and deep ethical conflict. This historical trajectory can be read as a gradual move from managing discrete “nuisances” to governing planetary risks characteristic of the Anthropocene and the Risk Society, where law must address harms that are diffuse, long-term, and only partially knowable ex ante.

3.1 From Early Regulation to Industrial Risk

Early rules in Mesopotamia, classical Rome, and medieval England treated environmental issues as matters of property, public order, and health rather than as a distinct legal field. The Code of Hammurabi imposed duties for negligent damage to irrigation works and agricultural land, while Roman doctrines on servitudes and public waters constrained interference with shared resources. Medieval nuisance law and royal interventions against smoke or contaminated water similarly targeted immediate, localized harms and reflected a territorial, anthropocentric conception of law.

The Industrial Revolution transformed this picture by creating chronic air and water pollution, widespread occupational disease, and large-scale urban environmental crises.

Early “pollution law” emerged through public health statutes and factory regulation, such as the British Alkali Acts, which introduced emissions standards and inspections while still presuming that the state could manage risk through expert, centralized control. From the standpoint of Risk Society theory, these developments represent the first formal encounters between law and manufactured risks, but risks were still treated as bounded, measurable, and correctable within existing legal categories.

3.2 Conservation, Ecology, and the Foundations of Principles

Late-19th- and early-20th-century conservation laws—national parks, game protection, forest codes—extended legal concern from urban health toward landscapes, species, and ecological integrity. These measures remained largely statist and developmentalist, but they introduced recurring themes that later principles would formalize: limits to resource exploitation, intergenerational concerns, and the idea that certain ecological values justify constraints on property and sovereignty. Early ecological science reinforced this shift by emphasizing interdependence, feedback, and systemic fragility, which undermined purely utilitarian, sectoral approaches to regulation.

This historical layer is crucial for the later emergence of principles such as prevention and sustainable development. Prevention responds to the insight that ecological harms can be irreversible and that ex post compensation is often meaningless once species, ecosystems, or cultural landscapes are lost. Sustainable development, articulated internationally in the late 20th century, integrates conservation-era ideas about limits with developmental commitments, foreshadowing the normative tensions that define environmental governance in the Anthropocene.

3.3 The Modern “Big Bang” and Post-Normal Conditions

The 1960s–1970s “Big Bang” of environmental law—symbolized by Silent Spring, the Santa Barbara oil spill, and landmark statutes like NEPA, the Clean Air Act, and the Clean Water Act—marked the consolidation of environmental law as a distinct field. At the international level, the 1972 Stockholm Conference inaugurated global environmental diplomacy and

created UNEP, embedding the environment in the agenda of international organizations and development policy. These developments institutionalized comprehensive permitting, environmental impact assessment, and administrative enforcement and reflected an optimistic belief that expert-led regulation could stabilize environmental risks.

Viewed through the lens of Post-Normal Science, however, the Stockholm–Rio–Paris trajectory reveals how environmental governance progressively moved into a context where "facts are uncertain, values in dispute, stakes high and decisions urgent." Climate change, biodiversity loss, and chemical pollution are not mere externalities but systemic phenomena that exceed the predictive capacity of traditional risk assessment and challenge the assumption that better data alone can produce optimal legal solutions. The chapter's history thus sets the stage for understanding contemporary principles—especially precaution and prevention—as institutional responses to these post-normal conditions.

3.4 Principles under Uncertainty and Inequality

Key environmental principles emerged as legal tools to manage uncertainty, distribute burdens, and structure decision-making at multiple scales. The preventive and precautionary principles are often treated as complementary, yet they embody different regulatory logics. Prevention assumes reasonably knowable risks and supports ex ante measures to avoid identified harms, as in classic pollution-control regulation or environmental impact assessment. Precaution, by contrast, is triggered precisely when risks are serious but uncertain, insisting on action despite incomplete evidence. This anticipatory, "pessimistic" stance has been criticized for alleged vagueness and potential to paralyze innovation, but risk-science scholarship stresses that precaution is only meaningful where uncertainty and potential harm are both high and where governance must be iterative and revisable.

The polluter-pays principle and common-but-differentiated responsibilities (CBDR) illustrate further tensions. Polluter pays aims to internalize environmental costs, yet diffuse sources, long causal chains, and historical emissions undermine clear identification of

"polluters," especially for climate change and biodiversity loss. CBDR recognizes structural inequality and unequal contributions to global harms, but its operationalization in treaties and domestic law remains contested, often producing ambiguous burden-sharing and weak enforcement. These contradictions signal a broader governance gap between planetary-scale problems and territorially bounded legal systems.

3.5 Anthropocene, Risk Society, and Hyperobjects in Practice

The Anthropocene concept foregrounds that humans have become a geological force, bending Earth-system processes and blurring distinctions between "natural" and "social" hazards. Legal scholars argue that this calls into question basic assumptions of territorial jurisdiction, individualized liability, and the separation of environmental and economic regulation. Risk Society theory similarly highlights how modern law is increasingly preoccupied with managing manufactured, potentially catastrophic risks whose distribution reflects and amplifies social inequalities. Together, these frameworks explain why environmental law must engage with issues like climate justice, intergenerational equity, and ecological limits rather than only with localized pollution.

The notion of climate change as a "hyperobject"—a phenomenon massively distributed in time and space and only partially perceptible—helps to illuminate why traditional liability models struggle with causation, standing, and remedy in climate litigation. Emissions are fungible, harms are probabilistic and delayed, and the actors involved range from states and corporations to individuals and financial institutions. These conditions complicate doctrines that presuppose discrete acts, identifiable victims, and proximate causation.

3.6 Governance Structures, Iterative Treaties, and Climate Litigation

Global environmental governance has responded to these challenges by adopting frameworks that rely on iterative targets, review cycles, and flexible implementation rather than rigid, centrally enforced obligations. The Paris Agreement exemplifies this shift: nationally determined contributions (NDCs), stocktake mechanisms, and evolving guidance on transparency reflect an explicit recognition of uncertainty and the need for adaptive,

learning-oriented governance. From a post-normal perspective, Paris institutionalizes extended peer communities—states, scientists, civil society—and treats climate policy as an ongoing process rather than a one-off contractual settlement.

At the same time, climate litigation has emerged as a critical site where courts confront the governance gaps created by weak or under-implemented political commitments. Landmark cases such as Urgenda in the Netherlands, Neubauer in Germany, and the Shell decision in Dutch courts illustrate how judges interpret human rights, constitutional duties, and corporate responsibilities in light of climate science and international norms. In Urgenda, Dutch courts required the state to adopt stronger emissions reductions, effectively judicializing aspects of climate governance and operationalizing intergenerational justice when political processes under-delivered. Neubauer framed insufficient climate legislation as a violation of fundamental rights because it shifted disproportionate mitigation burdens onto younger and future generations, while the Shell case imposed a due-diligence-type obligation on a multinational corporation to align its strategy with global temperature goals.

These cases show, first, how principles like precaution, prevention, and intergenerational equity are translated into enforceable standards under highly uncertain and contested conditions; and second, how courts are drawn into the heart of climate politics, raising questions about democratic legitimacy, separation of powers, and the limits of adjudication in the Anthropocene. They also expose the continued fragility of enforcement: court orders depend on domestic political will and transnational corporate behavior, underscoring the persistent gap between normative ambition and material change.

3.7 Synthesis and Outlook

Taken together, the historical evolution of environmental law reveals a shift from localized, reactive regulation to a multilayered governance architecture grappling with systemic, uncertain, and ethically charged risks. Ancient and industrial-era rules treated environmental harms as discrete nuisances or externalities to be corrected ex post, while 20th-century statutes and principles constructed preventive, expert-driven regimes for

pollution and conservation. Under Anthropocene conditions, however, law increasingly operates in a Risk Society where harms are global, feedbacks nonlinear, and vulnerabilities unevenly distributed, necessitating precaution, iterative governance, and new forms of accountability.

The core argument is that environmental law today is defined less by the existence of specific statutes or treaties than by its struggle to align territorial legal orders with planetary boundaries and intergenerational justice. Emerging concepts such as Earth-system law and ecological constitutionalism, along with experimental practices like climate litigation and citizen assemblies, suggest attempts to reimagine law “for” rather than merely “of” the Anthropocene. Yet enforcement deficits, distributive conflicts, and epistemic uncertainty remain profound, indicating that the future of environmental law will depend on whether governance structures can become more reflexive, inclusive, and responsive to the complex risks that they seek to regulate.

4. KEY TURNING POINTS IN INTERNATIONAL ENVIRONMENTAL GOVERNANCE

The development of international environmental governance reflects a gradual but profound transformation in the way states, institutions, and societies understand ecological risks. Rather than merely responding to pollution or resource depletion, global governance structures have increasingly acknowledged the systemic and transboundary nature of environmental threats, features often associated with the Anthropocene and with what Beck (1992) describes as the “risk society.” Each historical turning point marks a shift from reactive and state-centric regulation toward more complex, multilayered forms of cooperation shaped by uncertainty, scientific pluralism, and ethical considerations. These moments redefined state responsibility, strengthened foundational principles of environmental law, and facilitated the creation of institutions capable of addressing cross-border environmental harms. The evolution of this regime was shaped not only by scientific evidence but also by geopolitical tensions between North and South, divergent economic interests, and competing ideas about fairness and historical responsibility. Growing societal

pressure, media attention, and the involvement of scientific and civil communities contributed to the recognition that environmental protection must be embedded within economic and social policy. As environmental problems became increasingly global in scale, the need for flexible, adaptive, and polycentric governance mechanisms aligned with concepts of post-normal science became evident. Over time, this evolution also revealed the link between ecological degradation and global security, showing that environmental governance is no longer a peripheral policy area but a central component of international stability.

4.1 The Stockholm Conference (1972)

The 1972 Stockholm Conference on the Human Environment represents the first major turning point at which environmental issues became embedded in international diplomacy. It responded to rising concerns about global pollution, ecosystem degradation, and warnings about planetary limits (Meadows et al., 1972). The Stockholm Declaration articulated foundational principles such as the obligation of states to prevent transboundary environmental harm and the need to integrate environmental considerations into development planning (UN, 1972). One of the most significant outcomes was the establishment of the United Nations Environment Programme (UNEP), the first global body mandated to coordinate environmental governance and provide scientific assessments.

The conference also exposed the structural divide between developed and developing states. Industrialized countries advocated stricter environmental regulation, while countries of the global South stressed economic growth priorities and highlighted the historical responsibility of wealthy nations for environmental degradation. This tension gradually evolved into the principle of “common but differentiated responsibilities,” which later became central to international climate negotiations. Stockholm also strengthened the role of science in global policymaking: the creation of UNEP facilitated systematic data collection and laid the foundation for major scientific and legal developments, including the Montreal Protocol and the establishment of the IPCC. Importantly, Stockholm marked a

shift toward recognizing environmental issues as politically significant, stimulating public awareness, shaping institutional priorities, and helping develop early models of cross-sectoral policymaking, an essential feature of later governance frameworks.

4.2 The Brundtland Report (1987)

The Brundtland Report, *Our Common Future* (WCED, 1987), introduced a transformative conceptual shift by defining sustainable development as development that meets present needs without compromising the ability of future generations to meet their own. This formulation brought environmental protection, economic development, and social equity into a single normative framework and firmly embedded intergenerational justice within international environmental law. The report further emphasized that environmental degradation and poverty are interconnected, reinforcing the idea that environmental governance must address social and economic structures rather than focus solely on ecological protection.

Importantly, the Brundtland Report explicitly linked scientific knowledge with political responsibility. Reflecting early post-normal science thinking, it acknowledged the complexity, uncertainty, and potentially irreversible consequences of technological and industrial expansion. The report also encouraged participatory governance, involving civil society, scientific experts, and marginalized communities in environmental decision-making. This broadened approach created the intellectual and policy foundation for Agenda 21 and later multilateral agreements. Moreover, the report challenged traditional growth-based economic models by arguing that environmental stability is a precondition for long-term prosperity. It thus expanded the scope of international law, urging governments to adopt integrated and forward-looking policies that balance ecological limits with human development needs.

4.3 The Rio Earth Summit (1992)

The 1992 Rio Summit marked a paradigm shift by providing comprehensive frameworks for sustainable development and creating lasting multilateral environmental agreements.

Agenda 21 offered a detailed action plan addressing environmental, social, and economic issues simultaneously. The UNFCCC and the Convention on Biological Diversity (CBD) established legal and institutional foundations for global climate governance and biodiversity protection.

Rio underscored that environmental problems are inherently complex and require multi-level, transdisciplinary approaches. The reaffirmation of “common but differentiated responsibilities” and the emphasis on public participation reflected growing awareness that legitimacy and effectiveness in environmental governance depend on transparency, inclusion, and fairness. Non-state actors including NGOs, scientific organizations, and indigenous groups were given unprecedented roles, demonstrating an early shift toward polycentric governance.

The summit also highlighted the need for adaptive legal mechanisms capable of evolving alongside scientific knowledge. As global economic trends accelerated, Rio encouraged states to integrate sustainability into economic planning, reinforcing that environmental governance must adapt to global interconnectedness. By linking global environmental commitments with national level policies, Rio set the stage for more flexible and iterative governance structures in the decades that followed.

4.4 The Paris Agreement (2015)

The 2015 Paris Agreement represents a fundamental shift in climate governance toward flexibility, universality, and iterative progress. Through nationally determined contributions (NDCs), it established a bottom-up structure that reflects the post-normal nature of the climate crisis characterized by uncertainty, high stakes, and contested values (Funtowicz & Ravetz, 1993). The agreement commits all countries to mitigation and adaptation efforts while emphasizing transparency, long-term planning, and climate finance.

Unlike earlier top-down regimes, Paris relies on cooperation, peer pressure, and continuous review rather than punitive enforcement. This reflects recognition that climate governance must function across diverse political and economic systems. The agreement also

introduced iterative governance mechanisms, whereby scientific assessments, technological developments, and social expectations progressively shape national commitments. This design acknowledges that climate change, as a hyperobject in Morton's sense, cannot be addressed through fixed legal rules but requires adaptive, evolving responses. Paris therefore marks a transition toward governance that is dynamic, decentralized, and responsive to scientific and societal change.

4.5 Lessons from the Governance Gap

Despite these advances, a persistent governance gap remains a mismatch between planetary-scale environmental problems and territorially bounded legal systems. Historical turning points show that effective implementation requires stronger multilateral mechanisms, better coordination between international and regional institutions, and polycentric governance models capable of managing complex risks. Many states still lack the institutional capacity or political commitment to implement global agreements, and growing transboundary risks such as climate migration, plastic pollution, and biodiversity loss demand deeper cooperation across sectors and jurisdictions.

The governance gap also highlights the challenges of translating scientific knowledge into political action. While science clearly communicates the urgency of environmental crises, responses often remain fragmented or limited by short-term national interests. As a result, soft-law instruments, voluntary commitments, and transparency mechanisms play an increasingly important role. Addressing these challenges requires flexible legal frameworks, stable long-term financing, and strengthened scientific advisory systems capable of guiding decision making under uncertainty. As global environmental threats intensify, bridging the governance gap is essential for ensuring the credibility and effectiveness of international environmental law.

5. CORE PRINCIPLES OF ENVIRONMENTAL LAW

Environmental law in the European Union (EU) is founded on a constellation of normative principles that crystallize the broader historical shift from reactive, state-centric regulation

to anticipatory, multilevel environmental governance. These principles, normatively precaution, prevention, polluter pays, sustainable development, integration, participation, and rectification at source, do not function as isolated mechanisms. Rather, they form a coherent architecture through which the EU responds to the defining conditions of contemporary environmental governance: scientific uncertainty, transboundary risk, ecological complexity, and intergenerational moral responsibility.

By embedding these principles into EU law and aligning them with theoretical frameworks such as Risk Society, Post-Normal Science, and the Anthropocene, this section shows how environmental principles serve not only as legal tools but as conceptual anchors for navigating environmental challenges in an era defined by uncertainty and planetary destabilization.

The Precautionary Principle exemplifies the EU's transition toward anticipatory environmental governance. Emerging prominently in the late twentieth century, its development was catalysed by crises—most notably the BSE (mad cow disease) scandal—that exposed the limits of deferring regulatory action until full scientific certainty was achieved. The BSE crisis did more than erode public trust; it revealed the fragility of governance structures in an increasingly complex and interconnected world.

Codified in Article 191(2) TFEU, the principle obliges EU institutions to act when there exists a *reasonable possibility* of harm, even if scientific knowledge remains incomplete. Regulatory measures must be proportionate and subject to revision as new evidence emerges. Rather than freezing decision-making, precaution institutionalises a *cycle of adaptive learning* within environmental governance.

This approach resonates strongly with Post-Normal Science (PNS), which argues that in contexts marked by high uncertainty, disputed values, urgent decisions, and systemic stakes—precisely the conditions of the Anthropocene—classical scientific methods are insufficient. PNS calls for extended peer communities, deliberation, and transparency, thereby expanding the epistemic base of environmental governance. The precautionary

principle thus translates PNS into legal form: it is not only a rule for action under uncertainty but also a demand for broader, more democratic modes of knowledge production.

Moreover, within Risk Society theory (Beck), precaution marks a shift in governance from managing localized, predictable hazards to confronting global, systemic risks—climate change, biodiversity collapse, endocrine disruptors—whose consequences are diffuse, irreversible, and often invisible. Precaution responds to this "second modernity" where risks are manufactured and distributed by industrial society itself.

Where precaution addresses uncertainty, the Prevention Principle guides governance when risks are known, identifiable, and measurable. Prevention embodies the normative priority of avoiding degradation rather than repairing its consequences. In EU law, prevention is deeply embedded: Environmental Impact Assessment (EIA) requires developers to anticipate and mitigate environmental effects before undertaking projects, whilst waste law embodies prevention through its hierarchy: reduction, reuse, recycling, recovery, and disposal as a last resort. Another demonstrable example is *The Birds and Habitats Directives*, which impose strict protective measures to avoid harm to vulnerable species and habitats before it occurs.

Historically, the Montreal Protocol (1987) epitomizes preventive governance. States acted before catastrophic ozone depletion materialized, demonstrating that proactive, science-informed regulation could avert planetary harm. This global success has influenced the EU's preventive ethos, particularly in chemicals regulation (REACH) and climate policy. Seen through the prism of the Anthropocene, prevention reflects a growing awareness that human activity has become a geological force capable of destabilizing Earth systems. Legal regimes cannot wait for full impact to manifest; prevention becomes an ethical and practical necessity in a world of accelerating ecological thresholds.

The Polluter Pays Principle (PPP) is both an economic instrument and a principle of fairness. It assigns responsibility—financial, legal, and moral—to those who generate environmental damage. This prevents externalizing environmental costs onto the public, ecosystems, or

future generations. In EU law, PPP underpins frameworks such as: the Environmental Liability Directive, which mandates remediation of damage to biodiversity, land, and water; and sectoral legislation, which requires producers to internalize costs related to waste, emissions, and hazardous substances. Outside the EU, the US Oil Pollution Act (1990) illustrates an uncompromising version of PPP, compelling polluters to fund cleanup and compensation in the wake of the Exxon Valdez spill. Yet structural challenges remain. Diffuse pollution—agricultural runoff, microplastics, atmospheric emissions—often lacks identifiable individual polluters. In some sectors, polluters can pass compliance costs to consumers, blunting deterrence. And catastrophic risks (major oil spills, nuclear accidents) may exceed the financial capacity of responsible actors, revealing limits to liability-based regimes.

PPP thus functions both as a *corrective* and an *aspirational* principle, pushing legal systems toward fairness while revealing the need for more transformative regulatory tools when accountability becomes structurally elusive. Sustainable development provides the broad normative horizon for modern environmental governance. Introduced by the Brundtland Report (1987), it calls for balancing environmental protection, social wellbeing, and economic development. Within the EU, it is a treaty-level commitment that informs climate policy, trade, agriculture, and energy legislation. The 2030 Agenda and the Sustainable Development Goals (SDGs) deepen this integrated approach, linking environmental crises with issues such as poverty, inequality, and global governance. The EU's interpretation of sustainable development increasingly aligns with systemic ecological thinking. Ecosystemic governance emphasizes the interdependence of ecological processes and highlights the need for resilience, adaptive management, and long-term thresholds. This reflects the scientific understanding that ecosystems are complex, dynamic systems whose stability is easily disrupted by cumulative pressures.

Object-Oriented Ontology (OOO) further challenges anthropocentric assumptions by recognizing non-human entities—species, ecosystems, landscapes—as possessing their own intrinsic existence and agency. While still emerging in legal scholarship, OOO supports

more ecocentric interpretations of intergenerational justice, suggesting that future generations of both humans and non-humans have legitimate claims to a livable planet.

Sustainable development thus bridges law, science, and ethics, encouraging a governance model that accounts for ecological complexity, long-term planetary boundaries, and moral obligations toward future generations. The EU's environmental governance architecture is strengthened by several complementary principles that ensure environmental protection permeates all levels and sectors of policy.

1. The Integration Principle (Article 11 TFEU)

Environmental considerations must be woven into the fabric of all EU policies—from agriculture to trade, from transport to competition law. Integration prevents environmental protection from being sidelined and transforms it into a cross-cutting obligation. Historically, this reflects the recognition that environmental degradation often results from sectoral policies that were once designed in isolation.

2. Participation and Transparency (Aarhus Convention)

The Aarhus Convention enshrines three pillars: On the first place, access to environmental information, on the second place, public participation in decision-making, and lastly access to justice. These provisions democratize environmental governance. They embody the PNS insight that environmental decisions—marked by uncertainty and contested values—require input from extended peer communities, not just experts and administrators. Participation also aligns with Risk Society theory by ensuring that affected communities have a voice in how risks are governed.

3. Rectification at Source

This principle mandates addressing environmental harm as close as possible to its origin. It underlies regulatory tools such as: emission limit values, product standards, and Best Available Techniques (BAT). By intervening at the source, regulators prevent the dispersal of pollutants and the escalation of environmental harm. This reflects a logic of efficiency,

but also a logic of responsibility: those closest to the creation of harm must act earliest and most directly to prevent it.

Taken together, these principles form a coherent normative and practical framework for environmental governance in the European Union. They illustrate a profound historical and conceptual evolution: from reactive regulation to anticipatory stewardship, from technocratic decision-making to participatory governance, and from anthropocentric frameworks to more ecocentric and systemic worldviews. By integrating theoretical insights from Risk Society, Post-Normal Science, and the Anthropocene, the EU's principles embody a legal response tailored to an era of unprecedented complexity. As environmental challenges intensify, the interplay among precaution, prevention, accountability, sustainability, integration, participation, and source-based control will remain central to shaping both EU law and global environmental governance.

6. THEORETICAL LENSES FOR ENVIRONMENTAL LAW

One will find numerous developmental theories shaping the evolution of environmental law from a regional and simple apparatus, to a sprawling global phenomena. Each has been deeply influenced by the context of time and place for which it was brought forth into existence. Environmental law's evolution from a reactive, state-centred field to a complex system of global governance can be understood through several theoretical lenses. Contemporary environmental governance increasingly operates through dispersed, multi-actor incentives rather than traditional state command-and-control methods. (Ewing-Chow, 2009) This shift mirrors the broader argument of this thesis: that environmental law must now respond to uncertainty, complexity, and competing ethical imperatives, and can no longer rely on hierarchical or sovereignty-bounded regulatory models.

6.1. Economic Lens

Crucial amidst the field of Environmental Law is the economic lens through which to view regulations: that of global trade. Beginning far before World War Two, international trade has been governed by an enormous and everchanging list of regulations. Of those it is the

environmental regulations which are often ignored or unenforced as a ‘cost’ or barrier to the traditional view of trade liberalisation. Only in 1994 was the ‘first major regional trade … agreement … which included environmental protection and sustainable development in its objectives.’ (Bengtsson, 2015, 50) The ‘age of frameworks’ in environmental law, which is when states attempted to construct comprehensive regulatory systems, has given way to an ‘age of compliance,’ in which the effectiveness of environmental norms depends on dynamic interactions between states, international institutions, and especially multinational corporations (MNCs). (Ewing-Chow, 2009)

Analysis highlights three compliance-generating mechanisms across this period: coercive legal or trade sanctions, economic incentives, and reputational pressures. These mechanisms collectively illuminate how environmental law now functions within a polycentric order shaped by global markets, international economic law, civil society monitoring, and shifting ethical expectations. (Ibid.)

6.2 Hyperobjects

One foundational lens through which to view the modern position of environmental law are the Hyperobjects of Morton and their bringing of the ‘Age of Asymmetry’. (Morton, 2016) It had become certain by the mid 1940s that humanity’s ability to construct impressively destructive materials of such extensive temporal existence was now unrestrainable. By the mid 2010s the reality of tonnes of nuclear waste, immense floating and un-degradable islands of plastic pollution, and other human by-products, ‘of … massive distribution [and innate] viscosity’ have ushered in a new age, that of ‘Asymmetry’ between man and nature. (Morton, 2016)

These hyperobjects epitomise the kinds of environmental harms that defy territorial jurisdiction. Their spatially dispersed and scientifically uncertain nature exposes the inadequacy of prior regulatory models that assumed measurable environmental harms. In this sense, hyperobjects reinforce the argument that environmental law must grapple with problems that cannot be fully ‘known,’ or spatially contained. (Ibid.) They therefore

underscore the transition away from traditional, reactive law towards precautionary, polycentric, and knowledge-dependent governance structures.

Finally, hyperobjects highlight the centrality of scientific uncertainty and epistemic limits. Hyperobjects can only be partially apprehended through scientific proxies. (Ibid.) They bring into focus competing ethical imperatives inherent in contemporary environmental regulation. Because hyperobjects unfold across centuries and affect distant peoples and ecosystems, they necessitate ethical considerations of intergenerational justice. (Ibid.)

6.3 The Anthropocene

Other important modern lenses are those grappling with the Anthropocene as a legal issue, including Object-Oriented Ontology by Graham Harman and Levi Bryant, and the Stack by Benjamin Bratton. And there are far more historical lenses which may have been outphased by the rapid industrialisation and immense technological advances of the previous decades. These include a majority of state-centric models which fail to accurately target transboundary issues, such as ocean acidification and atmospheric pollution.

6.4 Polluter Pays

Even the common lens incorporating the ‘Polluter Pays’ principle can be heavily criticised as outdated and itself prone to upcoming evolution; as treating near global environmental degradation as a simple failure of the market ignores how difficult these threats are to manage, and indeed often enables the divestment of their costs onto developing nations inequipped to remedy the costs.

6.5 Conclusion

Taken together, these theoretical developments reaffirm that environmental law is no longer simply a system of state obligations, but a diffuse governance regime shaped by uncertainty, complexity, and deeply contested ethical priorities. Theoretical lenses must therefore acknowledge both the structural limits of traditional international law and the emerging opportunities found in new regulatory instruments and actors.

7. ENVIRONMENTAL LAW IN THE RISK SOCIETY

This section argues that environmental law has shifted from a reactive, state-centric model of addressing pollution to a multilayered global governance system capable of navigating uncertainty, complexity, and long-term systemic risks. Within Ulrich Beck's "risk society," environmental harms increasingly manifest as global, diffuse, and scientifically uncertain processes that challenge traditional legal assumptions about causation, liability, and temporal boundaries. Climate change, chemical dispersion, biodiversity loss, and disruptive technologies all exemplify risks that transcend borders and cannot be clearly linked to a singular polluter or discrete event. Consequently, environmental law must evolve beyond conventional regulatory tools and adopt anticipatory, adaptive, and participatory mechanisms that reflect the realities of governing under conditions of non-knowledge. Integrating sociological theories of risk with legal principles helps illuminate not only how environmental law has changed, but why such transformations are unavoidable in the contemporary era.

The Risk Society (Ulrich Beck): Managing Manufactured Risks

Ulrich Beck's concept of the risk society marks a paradigmatic shift in how modern societies perceive, produce, and regulate hazards. According to Beck, industrial modernity generated wealth, growth, and technological progress, but it also produced unforeseen and often undetectable risks whose consequences cut across generations and geographical boundaries. Unlike traditional dangers—storms, floods, or volcanic eruptions—manufactured risks are by-products of human innovation. They include radiation, endocrine disruptors, persistent pollutants, methane emissions, genetically modified organisms, and microplastics. Crucially, these risks are characterized by invisibility, uncertainty, and irreversibility.

For legal systems, this poses fundamental challenges. Traditional environmental law was designed to identify a polluter, prove harm, and impose liability. Yet manufactured risks often lack clear causation chains. Greenhouse gas emissions cannot be traced to a single

source; chemical exposures accumulate over decades; and biodiversity loss results from multiple interacting pressures rather than one identifiable culprit. This mismatch between classical legal structures and modern environmental realities leads to what Beck terms a "crisis of control." Institutions built for predictable, discrete harms are tasked with regulating global, uncertain, and often probabilistic risks that defy existing frameworks of evidence and responsibility.

In this context, Beck's theory explains why environmental law increasingly embraces principles such as precaution, prevention, transparency, and public participation. These mechanisms compensate for scientific uncertainty and enable regulatory action even when knowledge is incomplete. Beck also predicts the "judicialization of politics," where courts become central actors in environmental governance when political branches fail to respond to systemic risks. This prediction has proven remarkably accurate in the era of climate litigation.

7.1 Typologies of Risk: From Damocles to Medusa (Klinke & Renn)

Klinke and Renn expand Beck's insights by offering a nuanced typology of risk that reflects the heterogeneity of modern hazards. Their six metaphors—Damocles, Cyclops, Pythia, Pandora, Cassandra, and Medusa—illustrate how risks differ not only in probability and impact, but also in the types of scientific uncertainty and societal perception that accompany them. Understanding these distinctions is crucial for designing legal responses that are both proportionate and effective.

- Damocles risks, such as nuclear catastrophes, are characterized by low probability but catastrophic consequences. These risks demand strict safety regimes, redundant monitoring, and robust emergency preparedness. Environmental law must incorporate high safety margins and long-term oversight, often involving international regulatory bodies.
- Cyclops and Pythia risks reflect conditions of high uncertainty and partial ignorance. For emerging technologies—like AI-driven environmental monitoring,

nanomaterials, or synthetic biology—existing laws cannot rely on traditional risk assessments. Instead, adaptive regulation and iterative policy cycles become essential.

- Pandora risks, including PFAS contamination, ocean acidification, and species extinction, cause irreversible and cumulative harm. Once unleashed, they cannot be easily contained. Legal responses must therefore prioritize precaution, persistent monitoring, and long-term restrictions.
- Cassandra risks—where science clearly warns of danger but society responds inadequately—are exemplified by climate change. Here, politics and economics paralyze effective action despite overwhelming scientific consensus. These risks illustrate why legal systems must sometimes override political inertia through enforceable obligations.
- Medusa risks, which provoke disproportionate public fear relative to their actual harm, reveal the importance of transparent risk communication. Environmental law must balance public concern with evidence-based regulation, avoiding policies driven solely by emotional reactions.

This typology demonstrates that modern environmental governance cannot rely on one-size-fits-all solutions. Diverse risks require differentiated legal, institutional, and communicative strategies that reflect their specific characteristics.

7.2 Legal Responses to Uncertainty and Complexity: Precautionary principle

The precautionary principle represents a cornerstone of modern environmental law, particularly in the EU and international frameworks. It allows regulators to intervene even when full scientific certainty is lacking. This principle operationalizes anticipatory governance by shifting the burden of proof, requiring potentially harmful activities to demonstrate safety rather than expecting victims to prove harm.

However, the precautionary principle also faces critiques. Opponents argue that it may discourage innovation or produce excessive costs. More importantly, under conditions of

radical uncertainty—such as climate tipping points or interacting ecological crises—precaution alone may be insufficient. Environmental law increasingly recognizes that precaution must be paired with adaptation, resilience planning, and iterative learning.

7.3 Adaptive governance

Adaptive governance addresses the limitations of static, prescriptive regulations by promoting flexibility, learning, and continuous revision. For example, the EU Water Framework Directive adopts cyclical planning, monitoring, and assessment practices that update management strategies every six years. This reflects a move toward post-normal governance, in which decisions are revisited as new knowledge emerges.

Adaptive governance also requires collaboration among scientists, policymakers, civil society, and affected communities. By integrating multiple perspectives, it aligns with the principles of extended peer review proposed in post-normal science theory.

7.4 Transparency and participation

The Aarhus Convention illustrates how democratic participation becomes essential in managing uncertain and contested risks. Access to environmental information, public participation in decision-making, and access to justice increase the legitimacy of regulatory processes and help ensure accountability. These mechanisms embody Beck's argument that risk society necessitates broader inclusion of publics traditionally excluded from expert-driven decision-making.

7.5 Liability and international cooperation

Global environmental risks require coordination beyond national jurisdictions. Yet international environmental law remains fragmented and often lacks binding enforcement. Liability regimes struggle with diffuse causation, long latency periods, and complex damage attribution. Attempts to create transboundary liability frameworks—such as those for nuclear accidents or oil spills—remain limited in scope. This enforcement gap underscores the tension between territorial legal systems and planetary-scale risks.

7.6 From Precaution to Adaptation: Climate Litigation as Governance

Climate change illustrates the limits of precautionary governance. Given that certain impacts—such as sea level rise—are already unavoidable, environmental law increasingly incorporates adaptation measures. However, litigation has emerged as one of the most significant governance tools in bridging the gap between scientific evidence and political inaction.

Cases such as Urgenda Foundation v. Netherlands established that governments owe a duty of care to their citizens and must adopt emission reduction targets aligned with scientific recommendations. Similarly, the Neubauer v. Germany decision recognized intergenerational rights, ruling that inadequate climate laws place disproportionate burdens on future generations. The Milieudefensie v. Shell ruling extended responsibility beyond states, holding corporations accountable for their contributions to climate change.

These cases exemplify governance under post-normal conditions: uncertainty is high, stakes are existential, and values are contested. Courts thus become arenas where scientific evidence, human rights, and political obligations intersect. Climate litigation not only compels action but also clarifies legal duties in the face of systemic risks, thereby reshaping the architecture of environmental law.

7.7 Conclusion

Environmental law has transformed into a governance system capable of navigating the complexity and unpredictability of the risk society. Beck's analysis of manufactured risks explains why traditional legal tools—rooted in causation, territoriality, and ex post liability—prove insufficient in managing phenomena such as climate change, chemical pollution, and biodiversity collapse. Klinke and Renn's typology further illustrates the need for differentiated legal strategies tailored to the unique characteristics of diverse risk types.

In response, modern environmental law increasingly embraces precaution, adaptation, transparency, public participation, and flexible governance. Climate litigation demonstrates how courts can fill governance gaps by enforcing scientific commitments and protecting

intergenerational rights. While environmental risks cannot be eliminated, strong, adaptive, and inclusive legal frameworks can guide societies toward more resilient and sustainable futures. In this sense, environmental law is not merely a regulatory tool but a central component of global governance in an era defined by uncertainty, complexity, and irreversible planetary change.

8. POST-NORMAL TIMES AND POST-NORMAL SCIENCE

We are currently living in what Jerome Ravetz and Silvio Funtowicz have referred to as post-normal times (Funtowicz & Ravetz, 1993). The term is a diagnostic, not hyperbole. The traditional certainties of laboratory research and linear risk assessment are no longer enough when facts are ambiguous, values are in question, stakes are high, and decisions must be made quickly. Environmental law is now requested to regulate the behavior of the entire Earth system, whereas before it was just concerned with determining the acceptable parts per million of a toxin in a river. The sixth mass extinction, the spread of plastics and other chemicals throughout the world, the passing of irreversible tipping points, and climate change are no longer aberrations; they are now commonplace aspects of legal practice.

According to Thomas Kuhn, riddles are solved within an established paradigm in normal science (Kuhn, 1962). Regulators set thresholds, measure risks, and hold off on taking action until they have statistically substantial evidence. The smog above nineteenth-century London, the mercury in Minamata Bay, and the acid rain pouring on Scandinavian lakes were examples of the localized, reversible, and comparatively predictable pollution of the industrial period that the model adequately described. However, it breaks down when faced with what Timothy Morton refers to as hyperobjects (Morton, 2013)—entities so widely dispersed in space and time that they subvert conventional modes of perception and behavior. The archetypal hyperobject is the global climate, which is non-local, viscous, phasing through human scales, and unable to directly address. When such objects are present, the law moves into the post-normal area.

This change has not gone unnoticed by the legal system, which has institutionalized it. The precautionary principle, which is reflected in hundreds of international instruments and enshrined in Article 191(2) of the Treaty on the Functioning of the European Union, is the first clear acknowledgement that, when the cost of being wrong is measured in terms of civilization, we are no longer entitled to wait for definitive proof. The idea calls for humility and anticipatory responsibility rather than certainty. It is a translation of post-normal science into a legally binding standard.

Another significant step toward post-normalcy is the 2015 Paris Agreement. The Kyoto Protocol continued to act as though science could produce a single, universally applicable emission budget that politicians would only need to carry out. Paris lets go of the pretense. A top-down, science-dictated goal that is imposed on submissive states has vanished. Rather, there are periodic stocktakes, nationally decided contributions, and an ongoing call to improve the next time. The 1.5 °C goal is a moral and political line set by the most vulnerable countries and supported by youth movements and small island governments; it is not a physical threshold derived from undisputed models. The Agreement's architecture, which is adaptable, transparent, iterative, and unavoidably value-laden, is the closest approach to a post-normal governance system that international law has yet created.

The language of post-normality has already started to be used by courts. Judges have publicly acknowledged significant uncertainty in the modeling of tipping points and carbon budgets in Urgenda v. Netherlands (2015–2019), Neubauer v. Germany (2021), Milieudefensie v. Shell (2021), and dozens of other cases that are currently pending across continents. However, they have refused to treat this uncertainty as a license for paralysis. They acknowledge the rights of future generations as tangible legal subjects, balance intergenerational equality against immediate economic interests, and compel businesses and governments to take action in the face of inadequate knowledge. Once the patient servant of established science, law now actively participates in the larger peer community required by post-normal science.

Extended peer groups are arguably the theory's most revolutionary conclusion. Credentialed professionals working in restricted laboratories can no longer monopolize quality control when systems uncertainties are severe and decision stakes affect the basic feasibility of organized human life. Indigenous peoples who have witnessed seasonal changes for generations, fisherman who witness the devastation of nursery habitats, citizens who use inexpensive sensors to evaluate air quality, and kids who skip school on Fridays are all acceptable contributors to the knowledge that the law needs to act upon. The Aarhus Convention (1998) and its Latin American successor, the Escazú Agreement (2018), are the legal embodiments of this democratisation of expertise: access to information, participation in decision-making, and access to justice are not ornamental rights; they are essential instruments for navigating post-normal conditions.

The Bhopal catastrophe of 1984 remains the starkest warning of what happens when post-normal signals are ignored. The risk of a catastrophic release of methyl isocyanate was known to be non-negligible; the plant's safety systems were visibly degraded; the surrounding population was densely packed and uninformed. Yet regulators and the corporation treated the hazard with the probabilistic complacency of normal science: the event was "extremely unlikely," and therefore tolerable. Forty years later, the survivors are still dying, the groundwater is still poisoned, and the legal aftermath remains unresolved. Bhopal is the ghost that haunts every claim that we can wait for more data before acting.

Post-normal times do not render the older principles obsolete; they radicalise them. Prevention and precaution, polluter-pays and public participation, integration and rectification at source—all remain indispensable. But they must now operate within a horizon of radical uncertainty, planetary scale, and inescapable ethical entanglement. The foundations of environmental law were laid in an era when nature could still be treated as an externality. We no longer have that luxury. In the Anthropocene, law itself becomes part of the extended peer community struggling to keep the Earth system within a safe operating space. The task is no longer to manage the environment. It is to learn, urgently and collectively, how to coexist with a living planet that has begun to answer back.

9. GOVERNANCE STRUCTURES AND KEY ACTORS

It is immediately clear that environmental law today is a global system. Modern environmental Law is a truly international area, with several essential transnational structures and actors. These serve as a crucial element of the demonstration of its evolution from a limited and state-centric system of addressing environmental issues, setting standards, and ensuring enforcement. (Ackerman, 1985) Those discussed below will include international and transboundary bodies, domestic structures, and even non-state actors, and how each demonstrates a shift beyond the historical roots of regional regimes. (Sands, 1991)

9.1 Governance Structures

Philippe Sands' analysis of the European Community (EC) provides a particularly illustrative example of this trajectory, demonstrating how institutional design evolved in response to both political integration and the growing complexity of environmental problems. In the early "Foundational Period," governance structures remained limited by the Treaty of Rome's silence on environmental protection, rendering environmental matters peripheral and indirectly regulated through market-integration provisions, such as Article 100. (Sands, 1991) However, the 1972 Stockholm Conference catalysed institutional transformation, pushing the Community to adopt its first Environmental Action Programme and stimulating an architecture capable of issuing harmonised, legally binding directives across diverse sectors. (Ibid.)

The subsequent "Mutational Period" marked a decisive shift toward supranational governance. Here, the EC expanded beyond mere coordination to develop a functional environmental regime with its own legislative momentum, increasingly detached from the preferences of individual member states. (Ibid.) This culminated in the Single European Act (SEA), which introduced Title VII and embedded environmental protection as an explicit Community objective, thereby extending the scope of governance to encompass preventive action, the polluter-pays principle, and participation in international environmental agreements. (Ibid.) The SEA also reconfigured decision-making authority, allowing

measures under Article 100A to be adopted by qualified majority voting—thus reducing the veto power of states and enhancing the autonomy and effectiveness of EC environmental governance.

At the widest level it is international institutions which play the vital role of the regulation, funding, and enforcement of international Environmental Law. The United Nations has several active components, including the UN Environment Program (UNEP) and the UN FCCC Secretariat. Beyond these are other colossal institutions such as the World Trade Organisation (WTO) and the World Health Organisation (WHO). It has been held that, ' ... environmental law generally developed according to the periodic evolution' of its working systems, themselves arising at moments of need. (Sands, 1991).

This macro lens is then narrowed into specific areas; regional environmental governance agreements (such as ASEAN or the Arctic Council) are made between states and their respective politicians and courts. The power of state-emboldened agreements such as these include the resources applicable for enforcement, and indeed rationales for compliance. Indeed, purely domestic governance makes up a significant portion of global structures. National domestic legal frameworks often have passed laws governing the sustainable development of the environment, internal climate-change obligations, and other Environmental impact assessments (EIAs) or strategic environmental assessments (SEAs).

9.2 Key Actors

Likewise, states are the primary actors in Environmental Law. They negotiate treaties, create and manage domestic regulations, and are the primary force behind compliance and funding for environmental initiatives. These may be borne from the evolving standards of 'community environmental law', and the success of group action from the 1970s onwards. (Sands, 1991)

Apart from states, modern environmental law is shaped by various actors that exert regulatory and significant influence. Treaty secretariats such as UNEP, the UNFCCC Secretariat, and the CBD Secretariat play central roles in agenda-setting, coordination, and

implementation of Environment focussed initiatives. Specialised agencies like the FAO and IMO, and scientific bodies, most notably the IPCC and IPBES, provide the authoritative knowledge base upon which environmental norms and obligations now depend. Non-governmental organisations, including advocacy groups (like Greenpeace, ClientEarth, WWF) function as both advisers, and policy makers. Before this status quo there were far fewer of these actors: it was not until a 'rapid expansion' of environmental legislation, otherwise described as a 'legislative expansion', emerged due to the strong 'will of the member states' within the European economic area. (Sands, 1991) In many ways Europe has been the historic driver of an expansion of empowered actors and structures.

Notably, Indigenous peoples and local communities are additional and vital governance actors whose land stewardship and knowledge of an ecological nature shape environmental decision-making at all levels. Finally, the private sector, ranging from corporations to global financial institutions, increasingly regulates itself and others through ESG standards, due diligence, and participation in Environmental Law-led carbon markets. Even cities, regions, and provinces often act as policy makers in fields such as land planning.

Collectively, these actors contribute to a polycentric governance landscape in which environmental law has grown beyond the sole domain of states to a multi-phased regulatory system.

10. CONCLUSION

This chapter has demonstrated that environmental law has shifted from a reactive, state centred regulatory model to a global governance system shaped by uncertainty, complexity, and normative pluralism. The historical analysis showed that early environmental regulation was limited in both ambition and jurisdictional reach, and that it largely addressed identifiable and localised harms through conventional legal techniques. These approaches reflected the scientific and political assumptions of their time. They are no longer adequate in the face of contemporary environmental problems that unfold across

multiple scales and whose causes and consequences frequently transcend territorial boundaries.

The theoretical frameworks examined here help explain why such a transformation has occurred. Beck's risk society highlights how environmental risks in late modernity are manufactured, uncertain, and globally diffused. Post normal science elucidates the limits of traditional scientific authority in situations where facts are uncertain, values are contested, and decisions cannot be postponed. Morton's hyperobjects further demonstrate that many environmental phenomena cannot be captured within linear models or confined within state borders. Collectively, these perspectives show that environmental law must now be grounded in regulatory approaches that are anticipatory, adaptive, and capable of functioning despite significant epistemic constraints.

The evolution of governance structures provides further support for the dispersive trajectory of environmental law. Sands' account of the European Community demonstrates how regional legal orders enhanced the role of non-state actors. These institutional developments exemplify an emerging pattern of polycentric governance in which no actor holds exclusive authority. Instead, environmental regulation is increasingly distributed across states, international institutions, corporations, Indigenous communities, and civil society organisations. This diffusion of authority reflects the complex and interconnected nature of contemporary environmental challenges.

To conclude, environmental law now functions on a global scale, with incredibly interconnected systems of governance, and no longer reflects its inception as stranded in the peripheries of local and national regulations. This transformation reflects a broader recognition that environmental problems cannot be effectively addressed within the constraints of traditional legal frameworks. Environmental law will continue to adapt to the complexities and ethical issues that define the systemic ecological conditions of the present and future.

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CHAPTER TWO. INTERNATIONAL & EU ENVIRONMENTAL LAW: FRAMEWORKS, CHALLENGES, AND GOVERNANCE

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1. INTRODUCTION

This chapter looks at how international and European environmental law have developed into essential, though still very imperfect, tools for dealing with today's major ecological crises. Our main concern is a simple but crucial question: how far can these legal systems really go in tackling huge problems like ozone depletion, biodiversity loss, environmental injustice, or the climate crisis? More importantly, what do their limits reveal about the complex relationship between law, political power, and the boundaries of our planet?

Our core argument is that both international and EU environmental law are now indispensable for protecting the environment. Still, they remain held back by their own structures. They've made real progress, but they continue to be constrained by state sovereignty, economic models that depend on constant growth, and governance systems that are often fragmented.

The chapter is organized into three main sections. First, Section 1 gives a broad overview of how environmental law has evolved as ecological crises intensified. Section 1.1 looks at five major international agreements; the Montreal Protocol, CITES, the Convention on Biological Diversity, the Aarhus Convention, and the Paris Agreement. It shows how rising global concern has been transformed into legal rules, institutions, and procedures. At the same time, it highlights the ongoing gaps in ambition and enforcement. This section also examines the wider set of legal tools that make up international environmental governance. Section 1.2 then shifts to the European level, showing how EU environmental law grew from scattered responses to industrial pollution into a central policy area, eventually leading to the broader European Green Deal framework.

Building on this, Section 2 introduces our theoretical approach. Here we look at international law as a “flawed interface” for dealing with planetary-scale problems, and we examine its weaknesses in terms of enforcement, political backing, and overall scope. We also describe the EU as a “semi-coherent software” for environmental governance, exploring how its unique institutional design both enables stronger action and, at times, limits it.

The chapter ends by bringing these perspectives together and evaluating how effective international and EU environmental law actually are in the face of the accelerating ecological crisis. In fact, we also consider what deeper transformations would be needed for these legal systems to become more suitable tools for navigating the challenges of the Anthropocene.

Building on this doctrinal groundwork, Section 2 introduces the chapter’s theoretical lenses. Section 2.1 develops the idea of international law as a flawed interface, analysing three structural weaknesses—lack of enforcement, lack of support from great powers and limited scope—and their implications for environmental problem-solving. Section 2.2 then conceptualizes the EU as a semi-coherent software of governance, examining how treaty-based competences, multi-level regulation and Member State politics shape the Union’s capacity to act on climate and environmental issues.

The final section offers an overall conclusion that brings these strands together. It assesses the combined effectiveness of international and EU environmental law, reflects on their shared constraints, and suggests what kinds of legal, institutional and conceptual changes would be necessary for these frameworks to respond more adequately to accelerating ecological crises.

2. CONTENT

2.1 Key Features of International Law in Responding to Environmental Crises

International law was traditionally preoccupied with governing the relationship between states concerning peace and war, but it has taken a new route since the mid-20th century.

This evolution has been driven by new challenges, challenges that cross the boundaries of the states and as a result of which states need to work together. Chief among these are environmental challenges. The norms of international environmental law (IEL) are the rules, principles, and soft law policies that, while not legally binding, possess political and moral authority and can influence the behaviour of those they address, either directly or indirectly (Cheigh et al., 2025). International standards have evolved over time, requiring environmental law not only to foster awareness but also to adhere to binding global norms that promote sustainable development and prevent cross-border environmental harm (Khalil, 2025). The shift from state sovereignty to shared responsibility was first seen in the 1972 Stockholm Declaration on the Human Environment (G Handl - United Nations Audiovisual Library of International & 2012, n.d.). In this leading conference, it was declared that environmental protection must be a shared global responsibility, particularly among industrialized nations.

This text will explain that the key features of contemporary international environmental law have been shaped in direct response to specific, often catastrophic, ecological crises. These events revealed the limitations of unilateral action and showed that creation of multilateral legal instruments was necessary to have a uniform look at the future of the world. This analysis explores 5 key legal frameworks such as the 1987 Montreal Protocol, the 1998 Aarhus Convention, the 2015 Paris Agreement, the 1973 CITES, and the 1992 Convention on Biological Diversity to clarify the events, their environmental subsequence's, and the legal responses that have shaped the global effort to address humanity's impact on the Earth.

2.1.1 Montreal Protocol on Substances that Deplete the Ozone Layer (1987)

It is often said that the Montreal Protocol on Substances that Deplete the Ozone Layer of 1987 (Montreal Protocol) is the most successful international environmental treaty. It regulates the production of ozone-depleting substances (ODS), which are chemicals that were used in products such as air conditioners, fire extinguishers or refrigerators. These

chemicals damage the ozone layer, a shield that absorbs the majority of the sun's harmful ultraviolet radiation, protecting life on Earth.

The visual evidence of the ozone hole was a turning point. It made clear that action was urgently needed to prevent further damage. Without intervention, the environmental consequences would be severe and universal, affecting ecosystems, human health, and future generations. Crucially, this action had to be taken globally to have an effect, no single nation could take the action alone. The Protocol thus exemplifies the necessity of collective international action to address environmental threats that transcend borders (Cheigh et al., 2025).

The Protocol demanded a precautionary approach. Although there was scientific evidence of the problem, uncertainties remained, nonetheless the potential risks justified immediate action. The issue of chemical pollution leading to the deterioration of the ozone layer is highlighted as a concern that raises important intergenerational problems. The ozone layer is classified as one of the common areas known as the "global commons", these are resources that belong to all humanity and not to one in particular (Cheigh et al., 2025).

Established under the framework of the 1985 Vienna Convention, the Montreal Protocol's design reflected a two-step process that not only secured the protection of the ozone layer but also influenced the architecture of subsequent environmental agreements, including the UNFCCC (Maljean-Dubois, 2017). Its success is attributed to the rapid adoption of detailed rules and mechanisms for phasing out ODS. This regulatory response is widely seen as a triumph of international environmental law (IEL), demonstrating how legal instruments can effectively address complex global challenges. Furthermore, the effectiveness was boosted by concurrent shifts in producer behaviour, which were motivated by legal requirements and the economics resulting from greater consumer information (French & Kotzé, 2019).

The name of the most successful protocol doesn't come from nowhere. The Montreal Protocol has led to a phase-out of over 99% of ODS, and the ozone layer is showing clear

signs of recovery. It is estimated that by 2030 it will have prevented approximately two million cases of skin cancer annually. A key component of its success is the establishment of the Multilateral Fund, which provides financial and technical assistance to help developing countries transition to safer alternatives. This fund, financed by developed nations, reflects the principle of common but differentiated responsibilities and capabilities, which is a cornerstone of IEL (About Montreal Protocol, n.d.). This principle, which has profoundly influenced environmental administrative decisions, recognizes the differing capacities and historical responsibilities of states, allowing for a more equitable distribution of obligations and redefining the discretionary power of administrative authorities, especially in developing countries (Khalil, 2025).

Critic on the Protocol however also exists. While it's widely praised, the Montreal Protocol's success isn't perfect. Scholars point out that phasing out CFCs worked so well largely because it made financial sense for big chemical companies, it was a "best-case scenario" for the industry (Perry et al., 2024) .The struggle to phase out methyl bromide, a pesticide used in farming, shows the agreement's weakness: when powerful countries like the U.S. don't see a clear economic benefit, they delay action and push for loopholes to protect their own markets (Perry et al., 2024). This highlights a major limitation: the Protocol tackled a relatively narrow set of industrial chemicals. Its model is much harder to apply to huge, economy-wide problems like climate change, where there are far more stakeholders, costs are higher, and easy replacements don't exist. On top of that, the treaty's enforcement has shown flaws, with illegal production and emissions of banned chemicals like CFC-11 still occurring (Perry et al., 2024). So, while groundbreaking, the Protocol isn't a simple blueprint for solving all global environmental crises.

2.1.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1975)

Following the Second World War, the expansion of international trade and the surge in global consumer demand placed increasing pressure on countless vulnerable species. This intensifying exploitation of life on earth, driven by economic growth and market

globalization, led to a dramatic decline in biodiversity across the planet. Ecosystems were destabilized, ecological balances were disrupted, and the loss of species became not only a scientific concern but an irreversible loss of the Earth's ecological heritage. This was a turning point in environmental awareness, highlighting the urgent need for coordinated international legal responses to safeguard the planet's biological richness (Cheigh et al., 2025).

In many cases, national legislation designed to safeguard wildlife proved inadequate when faced with the complexities of international trade. Species legally protected within the borders of one country could still be hunted in another jurisdiction lacking such protections, and the resulting animal products could be transported and sold in yet another country where trade regulations were weak or non-existent. This enforcement gap created a global pathway for the exploitation of endangered species, severely undermining conservation efforts and accelerating the loss of biodiversity (Maljean-Dubois, 2017).

In response to these threats, the international community acknowledged the urgent need for a coordinated legal framework to regulate the cross-border movement of wildlife. Rather than banning all trade, the focus shifted toward creating systems that ensure trade is sustainable, lawful, and transparently monitored. This approach tries to balance caring for the environment with doing business, encouraging that trade that helps protect nature instead of harming it.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which entered into force in 1975, established a comprehensive international licensing framework governing the trade in wild animals and plants. A distinctive feature of the Convention is its normative character as a lawmaking treaty, setting general standards for future regulatory conduct and contributing to the codification of customary international law. Almost all countries are part of this Convention.

The CITES website (2023) says that "Over 40,900 species – including roughly 6,610 species of animals and 34,310 species of plants – are protected by CITES against over-exploitation

through international trade”. These species get divided into three appendices, which list species according to their conservation status and their risk of being traded on international level.

Appendix I: Includes species threatened with extinction. Commercial trade in these species is prohibited. It holds about 600 animal species and 300 plant species.

Appendix II: Includes species that are not presently threatened with extinction, but whose trade must be regulated to prevent consumption or trade that endangers their viability. Trade is permitted but strictly regulated through export permits. It holds about 1,400 animal species and 25,000 plant species.

Appendix III: Includes species that are protected in at least one country, where that country has requested assistance from other CITES parties to regulate as well. It holds about 270 animal species and 30 plant species.

International trade in species listed in the Convention's Appendices must meet three conditions. Firstly, the species must be obtained in accordance with national laws and regulations that protect fauna and flora. Parties are required to confirm this through a document called “legal acquisition finding (LAF)”. Secondly, the trade must be sustainable. Parties must conduct a non-detriment finding, which is a scientific assessment confirming that the trade does not harm the survival of the species and considers its role in the ecosystem. Thirdly, trade must be traceable. Parties must issue and control the appropriate CITES permits and certificates. They must report all permits and certificates in national annual reports, which are organized in the CITES Trade Database. Yearly, there are over 1 million CITES permits and certificates issued (What Is CITES? | CITES, n.d.).

CITES operates by making international trade in listed species conditional upon the issuance of permits certifying that the specimen was not obtained illegally and that its trade will not be detrimental to the species' survival. This legal intervention has been crucial in curbing the illegal wildlife trade, allowing for the recovery of some species like the crocodile, and providing a framework for managing commercial pressure on thousands of others. It

represents a key feature of international law: using trade controls as a direct instrument to achieve a conservation objective (What Is CITES? | CITES, n.d.).

Several key milestones have marked the evolution of the Convention. One such moment occurred during the third Conference of the Parties, convened in New Delhi, India, in early 1981. Delegates formally adopted the Guidelines for Transport and Preparation for Shipment of Live Wild Animals and Plants, establishing a standardized framework to ensure humane and safe handling. The Conference also created the Technical Committee to strengthen the Convention's implementation and oversight. A significant outcome of this meeting was the decision to transfer sea turtles from Appendix II to Appendix I, granting them the highest level of protection under CITES.

Another landmark moment occurred during the seventh Conference of the Parties, held in Lausanne, Switzerland, in October 1989. At this meeting, the Parties to CITES agreed to transfer the African elephant from Appendix II to Appendix I. This decision effectively prohibited commercial international trade in elephant ivory, marking a significant step toward curbing poaching and protecting one of the world's most iconic and threatened species.

Further recognition of the Convention's global significance came on 20 December 2013, during the 68th session of the United Nations General Assembly. The Assembly proclaimed 3 March, the date of the Convention's original signing in 1973, as UN World Wildlife Day. This annual observance was established to honour and raise awareness of the rich diversity of wild animals and plants across the globe.

A major critique of CITES is that it relies heavily on deterrence through state-led law enforcement. This design flaw poses a serious risk to the Convention's effectiveness in many contexts. The assumption that strict legal enforcement leads to compliance has not held true for many Parties. This reliance on deterrence highlights a classic technical gap; the treaty's design often overlooks the need for capacity building and resources in developing states, leading to weak enforcement and a gap between legal commitments and on-the-

ground reality (French & Kotzé, 2019; Maljean-Dubois, 2017). Emphasis on the severity of punishment has proven ineffective, whereas the certainty of enforcement, such as the likelihood of apprehension, has a greater impact on preventing illegal activities. There is also a lack of awareness among the stakeholders, and there are resource and capacity deficits. Challender also warn us about unintended effects. Regulating or banning international trade can lead to unintended consequences. These include driving trade underground, accelerating hunting due to scarcity-driven price increases, and removing local incentives to protect species. Trade restrictions may also shift hunting and trade pressure to other, unregulated species or regions (Challender et al., 2025). This may create black markets; when a species becomes very rare, its market value goes up. A banned or restricted species can become more profitable to smuggle and criminal networks step in to meet the demand.

2.1.3 The Convention on Biological Diversity (CBD) (1992)

While CITES addressed a specific driver of extinction, namely trade, the 1980s saw a growing scientific and public awareness of a broader, more systemic crisis: the rapid and widespread loss of biological diversity at the genetic, species and ecosystem levels. Driven by habitat destruction from agriculture and urbanization, pollution, overexploitation, and the introduction of invasive species, extinction rates were accelerating to levels unseen since the last mass extinction events. The environmental consequences are profound: biodiversity loss undermines ecosystem resilience, reduces potential sources (bioprospecting), threatens food security, and disrupts vital ecosystem services like water purification, pollination, and climate regulation. This rapid erosion of the planet's biological wealth is now widely recognized as a pressing global environmental risk. It raises serious concerns about intergenerational equit1 (Brown Weiss, 2021), as it irreversibly deprives future generations of the ecological richness and services inherited from the past (Maljean-Dubois, 2017).

[1] Affirms that each generation shares the Earth collectively with the present, as well as with those who came before and those yet to come.

The biodiversity crisis required a comprehensive legal approach that went beyond trade. It needed to address habitat conservation, the sustainable use of biological components, and the contentious issue of access to genetic resources and the sharing of benefits arising from their use. This complex interplay of conservation, sustainable use, and equity was the central challenge addressed at the 1992 Earth Summit in Rio de Janeiro (Maljean-Dubois, 2017).

The 1992 United Nations Conference on Environment and Development (UNCED), or Earth Summit, convened in Rio de Janeiro twenty years after the Stockholm Conference, to establish a global agenda for sustainable development (Fast Facts - What Is Sustainable Development? - United Nations Sustainable Development, n.d.) and environmental protection. It led to the adoption of the UNFCCC and the Convention on Biological Diversity (The Convention on Biological Diversity , n.d.), two cornerstone instruments of modern environmental governance

The CBD, also adopted at the Earth Summit, represents a landmark legal instrument that codifies the principles of conservation, sustainable use, and equitable benefit-sharing of biological resources. Its legislative authority and normative influence have positioned it as a central pillar of international environmental law. Within this framework, Article 14 on Impact Assessment and Minimizing Adverse Impacts plays an essential role in operationalizing the Convention’s preventive and precautionary ethos.

By mandating environmental impact assessments (EIAs) for projects likely to cause significant harm to biodiversity, Article 14 compels parties to integrate ecological considerations at the earliest stages of planning and development. EIAs function as legal instruments mandating, prior to project implementation, the identification and description of both direct and indirect significant effects of the proposed activity, including those related to climate. In doing so, they uphold essential procedural safeguards and provide scientifically grounded evaluations, thereby ensuring that any subsequent authorization of the project proceeds with a comprehensive understanding of its potential consequences (Helme et al., 2025). This requirement not only enhances transparency and accountability

but also fosters a culture of environmental due diligence. The inclusion of public participation provisions further democratizes environmental governance, allowing civil society to contribute to biodiversity protection and ensuring that decisions reflect broader societal values.

Moreover, Article 14 extends its scope beyond national borders by encouraging parties to notify and consult with other states when activities under their authority may adversely affect biodiversity in areas beyond national authority. This provision reinforces the principle of international cooperation and shared responsibility, recognizing that biodiversity is a global public good whose protection transcends political boundaries.

The article also addresses emergency preparedness by urging parties to establish national arrangements for responding to imminent threats to biodiversity, whether natural or anthropogenic. It promotes the development of joint contingency plans and international cooperation to supplement national efforts, thereby strengthening collective resilience to ecological crises.

Despite its normative ambitions, the CBD faces persistent challenges. Critics argue that the initiative suffers from imprecise objectives, a lack of consensus among stakeholders, and persistent challenges in effective implementation. They argue that Multilateral Environmental Agreements (MEAs), including the CBD, often fail to clearly define their core goals or the means to achieve them, particularly in Article 6. This imprecision, often resulting from political compromise or limited scientific consensus, pushes treaties toward the lowest common denominator. As a result, a fundamental paradox emerges: these agreements articulate comprehensive global agendas but lack the binding enforcement tools to realize them, an implementation gap that mirrors the challenges of the Aarhus Convention, see later. Vague and unquantified goals hinder monitoring, obstruct enforcement, and undermine the possibility of meaningful sanctions (Maljean-Dubois, 2017).

This points to a fundamental issue in IEL: the existence of normative gaps where rules and principles are either omitted or insufficiently developed to meet the scale of the environmental challenge (French & Kotzé, 2019). Addressing this requires moving beyond the current state-centric model to explore solutions like supranational oversight for critical biodiversity areas, polycentric governance involving sub-national actors, and the integration of ecological ethics to give nature intrinsic legal value.

2.1.4 The Aarhus Convention (1998)

The Aarhus Convention, formally known as the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, was adopted in 1998 in the Danish city of Aarhus. The impetus for this treaty lay in the growing recognition that environmental protection is not merely a technical or administrative matter but also a fundamental democratic issue. According to international institutions, citizens and civil society organizations needed greater opportunities to influence environmental decisions that directly affect their living environment. This idea aligned with broader developments in international environmental law, in which transparency and participation were becoming increasingly significant (Khalil, 2025).

The content of the Aarhus Convention is structured around three pillars that together form a legal framework for democratic environmental protection. The first pillar concerns the right of access to environmental information, requiring governments to make relevant data available to the public. The second pillar guarantees public participation in environmental decision-making, ensuring that citizens and organizations can express their views before decisions are taken. The third pillar provides access to justice, enabling citizens and organizations to initiate legal proceedings when their rights are violated or when environmental laws are improperly applied. These pillars enhance transparency and legitimacy in environmental governance and have been incorporated into national legislation by various states (Khalil, 2025).

The Convention also has an important international dimension. It imposes procedural obligations on states that extend beyond purely national policy choices. For example, the Aarhus Convention requires states to involve citizens in environmental decisions that may have transboundary consequences. This obligation reflects broader international principles such as the precautionary principle and the principle of sustainable development. The Convention is often regarded as an instrument that bridges the gap between international environmental norms and national implementation by granting citizens an active role in ensuring compliance with environmental law (French & Kotzé, 2019).

The Aarhus Convention is a milestone in international environmental law, establishing a pioneering normative framework that strengthens environmental governance by linking it to democratic principles through rights to information, public participation, and access to justice. However, its transformative potential is contingent on national implementation, where persistent technical gaps in resources, capacity, and political will often prevent these procedural rights from becoming a practical reality for citizens. Overcoming this requires moving beyond a state-centric compliance model to embrace polycentric governance, empower non-state actors, and secure dedicated funding to make environmental democracy a lived experience rather than a theoretical promise. Consequently, the Convention stands as a powerful but imperfect tool, its ultimate problem-solving effectiveness still a work in progress (French & Kotzé, 2019; Khalil, 2025; Maljean-Dubois, 2017).

As any other legal instrument, criticism has been directed at the effectiveness of the Aarhus Convention. Several authors point out that its practical implementation frequently falls short. The Convention embodies a central paradox: it sets a high normative standard for procedural rights yet suffers from a chronic implementation gap that creates a democratic deficit. Although the Convention formally grants rights, many countries lack the resources and political will to realize these rights in practice. This implementation deficit reveals a technical gap where a lack of financial resources, administrative capacity, and political will prevents the legally enshrined rights from becoming a practical reality for many citizens, a

common problem in IEL noted by Maljean-Dubois. Problems of implementation and enforcement are recurring themes in international environmental law and apply equally to Aarhus. Furthermore, access to justice in environmental matters often remains limited in practice due to excessive costs, lengthy procedures, and insufficient legal expertise among citizens and civil society organizations. As a result, the promise of the Convention sometimes remains largely theoretical (Maljean-Dubois, 2017).

2.1.5 The Paris Agreement (2015)

The Paris Agreement, adopted in December 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), represents one of the most significant milestones in international environmental law. Its creation was driven by the urgent need to address the escalating global climate crisis, which had become increasingly evident through scientific reports and political debates in the years leading up to the agreement. The preceding Kyoto Protocol had established binding emission reduction targets for developed countries, but its limited scope and uneven participation revealed the necessity of a more comprehensive and inclusive framework. The Paris Agreement was designed to overcome these shortcomings by involving all states, regardless of their level of development, in a collective effort to mitigate climate change (French & Kotzé, 2019).

The need for the Paris Agreement stemmed from the recognition that climate change posed an existential threat to ecosystems, economies, and societies worldwide. Rising greenhouse gas emissions had already led to observable impacts such as extreme weather events, sea-level rise, and biodiversity loss. Small Island Developing States (SIDS) were particularly vocal in demanding stronger international action, as their very survival was threatened by rising seas and intensifying storms. The agreement was therefore conceived not only as a technical instrument of emission reduction but also as a political and moral commitment to safeguard the rights of present and future generations. It reflected the growing consensus that climate change was not merely an environmental issue but a matter of justice, equity, and human rights (Lamm, 2024).

The Paris Agreement sought to solve a central problem in international climate governance: the gap between existing commitments and the level of action required to prevent catastrophic warming. Scientific assessments had made clear that limiting global temperature rise to below 2°C above pre-industrial levels was essential, with a more ambitious target of 1.5°C necessary to protect vulnerable populations and ecosystems. Prior frameworks had failed to generate sufficient ambition or compliance, leaving a dangerous discrepancy between pledged reductions and actual emissions. The Paris Agreement addressed this by establishing a universal framework in which all parties were required to submit nationally determined contributions (NDCs). These NDCs represented each country's self-defined commitments to reduce emissions and adapt to climate impacts, thereby creating a dynamic system intended to progressively increase ambition over time (Maljean-Dubois, 2017).

The treaty itself is structured around several key provisions. First, it sets the overarching goal of holding the increase in global average temperature to well below 2°C, while pursuing efforts to limit it to 1.5°C. Second, it requires parties to prepare, communicate, and maintain successive NDCs, with each new submission expected to represent a progression beyond the previous one. Third, it establishes a transparency framework, obliging states to report on their emissions and progress toward their commitments, subject to international review. Fourth, it emphasizes adaptation, recognizing that mitigation alone is insufficient and that states must also strengthen resilience to climate impacts. Fifth, it incorporates the principle of common but differentiated responsibilities and respective capabilities, acknowledging that developed countries should take the lead in providing financial and technological support to developing nations (Khalil, 2025).

The Paris Agreement also introduced mechanisms to encourage compliance and ambition. A global stock take is to be conducted every five years to assess collective progress toward the long-term goals, thereby informing future NDCs. In addition, developed countries committed to mobilizing at least 100 billion USD annually by 2020 to support climate action in developing countries, with a view to scaling up this financing in the future. These

provisions were intended to foster trust and solidarity among parties, ensuring that the burden of climate action would be shared equitably (Khalil, 2025).

Despite its groundbreaking nature, the Paris Agreement has been subject to significant criticism. Scholars and practitioners highlight that its reliance on voluntary nationally determined contributions rather than binding emission reduction targets risks insufficient ambition and weak accountability. This structure creates a fundamental paradox: the very flexibility that secured universal adoption also creates an unbridgeable ambition gap, as it defers to national sovereignty and lacks any supranational enforcement, in stark contrast to the Montreal Protocol's binding and funded approach. Financial commitments, such as the pledge of 100 billion USD annually to support developing countries, have been criticized as inadequate and inconsistently delivered, undermining trust in the system. Moreover, analyses of current NDCs show that they fall short of achieving the 1.5°C target, revealing a persistent gap between aspirational goals and actual policies. Finally, the emphasis on national sovereignty, while politically pragmatic, has led to uneven ambition and fragmented implementation, raising doubts about whether the agreement can generate the collective action needed to confront the global climate crisis (French & Kotzé, 2019; Lamm, 2024; Maljean-Dubois, 2017).

In conclusion, the Paris Agreement of 2015 represents a landmark in international climate governance, born out of the urgent need to address the inadequacies of previous frameworks and the escalating threat of climate change. It established a universal, flexible, and dynamic system of commitments, transparency, and support, aiming to progressively increase ambition and foster global solidarity. Its ultimate legacy, however, hinges on closing the ambition-implementation gap through successive rounds of NDCs and fulfilling the financial promises that underpin global equity and trust. Achieving this requires moving beyond its current voluntary model to explore stronger mechanisms, such as a supranational enforcement body for major emitters, truly polycentric governance involving cities and corporations, and the integration of climate justice and ecological ethics into its core operational principles. While the Paris Agreement has reshaped the landscape of

climate diplomacy, it continues to face significant challenges that must be addressed if its goals are to be realized.

2.1.6 Conclusion on International Environmental Law

In conclusion, the Montreal Protocol (1987) successfully reversed ozone depletion through a binding, precautionary regime, while CITES (1973) established a controlled trade system to protect endangered species from overexploitation. The Convention on Biological Diversity (1992) created a comprehensive framework for conservation and benefit-sharing, and the Aarhus Convention (1998) fortified environmental democracy by linking public rights to environmental protection. Finally, the Paris Agreement forged a universal, if voluntary, framework for global climate cooperation (The Paris Agreement | UNFCCC, n.d.). Collectively, these diverse legal instruments demonstrate that the architecture of international environmental law has been built in direct response to specific and pressing ecological crises, each representing an attempt to translate global concern into coordinated, if imperfect, action.

However, the collective analysis of these instruments reveals persistent challenges. Despite the proliferation of legal tools, the overall effectiveness of international environmental law is often hampered by "factual gaps" (unregulated or under-regulated areas), "technical gaps" (weak implementation and enforcement), and "normative gaps" (the absence of ambitious, systemic principles needed for the Anthropocene) (French & Kotzé, 2019). The ultimate measure of success; problem-solving effectiveness, or tangible environmental improvement; remains elusive for many regimes, highlighting a critical disconnect between legal development and on-the-ground ecological outcomes (Maljean-Dubois, 2017). The future of international environmental law, therefore, depends not only on creating new instruments but on enhancing implementation, strengthening judicial review, embedding environmental standards into administrative decision-making, and having the courage to address the profound normative gaps that currently limit its transformative potential (French & Kotzé, 2019; Khalil, 2025).

This raises an important question: to what extent can the European Union, with its supranational institutions, binding legislation, and harmonised internal market, provide a more coherent, ambitious, and enforceable environmental regime?
The following section therefore examines how EU environmental law developed over time and what key features characterise this distinct legal framework.

2.2 The Key Features of European Law

In this part of the handbook, we will focus on the key features of EU environmental law, and more specifically, on how environmental protection gradually emerged as one of the most important policy areas within the European Union. While the European economy has grown exponentially over the past decades, this progress stands in paradox with the environmental damage that accompanied it.

Generally, environmental degradation is closely associated with economic growth. Economic and social activities are responsible for the transformation and degradation of the environment in various forms and intensities (Badulescu et al., 2020). One of the greatest challenges for environmental policymakers lies in integrating environmental protection objectives into economic and sectoral policies. Unless this integration is effectively achieved, it is clear that environmental degradation will continue at an accelerated pace (Kingston, n.d.).

To analyse the origins of EU environmental law, we will first focus on how the topic of the environment, initially absent from political and legal discussions, eventually became one of the most pressing issues on the European and global agenda.

2.2.1 Industrial Growth and Visible Pollution

The post-war period marked a turning point in Europe's economic and industrial development. After the devastation of World War II, most European countries prioritized rapid reconstruction and modernization of their economies. Massive investments were made in industrial infrastructure, manufacturing, and energy production, especially in coal, steel, and chemicals. This era of unprecedented expansion, often referred to as the

“economic miracle” (Milward, 2003), brought about sustained economic growth and a significant rise in living standards across Western Europe.

However, this economic boom came at a substantial environmental cost. The focus on productivity and competitiveness left little room for ecological considerations. Industrial facilities emitted large quantities of pollutants into the air and water, while waste management and emission control were virtually non-existent. By the late 1950s and 1960s, the visible consequences of unchecked industrialization became impossible to ignore: rivers, forests, and urban centers were heavily degraded.

One of the most striking examples was the pollution of major European rivers such as the Rhine, which was so heavily contaminated with industrial effluents that it became known as “Europe’s sewer” (McCormick, 2001). Toxic discharges from chemical and metal industries in Germany, France, and the Netherlands affected aquatic ecosystems and drinking water quality far beyond national borders. Similarly, high concentrations of sulfur dioxide (SO_2) emissions from factories in the United Kingdom and Central Europe led to acid rain, which severely damaged Scandinavian forests and lakes (Krämer & Badger, 2022).

Urban environments also faced alarming levels of pollution. Cities like London suffered from severe smog events, the most infamous being the Great Smog of 1952, which caused more than 4,000 premature deaths (Brimblecombe et al., 1987). Comparable problems were reported in other industrial cities such as Essen, Milan, and Paris, where air quality deteriorated dramatically due to industrial emissions and the rapid increase in motorized transport. These visible and tangible signs of pollution made it increasingly clear that environmental degradation was not a local issue, it was a regional and transboundary phenomenon.

Furthermore, the cross-border nature of pollution created new challenges for European policymakers. Rivers, air currents, and seas ignored political boundaries, spreading pollutants across entire regions. As a result, national environmental regulations proved insufficient. Countries such as Denmark and Sweden began to pressure their neighbors to

take action against transboundary pollution, while early intergovernmental efforts, like the 1963 Council of Europe Resolution on Air Pollution Control, started to recognize the need for coordinated responses (Council of Europe, 1963).

This illustrates how national regulatory systems, which were primarily designed to address environmental concerns within domestic borders, were structurally incapable of responding to transboundary environmental challenges. Such limitations underscore a broader critique of environmental governance: international environmental law is frequently characterized as weak, fragmented, and insufficiently coherent, thereby undermining its overall effectiveness.

This historical context demonstrates that the roots of EU environmental law were not primarily ideological but practical. The post-war industrial boom revealed that economic growth could no longer be sustained without addressing the environmental consequences that accompanied it. The first steps toward cooperation thus emerged from a shared recognition that pollution transcended borders and required collective solutions. These realizations would later serve as the foundation for the development of European environmental policy in the 1970s.

The recognition of these limitations created the first political space in which policymakers began to focus more on supranational solutions, foreshadowing the later development of a more integrated, yet still only semi-coherent, European environmental governance model.

2.2.2 Rising Public Pressure and Environmental Disasters

By the late 1960s, the visible effects of pollution and environmental degradation were no longer limited to industrial zones or urban areas, they became a matter of widespread public concern. The ecological damage caused by decades of uncontrolled industrialization led to a growing sense of environmental awareness among European citizens, scientists, and policymakers. This period marked the emergence of the modern environmental movement, which would soon play a decisive role in shaping both national and European environmental policy.

One of the key catalysts for this awakening was the publication of Rachel Carson's Silent Spring (1962). The book, which exposed the devastating ecological and health effects of pesticide use, sparked a wave of public outrage across the Western world. It revealed, for the first time in accessible language, how human actions could irreversibly disrupt natural ecosystems (Carson, 1962). The influence of Silent Spring was not limited to the United States; it also inspired European activists, scientists, and policymakers to reconsider the relationship between economic growth and environmental limits (McCormick, 2001).

In Europe, a series of major environmental disasters throughout the late 1960s and early 1970s further amplified public concern. One of the most notorious was the Torrey Canyon oil spill in 1967, when a supertanker ran aground off the coast of Cornwall, releasing approximately 120,000 tons of crude oil into the sea. The disaster polluted hundreds of kilometers of coastline in the United Kingdom and France and caused enormous ecological damage to marine life and coastal ecosystems (Kingston, n.d.). Other similar incidents, such as the Amoco Cadiz spill in 1978 and the Seveso chemical disaster in Italy in 1976, demonstrated the devastating impact of industrial negligence and the lack of preventive regulation at both national and international levels (Jasanoff, 1997).

These disasters revealed a structural paradox: while governments acknowledged the urgency of certain environmental crises and the damage they caused, they remained unwilling to impose the binding constraints necessary to address them, particularly when such measures threatened economic growth. This tension continues to influence both international and European environmental governance today.

During this time, new NGO's and grassroots movements emerged, bringing environmental issues into public discourse and political agendas. Groups such as Friends of the Earth (founded in 1969), Greenpeace (1971), and numerous local European initiatives began organizing protests, publishing reports, and pressuring governments to act. This growing activism coincided with the broader rise of the "New Social Movements" of the 1960s and 1970s, characterized by a focus on post-materialist values: quality of life, health, and sustainability, rather than purely economic welfare (Inglehart, 2015). The rise of civil society

actors highlighted the governance gap created by weak international enforcement mechanisms. It demonstrated that the public was no longer willing to accept environmental degradation justified in the name of economic growth, especially since society itself bore the consequences most directly. It became increasingly evident that voluntary national measures were insufficient to address these challenges.

The environmental issue thus shifted from being a concern of scientists to a mainstream political question. Across Europe, public opinion polls began to show that citizens were increasingly worried about pollution, resource depletion, and the health risks associated with industrial activity (Vogel, 1995). Governments responded by creating national environmental agencies, adopting pollution-control legislation, and participating in international negotiations.

At the European level, this societal and political momentum laid the groundwork for the European Economic Community (EEC) to begin addressing environmental protection, despite the absence of a clear legal mandate in the founding Treaties of Rome (1957).

The environmental disasters and public mobilization of the 1960s and 1970s thus served as a political turning point: they demonstrated that environmental issues could no longer be treated as secondary to economic development. Instead, they required coordinated policy responses, scientific expertise, and, crucially, cooperation beyond national borders. This societal momentum laid essential groundwork for European-level initiatives, while also illustrating how environmental progress depends on political will and economic priorities.

2.2.3 From Global Awareness to European Action: Institutionalizing Environmental Policy (1970s–1990s)

The early 1970s marked a decisive turning point in the international recognition of environmental issues. The United Nations Conference on the Human Environment, held in Stockholm in 1972, was the first global summit to place the environment at the center of international diplomacy. The conference emphasized that economic growth and environmental protection were not mutually exclusive but had to be pursued in together, a

concept that would later evolve into the idea of sustainable development (G Handl - United Nations Audiovisual Library of International & 2012, n.d.). The Stockholm Declaration, signed by 113 countries, called for global cooperation in addressing pollution, resource depletion, and cross-border environmental threats. For the European Economic Community (EEC), this international momentum provided both a political and moral imperative to develop a common environmental policy (McCormick, 2001).

However, Stockholm's impact was limited by the absence of enforceable obligations, reflecting a recurring weakness of international environmental law as a "flawed interface".

The Treaty of Maastricht (1993) further strengthened the institutional role of the environment by embedding the principle of sustainable development into the European Union's objectives. It also expanded the role of the European Parliament through the co-decision procedure, ensuring greater democratic oversight of environmental legislation. Yet despite its innovations, Maastricht left implementation largely in the hands of Member States, revealing the consistent limitations and the semi-coherent nature of EU environmental governance.

Building on Maastricht, the Treaty of Amsterdam (1999) reaffirmed environmental protection as a cross-cutting objective to be integrated into all EU policies, from transport to energy and agriculture (Treaty of Amsterdam, 1999). Despite the integration principle, persistent tensions between economic development and ecological protection continued to fragment EU action, limiting the Union's ability to develop a fully coherent system.

By the end of the 1990s, environmental policy had evolved from a marginal concern into a central pillar of the European project. What began in the 1960s as fragmented national responses to pollution had, over three decades, transformed into a coherent framework grounded in law, scientific expertise, and citizen participation. The successive crises, public mobilization, and international initiatives of the previous decades revealed that environmental challenges were inherently transboundary, demanding coordination, solidarity, and shared responsibility. The European Union's environmental policy thus

became not only a response to ecological degradation, but also a defining expression of European integration itself. Overall, the evolution of EU environmental law from the 1970s to the 1990s demonstrates how the Union developed a more integrated system than the international level, yet remained constrained by political compromise, economic pressures, and implementation gaps. These features explain why EU environmental law today is more advanced than international law but still only partially coherent.

This gradual institutional consolidation laid the foundation for a progressively more ambitious environmental policy within the EU. Yet environmental pressures continued to intensify, revealing the limitations of fragmented sectoral approaches and isolated regulatory initiatives. Against this backdrop, the European Green Deal emerged in 2019 as the most comprehensive and transformative policy framework adopted by the Union to date.

The next section examines the Green Deal's objectives, instruments, and governance architecture.

2.3 The European Green Deal (2019)

The European Green Deal, introduced by the European Commission in December 2019, represents one of the most comprehensive and ambitious policy frameworks ever adopted by the European Union, signalling a decisive shift in its approach to environmental governance. Conceived as a "new growth strategy", it aims to reconcile economic development with environmental sustainability by transforming the Union into a climate-neutral continent by 2050 (European Green Deal, 2019). The Green Deal functions both as a political vision and as a legislative umbrella under which numerous directives, regulations, and initiatives converge, encompassing climate action, energy transition, biodiversity protection, circular economy strategies, and sustainable finance (De Sadeleer, n.d.). It thus operates as a multi-layered legal architecture, where binding obligations coexist with soft-law guidance, reflecting the EU's hybrid governance model that merges hierarchical control, polycentric coordination, and market-based mechanisms(Scott et al., 2017)

At the centre of this framework lies Regulation (EU) 2021/1119, the European Climate Law, which enshrines the principle of climate neutrality as a legally binding objective. By doing so, the EU became the first regional bloc to translate its long-term climate ambition into a statutory obligation. The Regulation establishes a trajectory for reducing greenhouse gas emissions by at least 55 per cent by 2030 compared with 1990 levels, known as the “Fit for 55” target, and achieving net-zero emissions by mid-century. It compels the European Commission to assess collective progress and national measures against these targets through a mechanism of periodic review and adaptive policy adjustment (Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 Establishing the Framework for Achieving Climate Neutrality, n.d.) This legal codification embeds climate governance at the constitutional level of EU law, transforming it from a sectoral concern into a structural principle guiding all Union policies, as reaffirmed by Article 11 TFEU, which mandates environmental integration across all policy areas (Consolidated version of the Treaty on European Union en, 2016)

The Green Deal, however, extends far beyond emission reduction. It encompasses a wide array of initiatives intended to reconfigure Europe’s economic metabolism. The Circular Economy Action Plan promotes sustainable product design, waste prevention, and the establishment of closed material loops, while the Farm to Fork Strategy seeks to realign agricultural practices with ecological limits (Circular Economy Action Plan, n.d.)The EU Biodiversity Strategy for 2030 calls for the protection of at least 30 per cent of the Union’s land and sea, while the Renovation Wave Initiative addresses energy inefficiency in buildings, a sector responsible for roughly 40 per cent of energy consumption (EU Biodiversity Strategy for 2030, 2020). Complementing these sectoral measures is the European Industrial Strategy, which aims to support the green transition of heavy industries through innovation, digitalisation, and clean technologies (A New Industrial Strategy for Europe, 2020). Financially, the Green Deal is underpinned by the Sustainable Europe Investment Plan and the Just Transition Mechanism, designed to mobilise at least €1 trillion in sustainable investments over the coming decade, with particular support for regions and workers most affected by the transition (Committee and the Committee Of The Regions

Sustainable Europe Investment Plan European Green Deal Investment Plan, n.d.; The Just Transition Mechanism, n.d.).

From a governance perspective, the European Green Deal exemplifies a polycentric approach. It requires coordination between multiple overlapping authorities at the supranational, national, and subnational levels, as well as partnerships between public institutions, private actors, and civil society (Scott et al., 2017). The European Climate Pact seeks to engage citizens and communities, reflecting the participatory ethos of environmental democracy that is also embedded in the Aarhus Convention (Aarhus Convention, 2001). Nonetheless, this participatory ambition coexists with strong hierarchical features, as the European Commission retains significant agenda-setting and enforcement powers through its legislative proposals, delegated acts, and oversight mechanisms under Articles 290 and 291 TFEU (Consolidated version of the Treaty on European Union En, 2016). Market-based instruments, such as the Emissions Trading System (ETS) and the forthcoming Carbon Border Adjustment Mechanism (CBAM), further illustrate how the Green Deal blends regulatory command with economic incentives, aligning it with the EU's long-standing reliance on hybrid governance (Carbon Border Adjustment Mechanism Proposal, 2021).

The European Green Deal's normative innovation also lies in its explicit link between environmental protection and social equity. The Just Transition Mechanism operationalizes the principle of solidarity enshrined in Article 3 TEU, recognizing that climate neutrality cannot be achieved without addressing socio-economic disparities. This redistributive component reflects an awareness that environmental law must not only prevent harm but also promote fairness in burden-sharing (Consolidated version of the Treaty on European Union En, 2016). However, scholars have pointed out that the Green Deal's framing as a "growth strategy" remains deeply embedded in the same economic logic that produced the Anthropocene. By seeking to decouple economic growth from environmental degradation, it reaffirms the capitalist pursuit of expansion, merely attempting to render it "green" rather than fundamentally questioning its sustainability (Latour, 2018).

Through a hyperobject lens, climate change and ecological collapse appear as entities that far exceed the human and institutional scales of governance. The Green Deal's instruments, including quantified targets, emissions metrics, and financial incentives, attempt to manage these phenomena through human-centred systems of measurement and control. Yet such efforts, while necessary, may fail to grasp the non-linear, dispersed, and self-sustaining dynamics of ecological systems (Morton, 2013; Scott et al., 2017). The Object-Oriented Ontology (OOO) perspective critiques this anthropocentric reductionism by arguing that the Green Deal continues to perceive the non-human world as a set of "resources" to be managed efficiently rather than as autonomous agents with intrinsic value. This managerial orientation, grounded in Enlightenment rationalism, perpetuates the very separation between humans and nature that underlies the environmental crisis (Harman, 2018).

From a green anarchist viewpoint, the European Green Deal represents a quintessential techno-fix, a sophisticated attempt to reconcile industrial capitalism with ecological limits without dismantling the structures that drive overconsumption and inequality. Its reliance on innovation, technological efficiency, and market-based solutions may mitigate symptoms but does not address the root causes of unsustainable growth (Clark & Marshall, 2019). In this sense, it exemplifies the dilemma captured by Audre Lorde's metaphor: "the master's tools will never dismantle the master's house."(Lorde, 2023) The Green Deal, though progressive in scope, operates within the same institutional and economic paradigms that precipitated the crisis it seeks to resolve (Clark & Marshall, 2019).

In conclusion, the European Green Deal embodies both a legal milestone and a conceptual paradox (European Green Deal, 2019). It redefines environmental governance by integrating climate objectives across all policy areas, embedding climate neutrality as a binding legal norm, and mobilizing unprecedented financial resources for sustainable transformation (Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 Establishing the Framework for Achieving Climate Neutrality, n.d.). Yet its ambition to achieve "green growth" reveals the persistent tension between ecological imperatives and economic orthodoxy (Tubiana, 2023). Whether it marks a true paradigm

shift or merely a refined continuation of the status quo remains a contested question. As a governing model, it is neither fully hierarchical nor anarchic but polycentric, complex, adaptive, and multi-scalar (Scott et al., 2017). However, in managing the symptoms of the Anthropocene within the same logic that created them, the Green Deal illustrates both the promise and the limits of legal innovation in confronting the ecological crisis (Latour, 2018).

The examination of international and EU environmental law reveals that both levels have achieved significant progress, yet both remain constrained by structural weaknesses that limit their problem-solving capacity. To better conceptualise these limitations and understand their deeper roots, a theoretical framework is required.

The following chapters therefore introduce two analytical lenses: international law as a "flawed interface" and the EU as a "semi-coherent software" for environmental governance. These theoretical perspectives help interpret the institutional, political, and normative dynamics identified in the preceding sections.

3. THEORETICAL LENS

3.1 International Law as a Flawed Interface for Planetary Problems

3.1.1 Intro to International Law as a Flawed Interface

The term "international law as a flawed interface" describes how international law connects sovereign states through shared norms and institutions, yet fails to function as a coherent legal system. Unlike domestic law, it lacks a central authority, unified enforcement, and comprehensive scope. Its authority depends on voluntary consent and political will, leaving gaps between legal ideals and practical outcomes.

This section examines three core weaknesses that define this flawed interface. First, the lack of enforcement reveals the dependence of international institutions on state cooperation. Second, the lack of support from major powers exposes how politics undermines universality. Third, the limited scope of international law highlights its inability to fully address global issues such as climate change and inequality. Together, these

dimensions illustrate how international law remains a fragmented framework, normatively ambitious, yet structurally constrained.

3.1.2 Lack of Enforcement

One of the most persistent structural weaknesses of international law lies in its lack of enforcement mechanisms. Unlike domestic legal systems, international law operates without a centralized authority capable of compelling compliance or executing judgments. The International Criminal Court (ICC) serves as a clear illustration of this systemic limitation. Despite its ambition to end impunity for the world's gravest crimes, the ICC possesses neither its own police force nor any direct power to enforce its decisions. As Adam White observes, "the ICC actually has relatively weak enforcement capabilities. It has no police force or enforcement capabilities of its own and therefore relies on states to carry out this task for them" (White, 2019, p. 12). This dependency undermines both the Court's legitimacy and its deterrent effect, since perpetrators who believe arrest is unlikely may continue to act with impunity. The ICC's limited record of prosecutions, alongside fifteen outstanding arrest warrants, reveals how its authority is constrained by state cooperation rather than grounded in any autonomous enforcement power (White, 2019, p. 13).

This structural weakness becomes particularly visible in concrete cases where states openly defy the Court's decisions. The most prominent example is Sudan's former president Omar al-Bashir, who travelled freely for nearly a decade after the ICC issued two arrest warrants against him in 2009 and 2010. States parties such as South Africa (2015), Kenya (2010), and Uganda (2016) declined to arrest him despite their treaty obligations under the Rome Statute. South Africa even allowed Bashir to attend an AU summit in Johannesburg, later arguing that diplomatic immunity justified its refusal to execute the Court's order. These incidents demonstrate how state non-cooperation renders ICC decisions effectively unenforceable. A similar pattern appears outside the criminal law sphere: in 2016, China simply rejected the legally binding UNCLOS arbitration ruling in the South China Sea case, calling it "null and void" and refusing to comply. Such examples highlight that even binding international judgments can be ignored without consequence.

The consequences of this structural weakness extend beyond inefficiency: they affect the very perception of international justice. As White further argues, “if the ICC appears unable to bring those who commit these crimes to justice then it drastically reduces its ability to serve as a deterrent” (White, 2019, p. 12). The lack of enforcement thus erodes both the ICC’s legitimacy and the broader credibility of international law. Efforts to create a supranational enforcement body, such as an independent police or military force, have been proposed, yet they remain politically unrealistic. Even if established, such a body would still rely on state consent to operate, reinforcing rather than resolving the underlying problem of state sovereignty (White, 2019, pp. 32–34).

Hans-Peter Kaul, one of the ICC’s founding judges, reached a similar conclusion from within the institution itself. Reflecting on the Court’s first years, Kaul noted that the ICC “does not have the competencies and means to enforce its own decisions. Under the Statute, the ICC has no executive powers, no police force of its own or other executive units. It is totally dependent on full, effective, timely and predictable cooperation, in particular from States Parties” (Kaul, The ICC and International Criminal Cooperation, 2008, p. 86). This total dependency means that enforcement ultimately hinges on the political will of states. When governments refuse to arrest indicted individuals such as Sudan’s Omar al-Bashir, the ICC has no alternative means of ensuring compliance. Kaul emphasized that “arrests are primarily the responsibility of relevant territorial States… above all, it requires the necessary political will” (Kaul, 2008, p. 90). Without such will, international justice remains largely symbolic.

This fundamental reliance on state cooperation reflects a deliberate compromise embedded in the 1998 Rome Statute, which preserved national sovereignty over executive powers. Article 86 of the Statute obliges state parties to “cooperate fully” with the Court, yet provides no mechanism to compel them to do so. As a result, the ICC’s enforcement regime operates as a hybrid of supranational aspiration and intergovernmental reality. Kaul aptly described this as “a decisive structural weakness,” where the success or failure of the

Court, and by extension international law itself, depends on states' voluntary compliance rather than any binding enforcement system (Kaul, 2008, p. 3).

A similar enforcement gap exists in international environmental governance. The Paris Agreement (2015) contains no sanctions for states that fail to meet their nationally determined contributions, and several major emitters, including Brazil, India, and the United States (during the 2017–2020 withdrawal period), have fallen short of targets without consequence. Likewise, Canada withdrew from the Kyoto Protocol in 2011 after failing to meet its obligations, facing no legal penalty. These examples parallel the ICC's experience: even when norms are clear, enforcement remains entirely dependent on state willingness.

In sum, the problem of enforcement within international law exposes the tension between universal justice and sovereign autonomy. The ICC embodies this paradox: created to transcend politics, it remains bound by political will. As Anthony D'Amato observed more broadly, international law lacks the essential element that makes domestic law effective, "a coercive mechanism that ensures compliance" (D'Amato, International Law: A Selective Critique, 2008). Until international institutions gain the capacity to act independently of states, enforcement will continue to be the Achilles' heel of international law, limiting its ability to function as a truly effective legal order.

3.1.3 Lack of Support: The Problem of State Will and Great Power Commitment

A second major weakness undermining the effectiveness of international law is the persistent lack of political support and engagement from powerful states. Even the most sophisticated legal frameworks depend on the willingness of states to consent, cooperate, and internalize obligations. Without the participation of major powers such as the United States, China, and Russia, international institutions often struggle to achieve both legitimacy and practical effect. This dynamic becomes clear in several concrete cases. For example, although the United States initially signed the Rome Statute under the Clinton administration, it never ratified the treaty; under President George W. Bush, the U.S. even

“unsigned” it and passed the so-called Hague Invasion Act, authorizing the use of force to free American personnel held by the ICC. Similarly, the U.S. withdrew from the Paris Agreement in 2017, formally exiting in 2020, before rejoining under President Biden in 2021. These shifts illustrate how great-power inconsistency can weaken the credibility and stability of global governance regimes.

As Alexander Bower observes, “coalitions of middle power states and their civil society allies have successfully negotiated binding multilateral rules that were more stringent than the United States and others like China, India, and Russia were willing to accept” (Norms Without the Great Powers, 2015). Treaties such as the 1997 Mine Ban Treaty or the Kyoto Protocol exemplify this phenomenon. While they represent significant normative progress, their reach and influence remain limited because major powers refused to join or comply. China and India, for instance, rejected binding emissions reduction obligations under the Kyoto Protocol and later opposed top-down targets under the Paris Agreement, insisting instead on nationally determined contributions. Russia also withdrew from the second commitment period of the Kyoto Protocol in 2011, effectively undermining what little remained of its binding architecture. These concrete examples illustrate how even the most ambitious multilateral agreements falter without the engagement of key geopolitical actors.

Bower’s research highlights how these dynamics reflect a structural imbalance between global normative ambition and geopolitical reality. International law aspires to universality, yet “great powers frequently use their predominant status to entrench unequal rights and responsibilities in international law,” thereby shaping the system to fit their strategic interests (Bower, 2015). The decision of smaller states to “proceed without the great powers” reveals both resilience and fragility: while norms can advance through moral leadership and legal codification, the absence of major military and economic actors limits their enforcement, global diffusion, and long-term influence. This pattern extends far beyond environmental and disarmament treaties; the United States is not a party to UNCLOS, CEDAW, or the Convention on the Rights of the Child (CRC), which further

illustrates the systemic disengagement of powerful states from critical international frameworks.

The philosophical roots of this problem lie in the consent-based nature of international law itself. As Samantha Besson argues, “no state can be bound by international law without its consent and hence without agreement” (State Consent and Disagreement in International Law-Making, 2016). State consent functions as both a legal principle and a political safeguard of sovereignty. Yet, in practice, it creates a paradox: when powerful states withhold consent, the resulting legal order becomes fragmented and incomplete. Besson challenges the assumption that consent automatically legitimizes international law, suggesting instead that “democratic state consent operates as an exception to the legitimate authority of international law” (State Consent, 2016). In other words, deference to national will, especially that of influential democracies, can paradoxically weaken the universality of international legal norms by permitting opt-outs from collective obligations.

The sceptical strand of legal theory reinforces this diagnosis. As Pavel (2018) notes, “states’ legal obligations often depend on their consent … enforcement in international law is weak and, for many treaties, non-existent,” leading critics to doubt whether international law can ever compel states beyond prudential self-interest (Skeptical Challenges to International Law, 2018). For such sceptics, international institutions reflect not moral authority but “an attempt by states to advance their national interests.” This view exposes a central tension between legality and legitimacy: states obey international law only insofar as it aligns with their strategic calculations, not because they recognize an overarching obligation to do so.

The cumulative insight of these scholars underscores that international law’s legitimacy depends not only on formal institutions but also on political will. Normative progress, whether in human rights, environmental protection, or disarmament, requires the active participation of the world’s most powerful actors. In their absence, the international legal order risks becoming a patchwork of partial commitments, where compliance is voluntary and authority selective. As Bower concludes, “the decision to proceed without the great powers may achieve moral clarity but at the expense of political efficacy” (Bower, 2015).

The result is a fragile international system in which law aspires to universality yet remains hostage to the selective engagement of sovereign states.

3.1.4 Limited Scope: The Narrow Reach of International Law

A further limitation concerns the narrow scope of international law. Its traditional structure is designed primarily to regulate relations between sovereign states, leaving many pressing global issues such as poverty, inequality, terrorism, and especially climate change outside its effective reach. As a result, international law struggles to address transnational challenges that involve private actors, corporations, and future generations, revealing a significant gap between the system's normative ambitions and its practical capacity.

These structural limits are particularly visible within international environmental law. Despite decades of negotiations and the adoption of numerous global treaties, the system continues to lack the comprehensive reach needed to respond to complex and interlinked environmental crises. Cinnamon Carlarne (2014) argues that international environmental law "has struggled since its inception to find workable solutions to complex problems" and remains too fragmented to manage the cross-cutting realities of climate change (Delinking International Environmental Law and Climate Change). According to Carlarne, environmental law is still constrained by its "state-centric" logic: it focuses on narrow environmental concerns rather than embracing broader economic and human rights dimensions of sustainability. This separation prevents climate change from being treated as the systemic global threat it is.

Concrete examples illustrate this narrow scope. The Paris Agreement, the cornerstone of today's climate regime, relies entirely on voluntary "nationally determined contributions" (NDCs) and contains no sanctions for non-compliance. Similarly, states retain full sovereignty over environmental decisions with global consequences: the ongoing deforestation of the Amazon rainforest under successive Brazilian administrations demonstrates how international law lacks mechanisms to intervene even when national actions trigger irreversible planetary harm.

Recent empirical studies confirm that the limited scope of international law also affects the judicial sphere. Wael Mahmoud Fakhry, Maher Ibrahim Ebed Emam, and Hussain Said Saif Al Ghafri highlight that only a small number of climate-related cases ever reach international courts, and even fewer result in binding or enforceable judgments. The International Court of Justice (ICJ) has declined jurisdiction in several climate-related applications, while the International Tribunal for the Law of the Sea (ITLOS) is largely restricted to delivering advisory opinions, which are non-binding. As a result, effective climate litigation has taken place almost exclusively in domestic courts, such as the landmark Dutch Urgenda case, rather than in international fora, underscoring the inability of the international judiciary to articulate a coherent and enforceable body of environmental jurisprudence.

The limited scope of international law is additionally evident in its inability to regulate non-state actors. Multinational corporations such as ExxonMobil, Chevron, or Shell play central roles in global emissions and environmental degradation, yet they cannot be held directly accountable under international law; only states bear responsibility. This leaves significant gaps in areas such as corporate environmental liability, transnational pollution, and the regulation of global supply chains.

Similar limitations emerged during the COVID-19 pandemic. Although all states are legally bound by the International Health Regulations (IHR), more than 70 states violated their obligations regarding border closures, reporting delays, and restrictions on medical trade and none faced sanctions. The World Health Organization (WHO) has no enforcement powers and cannot compel compliance, illustrating once again how international law lacks effective instruments when global crises require coordinated, binding action.

The consequences of this limited scope are far-reaching. First, it undermines legal certainty by leaving key areas of global governance, such as carbon markets, corporate responsibility, and intergenerational justice, under-regulated. Second, it reinforces dependency on voluntary state action and political goodwill. Even the most ambitious instruments, like the Paris Agreement, rely on self-determined commitments rather than binding legal duties.

Finally, it weakens public trust in the ability of international law to deliver justice in the face of existential global threats. As Carlarne warns, unless international law expands beyond its narrow sectoral focus, it risks remaining reactive rather than transformative.

In short, the limited scope of international law, especially in the environmental field, illustrates the structural mismatch between a globalized world and a state-based legal order. Without broader mandates, cross-regime coordination, and the effective inclusion of non-state actors, international law will remain a fragmented framework: normatively rich, but operationally thin.

3.1.5 Conclusion: The Paradox of the Flawed Interface

The three weaknesses discussed, lack of enforcement, lack of support, and limited scope, reveal the paradox at the heart of international law as a "flawed interface." The empirical examples examined throughout these sections demonstrate how systemic flaws manifest in practice: states ignore binding ICC arrest warrants such as those issued against Omar al-Bashir; major powers withdraw from key regimes, reject binding emissions targets, or refuse treaty participation altogether; and global crises like Amazon deforestation, climate inaction, and pandemic mismanagement remain beyond the reach of any effective international mechanism. These cases illustrate that international law, while normatively ambitious, remains structurally dependent on political will, selective great-power engagement, and a narrow, state-centric mandate.

International law aspires to universality, yet its enforcement mechanisms rely on voluntary cooperation; its authority is undermined when influential states refuse to join, comply with, or internalize legal obligations; and its scope leaves private actors, corporations, and future generations largely unprotected. Together, these weaknesses expose the enduring tension between law as an instrument of order and law as a projection of state power. Far from abstract theoretical deficiencies, these limitations continually shape real-world outcomes, determining which violations are punished, which global harms remain unaddressed, and which communities bear the costs of institutional paralysis.

Yet, as scholars from Kaul to Carlarne suggest, the imperfections of international law also reflect its complex sociopolitical environment. The system's reliance on negotiation, persuasion, and norm diffusion allows for gradual, if uneven, progress even in the absence of coercive authority. International law may not function as a fully coherent or effective system, but it continues to shape expectations of legitimacy, accountability, and justice. Its influence lies not only in formal enforcement, but also in its ability to generate shared standards, mobilize civil society, and create pressure for compliance through reputation and diplomacy.

In that sense, the “flawed interface” remains indispensable: it mirrors the fragmented, interdependent nature of global society and offers a common language through which states negotiate collective problems. While its limitations are stark, particularly in the environmental domain where global threats collide with the boundaries of sovereignty, understanding these structural constraints is essential for imagining more resilient forms of governance.

In sum, the weakness of international law is not merely a design flaw but a reflection of its dual identity: a bridge between sovereignty and solidarity, power and principle, law and politics.

3.2 The EU as a semi-coherent ‘software’ for governance

3.2.1 Introduction

In recent decades, the European Union (EU) has developed environmental legislation that gradually has been constructed over time to make sure it can handle the challenges the European Union faces today. But because of this gradual development of EU environmental law, the body of legislation comprises many inconsistencies and incoherences.

An academic study shows that the interaction between the Water Framework Directive and the Habitats Directive creates administrative fragmentation, undermining river restoration and biodiversity efforts. This results in governance incoherence overlapping goals, unclear

responsibilities, poor coordination, and uneven implementation meaning that well-designed laws often fail or are applied inconsistently across regions (Pröbstl et al., 2025).

Although incoherences and inconsistencies do not necessarily interfere with the functionality of specific legislative instruments, they can still lead to a lack of clarity at the operational level and lay unnecessary burdens on the implementation of EU Policy. Moreover, inconsistency and fragmentation prevent Member States from developing coherent national policies that integrate the different elements of EU legislation into one framework (A More Consistent and Effective EU Environmental Legislation | Spatial Planning | Government.Nl, n.d.). When addressing climate change, the most pressing challenge facing humanity in the twenty-first century (Morgera & Kulovesi, 2014), it is essential to examine the role of the European Union in international climate negotiations and to determine whether it possesses the authority to act autonomously, independent of its Member States, or whether effective action requires coordinated governance between both levels (Aertgeerts, 2014).

3.2.2 The EU as Software

The European Union can metaphorically be referred to as a software of governance. This metaphor paints the EU not as a static stat-like entity, but as a dynamic, rule-based operating system designed to oversee complex, cross-border interactions between its Member States. The base and main core of this software are the treaties. “The EU has only those powers which have been given to it by the Member States” (Best, 2016), which means that the EU’s decision-making power stems from treaties signed between the Member States and are the legal basis for EU activity. The Treaty on European Union (TEU) and the Treaty on the Functioning of the European Union (TFEU) are serving as the constitutional basis for the system Consolidated version of the Treaty on European Union En, 2016, Treaty of Maastricht on European Union | EUR-Lex, n.d. These treaties establish the fundamental protocols and parameters within which the system runs, defining the scope of EU action through principles like subsidiarity and proportionality (Best, 2016).

How the EU is programmed can be divided in four types of action:

First, the EU implements rules which is regulatory decision-making in the traditional sense. This legislative process makes binding regulations and directives.

Second, the EU acts by financing. “This financing is based in the EU’s Multi-annual Financial Framework, which is agreed by the Council.” (Best, 2016)

Third, the EU provides policy coordination through which Member States can work together effectively.

Fourth, EU-Member State cooperation. In areas like foreign policy and security, where the EU works more like a club where every single member has to agree (Best, 2016).

These types of actions could be seen as the applications of the software, where each type is created to handle a different policy challenge. The EU also works like software because it has a system for automatic updates (Best, 2016). The main EU laws are like the core operating system. But instead of making a whole new law for every small change, the EU delegates the power to the Commission to issue quick updates. This is like an app getting automatic updates to fix bugs or to add new features to the system, without having to reboot the whole system all the time. An example of this is the drinking water directive of 2020. This directive stablishes overarching standards and mandatory targets for water quality, including microbiological and chemical safety, and outlines the duties that Member States must fulfil (Drinking Water Directive, 2020). However, in 2024 the Commission adopted several acts specifying the rules of application of the directive (Delegated Acts Drinking Water Directive - Environment - European Commission, n.d.).

3.2.3 Governance Tensions Between the EU and Member States

The EU can add regulations on top of regulations made by Member States and does this often in many fields of policy. Therefore, the EU carries the potential to have a considerable impact on the totality of climate regulations made in Europe and as a result make a significant difference (Aertgeerts, 2014). Because climate change knows no borders it

seems like the more effective approach to solve those issues at EU-level (De Cendra Larragán, J. (2010). Distributional Choices... - Google Scholar, n.d.). Quickly the European commission had expressed their intention of taking the lead in the area of climate change on the international level (Oberthür & Kelly, 2008) and since the year 2000 the EU has taken on the task of fighting climate change (Massai, 2011) , and in doing so aims to pursue binding objectives for as many countries as possible (Groenleer & Van Schaik, 2007) . Following the Treaty of Lisbon, it is stated in article 191, lid 1 TFEU that the EU's policy on environment has to follow the objective of 'promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change.' (Consolidated version of the Treaty on European Union En, 2016) Although the European Union has positioned itself as a global leader in climate regulation, it is essential to question whether it possesses the legal authority to assume this role. According to Article 4(2)(e) TFEU, environmental policy falls under shared competence between the EU and its Member States. Furthermore, Article 191(4) TFEU provides that both the EU and the Member States are entitled to cooperate with third countries and international organizations in this domain (Consolidated version of the Treaty on European Union En, 2016)). Therefore, the development and implementation of effective environmental policy inherently require coordinated action between the EU and its Member States (Aertgeerts, 2014).

The European Union's role in climate regulation shows both their regulatory ambition and the limits of their authority, perfectly illustrating why the EU can be seen as a semi-coherent system. On the one hand, the EU is capable of complementing national regulations, working towards binding climate goals and expressing their international leadership when it comes to environmental policies, which have been enforced by the Lisbon Treaty's explicit policy aim to fight climate change. On the other hand, environmental policy remains a shared competence under Article 4(2)(e) TFEU, and international cooperation is collectively exercised under Article 191(4) TFEU. This division of authority means that the EU cannot fully act on its own but has to work together with the Member States to achieve effective outcomes. The result of this is that we have a type of governance structure that is not

entirely fragmented, but also not really centralized either. The EU is coherent enough to lead in solving environmental issues, yet still too dependent on national cooperation to remain only semi-coherent

3.2.4 Conclusion

In summary, the European Union operates as a semi-coherent system of governance that, like a software, depends on its foundational treaties and the cooperation of Member States. While the EU possesses significant regulatory and coordinating capacities, its authority remains limited by the overlapping jurisdiction with Member States of environmental policy under Article 4(2)(e) TFEU and the system for EU-Member State cooperation in international matters under Article 191(4) TFEU. This duality demonstrates the EU's semi-coherent character: it can exercise effective leadership on cross-border challenges while remaining reliant on Member State cooperation, producing a governance framework that is not completely centralized while also not being fully fragmented.

4. OVERALL CONCLUSION

International and European environmental law together constitute a dense, multi-layered architecture designed to confront the accelerating ecological crises of the Anthropocene. At the international level, treaties such as the Convention on Biological Diversity (1992), the Aarhus Convention (1998), and the Paris Agreement (2015) illustrate how legal instruments have emerged in response to pressing environmental challenges, translating global concern into coordinated, if imperfect, action. These instruments demonstrate the capacity of international law to structure collective responses, from biodiversity conservation and benefit-sharing, to environmental democracy, to voluntary climate cooperation.

Yet, a closer examination reveals persistent gaps that constrain their effectiveness. Factual gaps emerge where critical areas remain unregulated or under-regulated, such as transnational corporate emissions or ecosystem-level interventions. Technical gaps persist due to weak enforcement, inconsistent compliance, and limited judicial or administrative review, as seen in ICC arrest non-compliance, voluntary NDCs under the Paris Agreement,

and the inability to hold powerful states accountable. Normative gaps highlight the absence of systemic principles adequate for governing planetary-scale crises, reflecting a continuing reliance on state-centric, anthropocentric frameworks that struggle to address intergenerational justice and ecological complexity (French & Kotzé, 2019; Khalil, 2025). Collectively, these gaps reveal the structural limitations of international law. It remains normatively ambitious yet operationally fragile, capable of framing obligations and mobilizing consensus but rarely achieving full problem-solving effectiveness.

At the European level, the trajectory from fragmented post-war industrial regulation to the European Green Deal mirrors this duality. EU environmental law has evolved into a sophisticated, multi-scalar system. The European Climate Law enshrines climate neutrality as a binding objective, while sectoral policies, including the Circular Economy Action Plan and the Farm to Fork Strategy, seek to reshape Europe's ecological and economic metabolism. Yet the EU remains a semi-coherent governance system. Its authority is robust in design but contingent on shared competence with Member States, dependent on consistent implementation, and vulnerable to political negotiation and institutional incoherence. The Green Deal exemplifies both the promise and limits of legal innovation, translating normative ambition into concrete targets while operating within the constraints of existing economic and political paradigms.

Viewed through this lens, both international and European environmental law reveal a structural paradox. They are indispensable frameworks for coordinating collective action, yet insufficient to fully address the systemic transformations demanded by the Anthropocene. Their effectiveness depends not only on legal drafting but on strengthening enforcement, closing factual and technical gaps, embedding ecological and intergenerational principles into policy, and mobilizing sustained political commitment. Environmental law thus functions as both an instrument of governance and a reflection of systemic constraints. It shapes expectations of responsibility, accountability, and justice, but its transformative potential hinges on the willingness of states, institutions, and

societies to confront the deep-seated economic and normative assumptions that continue to drive ecological harm.

In sum, the challenge for the coming decades is not simply legal but systemic: how to leverage the existing architecture of environmental law to catalyze deeper societal, institutional, and ecological transformations. The law provides the scaffolding for action, but its ultimate impact will be determined by the alignment of implementation, enforcement, and normative ambition with the scale and urgency of the planetary crises it seeks to address.

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CHAPTER THREE. FROM DOÑANA TO THE PACIFIC: HOW EU AND INTERNATIONAL LAW STRUGGLE WITH WATER AND BIODIVERSITY IN THE ANTHROPOCENE

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1. INTRODUCTION

The dramatic loss of water and biodiversity marks one of the defining the challenges of the defining challenges of the Anthropocene. Despite the plurality of environmental law frameworks at both European and international levels, ecological decline continues largely unresolved. This chapter evaluates why, by examining two legal cases: the Doñana wetlands case (Commission v. Spain, C-559/19) within the EU context, and the Nuclear Tests case (Australia v. France, ICJ, 1974) at the international level.

The first section situates water and biodiversity loss as interlinked global issues and how ecological degrading already exceeds the impulses Environmental law uses to govern them. The following two sections analyze the Doñana and nuclear Tests cases in depth, using legal reasoning and post- anthropocentric theories in tandem to uncover the structural and systematic limits of fragmented Environmental EU and international law. A comparative section follows said reasoning by outlining shared weaknesses, which exist despite differing legal architectures.

In a circular way, the last sections develop reconstruction out of critique. Having post-anthropocentric theories in mind, the chapter concludes by exploring how law could evolve to recognizes ecosystems as active agencies rather than passive objects. By doing so, it stands for a post- anthropocentric legal reimagination capable of addressing the hyper-scale environmental realities of the Anthropocene.

2. FRESHWATER AND BIODIVERSITY AS A LEGAL AND THEORETICAL CHALLENGE

The ecological importance of nature and biodiversity lies in moving beyond the traditional anthropocentric view, which sees nature only as an object for human resource consumption and exploitation. Law pressures ecological systems primarily through the traditional anthropocentric perspective by treating nature as a passive object that humans consume, exploit and alter via activities like waste discharge, land reclamation, and resource extraction. This section examines how post-anthropocentric theories such as OOO, hyperobjects, and rights of nature offer a theoretical framework for understanding ecosystem protection.

2.1 Rights of nature

The traditional anthropocentric view sees nature as a passive object for human use and alteration, though humans may attempt mitigation and restoration (Sybesma & Konijnenbelt, 2024). In this view, humans are the actors or subjects, and nature is the object of human activity, often a passive or suffering object. Humans and human organizations can have rights and obligations, but nature cannot.

Since the 1970s, alternative perspectives have emerged, viewing Earth as an interconnected ecosystem (Lovelock). This ecocentric thinking aligns with the influential article “Should Trees Have Standing? – Towards Legal Rights for Natural Objects” by Professor Christopher D. Stone. Stone argued that endangered forests, rivers, and animal species should be recognized as having legal rights and be allowed to participate in legal proceedings, rather than limiting representation to humans or legal entities affected by environmental harm. This challenges the idea that only humans can hold rights, reflecting a more interconnected view of the world.

2.2 Object-Oriented Ontology (OOO)

Object-Oriented Ontology (OOO) by Graham Harman presents a perspective, in which the meaning and function of objects are fundamental. To adopt this approach, the definition of

“object” must be expanded to include entities that have not traditionally been considered objects (Ospina, 2019). OOO locates truth in objects themselves, building on thinkers such as Heidegger, Latour, and Husserl (Ospina, 2019). This expansion is particularly relevant for water and biodiversity, because rivers, wetlands, species and ecological processes are objects with independent roles and relations, rather than passive resources. By recognizing these

entities as objects in their own right, OOO highlights the complexity and autonomy of water and biodiversity. Legal systems struggle to represent independent ecological entities. This perspective helps us recognize independent entities, not just human-defined categories, strengthening the theoretical basis for more ecologically attuned legal frameworks.

2.3 Hyperobjects

Timothy Morton's concept of hyperobjects highlights how environmental phenomena such as climate change or microplastic pollution exceed the temporal and spatial scales that law has traditionally been able to address. These processes are vast, diffuse, and often invisible, unfolding over timespans and territories that defy conventional legal categories of causation, harm, and liability. This perspective requires new procedural approaches that respond to slow-moving, distributed damage and responsibilities across generations. In this way, the law is forced to expand its temporal and spatial imagination, developing tools capable of addressing the realities of the Anthropocene (Morton, T. 2013). This is applicable to water and biodiversity because both are shaped by processes that function like hyperobjects. Water operates across long timescales and national borders making their degradation difficult for law to trace or attribute. Biodiversity loss similarly unfolds through slow, cumulative, and interconnected processes that cannot be reduced to a single cause or moment of harm. By understanding water and biodiversity as hyperobjects we can better grasp why traditional legal tools fail to address their complexity and invisibility.

3. EU LAW IN PRACTICE: DOÑANA WETLANDS

3.1 Introduction

To fully understand the need for a post- anthropocentric way of thinking in relation to the context of Environmental Law and the need to shift from fragmented and human- centered legal frameworks to the development of non- human agencies and rights of nature, one cannot disregard the paradigmatic character of the Doñana Wetlands case. Not only does the concerning progression of degradation of freshwater and biodiversity in and around Doñana show that legal frameworks like the EU Environmental Law only concern themselves with the inherent value of nature in a superficial way but also show that even when EU representatives detect a breach of said Law, enforceability remains weak.

The main goal of this chapter will be to proof the hypothesis in question and show why a reform in EU Environmental Law is not only needed but crucial for the survival of nature in Europe and, having the Brussels effect in mind, for nature around the whole world.

3.2 Doñana´s Ecological Significance and Conservation Value

The Doñana Wetlands of Doñana National Park are one of nature´s few remaining wonders in Europe. Described by UNESCO World Heritage as a place of “outstanding universal value” (UNESCO World Heritage Centre), it is shaped by a surplus of ecosystems and landscapes, valuable flora and fauna and its importance as a place of refuge for several endangered species like the Iberian Lynx and the Iberian Eagle. As one of the largest surviving wetlands in Europe, it´s international importance lies not only in its clean water resources but also in it being an indispensable refuge for numerous wintering and migrating waterbirds on the East- Atlantic flyway (Ramsar Sites Information Service).

To preserve Doñana as one of the largest surviving wetlands in Europe, keeping its integrity must be of upmost importance. The interdependence of Doñana´s network of ecosystems and the hydrological integrity of the Guadalquivir basin show the difficult relationship of freshwater and biodiversity in the wetlands. The perseverance of Doñana relies “on a complex interaction between the water course, marches and the underground aquifer

system." (UNESCO World Heritage Site, section "Integrity"). Ongoing agricultural efforts around the Natural Park, groundwater extraction and aquifer decline and the high number of tourist visits in an ever more globalized world threaten the Doñana Wetlands and its conservation. Especially Spain´s dependance on agriculture created tensions between ecological preservation and economical effort, ultimately finding itself before the European Court of Justice for failing in creating adequate harmony in that regard.

3.3 Systematic Pressures and Spain´s Breaches of EU Environmental Obligations

Understanding the need for a reimagination of environmental law and regulation means to also understand that Spain´s breaches of EU environmental obligations cannot be understood in insolation. They are a product of broader systematic pressures that shape governance, enforcement capabilities and political decision- making in the Doñana region. The subsequent sections of the case analysis will show why a reimagination is not possible without a reform, that a broken system will not be able to heal itself from within.

3.3.1 Anthropogenic Pressures on Doñana´s Hydrology and Biodiversity

Despite Doñana's wetlands 'status as an "iconic and highly protected ecosystem "(Andy J. Green et. al., 2024) and them being protected within a National Park, Natura 2000 site, UNESCO World Heritage Site, Biosphere Reserve and a Ramsar Site, watershed and groundwatershed stay highly underprotected. This decline in water quantity must be ascribed to the ongoing extraction of groundwater for agricultural and urbanistic reasons. Manzano (2005) even detected a drop in water table of up to 20 m in the northern areas of Doñana between 1972 and 1992 (p. 215), 20 years before a formal complaint ever reached the European Commission. Berry farming around Doñana heavily relies on groundwater, leading to thousands of wells in the region, including many illegal wells. These wells extract more groundwater than the aquifer can naturally regenerate, leading to distortion in Doñana´s hydrological ecosystem.

Additionally, climate change and drought lead to more water deterioration in Doñana. The aquatic environments in Doñana are shaped by wide marshland, which floods during raining

season and dries out every summer. While drought is part of the marshland´s natural cycle, climate change and unstainable groundwater over-extraction lead to a disproportionate amount of dried out ponds and marshes. Most of Doñana´s temporary ponds, which at a certain point in time counted to 3000, are no longer flooded and the still remaining ponds and marshes are highly affected by progressing climate change and drought trends. Despite wide media coverage and outcry from scientific bodies, Spanish administration stays mostly inactive. (Estación Biológica de Doñana – CSIC, 2024).

3.3.2 Applicable EU legal Framework

As a part of the EU, Spain is obligated to protect Doñana´s water and biodiversity in accordance with EU Environmental Law. The legal protection of water and biodiversity in the EU is primarily anchored in certain EU Directives; the Water Framework Directive (2000/60/EC), the Habitats Directive (92/43/EEC), and the Birds Directive (2009/147/EC). These directives not only bind EU Member States to maintain or restore the ecological status of water bodies, prevent the deterioration of habitats, and ensure the conservation of bird population but also require Member States to implement monitoring and enforcing measures, which become vital in evaluating Spain´s compliance. Forming the legal framework for EU Environmental Law, Spain´s governance of Doñana was assessed by the European Court of Justice considering the aforementioned directives (European Commission, n.d., Water Framework Directive; European Commission, n.d. Habitats Directive; European Union, 2009, Birds Directive).

3.3.3 Hypothesis in Breaches of EU Environmental Law

While deterioration in the Doñana region progressed over the last decades, Spain remained mostly inactive, even described by the Estaciónn Biológica de Doñana as an “incomprehensible passivity of the administrations (CSID, 2024). This failure in governance becomes evident while evaluating Spain´s course of (in)action considering the EU legal framework. This raises questions of adequacy regarding Spain´s governance in the Doñana region. The following subsections advance hypotheses regarding potential breaches of EU

environmental law by Spain, which will subsequently be confirmed or dismissed in the analysis of the ECJ´s ruling.

3.3.3.1 Failure to Maintain Groundwater Status

Spain failed to achieve and maintain satisfactory quantity of groundwater for the Almonte-Marismas aquifer, as required under Article 4 (1) (b) (ii) WFD (2000/60/EC). Research by the Spanish National Research Council has shown "…that there is ample scientific evidence of serious impacts caused by groundwater abstraction." (Spanish National Research Council, 2024). Spain´s inaction could amount to a breach Article 4 WFD.

3.3.3.2 Failure to Prevent Habitats Deterioration

Under Article 6 (2) of the Habitats Directive, Member States must take appropriate steps to avoid the deterioration of natural habitats and the habitats of species for which the site has been designated, in so far as the disturbance could be significant in relation to the objectives of the directive. As a Natura 2000 Site, Doñana befalls special protection under the Habitats and Birds Directive (European Commission, n.d.). Spain had not taken sufficient measures to prevent degradation, as instigated in subsection 3.1. This failure to prevent excessive groundwater abstraction could have led to measurable habitat deterioration in Doñana and therefore a breach in Article 6 (2) 92/43/EEC.

3.3.3.3 Failure to protect Bird Populations

Articles 3, 4 and 5 of the Birds Directive require protection of habitats used for breeding, feeding and migration. Member States are required to create a general system of protection for all species that fall under the definition of Article 1 Birds Directive. The deterioration of wetland habitats could have adversely affected populations of migratory and wintering birds, demonstrating Spain´s non- compliance with its conservation obligations.

3.3.3.4 Monitoring and Enforcement Gaps

Spain´s lack in monitoring and enforcement measures (Green et al., 2024) could have not only aggravated habitat deterioration but could have also constituted a breach 5 WFD,

which obliges Member States to characterize river basin districts, monitor pressures, and evaluate human impacts. Spain´s insufficient assessment and monitoring of groundwater extraction in Doñana may have allowed deterioration to occur unnoticed, disregarding the objectives of Art. 5 WFD.

These actions could have also instigated a breach in Art. 11 WFD, which requires Member States to establish programs of measures and monitor their effectiveness regarding the achievement of the objectives established in Art. 4 WFD.

Furthermore, failure to create adequate control mechanisms could have diminished the objectives of Articles 6(1) and Article 6(3) Habitats Directive, which raise the obligation for States to take appropriate steps to avoid deterioration and to assess the impacts of plans or projects on Natura 2000 Sites. Spain´s non- compliance could be both substantive and procedural.

3.3.4. Activation of EU Enforcement Mechanisms

While Spain´s non- compliance with EU Environmental Law and the subsequent deterioration of Doñana can be traced back decades - as indicated by scientists and authors like Manzano et.al, J. Green et.al and Acreman & Salathe, as well NGO´s and International Organizations like WWF and UNESCO - the ECJ´s judicial assessment of the Doñana case is of recent nature, namely 2021. This subsection traces the procedural steps of EU enforcement mechanisms, illustrating how political, administrative and judicial tools were mobilized in response to Spain´s non- compliance.

3.3.4.1 NGO- Triggered Complaint and Opening of the Infringement Procedure

On 5th April 2010, WWF Spain filed a formal complaint with the European Commission, demanding action being taken regarding the excessive groundwater extraction in the Doñana region for agriculture (WWF, 2020). On the 16th of October 2014 the European Commission reacted in opening an infringement procedure against Spain (INFR (2014) 2090), sending a Letter of Formal Notice to Spain, in accordance with the procedure of Article 258 TFEU (European Commission, n.d.). This action shifted the Doñana case into a

legal sphere, signalizing that the EU considered Spain´s water and habitats governance in Doñana as inconsistent with its obligations under EU Environmental Law.

3.3.4.2 Commission´s Reasoned Opinion (2016)

On the 28th of April 2016 the EU Commission took the next step by "urging Spain to stop the deterioration of natural habitats in the area around the Doñana National Park…" (European Commission, 2016). It denounced Spain´s actions in the Doñana region as endangering to the unique biodiversity in the region and inconsistent with EU Water Framework Directive and Habitats Directive. It highlighted the importance of Doñana National Park as home to several Natura 2000 sites. This reasoned opinion came as an answer to the remaining breaches after the formal notice issued in 2014. The EU Commission ordered Spain to act within two months and threatened to refer the case to the ECJ if actions remained absent (European Commission, 2016).

3.3.4.3 Parliamentary Scrutiny: the 2018 Parliamentary Question

However, the EU Commission did not act on its threat. On the 15th of October 2019 the EU parliament issued a Parliamentary question (E- 003314/2019) to the Commission raising awareness on the remaining nearly thousand illegal wells, rise in irrigation-dependent crops, water diversion and long drought risks. EU parliament intervention underlined the political urgency of the Doñana case and the institutional frustration with Spanish compliance deficits. The parliamentary question reinforced pressure on the Commission, leading to it referring the Doñana case to the ECJ in January 2019 by opening the procedure of Article 258 TFEU.

3.3.4.4 Referral to the Court of Justice (2019)

On the 21st of January 2019, the EU Commission decided to refer Spain to the Court of Justice "over a failure to take adequate measures to protect the groundwater bodies that feed the Doñana Wetlands…", as well as "… failing to take to take adequate steps to prevent the deterioration of protected habitats in the Wetlands,…" (EU Commission, 2019). Despite the Formal Notice in 2014 and Reasoned Opinion in 2016, Spain remained mainly inactive.

This step in judicial escalation catalyzed binding legal accountability when administrative and political pressure alone had proven insufficient.

3.4. The ECJ´s Judgement and the Persistence of Compliance Deficits

While the prior part of this Doñana Wetlands case analysis dealt with indicating and evaluating the ´status quo´ of wetland degradation, this subsequent part will deal with analyzing the EU enforcement mechanisms considering the EU infringement procedure of Article 258 TFEU and show why despite a clear ruling and normative obligations, non-compliance persists.

3.4.1 The ECJ´s Judgement on the Doñana Wetlands Case

On the 24th of June 2021 the European Court of Justice ruled that the Kingdom of Spain failed to fulfill its obligations under Article 5 (1) of the Water Framework Directive by "failing to take into account illegal water abstraction and the abstraction of water intended for urban supply when estimating the abstraction of groundwater from the Doñana region…"(C-559/19, para 177). Furthermore, Spain failed to fulfill its obligations under Article 11 WFD, read in conjunction with Article 4 (1) of that directive "by failing to lay down, …, any measure to prevent disturbance of the protected habitat types located within the Doñana protected area…" (C-559/19, para 177). Moreover, the Court found that Spain´s actions were inconsistent with Article 6 (2) of the Habitats Directive "… by failing to take appropriate steps to avoid significant disturbance of the protected habitat types located within the protected area of Doñana, …" (C-559/19, para 177).

The Court´s findings largely confirm the hypotheses advanced in subception 3.3 regarding Spain´s failures to assess and control groundwater abstraction and to prevent habitat distortion. In particular, the ruling validates that insufficient consideration of illegal and urban water withdrawals constituted a breach of Art. 5 (1) WFD and that the lack of protective measures violated Article 11 WFD and Article 6 (2) of the Habitats Directive. Conversely, the Court´s dismissal of claims under the Birds Directive and Article 6 (1) and 6

(3) Habitats Directive indicates that the corresponding hypotheses regarding these provisions were not substantiated.

dismissed the case as to the remainder of the alleged breaches, that were brought on by the European Commission.

3.4.2 Implications

While rulings of the European Court of Justice do not constitute enforceable titles like national rulings do, they still do merit certain implications. The infringement procedure under Article 258 TFEU underscores the legal and practical consequences of Spain´s non-compliance. By finding breaches of Article 5 (1) and 11 WFD, as well as Article 6 (2) Habitats Directive, the Court not only mandates Spain to take corrective measures but also signals the accessibility of further enforcement impulses, in particular financial sanctions under Article 260 TFEU should compliance fail. From a broader perspective, the ruling clarifies the Member State´s obligations regarding groundwater assessment, habitat protection, and monitoring, thereby reinforcing EU environmental law and providing a precedent for other Member States to adjust their governance and enforcement practices.

Still, it must be seen that it is not part of the EU´s prerogatives to enforce ECJ rulings. Member States stay sovereign, no matter what international organization they might join and cannot be coerced to certain action, neither under European Law, nor under International Law. The European Commission is mostly limited to Art. 260 TFEU and similar financial sections in answering to compliance deficits.

3.4.3 Persistence of Compliance Deficits

This subsection analyses the persistence of Spain´s compliance deficits in the Doñana case, demonstrating how intertwined structural, political and administrative constraints weakened both national and EU enforcement efforts.

3.4.3.1 Fragmented Governance

Unlike other big democracies around the world like the United States of America or Germany, Spain is not governed by a federal state system. It is a decentralized parliamentary democracy with strong autonomous regions. These autonomous regions have broad powers that can overlap or conflict with national law. Competences are not clearly divided and only partially constitutionally guaranteed. As each autonomous community negotiates its own Statute of Autonomy, environmental responsibilities can vary from region to region, leading to much more fragmentation in highly politicized fields, than one would find in a federal state Acknowledging that fragmentation is also problematic in federal states, one still must see that multi- layered decision- making as such is dispersing responsibilities and producing coordination failures. Competences are divided between national administration, the Autonomous Community of Andalusia, basin authorities and local municipalities (Hispagua, 2021). In practice, no authority acknowledges full responsibility for environmental obligations. Börzel (2003) argues that "if an EU policy does not fit the regulatory structures in a member state, its legal transportation, practical application, and enforcement impose considerable costs of adaptation, which domestic actors are hardly inclined to bear" (p.3). For the Doñana region, where over- exploitation of groundwater recourses and agriculture around the region have gone on for the last decades and brought in a substantial local revenue (e.g. subsection 4.3.2.), local authorities´ incentives in monitoring and enforcing EU environmental obligations may stay limited.

3.4.3.2 Socio-Economic Incentives

Additionally, Doñana´s progression in becoming an economic driver in the region, has led to more potential for compliance deficits.

Rodriguez and De Stefano (2012) state that groundwater use in the Doñana region for agriculture contributes to "an annual production value of 250 M€, 1,7000 involved farmers, 12,000 permanent and 50,000 temporary employees in the province of Huelva, from which the largest part is located in the area of Doñana (…), …" (p. 272). Over the last decades, Doñana transformed into one of the largest strawberry producers in the world. Between

24% and 48% of the active population in the Doñana region work for the agriculture sector (Junta de Andalucía, 2009; 2010 b, Rodriguez&De Stefano; p. 272).

This strong economic reliance on agriculture in the Doñana region has created substantial socio- economic incentives, possibly conflicting with environmental protection objectives. A cycle of compliance deficits has developed in the region, as the intensive groundwater use leads to high revenue in the sector, generating employment and local income, which in turn strengthens political and social support for maintaining current practices. Lawmakers and authorities, aiming at re-election and the overall content of the people regarding their administration may prefer to face financial sanctions by the EU than face the consequences of heavy civil contempt.

3.4.3.3. Temporal Gaps in EU Enforcement

Compounding this, long time frames between infringement and ruling (e.g. subsection 3.4) in EU infringement procedures, led to the possibility for compliance deficits to manifest. It took the European Union more than ten years to activate enforcement measures after the WWF´s formal complaint. In that time, the agricultural sector around Doñana grew more, not only in revenue but also in influence. Illegal wells became practice, farmers dependent and the area itself highly politized, showing that one can have the most ambitious and sophisticated legal framework in the world but still face enormous struggles implementing it and balancing it to the realities of our world.

3.5. Structural Limits of EU Environmental Law: Overcoming Fragmentation and Anthropocentrism Through Post-Anthropocentric Approaches

3.5.1 Hyperobjects: Understanding Doñana's Slow-Moving Crisis

The ecological degradation occurring in Doñana-its declining groundwater table, drying marshes and ponds, and the increasingly visible impacts of climate change, illustrates what Morton describes as hyperobjects. These are processes that are so vast in time and space that they defy simple human perception and traditional causal reasoning, as illustrated in the first chapter. The degradation in Doñana has unfolded over decades, accumulating

multiple challenges such as groundwater overextraction, agricultural expansion, droughts, and altered hydrological cycles. Over more than 40 years, groundwater levels in the Almonte-Marismas aquifer dropped dramatically, yet EU enforcement mechanisms only responded after repeated warnings spanning decades. This slow and distributed process makes the crisis hard to detect, quantify, and ultimately regulate.

What makes Doñana illustrative of Morton's concept is the subtle way in which these changes manifest. There is no single dramatic moment that marks "the beginning" of the crisis. Instead, the degradation appears in small steps. The ponds that no longer refill, marshes that shrink a little more each season, or species whose absence becomes noticeable after several years. These small changes rarely lead to immediate action, but over time they summarize. The result: a decline that is hard to reverse once it becomes noticeable.

EU Environmental Law, which relies on simple targets and breaches which are clearly identifiable, struggles to address this type of environmental change. Hyperobjective processes do not align with the way EU law is applied in present times. In Doñana, reports repeatedly stated concerns about declining groundwater levels, but these warnings did not lead to an action. By the time Spain's inaction had legal consequences, the environmental damage was already serious and permanent in some cases. With our current legal system we tend to wait for breakdown before intervention. This reflects a broader structural problem: ecological processes often operate on timescales that are different from how human-centered legal frameworks work. Hyperobjects unfold diffusely and slowly, which makes it difficult for governance systems to keep up with the legislation. The result is a temporal mismatch between urgency and institutional action. While ecological signals accumulated over years, institutional processes advanced slowly. From early warnings to NGO complaints, administrative procedures, and finally a ruling by the European Court of Justice. This gap reveals what Morton's theory helps to point out: some environmental challenges overwhelm not only human perception but also the administrative and legal structures designed to regulate them. Doñana demonstrates that legal frameworks can lag

behind ecological realities when we're facing hyperobjective phenomena. The case again states that governmental structures need to be capable of responding faster to environmental processes. It also illustrates the fundamental problem Morton's concept shows: the scale of environmental threats exceeds human capacities and goes beyond what humans are able to handle.

3.5.2 Rights of Nature: When a Protected Wetland Has No Legal Voice

Even though Doñana is recognized globally for its biodiversity and is protected under multiple regimes like Natura 2000, Ramsar, UNESCO World Heritage, the wetland itself has no independent legal voice. Our current EU directives and the national legislation protect it only indirectly. Instead of recognizing the wetland as a living entity with its own rights, they focus on human responsibilities and conservation goals. Despite repeated warnings from scientists and NGOs, there has been a long inaction in Spain. The case of Doñana illustrates the limits of an human-centered approach.

The Rights of Nature perspective offers a lens to understand these shortcomings. The way we enforced laws could have been very different if Doñana with its aquifer, or the broader Guadalquivir system had been recognized as legal subjects with their own rights. Legal accountability would have focused on protecting the wetland itself, rather than just making sure that humans follow the rules. Courts could have acted in favor of the wetland and decisions could have been guided by its needs rather than by administrative or political considerations.

Moreover, the Doñana case shows how fragile an human-centered approach can be. Only, if humans notice the problems and decide to act, we are able to enforce laws to protect ecosystems- which is often too late. The EU infringement process unfolded over more than ten years- from the initial WWF complaint to the 2021 ECJ ruling. In the meantime, the wetland had to suffer ecological harm and remained vulnerable.

Recognizing ecosystems as legal actors could change the way we think about accountability. Violations could be seen as direct harm against the ecosystem, instead of seeing breaches

only as failure by the government or institutions. This perspective could help to protect habitats, water, and wildlife more quickly and effectively. Looking at Doñana from this angle shows the scale of the problem. Its wetlands, marshes, ponds, and aquifer work together as one interconnected system that provides a habitat for many different species. This includes endangered species such as the Iberian lynx, the white-headed duck, and the European eel. These species all rely on the integrity of the wetland and aquifers.

Current legal frameworks cannot represent these systems, leaving their protection fully dependent on human action. A Rights of Nature approach could give the ecosystem a voice with its own enforceable rights, allowing it to be defended in court and be safeguarded against harm. Doñana, and also other environments and entities would be taken into consideration in decision-making and legislation. Doñana reveals a new perspective. It reminds us of the limitations our legal frameworks face, while also letting us catch a glimpse of the potential of reimagining environmental law. Viewing the case through this lens not only reinforces the need for stronger legal protection but also encourages us to rethink what it means to “protect” nature in Europe today.

5.3 Object-Oriented Ontology: The Withdrawal of Doñana’s Ecological Realities

The theory of Object-Oriented Ontology (OOO) implies that natural entities have their own reality and exist independently from how humans perceive them. The idea of OOO becomes clear in Doñana. The aquifer, marshes, and ponds operate according to natural rhythms and dynamics that are often difficult to measure or predict. The wetland does not act according to human expectations. Water levels fluctuate in response to seasonal rains and broader climatic trends, which are all patterns that we can't control and that surprise even the most experienced scientists. Through decades of research, monitoring, and data collection scientists got valuable insights into Doñana’s hydrology and ecology. Nevertheless, they have struggled to capture the full scope and complexness of groundwater extraction and its effects on the wetland. Some ecological processes remain delayed, unpredictable or even hidden. The effects of small-scale groundwater withdrawals for example, can take years to manifest in pond levels or marsh vegetation. The interplay of climate variation, soil

permeability, and aquifer dynamics often have outcomes that no dataset can fully capture. Some parts of Doñana's ecosystem remain hidden from our view, leaving gaps in what we know. Doñana shows that ecological entities have their own rhythms. Interactions and thresholds often operate by themselves, independently of human monitoring or intervention. As a consequence, enforcement and management strategies lag behind the realities of the ecosystem. Action is mostly taken after the effects become visible, which is often too late. Environmental law usually assumes that ecosystems can be fully represented and understood. Doñana challenges this. In reality we are unable to manage ecosystems only through data, maps, and regulatory frameworks. Doñana shows how problematic it is to assume that if humans can quantify a problem, they can control it. In reality it is far more complex.

Instead of focusing only on data or compliance, laws need to be designed to handle uncertainty better, while also respecting nature's idependence. If we recognize the character of environments like Doñana, it would be easier to create legal approaches that work for such complex and interdependent ecological systems. Object-Oriented Ontology encourages us to view environments as whole systems of their own, not only as fragments. Environments like Doñana have their own realities, with dynamics that are only partially visible for us. Doñana provides a clear illustration of the limitations our current law system has to face. It also highlights the need for new frameworks that embrace ecological complexity and uncertainty. Recognizing the independent rhythms of Doñana's aquifer and wetlands could help to create legal frameworks that act rather proactively than reactively. Embracing ecological uncertainty would enable laws to apply the precautionary principle more effectively in order to prevent long-term damage.

5.4 Ecosystemic Thinking: Recognizing Interdependence in a Fragmented Legal Framework

The case of Doñana is the perfect example to illustrate the idea of Ecosystemic Thinking, which focuses on the interconnection, the relationships and the reciprocity between different ecological components, rather than treating them as separate, isolated units.

The wetland's health depends on a balance between water levels, vegetation, and wildlife. Small changes in one part of the ecosystem can have immense effects on the entire system. The yearly flooding cycles, the link between the Guadalquivir basin and the wetland, and the interdependent system of marshes, ponds, and groundwater all reveal the complexness and interconnection of Doñana's ecosystem. Any change in water quality or availability can lead to serious consequences. The issue of the groundwater decline for example has an impact on habitats, which in turn affect bird populations. The area of Doñana provides a home for many endangered species that cannot survive elsewhere. Additionally, some ecological interactions, like predator-prey relationships, may appear subtle but in reality are essential for maintaining a balance. When these relationships are disturbed and lose balance, the entire ecosystem is going to be affected.

Despite this, EU Environmental Law remains fragmented. Water is regulated under the Water Framework Directive, habitats under the Habitats Directive, and birds under the Birds Directive. Our current EU Environmental law system is unable to view ecosystems as a whole and therefore struggles to capture the reality of Doñana. Legal enforcement is often addressing the symptoms instead of the underlying systemic causes. Therefore, policies and laws need to recognize that all parts of ecosystems are interconnected. Incorporating the precautionary principle could allow earlier intervention. Only then, long-term legislation can be adapted in a way to prevent long-term damage. The case of Doñana again highlights why integrated, ecosystemic thinking is essential. Imagining it through the lens of ecosystemic thinking, ensures that governance is aware of the complexity that defines places like Doñana.

4. INTERNATIONAL LAW IN PRACTICE: NUCLEAR TESTS

4.1 Description of the Conflict: Australia (and New Zealand) vs. France's Atmospheric Buclear Weapons Tests in the Pacific.

The case of Nuclear Tests (Australia v. France; New Zealand v. France) before the International Court of Justice (ICJ) in 1974 represents a pioneering conflict in international environmental law.

The dispute is centred on a series of atmospheric nuclear weapons tests conducted by France in the South Pacific from 1966 to 1974 in the atolls of Moruroa and Fangataufa in French Polynesia, an overseas collectively attached to the French Republic (Danielsson, 1984).

The radioactive fallout from these atmospheric explosions drifted beyond France's national jurisdiction, depositing across vast areas of the Pacific Ocean and directly onto the territories of neighbouring countries, notably Australia and New Zealand (Firth, 1986). These states, alongside other Pacific Island states, raised grave concerns over the significant and unacceptable risks posed to the health of their populations and the contamination of their territorial seas, airspace, and overall environment (International Atomic Energy Agency, 2001).

The legal action was initiated when Australia and New Zealand separately filed applications against France at the International Court of Justice (ICJ) in 1973 (Nuclear Tests (Australia v. France), Judgement, I.C.J.1973, May 9). They argued that France's atmospheric testing violated fundamental principles of international law, including the right of states to be free from the deliberate introduction of hazardous radioactive fallout into their territory. The case, Nuclear Tests (Australia v. France), became a landmark legal confrontation, pitting a state's claim to national security and defence testing against the emerging principles of environmental protection and the sovereign rights of other states (Suter, 1995; Thakur, 1986).

4.1.1 The Historical and Political Context: Decolonization, the Cold War, and the Emerging Global Environmental Consciousness (keyword: 1972 Stockholm Conference)

The dispute was profoundly shaped by the ongoing process of decolonization, which cast France's actions as a form of environmental colonialism. By using its distant colonial territory of French Polynesia as a testing ground for activities, deemed too hazardous for metropolitan France, Paris perpetuated a colonial-era power dynamic. This practice was vehemently opposed by newly independent and non-self-governing nations across the

Pacific, who saw it as an imposition of environmental risk by a European power onto non-European peoples and territories. Australia's legal challenge, while brought by a Western nation itself, strategically aligned with this anti-colonial sentiment. It framed the issue not merely as a bilateral disagreement, but as a defence of the fundamental right of all peoples, irrespective of their colonial status, to be free from externally imposed environmental harm. The principles debated at the recent 1972 Stockholm Conference, particularly the sovereignty of states over their own resources and their responsibility not to cause extraterritorial damage, provided a potent new legal and ethical language to articulate this long-standing grievance against colonial practice.

The Cold War provided the indispensable strategic rationale for France's nuclear testing program. In a world defined by superpower rivalry, France under Charles de Gaulle was determined to build an independent nuclear deterrent - the "force de frappe" - to guarantee its national sovereignty and maintain its status as a global power outside the direct hegemony of the United States. The atmospheric tests in the South Pacific were a critical, non-negotiable component of this national security strategy. From this perspective, Australia's lawsuit was a direct challenge to a core element of a major power's defence policy during a period of intense geopolitical tension. The environmental and health concerns raised by Australia were, in the Cold War calculus, subordinate to the existential imperative of maintaining a credible nuclear arsenal.

The United Nations Conference on the Human Environment, 5-16 June 1972, Stockholm was a key moment of crystallization of environmental consciousness on an international level. The Conference's Principle 21 explicitly recognized the responsibility of states to ensure that activities within their jurisdiction do not cause damage to the environment of other states. Australia's legal petition to the ICJ was a direct and pioneering attempt to transform this diplomatic principle into a binding legal obligation. The transboundary nature of radioactive fallout presented the perfect factual scenario to legally challenge the traditional, absolute concept of state sovereignty. Australia argued that France's tests violated the very spirit and letter of the emerging international environmental intention.

Therefore, the case was not just a bilateral dispute but a critical test case for the entire post-Stockholm work, seeking to establish that environmental protection had become a legitimate and enforceable concern of the international community, capable of limiting a state's freedom of action.

4.1.2 Central Research Question: To what extent did the case mark a turning point for the development of marine environmental law, even though the proceedings themselves did not yield a decision on the merits?

While the Nuclear Tests case concluded without a ruling on the merits due to France's unilateral undertaking to cease atmospheric testing, it nonetheless constituted a decisive, if unconventional, turning point in the development of marine environmental law. The case's great contribution was its successful procedural mobilization of bringing a claim against a major power for transboundary environmental harm. Australia demonstrated that such issues were justiciable at the highest international level, transforming abstract environmental concerns into a concrete legal dispute. The proceedings themselves forced the global community to confront the reality that pollution, particularly in the shared maritime domain of the high seas, was a matter of common concern. The case's legacy is not found in a judicial verdict, but in its role as a critical catalyst that elevated marine environmental protection from a peripheral issue to a central, non-negotiable pillar of the modern law of the sea.

4.2 Factual Background and legal starting points

To understand the impact of the conflict between France and Australia (New Zealand, Fiji), it is important to notice the factual and legal backgrounds of that case.

Before analyzing the reasons why France moved its locations it is also important to notice the historical pinpoints this dispute happened in, as stated before.

In the following the reasons to move, how the dispute was brought before the ICJ and the up following decision of the ICJ therefore shall be discussed.

4.2.1 France's Testing Program: Relocation from the Sahara to Mururoa (French Polynesia) and the conduct of atmospheric tests.

As stated before, the conflict between Australia and France started, when France moved it location for atmospheric nuclear weapons testing (Danielsson, 1884).

France relocated its nuclear testing program from the Sahara to Mururoa Atoll in French Polynesia in 1966, where it conducted 64 atmospheric tests until 1974 (Danielsson, 1984).

The reasons to move were simple:

France, while not a signatory to the Limited Test Ban Treaty (1963), has restricted its nuclear testing to underground explosions in the Sahara since 1961 (Suter, 1995).

The Limited Test Ban Treaty (1963) banned nuclear tests in the atmosphere, outer space and underwater.

However, as its weapons program advanced, information obtainable only from atmospheric tests has become increasingly critical (Danielsson 1984).

Also, France anticipated the loss of the Sahara testing location as the agreement with Algeria to use this site, would have been void until the mid-1967 (Danielsson, 1984).

Anticipating this need, Paris began searching for a new test site four years prior, announcing the selection of French Polynesia in 1963 and beginning construction there the same year (Danielsson, 1984).

French Polynesia was selected due to several points, mainly, political geographical and logistical reasons (Danielsson, 1984).

The political reasons were clear, French Polynesia was (and remains) a French overseas territory. This was the most critical factor (Firth, 1986).

By moving to its own territory, France avoided the kind of situation it had in Algeria, where it relied on an agreement with another government that had a fixed an end date (mid-1967).

This guaranteed long-term access and total political control over the test site (Danielsson, 1984; Central Intelligence Agency, 1975).

Geographically seen the isolation on the used atoll was perfect for atmospheric testing because it “minimized the immediate risk to civilian populations” from fallout and blast effects, addressing the key political and safety concern that had made atmospheric testing controversial elsewhere (Danielsson, 1984).

Also, the vast expanse of the Pacific Ocean provided a seemingly massive safety buffer and a controlled area for the tests, which would not have been possible in a more populated or confined region (Danielsson, 1984; Firth, 1986).

4.2.2 The Case before the International Court of Justice (ICJ):

France on the other hand felt, that the ICJ had no jurisdiction and expected the ICJ to declare itself unable for this complaint (International Court of Justice, 1973, June 22).

Then in June 1973 after the first round the ICJ deemed itself competent to rule over the complaint and therefore France lost its argument that the ICJ had no jurisdiction in that case (International Court of Justice, 1973, June 22). The ICJ gave the three countries that filed the complaint against France an interim measure of protection. The measure of protection was ordering France to avoid any nuclear tests in the South Pacific which could contain the sovereign territories of Australia (New Zealand and Fiji) with nuclear fallout (International Court of Justice, 1973, June 22).

Following that France boycotted future proceedings and went on with nuclear atomic testing (Nuclear Tests [Australia v. France], Interim Measure, Order of 22 June 1973, I.C.J. Reports 1973, p.99).

The ICJ went on working on the judgement on the substantive issues (Nuclear Tests [Australia v. France], Judgement, I.C.J. Reports 1974, p 253).

4.2.2.1 Australia's Submissions: Declaration of the illegality of the tests and cessation.

Australia not just simply implied that the nuclear tests were bad, furthermore it built a meticulous legal case on several pillars of international law around it.

"(..) have violated and, if the tests are continued, will further violate international law and the Charter of the United Nations, and, inter alia, Australia's rights in the following respects (..)" (International Court of Justice, 1973, May 9, p. 28, para. 49).

The first argument in Australia's application was the right to be free from atmospheric testing. Australia stated a sovereign right to, combined with other states meaningly the international community, be free from atmospheric nuclear test by any country.

This point claimed a violation against the whole international community (International Court of Justice, 1973).

The second and one of the most important points, was the violation of Australia's sovereignty through the French atmospheric testing.

The main argument was that the nuclear fallout on the territory of Australia and therefore also the dispersion of the radioactive fallout into Australia's airspace without the explicit consent was a direct violation of Australia's state sovereignty.

Therefore, impaired Australia to determine what shall happen within its territory and to its people.

Also, the Infringement of the freedom of the High seas was a point of argument.

The main argument was that the nuclear atmospheric tests and the therefore caused establishment of dangerous zones and the pollution of the high seas by radioactive fallout were against the freedom of the high seas (International Court of Justice, 1973).

These arguments led Australia to the formal request for cessation. This request for cessation was the legal consequence.

The request for ending the atmospheric nuclear tests were submitted to the ICJ: "(…) that the French Republic shall not carry out any further such tests (…) "(International Court of Justice, 1973, p.29).

4.2.2.2 The Legal Foundations of the Application:

In the following, the legal foundations which were discussed prior shall be analyzed. As stated before, in the application to the ICJ, Australia accused the French atmospheric nuclear testing to violate various principles of international law (International Court of Justice, 1973).

One of Australia's most concrete arguments was the violation of Australia's sovereign rights. This claim is based on the legal principle:

An important principle of international law is the sovereignty of states. Meaning that every state has the exclusive authority within its own borders. And therefore, the disregard of the Australian borders constitutes a violation.

Also, the counterplay between the freedom of the seas vs. the "no-harm" rule was at stake in the given case. Meaning the conflict between a state's right to act and its responsibility towards others (Danielsson, 1984).

One the one hand there is the freedom of seas, which includes the freedom of scientific research. France could have argued that it was conducting tests in an area under its sovereignty (French Polynesia) and over the high seas, where it had a right to do so (Firth, 1986; Suter, 1995). On the other hand, there is the no-harm rule. Australia argument was that the freedom of the seas is not absolute. It is limited by the duty to not cause harm to other states (International Court of Justice, 1973; International Atomic Energy Agency, 2001).

The radioactive contamination of the oceans and atmosphere, which traveled to Australia, represented a clear breach of even this duty. Exactly this turned France's lawful activity on the high sea into an unlawful one due to its harmful nature (Thakur, 1973).

4.3 The Proceedings Before the ICJ and The Surprising Decision of 1974

This section examines the pivotal legal proceedings before the International Court of Justice. It analyses Australia's successful request for provisional measures in 1973, which France ignored, and the Court's subsequent 1974 Judgment. The analysis will focus on the Court's surprising legal reasoning, terminating the case without a ruling on the merits by accepting France's unilateral declarations and the significant criticism this decision generated for avoiding the fundamental legal questions at the heart of the dispute.

4.3.1 Indication of Provisional Measures in 1973

On 9 May 1973, concurrently with its application instituting proceedings, the Government of Australia filed a formal "Request for the indication of Interim Measures of Protection." This urgent procedural mechanism, under Article 41.1 of the Statute of the ICJ, is designed to preserve the respective rights of the parties pending the court's final decision, aiming to prevent in this case further irreversible damage and ensuring the integrity of the judicial process.

The Government of Australia asked the court to indicate, the following interim measures of protection:

"The provisional measures should be that the French Government should desist from any further atmospheric nuclear tests pending the judgment of the Court in this case".

Australia's request for provisional measures was directly founded on the legal claims articulated in its Application. Australia argued that France's tests violated Australian sovereignty through the non-consensual deposit of radioactive fall-out on its people and territory, impaired its right to determine acts within its territory, and infringed upon freedoms of the high seas.

A critical and contentious aspect of this phase was France's refusal to participate in the proceedings on the interim measures. The French government, having challenged the Court's jurisdiction in a letter to the Registrar, chose not to appear before it. Nonetheless, the Courts strongly reaffirms, that “the non-appearance of one of the States concerned cannot by itself constitute an obstacle to the indication of provisional measures”. It demonstrates the procedural autonomy and hinders states from paralyzing the Court’s power to protect rights to pending the litigation by simply refusing to acknowledge the competence of the Court. The Court reasoned that it need only satisfy itself, prima facie, that it had jurisdiction to entertain the case, without making a final determination on the matter at this preliminary stage.

In its Order of 22 June 1973, the ICJ decided, by 8 votes to 6, to indicate provisional measures. It called upon the French Government to specifically refrain from conducting nuclear tests causing the deposit of radioactive fall-out on Australian territory. This specific injunction was framed within a general and reciprocal obligation incumbent upon both Australia and France to ensure that no action is taken which might aggravate the dispute, extend its scope, or prejudice the rights of the other party pending the Court’s final decision. However, to date, the Court has not been called upon to define if provisional measures have binding effects, made under Article 41 of the Statute.

From a critical legal perspective, the Court's Order constituted a pyrrhic victory for Australia. While symbolically significant as the Court’s first use of provisional measures to address transboundary environmental pollution and a robust assertion of its authority despite France’s non-appearance, it proved a profound practical failure. France's categorical disregard for the Order, continuing its 1973-74 test series and executing the project “Centaure” the 17th of July 1974, having one of the worst consequences for the Polynesian population. France acted with impunity, starkly exposed the enforcement deficit of international adjudication. The case highlighted a fundamental limitation against a powerful Permanent Member of the UN Security Council asserting a vital national interest, the

Court's authority, reliant on voluntary compliance, was insufficient to translate a legal victory into tangible environmental protection.

4.3.2 The 1974 Decision: No decision on the merits

4.3.2.1 The ICJ's Legal Reasoning: France's declarations had rendered the dispute moot; the proceedings were terminated

The core judicial phase of the Nuclear Tests case concluded not with a verdict on the legality of atmospheric nuclear testing, but with a decision that the dispute had ceased to exist. The Court's Judgment of 20 December 1974 is a landmark of international procedural law, notable for its reasoning rather than its substantive outcome.

The pivotal element was a series of public statements made by French authorities in 1974, announcing that France's 1974 nuclear test series would be the last of its atmospheric tests. Australia contended these were non-binding statements of future intent, insufficient to deprive the Court of its jurisdiction.

However, the ICJ declared that the unilateral declarations made by France from several plenipotentiaries, such as the French President, Valéry Giscard d'Estaing the 25th of July 1974 promising it would be the last series of atmospheric nuclear tests in a press conference. This intention was later followed by other ministers of the French government. Therefore, the Court declared that unilateral state acts can generate binding legal obligations. Where a state manifests an intention to be bound, the declaration constitutes a legal undertaking, imposing upon that state a subsequent obligation to conform its conduct to the declared terms (para 43).

Applying this principle, the Court found the French statements to be entirely unconditional and irrevocable and thus constituting a legal undertaking to cease atmospheric tests. Consequently, the Court ruled that Australia's claim no longer had any object and the dispute was "moot," terminating the proceedings without a judgment on the merits.

4.3.2.2 The strict interpretation of unilateral declarations allowing underground nuclear tests

The ICJ's 1974 decision, by strictly interpreting France's unilateral declaration as pertaining solely to atmospheric tests, created a significant legal and environmental loophole. This narrow framing effectively sanctioned France's immediate transition to an underground testing program in French Polynesia, which continued until 1996. The scale of this subsequent activity underscores that the declaration was not a move toward disarmament, but a strategic shift to circumvent the specific legal objection raised by Australia, while preserving the core of its nuclear weapons program. Between 1975 and 1996, France conducted 147 underground nuclear tests, a volume far exceeding the 46 atmospheric tests it conducted between 1966 and 1974.

Critically, the environmental and health risks of underground testing, while different from atmospheric fallout, are far from negligible. Scientific assessments indicate that underground tests can lead to the subsurface migration of radionuclides, potential venting of radioactive gases into the atmosphere, and the chronic leaching of radioactive materials into the aquifers and surrounding marine environment. Thus, the Court's acceptance of a declaration that halted one form of pollution implicitly permitted another, demonstrating how a rigid, textual interpretation of a unilateral act can fail to address the underlying spirit of an environmental dispute.

Ultimately, the cessation of French nuclear testing in the Pacific in 1996 was not a consequence of the 1974 ICJ decision or its unilateral declaration, but a result of broader geopolitical shifts. France halted its program only following the conclusion of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), and after facing intense international and regional condemnation, particularly in the aftermath of the resumption of tests under President Jacques Chirac in 1995. The French moratorium became permanent with its ratification of the CTBT. This timeline confirms that the 1974 judgment did not resolve the fundamental conflict, it merely displaced it, with a final resolution achieved through multilateral treaty law rather than the Court's adjudication.

4.3.2.3 Criticism of the Decision: Avoidance of the fundamental legal questions and the de facto reward of a fait accompli

The ICJ's 1974 judgment has been extensively criticized in legal scholarship for its failure to address the fundamental legal questions presented by Australia. By terminating the case on procedural grounds of mootness, the Court avoided ruling on the core substantive issues: whether the deliberate introduction of radioactive fallout into another state's territory constitutes a violation of sovereignty, and whether a customary international law norm prohibiting such transboundary environmental harm existed.

This judicial avoidance had the effect of de facto rewarding a fait accompli. France, having completed its atmospheric test series, was able to unilaterally declare the dispute over without ever having to defend the legality of its actions before the Court. Hence, the decision permitted a state, in theory to continue contentious activities while litigating, subsequently issue a narrow declaration to cease the specific activity challenged, and thereby evade a binding legal judgment on the merits. This undermined the judicial function and signalled to other states with nuclear power that with strategic conduct, they could shield their sensitive "vital interests" from authoritative legal scrutiny. The case remains a stark reminder of the judicial limitations of international adjudication and the potential for procedural doctrines to be used to sidestep the development of substantive legal principles, particularly in the critical field of environmental protection.

4.4 Legacy and Limits: The Case as an Anthropocene Paradox

4.4.1 The Catalytic Legacy: Normative Progress in a State-Centric System

Consequently, the case's legacy is embedded in Part XII of UNCLOS, which can be read as a direct response to the challenges it posed (Stephens, 2009; Verlaan, 2014). Article 192, establishing the general obligation to "protect and preserve the marine environment," and Article 194, requiring states to take all necessary measures to prevent, reduce, and control marine pollution, operationalize, and universalize the core legal principal Australia invoked: the no-harm rule. These provisions transform that rule from a contested claim in a

contentious proceeding into a bedrock, treaty-based obligation of due diligence applicable to all marine activities, explicitly aimed at preventing damage beyond national jurisdiction.

Furthermore, the impetus from the case contributed directly to regional instruments designed to prevent a recurrence of such disputes (Gee, 2018; Rothwell, 2015). Most notably, it galvanized regional action that culminated in the 1985 South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga). This treaty effectively codified the outcome sought by Australia and New Zealand at the ICJ, prohibiting nuclear testing within the zone and, through its protocols, seeking commitments from nuclear-weapon states to respect its terms. Thus, the Australia v. France case, through both the failure of its judicial resolution and the success of its normative appeal, acted as a critical catalyst, accelerating the crystallization of preventative environmental principles in both universal and regional legal frameworks.

4.4.2 The Structural Limit: Anthropocentrism and the Sovereignty Barrier

4.4.2.1 The Hyperobject Challenge

The core challenge in the 1974 Nuclear Tests case was that the harm France caused was what philosopher Timothy Morton calls a "hyperobject" (Morton, 2013). A hyperobject is something so vast in time and space that it breaks the normal ways of thinking. Radioactive fallout from the tests was a perfect example: It ignored borders: The radiation didn't stop at the edge of French territory. It spread across the open ocean and into other countries air and water, making the idea of a simple territorial dispute useless.

It lasted generations: The contamination poses risks for thousands of years, far beyond the timeline of any court case or political administration (Morton, 2013)

This created a huge problem for the law. Australia had to describe this enormous, long-term danger in the only language the ICJ understood: a present-day trespass on its land or further the breach of the sovereignty of Australia (Stephens, 2009). The legal system was blind to the real crime, a lasting poisoning of the planet and a debt owed to the future. The

case showed that our traditional laws, built on maps and short-term thinking, are completely unable to handle environmental threats of this big scale.

4.4.2.2 The Forced Legal Translation

To make its case against France's nuclear tests, Australia had to describe the problem in a way the court understood. The real problem, radioactive poison spreading across the ocean and lasting for thousands of years, was too big for the international law's vocabulary.

The ICJ's rules were built for fights between countries about borders and immediate injuries. So, Australia couldn't say France was "harming the future" or "damaging the sea itself." Instead, Australia had to shrink the problem down and argued, that it's about the population of Australia. That the radiation itself was a danger to the health of Australians today. Also, that the nuclear fallout was illegally entering Australia's air and territory right now. Keeping the long- term effects, as implied prior, out. In essence, the law made Australia tell a much smaller story. It had to turn a global, long-term environmental disaster into a simple case of one country littering on another country's lawn. This showed that the law was good at protecting a country's property, but completely unable to protect the planet or the future.

4.4.2.3 The ICJ's Revealing Logic: The 1974 decision is the proof

The 1974 judgment by the International Court of Justice demonstrates the fundamental logic and the limitation of the international legal system. In declaring the dispute "moot," the Court did not base its decision on the cessation of environmental harm. The radioactive contamination, a persistent and intergenerational threat, remained active in the ecosystem. Instead, the Court terminated the case because France's actions that triggered the complaint had ceased, based on France's unilateral declaration.

This reasoning reveals a core principle of the system: international law prioritizes the consent and sovereignty of states over ecological continuity or integrity.

The outcome confirms that the legal framework is designed to mediate conflicts between national governments, not to serve as a guardian of the environment itself.

The unresolved, lingering damage to the marine commons was deemed legally irrelevant once France changed its policy.

The ruling thus underscores that, in this system, planetary health remains subordinate to political agreement.

4.4.3 The Enduring Paradox: Articulated Norms vs. Sovereign Impunity

The Nuclear Tests case transmits a dual and contradictory legacy to international law, covering a core paradox of the Anthropocene. On one hand, it acted as a powerful normative catalyst. Global opposition and legal proceedings exposed the insufficiency of mid-20th-century ocean law and directly influenced UNCLOS III, culminating in the robust environmental obligations of Part XII. Articles 192 and 194 codified the preventive no-harm rule and the duty to protect and preserve the marine environment, elevating a previously diffuse principle into a cornerstone of environmental law. (Jacqueline Peel, 2024)

Conversely, the case crystalized structural failure. The ICJ's 1974 termination of proceedings based on France's unilateral declaration revealed, that these norms operated within an unchanged, state-centric framework. The Court treated the dispute as moot not when hyperobject of radioactive contamination ceased to pose a threat, but when the sovereign act of atmospheric testing was voluntarily halted. (Nuclear Tests (Australia v. France), Judgement, I.C.J. Reports 1974, p. 253., n.d.) This enforcement gap is a structural feature of an international legal order built on the twin pillars of sovereign equality and consent. The system is designed to manage inter-state disputes, not to autonomously protect the environment. When a state invokes "vital interests," – like France – it relies on the very state responsible for the harm to voluntarily limit itself.

This paradox continues to shape ocean governance. Although a sophisticated lex scripta of environmental principles now exists, it functions within a structure that often shields

sovereign and corporate actors from accountability. Contemporary issues such as deep-sea mining and oceanic climate disruption reproduce the same pattern, activities with severe transboundary impacts proceed under claims of sovereign rights or high-seas freedoms, while legal restraints remain slow, reactive, and politically contingent. (Oliver Ashford et al., 2025) The Nuclear Tests case thus underscores a foundational lesson, international environmental law can generate visionary norms, but its capacity to enforce them is constrained by its anthropocentric, state-privileging foundations.

4.5 Conclusion: Assessment and Contemporary Relevance

The Nuclear Tests case stands as the definitive embodiment of the “catalyst vs. non-event” paradox in international law.

While a procedural non-event for its lack of a merits ruling, it was a profound normative catalyst, galvanizing the codification of marine environmental protection in UNCLOS. Informed by an Anthropocene critique, however, this success reveals a deeper failure. The Court’s acceptance of France’s unilateral declaration privileged state consent over ecological integrity, demonstrating that the system’s anthropocentric architecture is structurally geared to resolve inter-state disputes, not to restrain sovereign harm to the planet.

This paradox defines its urgent contemporary relevance. The “translation problem” Australia faced—having to frame a diffuse, intergenerational environmental catastrophe as a present violation of its sovereign rights—is identical to the challenge confronting small island states today as they seek climate justice before the ICJ. (Obligations of States in Respect of Climate Change, 2025) Climate change, like radioactive fallout, is a hyperobject that defies the temporal and spatial scales of international law, yet victims must still argue within its limiting, state-centric logic.

Finally, it is necessary to contextualize France’s conduct within broader historical patterns of nuclear testing. Similar programs were undertaken by other nuclear powers in remote atolls and overseas territories, reflecting a recurring practice of externalizing the

environmental and human costs of nuclear deterrence. Viewing the case through this wider lens shifts focus from attributing blame to a single state toward critiquing a systemic tendency within the Cold War security paradigm: the treatment of geographically and politically marginalized spaces as acceptable zones for risk. This pattern underscores that the challenge exposed by the case was not merely French, but structural, rooted in an era where great-power interests routinely overrode the sovereignty and well-being of distant populations.

5. COMPARING THE DOÑANA AND NUCLEAR TESTS CASE

Both cases show how environmental law tries to react to serious ecological harm, but they both expose different weaknesses. The Doñana case reveals slow, fragmented and anthropocentric enforcement within a developed regional order (Centro de Documentación Europea, 2022). Conversely, the Nuclear Tests case shows that even when global principles exist, international law can end as a so-called “legal non-event” when a powerful state can stop a case politically before a final judgement takes place (ICJ 253, 1974).

5.1 Core Features of Each Case

5.1.1 Doñana Wetlands (Comission v Spain, C-559/19)

Doñana is a highly protected European Wetland (Natura 2000, Ramsay, UNESCO, Biosphere Reserve) that is affected by long-term overuse of groundwater. Especially from berry farming, tourism, illegal wells, fragmented governance and drought, driven by climate change (Marta Vidal, Kira Walker, Drying Out, 2023). The CJEU decided in 2021 that Spain breached the Water Framework Directive, by failing to account for illegal abstractions and also to achieve and especially maintain a good groundwater status. It was also conducted that Spain breached the Habitats Directive, in failing to prevent deterioration of protected habitats. However, a breach of the Birds Directive was not concluded (Centro de Documentación Europea, 2021).

5.1.2 Nuclear Tests (Australia v France, ICJ 1974)

France relocated atmospheric nuclear tests from the Sahara to Mururoa/Fangataufa in French Polynesia (1966-1974), causing a radioactive fallout across the Pacific and onto Australian and New Zealand territory. Australia and New Zealand brought separate ICJ cases. First of all arguing about violations of sovereignty, the no-harm rule and eventually emerging environmental principles. The Court declined to rule on the merits after France gave unilateral public assurances that it would end atmospheric tests and move to underground operations (International Lawyer, 2018)

5.2 Comparison of Legal Framework

Even though both deal with serious environmental harm, the Doñana and Nuclear Tests case are built on very different legal frameworks. In the Doñana Case, the Court of Justice of the European Union applied detailed, binding secondary EU law. Especially in correspondence to the Water Framework Directive and the Habitats Directive. These impose precise duties on Member States in order to prevent deterioration of water bodies and protected habitats (C-559/19, para 2, 2020). Spain is part of a supranational legal order where it has already accepted the Court's compulsory jurisdiction. Resulting from this, the European Commission can directly start an infringement procedure and obtain a final judgment that Spain had failed to fulfill specific (treaty-based) obligations concerning groundwater states, monitoring and habitat protection in the Doñana area (Santiago Álvarez, WFD and Habitats Directive, 2020)

In contrast, the Nuclear Tests case before the International Court of Justice relied primarily on broad principles of public international law. It also featured developing soft-law environmental norms, rather than on any detailed, codified regularity framework. Australia argued that France's atmospheric nuclear tests violated its territorial sovereignty by depositing radioactive fallout on Australian territory. Also concluded, was the breach of the no-harm rule by causing environmental damage and interfering with the freedom of the high seas by polluting ocean areas and creating exclusion zones (Jerome B. Elkind, Vanderbilt Journal of Transnational Law, 2021). The ICJ's jurisdiction depended on France's

consent, which they did, and although the Court was willing to proceed and even indicate provisional measures, the case never reached a substantive finding on illegality because France issued unilateral declarations. France announced that it would end atmospheric testing, leading the Court to treat the dispute as having lost its aim (International Court of Justice, 1974).

To simplify it, Doñana is protected by a strong regional system with clear rules and an effective court that can enforce them. The Nuclear Tests case takes place in the much looser world of global international law, where only broad principles exist and binding duties or court jurisdiction are weaker and depend mostly on whether states agree and also on political considerations.

5.3 Environmental Harm and Scientific Evidence

In Doñana, the damage built up slowly over many years. Groundwater levels fell, temporary ponds dried out, and protected habitats and species came under stress. This happened mainly because of intensive legal and illegal irrigation and climate change. Scientific institutes, UNESCO and NGO's documented this long before 2021, but the real legal action only started after many years of complaints and monitoring (WWF, EU court rules Spain at fault over degradation of Doñana, 2021).

In the Nuclear test, the harm was sudden and highly visible. Atmospheric nuclear explosions sent radioactive fallout across borders, which threatened human health, marine life and the freedom of the high seas. But still, there was uncertainty about exact radiation doses and Cold War security politics, which made it hard to turn this risk into a clear judicial decision on illegality (ICJ 253, 1974).

Both cases show that science is essential but not enough on its own. In Doñana detailed data eventually proved Spain's non-compliance but only after the fact that serious degradation was in process. In Nuclear Tests, the fear of long-term, invisible contamination justified provisional measures, but finally did not lead to a final judgement on the merits.

5.4 Enforcement and Outcomes

In Doñana, the European Commission followed all formal steps and took Spain to the EU Court of Justice. This issued a binding ruling, saying that Spain had broken EU water and nature laws (C-559/19, para 37, 2020).The Commission is still pressuring Spain to close illegal wells and change water plans, but local dependence on farming and tourism slows down real progress.

In the Nuclear Tests case, the ICJ told France not to let fallout reach Australian and New Zealand, but France ignored the case and kept testing until it chose to move tests underground. The Court then closed the dispute without judging legality or demanding compensation from France, which showed how powerful states can avoid real legal consequences.

5.5 Anthropocentrism and Structural Limits

Doñana shows that even advanced EU environmental law is still focused on humans and divides into separate rules for water, habitats and species. Action is usually late and shaped by economic interests. Ideas like hyperobjects, Rights of Nature and ecosystem thinking show how slow, complex ecological change does not fit well with a rigid law that is human-centered (Santiago Álvarez, WFD and Habitats Directive, 2020).

The Nuclear Tests case reflects human priorities. France stressed national security, and Australia and New Zealand focused on sovereignty and health. But the concern of the marine ecosystem was secondary. New environmental principles existed, but they could not override nuclear politics or the need for state consent (International law reports, Cambridge University, 2021)

In both cases, ecosystems have no legal voice. They appear only as things humans try to protect. A Rights of Nature view would stress that neither Doñana nor the Pacific Ocean had their own standing.

5.6 Temporal Dynamics and Overall Problem

As seen in the Doñana case, slow enforcement was illustrated. Scientists and NGO's warned for decades about the groundwater over-use and drying ponds. Only after serious deterioration did the EU obtain a judgement, which underlined the mismatch between ecological time and legal time.

The Nuclear Tests case is seen as a "legal non-event" because there was no merits judgment. Nevertheless, the proceedings helped to delegitimize atmospheric nuclear testing and reinforce environmental and anti-nuclear norms. This revealed how weak international law can be when a major power can end a dispute by changing practice without admitting any wrong doing.

Overall, the cases show that environmental law is largely reactive, fragmented and centered on state interests. This leads to a struggle to match the speed and scale of water and biodiversity crises, which then supports the argument that a post-anthropocentric approach should strengthen enforcement and give ecosystems a more direct role in law.

6. CRITICAL REFLECTION

Environmental law faces a persistent challenge. Ecosystems are complex, interconnected and constantly evolving. Environmental law is setting standards and trying to recognize the need for protection. Despite this, our current law system still struggles to grasp the complexity of living ecosystems and to keep pace with its realities. This reflects a deeper structural issue: environmental law still treats nature as a resource to be managed, rather than as a system with intrinsic value and interdependencies.

This tension becomes particularly visible in the case of Doñana. The excessive extraction from the Almonte-Marismas aquifer, including thousands of illegal wells, caused water tables to drop, which threatened migratory birds and endangered species such as the Iberian lynx. Despite clear evidence of harm, EU enforcement mechanisms took almost a decade to respond. This examines the slow pace of legal intervention, as well as the structural incapacity of institutions to act proactively. We are currently facing a mismatch

between scientific urgency and political or legal response. Furthermore, the legal frameworks remain fragmented. Our law distinguishes between the Water Framework, Habitats, and Birds Directives. All of these laws may address individual symptoms, yet they often fail to integrate the interconnected processes that sustain the ecosystem as a whole. The Doñana case moreover shows that even when legal breaches are identified, enforcement remains slow and politically constrained. Scientific warnings accumulated for decades, but intervention was taken only after irreversible damage occurred.

A similar pattern can be observed in the case of French nuclear testing. Between 1966 and 1974, France conducted 64 atmospheric nuclear tests at Mururoa and Fangataufa. Australia and New Zealand brought the case before the ICJ and the court issuing provisional measures in 1973, France still continued testing until it declared it would shift to underground explosions. This illustrates the limitations of enforcement in international law. International non-proliferation treaties, EU safety directives, and national energy strategies each target a particular aspect of risk, but they rarely address the overall consequences. Regulations frequently fail to cover the broader ethical and ecological dimensions, such as the potential for long-term contamination or cross-border health effects. The case further illustrates how state sovereignty can limit environmental accountability. France's ability to frame nuclear testing as a matter of national security positioned ecological concerns as secondary, mirroring a broader pattern in international environmental law.

This illustrates a fundamental challenge: the assumption that natural systems can be entirely understood, predicted, and controlled through data and regulation. Decades of research provided invaluable insights. Despite this, ecosystems like Doñana continue to surprise us. Laws, which are built on the expectation of predictable risk often intervene after damage has already occurred. The cases also show that environmental degradation often evolves on time scales that do not align with legal procedures. Instead of treating uncertainty as a barrier to action, legal frameworks should treat it as a trigger for precaution.

This phenomenon is not a failure of EU environmental law, but rather a reflection of its limits. The same precision and separation that make directives effective can become a problem when dealing with complex, interconnected systemic issues. Therefore, we need a shift in perspective. Legal frameworks must work across directives. They have to recognize uncertainty and follow precautionary principles, where our knowledge is limited. Protecting ecosystems and managing high-stakes systems like nuclear infrastructure requires laws that are as adaptive and relational as the systems they aim to govern. Our legal structures must reflect and respond to the complexity of the systems in order to safeguard the environment as well as society for the long term.

7. CONCLUSION

In this chapter the following research question is studied: how do the Doñana Wetlands case (C-559/19) and Nuclear Tests case (Australia v. France, ICJ, 1974) show the limits of EU and international water and biodiversity law and how might post-anthropocentric theories such as Object-Oriented Ontology (OOO), hyperobjects, and the Rights of Nature might help rethink ecosystem protection in the Anthropocene? The central thesis in this chapter is that existing legal frameworks are ambitious but structurally limited by anthropocentric and state-centered assumptions while post-anthropocentric theories provide conceptual tools for reimagining law in ways that better reflect ecological realities.

The Doñana Wetlands case and the Nuclear Tests case reveal the structural limits of EU and international environmental law. In the Doñana Wetlands case EU directives such as the Habitats Directive and Water Framework Directive aim to protect wetlands. However anthropocentric assumptions and economic pressures, especially Spain’s agricultural dependence and overextraction of groundwater, undermined their effectiveness. The ECJ confirmed legal breaches but compliance remained weak due to fragmented governance. This shows that EU law struggles with slow, cumulative ecological processes that exceed conventional legal categories.

The Nuclear Tests case demonstrates the limits of international law. France conducted atmospheric nuclear tests affecting Australian territory and ignored ICJ provisional measures. The Court avoided ruling on substantive issues terminating the case procedurally based on France's unilateral declarations. This illustrates that state-centered approaches prioritize sovereignty and strategic interests over environmental obligations. Enforcement lacks structural force against powerful states.

The structural limitations revealed by the Doñana Wetlands case and the Nuclear Tests case highlight a mismatch between human-centered legal frameworks and ecological complexity. Post-anthropocentric ideas such as Object-Oriented Ontology (OOO), Hyperobjects, and the Rights of Nature offer tools to rethink law in the Anthropocene.The focus from human actors will shift to ecosystems as autonomous entities with agency.

The Rights of Nature challenge the anthropocentric paradigm by granting legal personhood to rivers, wetlands, and aquifers enabling ecosystems to be represented in court and protected independently of human interests. In the Doñana Wetlands case this could have addressed governance failures and economic pressures by establishing enforceable duties for groundwater and marshland preservation. In the Nuclear Tests case, granting rights to the Pacific Ocean and atmosphere could have reframed the dispute from a conflict over national sovereignty to a matter of environmental justice. The states could be held accountable for transboundary ecological harm.

OOO emphasizes the autonomy and inherent reality of ecological objects. Recognizing aquifers, wetlands, and the atmosphere as independent entities reframes legal violations as harm to autonomous objects rather than mere breaches of human-centered rules. Hyperobjects describe ecological processes that are vast, diffuse, and long-term, such as groundwater depletion or radioactive fallout. Applying this lens encourages law to expand its temporal and spatial imagination, enabling regulatory systems to address slow, cumulative, and intergenerational harm.

Both cases show that legal frameworks often place human or state interests above ecological realities. They fail to regulate hyper-scale, transboundary processes effectively. These limitations suggest the need for post-anthropocentric approaches that recognize ecosystems as actors with intrinsic value. Collectively, these theories suggest that environmental law must evolve beyond anthropocentric assumptions. By recognizing ecosystems as active agents and addressing hyper-scale processes, post-anthropocentric frameworks offer a more robust, adaptive, and ecologically aligned model for governance in the anthropocene.

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CHAPTER FOUR. WASTE & CIRCULAR ECONOMY

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1. INTRODUCTION

Waste management has become one of the most complex and urgent challenges of our time. It is not merely a technical or local problem: the waste crisis spans environmental, legal, economic, and philosophical dimensions, questioning the foundations of our production and consumption models. This paper approaches the issue from three complementary perspectives: the international and European legal framework, which seeks to regulate waste flows through directives and treaties; philosophical reflection, which allows us to understand waste as hyperobjects, massive entities that are difficult to fully grasp; and the circular economy, whose promise of sustainability risks becoming a mere "technological fix" if it does not address the structural causes of the problem. Concrete case studies, such as the management of nuclear waste in Germany and electronic waste landfills in Ghana, illustrate the tensions between regulatory ambitions and the reality of waste flows that exceed human control, exposing deep global injustices.

2. THE LEGAL FRAMEWORK

2.1 International regulations

Effective management of waste is a critical global challenge, driven by growing waste quantities, environmental risks, and complex legal and economic aspects. Over past decades, states and international organizations have developed a global framework combining legally binding agreements, strategic initiatives, and voluntary measures to ensure environmentally sound management of waste. This framework aims not only to minimize environmental harm and safeguard public health but also to promote sustainable consumption, circular economy practices, and global cooperation. The following section provides an overview of the main international legal instruments, strategic frameworks, and persistent challenges in global waste control.

2.1.1 Legally Binding Agreements (Waste Control)

Key international agreements provide the main legal framework for waste regulation worldwide. The Basel Convention regulates the transboundary movement and disposal of hazardous wastes, establishing the "Prior Informed Consent" principle to prevent the export of hazardous waste to countries with lower environmental and safety standards, thus improving management and reducing risks.

The Rotterdam Convention governs information exchange and consent requirements for the international trade of specific hazardous chemicals and pesticides, allowing countries to ban or restrict such imports.

The Stockholm Convention addresses persistent organic pollutants (POPs), aiming for worldwide restriction and progressive elimination to protect health and the environment. These conventions form a globally ratified legal basis which contracting states must implement through national legislation. An important development, the Basel Convention's "Ban Amendment," prohibits the export of hazardous waste from OECD to non-OECD countries.

2.1.2 Strategic & Forward-Looking Frameworks (Global Goals)

Beyond these binding legal instruments, there are global strategies aimed at sustainable and resource-efficient waste management. The United Nations Sustainable Development Goals (for example, SDG 12 on Responsible Consumption and Production) set targets for waste prevention, circular economy, and sustainable resource use.

Strategic decisions made under relevant environmental agreements—such as the Basel Declaration on Environmentally Sound Management—promote international collaboration, technology transfer, and the development of global guidelines for the responsible treatment of hazardous substances and waste.

In addition, international initiatives and partnerships (such as UNDP projects) support technology development, capacity building, and technical standardization worldwide.

2.1.3 Key Challenges

Implementing and advancing the international legal framework faces several persistent barriers:

- Weak or incomplete implementation at national level, especially in developing countries, often caused by limited resources and capacity.
- Increasing complexity arising from new waste streams (such as e-waste, plastic, or textile waste) and the absence of clear global standards for these materials.
- Enforcement and compliance problems, including slow reporting, inadequate monitoring, and ongoing illegal waste shipments despite bans.
- Differing national interests, a lack of global consensus, innovation pressures, adaptation challenges, and the need for stronger international cooperation.
- The slow addition of new substances to treaties, which can reduce effectiveness.
- The difficulty of integrating circular economy concepts (like extended producer responsibility, product design for reuse, and broader recycling) into global legal regimes.

2.2 EU Directives e.g. EU Waste

Over the past decades, the European Union has developed an extensive regulatory framework to support the transition from a linear to a circular economic model. Faced with rising waste volumes, finite resources, and increasing environmental pressures, the EU aims to make products more durable, repairable, and recyclable. At the same time, it seeks to reduce material waste, encourage sustainable consumption, and strengthen the competitiveness and innovative capacity of European industries. Several interlinked directives form the legal backbone for waste management, product design, and consumer protection. While these rules established at the EU level, each Member State is responsible for implementing them, resulting in variations across national systems. Nonetheless, together these directives provide a coherent foundation for reshaping Europe's economy towards long-term sustainability and circularity.

2.2.1 Waste Framework Directive (2008/98/EC, amended 2018/851/EU)

At the core of this framework lies the Waste Framework Directive (2008/98/EC). It establishes the basic concepts and definitions for waste management across the EU, including recycling and disposal. Its central element is the five-step waste hierarchy: waste prevention comes first, followed by reuse, recycling, and other forms of recovery. Disposal is the least preferred option. This hierarchy legally binds Member States to design policies that keep materials in use for as long as possible. As the guiding foundation for all other EU waste-related legislation, the directive aims to protect human health and the environment, improve resource efficiency, and accelerate the shift towards a genuine circular economy.

Despite its conceptual clarity, the Waste Framework Directive faces persistent challenges in practice. Its broad scope and flexible implementation provisions lead to significant disparities between Member States, particularly regarding waste prevention and reuse. Many national waste strategies continue to prioritise recycling, partly because recycling targets are easier to quantify, while the more ambitious goal of prevention receives comparatively weaker enforcement. Furthermore, the reliability and comparability of waste data differ across Member States, complicating assessments of compliance and progress. As a result, although the directive provides an essential legal structure, its practical impact has been constrained by uneven implementation and insufficient monitoring mechanisms.

2.2.2. Landfill Directive (1999/31/EC)

A crucial complementary measure is the Landfill Directive (1999/31/EC). Historically, a large share of Europe's waste ended up in landfills, which is a practice associated not only with the loss of valuable resources but also with serious environmental risks, including methane emissions and the contamination of soil and groundwater. To address this, the directive requires Member States to progressively reduce the amount of biodegradable municipal waste sent to landfills. It also sets restrictions on the types and quantities of waste allowed in landfills, encouraging waste reduction and higher recycling rates.

While the directive has effectively reduced landfill reliance in many Member States, it has also resulted in unintended consequences. In some countries, the decline in landfilling has been accompanied by a rise in incineration, which, although preferable to landfill according to the waste hierarchy, may undermine waste prevention and reuse objectives. Incineration facilities often require a steady input of waste to remain economically viable, potentially discouraging long-term waste reduction. Moreover, major disparities persist between Member States, with some achieving near-zero landfill rates and others struggling to meet reduction targets due to infrastructural, financial, or administrative constraints. Consequently, while the directive has reshaped waste disposal practices, it has not wholly resolved broader systemic challenges.

2.2.3. Packaging Waste directive (94/62/EC)

Another key piece of legislation is the Packaging and Packaging Waste Directive (94/62/EC), which aims to reduce the environmental impact of packaging throughout its entire life cycle. Manufacturers must design packaging that uses fewer materials, is more efficient, and is easier to recycle. Member States are required to establish collection and recycling systems and to meet defined recycling targets. Because packaging represents one of the most visible and voluminous waste streams, the directive has spurred the development of recyclable mono-material packaging, reusable systems, and lightweight, resource-saving designs.

Despite these achievements, the directive faces criticism for lagging behind market developments. Rapid growth in online retail, the use of complex composite materials, and increasing consumer demand for convenience packaging have exposed regulatory gaps. While recycling targets continue to rise, many Member States struggle to achieve them due to inconsistent collection systems, inadequate sorting technologies, and differences in the design of extended producer responsibility schemes. A further challenge lies in consumer confusion. Labelling systems remain fragmented across Europe, limiting the effectiveness of recycling efforts. Thus, although the directive has fostered considerable progress, its capacity to keep pace with evolving consumption patterns remains limited.

2.2.4. Single-use plastics directive (2019/904/EU)

A more recent and highly visible measure is the Single-Use Plastics Directive (2019/904/EU), which targets everyday plastic items that are disproportionately represented in marine and terrestrial litter. These include disposable cutlery, plates, straws, cotton buds, and specific types of packaging. The directive bans several of these products outright and introduces reduction targets, design requirements, and labelling obligations for others. Its central objective is to curb plastic pollution and encourage a shift toward reusable and sustainable alternatives.

Although the directive represents an important step in combating plastic pollution, it has been criticised for its limited scope. The banned items constitute only a small portion of the total plastic waste generated in the EU, meaning that broader systemic issues, such as microplastic pollution, industrial plastic use, and the environmental impacts of synthetic textiles, remain insufficiently addressed. Furthermore, some industries have replaced banned plastic items with alternative single-use materials, such as coated paper or biodegradable plastics, whose environmental performance is highly variable and often poorly understood. As such, while the directive provides important momentum, it alone cannot resolve the multifaceted challenge of plastic pollution.

2.2.5. WEE-Directive (2012/19/EU)

The WEE Directive (2012/19/EU), which regulates waste electrical and electronic equipment, addresses one of the fastest-growing waste streams in the world. E-waste contains valuable raw materials such as gold, copper, and rare earths, but also hazardous substances that can harm human health and the environment if mishandled. The directive sets targets for the collection, reuse and recycling of electronic waste and is closely linked to the RoHS Directive, which restricts the use of certain hazardous substances in electrical and electronic equipment. Together, they promote safer products, increase the recovery of valuable materials, and ensure that electronics are properly treated at the end of their life cycle.

Despite its ambitious scope, the WEEE Directive struggles with persistent shortcomings. Collection rates remain far below targets in many Member States, with large quantities of e-waste either stored in households or channelled through informal and often illegal pathways. Significant volumes are exported outside the EU, frequently under the guise of second-hand goods, to regions lacking adequate recycling facilities. This undermines environmental protection goals and exacerbates global waste inequalities. Moreover, high-quality recycling of complex electronic products remains technologically challenging and costly. As a result, even with strong legislation, substantial gaps remain between policy intentions and real-world outcomes.

2.2.6. Right to Repair

In recent years, however, the EU's strategy has expanded beyond waste reduction to encompass the extension of product lifetimes. At the centre of this shift is the concept of the "Right to Repair". Initially a civil society movement, it has increasingly influenced EU policymaking. The Right to Repair revolves around enabling consumers and independent repairers to access spare parts, repair manuals, diagnostic tools, and long-term software updates. It challenges the traditional manufacturer-controlled model of repair and positions repairability as a consumer right and as a key component of a sustainable market.

This principle is now embedded in new Ecodesign regulations and consumer protection rules, which are being phased in from 2024 and 2025 onwards. Under these measures, many products must be designed to last longer and to be easier to repair. Examples include the mandatory use of screws rather than glue, the removal of software locks that hinder repairs, and the requirement for manufacturers to provide essential spare parts for many years after purchase. These rules not only empower consumers but also stimulate competition and innovation among repair businesses, while reducing the environmental impacts linked to fast product turnover.

Taken together, the EU's waste, product, and consumer regulations all aim at the same overarching goal: moving away from the traditional "take–make–waste" model and building

a circular, resource-efficient, and resilient European economy. They promote the reuse of products, reduce the generation of waste, improve recycling processes, and expand producer responsibility for the entire life cycle of their goods. While implementation still varies among Member States, the EU provides clear and ambitious direction: less waste, more reuse, and a stronger framework for sustainable products and consumption.

3. THEORETICAL ANALYSIS

3.1 Waste as a hyperobject

The concept of hyperobjects, introduced by Timothy Morton, offers a valía le framework for understanding the global waste crisis. Hyperobjects are phenomena that are “massively distributed in time and space relative to humans”, and whose full impact remains elusive because they extend beyond the scale of human perception and lifespan (Morton, 2013).

Waste whether nuclear residues, ocean pollution, or the accumulation of plastics fits this definition: it persists for centuries, circulates across ecosystems, and interacts with countless social, economic, and ecological processes.

Although humans are responsible for generating various forms of waste, its existence is no longer dependent on continued human activity. Stopping production does not erase the pollution already present, nor do current technologies allow for its comprehensive removal. Interventions such as surface-level ocean cleanup efforts address only a fraction of the problem, leaving submerged or dispersed pollutants untouched. Thus, viewing waste as a hyperobject compels us to recognize its magnitude and complexity, challenging simplistic narratives that suggest purely regulatory or technical measures can “solve” the issue. Instead, the theory prompts a reconsideration of what types of interventions and behavioural changes may meaningfully influence such a vast phenomenon.

3.1.1 Theory by Timothy Morton

According to Morton, hyperobjects are phenomena that extend far beyond the spatial and temporal scales familiar to humans. Because they exist across centuries, continents, and systems, their effects are not immediately visible or intuitively understood.

In the context of waste, this theory helps illuminate why issues such as nuclear waste, microplastics, and widespread ocean contamination cannot be grasped through conventional cause-and-effect thinking.

These forms of waste endure long after their sources are forgotten and continue to accumulate regardless of human attempts at control.

3.1.2 Characteristics of a hyperobject with examples relating to waste, Viscous, temporal undulation, nonlocal, phased, interobjective.

1. Viscous

A hyperobject adheres to everything it touches, regardless of attempts to resist it. In the case of waste, the residue is inescapable. For example, oil spills contaminate ecosystems and persist for long periods, plastic waste overflows into oceans, and the majority of plastics cannot be recycled, eventually accumulating in landfills. Waste sticks to the environment, contaminating it in ways that are difficult to reverse.

2. Temporal Undulation

Hyperobjects exist on timescales far beyond human experience, often stretching across centuries or millennia. Nuclear waste, for instance, remains dangerous for tens of thousands of years, far outliving any human timeframe. Similarly, the degradation of plastic materials takes hundreds or even thousands of years, making it difficult for humans to perceive the full consequences of their actions over such extended periods.

3. Nonlocal

Hyperobjects are distributed across vast spaces and times, making their totality impossible to grasp from a single vantage point. There is no place in the world that is immune to the effects of human waste. Countries export waste to poorer nations, and pollutants like plastic debris and chemical contaminants spread across oceans and landscapes globally. The full scale of the issue cannot be perceived in just one location; it is an issue that touches every part of the planet.

4. Phased

Humans can only perceive parts of a hyperobject at a time; we cannot apprehend the whole. The full scope of the waste crisis remains out of view, as we only see fragments of it. We can observe plastic floating in the ocean or waste piling up in landfills, but we cannot fully grasp the magnitude of human-generated waste in its entirety, nor can we predict the future consequences of the waste already produced.

5. Interobjective

Hyperobjects are formed by relations between multiple objects or systems. It is challenging to perceive a hyperobject as a whole because we typically see only isolated manifestations of it. For example, we may see piles of garbage, but we fail to connect these visible accumulations to broader systemic issues, such as capitalist overproduction, the demand for constant consumption, or the overuse of energy resources that, in turn, lead to more nuclear waste. The complexity of waste arises from the intricate relationships between production, consumption, and disposal, which combine to form a larger ecological and societal problem.

3.1.3 Why should we view these as hyperobjects and why is it relevant?

Understanding waste as a hyperobject is crucial for several reasons. First, it reframes waste not as a collection of isolated environmental issues but as a planetary-scale phenomenon shaped by industrial systems, consumption patterns, and long temporal processes.

Second, it forces us to confront the limits of traditional environmental governance. While human actions create these forms of waste, they quickly escape human control: ocean pollution persists regardless of reduced emissions, and nuclear waste remains hazardous for millennia, far beyond any regulatory horizon.

Current mitigation efforts illustrate these limits. Ocean clean-up technologies capture only surface-level pollutants, leaving deeper contamination unresolved. In the case of nuclear waste, we can store or contain it temporarily, but we cannot neutralise its radioactive properties on meaningful human timescales. Recognising these constraints emphasizes the need for structural changes—rethinking production systems, reducing material throughput, redesigning consumption patterns—rather than relying solely on technical fixes.

Viewing waste as a hyperobject thus shifts the debate: it highlights the scale, persistence, and interconnectedness of the problem, encouraging policymakers and societies to adopt long-term, systemic approaches rather than short-term, localised solutions.

3.1.4 Example. Plastic as a Hyperobject and Eco-Bricks in the Circular Economy

3.1.4.1 Plastic as a hyperobject

Plastic is a prime example of a hyperobject, according to Timothy Morton's theory. Its characteristics demonstrate the magnitude of the environmental challenge we face. Its viscosity causes it to adhere to ecosystems and living beings, remaining for centuries. A clear example is the case of a PET bottle, which can take between 450 and 1,000 years to degrade, consequently contaminating soils, rivers, and oceans.

Its temporal undulation shows that plastic waste exceeds the human timescale, generating impacts that will affect future generations. Furthermore, it is a non-local phenomenon, as ocean currents and global markets disperse plastics across the planet, forming accumulations such as the Great Pacific Garbage Patch.

Plastic also has a phased dimension, as we only see part of the problem, such as the bottles we find on the surface, while annual production exceeds 500 billion units. Finally, it is an

interobjective object, because each bottle reflects a complex network of relationships between oil, industry, consumption, advertising, and a culture based on disposability.

Therefore, it is clear that plastic is a global and systemic phenomenon that requires innovative and profound strategies, beyond traditional solutions focused solely on recycling.

3.4.1.2 Eco-bricks: a local strategy in the circular economy.

Eco-bricks represent a local strategy that turns the problem of massive plastic waste accumulation into a concrete and understandable solution for communities.

This practice is in line with the principles of the circular economy promoted by the European Union, as it proposes an approach based on reduction, reuse, and value creation from materials traditionally considered disposable.

Firstly, eco-bricks allow the global problem to be localized, bringing it down to a manageable human scale, so that waste that would normally go unnoticed is transformed into building materials. As a result, citizens can visualize and physically manipulate a fraction of an immense phenomenon, turning a diffuse threat into concrete action.

Likewise, this practice implies a re-signification of materials. Single-use plastic acquires a new utility when integrated as a construction element. This allows its life cycle to be partially closed and its function to be extended by implementing formal reuse strategies.

The strategy is clearly connected to the fundamental pillars of the circular economy, since by preventing plastics from ending up in landfills or natural ecosystems, reuse is promoted by giving the material a new function, transforming problematic waste into a useful resource for community, educational, or construction projects.

Finally, eco-bricks highlight an inevitable paradox: although they cannot eliminate the global phenomenon of plastic (hyperobject), they do allow for the local management of some of its effects and generate immediate social and environmental benefits.

3.4.1.3 Integration with European waste policy

1. Legal basis and waste hierarchy

The Waste Framework Directive 2008/98/EC is the standard that establishes the principles and definitions of EU waste law. Despite its age, this directive has been updated over the years, as was the case with the amendment included in Directive (EU) 2018/851.

Article 4 of Directive 2008/98/EC establishes the so-called waste hierarchy, which defines the order of priorities that should guide European legislation and policies on waste prevention and management. The text states: "The following waste hierarchy shall serve as an order of priority in waste prevention and management legislation and policy:

“1. The following waste hierarchy shall serve as an order of priority in legislation and policy on waste prevention and management: 1. prevention; 2. preparation for reuse; 3. recycling; 4. other recovery (e.g., energy recovery); 5. disposal”.

This hierarchy operates as a guiding principle that Member States must consider when designing and implementing their waste management measures.

2. What does the Directive mean by “preparing for reuse”?

The Directive defines and Community practice interprets “preparing for reuse” as checking, cleaning, or repairing operations whereby products or components that have become waste are prepared for reuse without further preprocessing. In other words, the aim is to return the product to a state in which it can be reused for its original purpose. (Definition and clarifications in the Commission's guidance and statistical glossaries).

3. Where do ecobricks fit in?

Ecobricks can be considered a form of “preparation for reuse”. When single-use plastics are cleaned, sorted, and manually inserted into bottles to create reusable modules (e.g., as domestic building elements or community furniture), these materials are used again without resorting to complex industrial processes. In this way, basic cleaning and verification operations are carried out to extend the useful life of materials that would otherwise become waste. This practice is in line with the waste hierarchy, as it helps to avoid lower stages such as disposal or energy recovery.

4. Benefits that justify their promotion from a circular economy policy perspective

The use of ecobricks helps reduce the amount of waste sent to landfills or incineration, improving overall environmental performance. In addition, they serve as educational tools that promote awareness and citizen participation, helping to understand the waste hierarchy and the principles of the circular economy.

They also enable the circular economy to be applied at the local level, demonstrating how community solutions can complement European and national policies, especially in terms of prevention and reuse. This, in turn, encourages waste separation at source and selective collection.

3.4.1.4 Reflection

The use of ecobricks illustrates that addressing hyperobjects requires creative and localized actions, even if they are partial. It shows how Morton's theory and the circular economy intersect: we cannot completely eliminate plastic waste, but we can transform our relationship with it, closing cycles, generating value, and promoting sustainability. Local action, when framed within global policies such as EU directives, becomes a tangible example of how humanity can responsibly and effectively manage massive waste.

3.2 Critique of circular economy (CE) as a "techno-fix"

3.2.1 Definition

"…Circular economy is a model of production and consumption, which involves sharing, leasing, repairing, refurbishing and recycling existing materials and products as long as possible" – according to the European Parliament. It is an economic system that aims to redefine our approach to production, consumption and waste management, unlike the traditional linear, take-make-dispose model which relies on large quantities of cheap, easily accessible materials and energy.

Since humanity faces extremely serious environmental challenges (limited natural resources, rapid deterioration of air, water, soil quality, global warming, deterioration of the ozone layer, glacier melting, the loss of biodiversity) posed by our current linear economic model and consuming society behaviour, it is recognised that the Earth's fine resources and current consumption patterns are unsustainable and the linear economy, which relies exclusively on resource extraction is no longer a viable action.

In 2015 the European Commission adopted the first Circular Economy Action Plan and since then, the idea gained a significant momentum as a powerful alternative model to minimalize waste, pollution and the depletion of natural resources. This model has become an essential part of fundamental European Union strategies such as the European Green Deal and Clean Industrial Deal since it is the opposite and an opportunity to replace the end-of-life concept with recycling, reusing and recovering materials in production or distribution and consumption processes.

The main considerations, key principles can be divided into different groups as:

1. <u>Designing out waste and pollution</u>:

The circular economic model's aim is to use and design products to be repairable, recyclable by using low impact new materials, recycled or secondary materials, prioritizing resource efficiency waste and pollution are minimized throughout the product's life cycle. This group

includes also the consumer rights movement, the “Right to Repair” due to the characteristics described in the previous chapter.

2. Keeping products and materials in use:

It involves prioritizing the reuse of already existing assets, recovering materials and products either on-site or from other locations, and sharing them for onward reuse whenever possible. This approach encourages longevity, flexibility, and adaptability in how building and systems are designed and operated. It also relies on principles of assembly, disassembly and recoverability, ensuring that components can be easily maintained, replaced or repurposed to extend their useful life. Additionally, the CE promotes a sharing economy that maximizes material resources through cooperative participation and creation of more employment opportunities (Korhonen et al., 2018).

3. Regenerating natural systems:

The model recognizes the importance of natural capital and seeks to restore ecosystems. It also emphasizes using renewable energy responsible sourcing of materials and restoring natural resources. It seeks to keep resources in use for as long as possible and extract maximum value from them. It is regenerative approach that minimizes waste, pollution and the depletion of natural resources.

3.2.2 Solution or techno-fix?

The European Union (EU) wants to build a circular and climate-neutral economy by 2050, and to achieve that, the EU has introduced many new measures to reduce waste and make products more sustainable. The EU consider this framework for plastics products the best possible solution to reduce the impact of exhaustive extraction of virgin resources and emissions of plastic waste in the environment (European Parliament and European Council, 2018).

However, many people argue that the CE functions as a technological solution (as a “techno-fix”) that promises sustainability without addressing the deeper social and economic roots

of ecological problems. From a deeper political-economic perspective, the CE does not provide a solution to overconsumption, overproduction, and the pressure to grow, but merely maintains the existing economy, resulting in superficial, technical improvements rather than systemic change. By focusing primarily on technological improvements, the CE frames environmental degradation as a technical problem that can be solved through innovation. This framing avoids addressing the more complicated structural and political issues within capitalism, such as the growth imperative planned obsolescence (when a product is designed to wear or fail after a certain period encouraging consumers to buy it again) and the continuous growing of markets. In conclusion, as long as economic success depends on selling more goods, circular principles will struggle competing with market incentives.

In addition, one major limitation of the CE is the assumption that waste can always be transformed back into a valuable resource. In reality, many materials cannot be endlessly reused because of physical and chemical degradation. Thermodynamic limits, such as entropy, cause unavoidable losses during recycling processes, which means that perfect circularity is impossible (Compart and Gräbner, 2024). Plastics also demonstrate another clear limit: during chemical recycling, a significant portion of carbon is lost and cannot be restored, which reduces the overall environmental benefit (Rochman et al., 2025). Because of these constraints, the idea of waste as an endless resource is more theoretical than practical, and circular systems still depend heavily on new raw materials.

Despite the impossibility of perfect circularity, the implementation of the model faces numerous difficulties in practice. Firstly, CE requires serious upfront capital investment, creating a formidable barrier for businesses: manufacturing firms face high start-up costs for the transition (Jaeger & Upadhyay, 2020), while small and medium businesses struggle with administrative and compliance expenses. These financial uncertainties make CE initiatives economically risky, especially for resource-dependent industries facing structural transition costs (Garcia-Quevedo et al., 2020).

Also, technical problems require a lot of expert knowledge, which many companies do not have. In order to reduce high expenses, companies tend to raise the products' prices, which is difficult for consumers to justify that circular sustainable products may have higher costs, even if lower in the long term, than continuously purchasing disposable or unsustainable items, Moreover, technical shortcomings reduce the practicality of circular strategies: many products are not designed to be easily taken apart, which makes reuse and remanufacturing extremely time-consuming and expensive (despite the Right to Repair movement).

Speaking of prices, companies tend to make false claims of sustainability, and misleads consumers, investors and the public with deceptive marketing: companies, corporations may use the circular economy discourse to appear more sustainable without real transformation (Lopes et al., 2023). Studies demonstrate that many firms use CE terms mainly for marketing, to improve their public image without changing their actual practices (Xu et al., 2025.). A perfect example is the famous 2022 lawsuit against H&M, a giant fast fashion brand, which was deceptively capitalizing on the growing segment of conscious consumers by creating an extensive marketing scheme to greenwash its products and present them as environmentally friendly when they weren't.

Overall, the CE could offer valuable ideas to improve resource efficiency, but its potential is limited when implemented with the existing growth-driven capitalist system. As a "techno-fix", the CE promises sustainability without any real change in practice and being only an ultimately limited technological solution to the ecological crisis.

4. CASE STUDY

4.1 Governing the Ungovernable: CASTOR Transports and the Hyperobject of Nuclear Waste in Germany.

This case illustrates hyperobject viscosity and temporal undulation—legal frameworks cannot govern entities persisting for millennia.

On October 4, 2025, over 500 protesters gathered in Ahaus, Germany, opposing planned radioactive waste shipments representing the largest CASTOR transport series in the

nation's history (Breites Bündnis protestiert gegen geplante Castor-Transporte, 2025). A coalition of 41 environmental organizations demonstrated against transporting approximately 300,000 fuel element spheres from Jülich Research Center to Ahaus interim storage (Nuclear Heritage Foundation, 2025). Despite completing its nuclear phase-out in April 2023, Germany faces an intractable challenge: managing radioactive materials that will remain hazardous for periods exceeding human civilization itself (World Nuclear Association, 2024). This case reveals the fundamental paradox of attempting to govern hyperobjects through institutions designed for human timescales.

Nuclear waste exemplifies what philosopher Timothy Morton (2013) terms a "hyperobject" —an entity so massively distributed in time and space that it transcends human-scale comprehension and control. The CASTOR container— Cask for Storage and Transport of Radioactive Material—embodies this paradox: sophisticated engineering containing materials whose radioactive persistence will outlast any conceivable political order. Morton's framework illuminates why conventional governance approaches prove inadequate: these materials exhibit viscosity (adhering to human existence despite our desire for separation), temporal undulation (existing on timescales measured in geological epochs), nonlocality (manifesting locally while their implications sprawl across vast distances and populations), and phasing (appearing and disappearing from human awareness while persisting indifferent to political systems or public opinion).

4.1.1 Viscosity and Temporal Undulation

The viscosity of nuclear waste —its tendency to adhere to human existence despite our desire for separation— becomes apparent in Germany's evolving storage timelines. Current operations focus on clearing research reactor waste, with the Federal Office for the Safety of Nuclear Waste Management (BASE) approving movement of approximately 300,000 fuel element spheres to Ahaus interim storage in 152 containers (Nuclear Heritage Foundation, 2025). While CASTOR containers represent rigorously engineered systems designed to withstand catastrophic scenarios (Bundesanstalt für Materialforschung und -prüfung, n.d.), their very robustness paradoxically binds generations to waste across timescales dwarfing

the political systems that created them. As permanent repository selection extends to "the 2040s at the earliest," spent fuel rods remain in interim storage far beyond original design specifications (Homeland Security Newswire, 2023).

The temporal undulation of radioactive waste creates a profound disconnect between the institutions managing it and the unfathomable duration of responsibility required. Germany's repository timeline has undergone repeated extensions, with current projections targeting final site selection between 2046 and 2068—a substantial delay from the original 2031 decision target (Clean Energy Wire, 2024). This means waste generated in the 1970s-1980s will remain in interim storage potentially a century before reaching permanent disposal. The eventual repository must meet extraordinary specifications: containment for one million years while maintaining retrievability for 500 years (Clean Energy Wire, 2024). This million-year requirement far exceeds actual decay timescales — spent fuel reaches natural radioactivity levels after approximately 300,000 years (Vision of Earth, 2023)— yet reflects attempts to accommodate geological uncertainties across unimaginable timescales.

4.1.2 Legal Framework and Its Limitations

Germany's nuclear waste transport operates within regulatory architecture centered on the Atomic Energy Act (Atomgesetz), establishing comprehensive licensing, supervisory, and liability provisions (Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, n.d.). Section 4 specifically governs nuclear fuel transport, requiring federal approval for all CASTOR shipments (Buzer, n.d.-a). Section 25 holds nuclear facility operators strictly responsible for damages, supplementing Germany's Paris Convention obligations (Buzer, n.d.-b). This legal architecture increasingly reflects Germany's constitutional obligation to protect future generations, particularly following the Federal Constitutional Court's 2021 climate ruling emphasizing fundamental rights having "anticipated effect" on present decisions (Springer, 2021).

Yet this comprehensive legal framework reveals the fundamental challenge of governing a hyperobject: legal systems predicated on generational continuity must somehow regulate materials whose hazardous persistence will outlast any conceivable governmental structure. The Site Selection Act requires that repository safety criteria remain valid for one million years (Clean Energy Wire, 2024)—a temporal ambition that exposes the gap between legal aspirations and the reality of institutional impermanence. As Morton (2013) argues, hyperobjects fundamentally challenge human systems designed for human-scale temporalities.

4.1.3 Nonlocality and Democratic Accountability

The CASTOR debate reveals hyperobject nonlocality —how entities manifest in specific places while their implications sprawl across vast distances and populations— (Morton, 2013). CASTOR transports evolved from logistics operations into what anti-nuclear movements term "media mega-events" dominating national attention (Nuclear Heritage Foundation, n.d.). From the first 1995 Gorleben shipment, these transports attracted massive resistance with escalating costs —eventually exceeding $150 million to move just eight casks— (Nuclear Heritage Foundation, n.d.). The October 2025 Ahaus protests criticized multiple dimensions: dangers of moving highly radioactive material on public highways, the unresolved final disposal question, and creating facts on the ground while lawsuits remained pending (Münsterlandzeitung, 2025).

A transport physically moves through particular German towns, yet its implications radiate outward: to communities hosting interim storage far longer than planned, to future generations inheriting radioactive burdens from energy they never consumed, to global debates about nuclear power's viability. Ahaus operates under a permit valid only until 2036, yet faces holding waste indefinitely as final repository timelines continue slipping (MS-Aktuell, 2025). Local resistance connects to existential questions about intergenerational responsibility and whether democratic accountability can meaningfully extend across centuries or millennia that nuclear waste governance requires.

4.1.4 Phasing and the Paradox of Nuclear Governance

Germany currently stores approximately 1,200 CASTOR containers across 17 interim sites, each facing uncertain futures as final repository plans remain delayed (Homeland Security Newswire, 2023). This situation reveals hyperobject phasing, their tendency to appear and disappear from human awareness while persisting across timescales making human attention ephemeral (Morton, 2013). CASTOR containers enter public consciousness during dramatic transports and protests, then fade into interim storage background, resurface when permits expire or safety concerns emerge. The radioactive contents continue inexorable decay according to physical laws indifferent to political systems, public opinion, or legal frameworks.

Germany's CASTOR transport system embodies a fundamental nuclear age paradox: attempting to manage hyperobjects through human institutions designed for human timescales. The German state attempts imposing institutional continuity —through BASE oversight, legal requirements, repository specifications— onto a problem that will outlast any conceivable governmental structure. Future generations in the 2100s, 2200s, or beyond will inherit not only physical waste but institutional knowledge, monitoring responsibilities, and ethical burdens of maintaining containment for materials whose creation preceded their existence by centuries. The engineering is sophisticated, regulations comprehensive, monitoring protocols rigorous—yet all operate within temporal frameworks dwarfed by the radioactive persistence they seek to control. This case demonstrates that purely legal or technical solutions prove inadequate for phenomena that fundamentally exceed human-scale comprehension and control.

4.2 E-Waste in Ghana

4.2.1 Introduction

The next case study we have selected to illustrate our critique of the failures of legal frameworks and circular economy promises in the context of waste, is Ghana’s e-waste crisis. It is hard to ignore the exponential growth of e-waste, which is one of the fastest growing forms of waste globally. Electrical and electronic equipment (EEE) becomes e-

waste when it is discarded, and the question becomes what do we do with this waste product? In 2022 62 billion kg of e-waste was discarded globally with only 22% of this being formally recycled, the majority of this taking place in the Global North (Baldé et al., 2024). The majority of e-waste is not recycled and how this waste is processed leaves a giant environmental impact on our planet. Countries in the Global North increasingly export both functioning and non-functioning electronics to the Global South, exploiting weaker regulatory environments to offload their waste. Africa, despite being the region that consumes and produces the least amount of waste, receives disproportionately large volumes of used and end of life electronics.

Much of the e-waste that arrives in African ports makes its way to informal e-waste processing sites in Ghana (Daum et al., 2017). For more than a decade, the Agbogbloshie scrapyard near Accra, Ghana, was internationally recognised as one of the top 10 most polluted places in the world (Blacksmith Institute, 2015). The site was demolished following international attention on the site and its levels of pollution, however several informal sites have now taken its place (Owusu-Sekyere et al., 2022). Despite Ghana's comprehensive domestic legal framework and international law instruments such as the Basel Convention discussed above, enforcement of these laws remains a challenge. From the lenses of waste as a hyperobject and our critique of the circular economy, the experience in Ghana demonstrates persisting environmental injustice and the inadequacy of law to address nonlocal waste flows.

4.2.2 Treatment of E-Waste and Health Risks

As mentioned above, formal e-waste recycling capacity exists almost entirely in the Global North, where the majority of electronic products are consumed. Although not a perfect process, formal recycling has the smallest environmental impact without reducing our overall consumption of e-waste (Baldé et al., 2024). In Ghana, the vast majority of e-waste is processed informally, particularly within and around the former Agbogbloshie site in Accra. Although the site was cleared in 2021, numerous smaller satellite sites have since emerged (Owusu-Sekyere et al., 2022). The informal processing chain typically involves

workers breaking apart discarded equipment with hammers and chisels, stripping wires for copper, and burning plastics and insulation to recover metals. These methods are cheap, requiring no specialised equipment but they impose significant environmental and health burdens on the workers and surrounding communities.

In Fobil et al. (2023), soil was analysed across Agbogbloshie and found concentrations of toxic metals, including arsenic, cadmium, lead, nickel, antimony, and zinc, at levels that far exceed international standards for both residential and industrial land use. These metals can be dissolved in the stomach and enter the bloodstream through incidental ingestion of soil and dust. Workers commonly do not wear protective clothing, which makes ingesting dust much more common (Huang et al., 2014). Therefore, the health risks are not limited to just when e-waste is being burnt, but is a chronic, daily phenomenon that has become embedded into the physical environment. There has also been a significant diffusion of this contamination into residential, agricultural and commercial areas (Asante & Agusa, 2016). This excessive contamination demonstrates how viscous e-waste is as a hyperobject as the hazardous metals that leak into the soil will not disappear even if e-waste ceases to arrive in Ghana. The damage will persist without active treatment.

4.2.3 Regulatory framework: Ghana's environmental law on E-Waste

4.2.3.1 Domestic Law

In 2016 Ghana introduced the Hazardous and Electronic Waste Control Act (Act 917) in response to the escalating e-waste problem. Act 917 represents Ghana's first comprehensive attempt to regulate the importation, transport, storage, treatment and disposal of hazardous waste and e-waste. Part One of Act 917 governs hazardous waste in accordance with Annex 1 of the Basel Convention, while Part Two establishes a specialised regime for electrical and electronic waste. Act 917 requires all importers and manufacturers of EEE to register with the Environmental Protection Agency (EPA) and pay an eco-levy, also known as an advanced recycling fee. This levy funds the development of formal e-waste recycling infrastructure and the safe handling of hazardous components. This use of command and control type law that imposes the polluter pays principle in theory should

render informal recycling redundant. However, as we have discussed in part two of this chapter, enforcement is one of the biggest challenges when it comes to regulating waste.

In Ghana, compliance monitoring has been weak and there has been limited enforcement action taken (Grant & Oteng-Ababio, 2019; Oteng-Ababio & Amankwaa, 2020). For example, misclassification of used goods in Ghanaian ports continues to occur frequently, often due to inadequate inspection capacity and limited coordination between the EPA, customs and port authorities. Amoah & Kosoe's (2021) evaluation of Act 917 concluded that while the eco-levy generated some revenue, most funds were not translated into large-scale infrastructure development and Ghana's formal recycling capacity remains significantly below what is required to handle national e-waste volumes. Importers and electronic dealers have also received little to no training on how to comply with both Act 917 and regulations L.L2250 which further contributes to noncompliance (Bortey et al., 2020). Therefore despite this comprehensive legal framework, weak enforcement, low industry awareness and limited infrastructure hinder its practical effectiveness.

4.2.3.2 International commitments

Ghana is also party to and has ratified the Basel Convention which we have discussed in detail above. One of the weaknesses of the Basel Convention is that it permits the export of used electronics that are labelled as "for repair" or "reuse" and this is exploited as a loophole by exporters who mislabel non-functional e-waste as second hand goods. As demonstrated in the next paragraph, international frameworks such as the Basel Convention cannot govern what exceeds Ghana's capacity to control. Without additional support from countries with greater resources, the gap between the Basel Convention's expectations and reality will continue to widen.

4.4 Illegal E-Waste Trafficking and Smuggling

Even with the current domestic and legal regime in place, illegal e-waste trafficking is a persistent challenge in Ghana. A substantial portion of Ghana's imported e-waste arrives mislabelled as "second hand goods" or "repairable" to evade the restrictions in Ghana's

domestic law and the Basel Convention (Lepawsky, 2015; Oteng-Ababio & Amankwaa, 2020). Those involved in the trafficking are primarily corporations who produce or are responsible for the waste, looking for a cheaper way of disposing of it, criminal and mafia groups who predominately arrange for and facilitate the trafficking of waste and government officials who turn a blind eye to the practice or are actively bribed to allow it to continue (Interpol, 2020; Heacock et al., 2016). Ghana's port authorities have little capacity to detect where waste has been mislabelled and even where it is detected, it can be difficult to then determine who is to blame for the waste reaching Ghana. Drawing parallels from the CASTOR case study, we can see that although law creates an appearance of control, the material reality is that waste continues to escape our regulatory timescales and jurisdictions, binding communities to long-term risks they did not choose.

4.5 Theories in context

The global flows of e-waste illustrates how environmental harms transcend national and international regulatory frameworks and disproportionately affect countries like Ghana, which contribute least to the generation of e-waste globally (Baldé et al., 2024). This case study reinforces our argument that looking at waste as a hyperobject, we can see that not only is it massive and distributed, but structurally entangled with global inequality. The same material that enables "green" digital economies in the Global North reappears as toxic residue in Ghana's citizens and local environment. In this light, Ghana is not just a local "pollution hotspot" but a situated manifestation of a planetary waste hyperobject whose enduring, widely dispersed material traces outlast individual gadgets, ownership cycles and most likely the legal and political regimes that briefly attempt to govern them.

Drawing on what we have already discussed in relation to the circular economy, the Ghana case study confirms that the principles of reuse, repair and recycle remains only an ideal without radical structural change. Ghana's formal recycling capacity remains limited despite the creation of the eco-levy. The circular economy ideal is only really achievable for countries with the resources and facilities to effectively recycle e-waste. Even where this is achieved, no e-waste recycling process is perfect because of material and technical limits to

how many times EEE products can be recycled. Meanwhile, planned obsolescence in wealthy countries continues to drive excess e-waste consumption. Companies design products deliberately difficult to repair and quickly outdated, leading to poor quality imports to flood Ghana's market faster than its formal systems can process them. The current situation in Ghana shows how global inequalities in production and consumption disproportionately affect the Global South, as wealthier countries pass on their environmental costs to countries with weaker enforcement capacity. This further proves our argument that the circular economy ideal cannot function without enforcement infrastructure and genuine accountability for a product's lifecycle.

5. CONCLUSION

The analysis presented here shows that the waste crisis goes far beyond the mere logistics of garbage disposal. As hyperobjects, materials like plastics, electronic waste, and nuclear byproducts exist on time and spatial scales that exceed our perception and control, with consequences that will last for centuries. Legal frameworks (from international conventions to European directives) represent important efforts to impose order and responsibility, yet the cases of Germany and Ghana demonstrate that these measures often confront practical limitations and the sheer scale of the problem.

The circular economy offers a hopeful model for rethinking our relationship with materials, but it can become a superficial "patch" if it fails to question the underlying logic of consumption and growth that generates waste. Ultimately, addressing waste in the twenty-first century requires more than technical solutions or new regulations: it demands a shift in perspective that challenges current economic models, addresses global injustices, and recognizes that we have created material forces that, in many ways, exceed our control. The future will depend not only on our ability to innovate but also on our willingness to reduce, rethink, and take responsibility for the material legacy we leave behind.

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CHAPTER FIVE. AN UNCONTAINABLE CRISIS: CLIMATE CHANGE AND AIR POLLUTION VS. MODERN LAW

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1. INTRODUCTION

The escalating crisis of climate change and air pollution presents a systemic and fundamental challenge for contemporary global environmental governance. Despite overwhelming scientific consensus and decades of political commitment, the institutional architectures of international and European Union law remain shockingly inadequate. The persistent failure, however, cannot solely be attributed to political hesitation, but also reflects a deeply epistemological rupture. The core structures of our legal systems — territorial jurisdiction, linear models of causation, and anthropocentric values — fundamentally misalign with the ontological reality of the problems they intend to regulate. This chapter argues that climate change and air pollution, understood through Timothy Morton's concept of the "hyperobject", expose a structural incompatibility with current legal systems, demanding radical rethinking of law itself.

This shortcoming finds its most powerful theoretical articulation Morton's Framework. Climate Change as the paradigmatic hyperobject (Morton, 2013, p.16) operates on temporal and spatial scales that defy human perception and political cycles. Its non-local character disperses causes and effects across vast distances, while its phased nature ensures it is only ever encountered through localized, seemingly individual manifestations. Within this framework, air pollution is not a separate environmental challenge but a constitutive feature of the hyperobject itself — a tangible, immediate "dripping" of a much larger systemic crisis: the same industrial processes that destabilize the global climate simultaneously poison the very air we breathe. Consequently, legal regimes that attempt to compartmentalize air pollution and climate change engage in a categorical error. An error which is fueled by neocolonial logic, where powerful governments and capital interests externalize its most severe costs — including pollution and climate impacts — onto marginalized populations and the Global South.

The critique that follows assesses this error across multiple scales: the state-centric and voluntarist architecture of international agreements, such as the Paris Agreement; the managerial but ultimately fragmented ambitions of the European Green Deal; and the catastrophic governance failure visualized by New Delhi's recurring severe smog episodes (Rai, 2025). Together, the cases reveal a common pattern: the inability of law to grasp phenomena that are diffuse, interobjective and vast. Ultimately, the climate hyperobject, with air pollution as one of its most prominent features, exposes not merely a regulatory deficiency but a fundamental incompatibility, demanding a radical re-imagination of legal thought itself.

2. THEORETICAL FRAMEWORK

2.1 Introducing Climate Change as the Ultimate Hyperobject

Timothy Morton defines hyperobjects as "things that are so massively distributed across time and space that they are impossible for humans to grasp in their entirety" (Morton, 2013, p.1). Climate change poses the ultimate hyperobject, its key characteristics directly opposing the foundational principles of modern law:

1. Vast Temporal and Spatial Dimensions:

Climate change unfolds over centuries - time scales which far exceed the short rhythm of political cycles or the span of a human life. Its causes and effects are globally dispersed, making national borders effectively useless. Law in contrast is inherently jurisdictional, territorial and designed for the present.

2. Non-Locality:

The causes of climate change (e.g.: carbon emissions produced decades ago) are radically disconnected in space and time from their most severe effects (e.g.: sea-levels rising). This disjunction fundamentally challenges the conventional legal model of causation and liability, which relies on establishing direct lines of responsibility.

3. Phased Nature:

Climate change is never experienced in its totality. Instead, we encounter intense, localized "drippings" (e.g.: Catastrophic wildfires in Spain (BBC News, 2025), heavy storms in the US). These climate phenomena appear as separate, individual and unrelated catastrophic events, allowing legal and political systems to treat them as isolated events rather than as interconnected symptoms of a larger structural crisis.

4. Interobjectivity:

The hyperobject exists in relationships between countless entities both human and non-human. It is defined by the interplay of oceans, industrial emissions, the atmosphere, forest and much more. Law, however, is intrinsically anthropocentric, focused on regulating human behavior and protecting human interest and struggles to account for the agency and intrinsic value of non-human entities.
These characteristics present an immense global challenge, which becomes notably visible when shifting the focus onto the specific issue of air pollution

2.2 Air Pollution as a Constitutive Feature of Climate Change

Treating air pollution and climate change as separate policy areas fundamentally misrepresents their nature. Both are linked expressions of the same systemic failure—most notably represented in the reliance on fossil fuel combustion: The same process which emits long-term climate forcing agents (CO_2) also emits short-lived air pollutants (PM 2.5, NO_x, SO_2) (Perera, 2018); creating critical theoretical links:

1. Interobjectivtity in Law:

The concept on interobjectivity becomes tangible through this link. A single diesel engine simultaneously contributes to the global, delayed, crisis of climate change and the local,

immediate crisis of pediatric asthma. The law however often creates artificial divisions: a Clean Air Directive (European Parliament and Council, 2016) addressing the particulates and a separate Climate Law (European Parliament and Council, 2011) targeting CO2; hence managing the symptoms while neglecting the systemic root of the issue. In effect the law aims at addressing the consequences of the hyperobject without tackling the cause.

2. Phased Nature in Politics:

The "dripping" of the hyperobject as local air pollution is extremely politically potent. While citizens may demand action in response to visible smog or immediate health impacts; the same "dripping" of the hyperobject as long-term climate disruption, feels abstract and distant. This in turn can generate a policy gap: governments may feel pressured to act on air quality (the immediate "dripping") while postponing measures to confront the actual broader climate crisis.

2.3 Complementary Critical Lenses: Deepening the Critique

To full articulate the challenge posed to law, the issue can be bolstered by various complementary concepts.

1. The Tragedy of the Horizon (Carney, 2015):

This financial concept suggests that the most severe impacts of climate change lie beyond the traditional horizon of business and political cycles. The hyperobjects vast temporal scale remains largely invisible to exiting decision-making structures. Legal Frameworks, in consequence, tend to favor end-of-pipe solutions, rather than pursuing systematic change.

2. Slow Violence (Nixon, 2011):

Nixon defines slow violence as "a violence that occurs gradually and out of sight, a violence of delayed destruction that is dispersed across time and space" (p.2). Both the long-term consequences of climate change and the chronic, cumulative health impacts of air pollution constitute to forms of slow violence. The effects usually disproportionately effecting the

poor, the marginalized and future generations. Legal and political systems, in contrast, are structured to respond to fast violence: oil spills, terrorism, war, etc..

3. The Metabolic Rift (Foster, 1999; Marx, 1867/1976):

This ecological concept poses that capitalist industrial agriculture disrupts the fundamental nutrient cycle between humans and the earth (Marx, 1867/1976, p.637). Climate Change is an example of such a rift: The fossil fuel economy revolves around digging up hundreds of millions of years stored carbon, metabolizing it all at once in the industrial present and thus overloading the atmosphere's capacity to process it → Air pollution being the tangible evidence of the rift.

4. Post-Politics and Techno-Managerialism (Mouffe, 2005; Swyngedouw, 2010):

The failure to grasp the hyperobject of climate change is fueled by a deliberate political evasion. Under a post-political condition, the fundamental ideological choices presented by the climate crisis are sidestepped in favor of techno-managerial consensus. Exemplary: The EU Green Deal. It seeks to manage the carbon budget and innovate green technology, yet without challenging the foundational logic of infinite economic growth, which created the hyperobject in the first place, a paradox. Climate Change demands a radical re-evaluation of our societal foundations but is met with laws to make the existing foundations more sustainable.

2.4 Synthesizing the Framework: The Impossibility for Modern Law

The theoretical synthesis presents a stark conclusion: there is a fundamental mismatch between the nature of the problem and the architecture of our solutions: While the hyperobject reality is interconnected, non-local, temporarily vast, and experiences through phased, localized drippings like air pollution; our legal reality of both international and EU law is compartmentalized, jurisdictional, short term, and defined for direct, attributable, and immediate harm.

The failure of these legal regimes therefore is centered around misconception. This misconception however is ultimately bolstered by neo-colonialism. The architecture of international climate agreements, despite rhetoric of universal responsibility, often enshrine neo-colonial logic. Core mechanisms of international agreements such as the Kyoto Protocol and the Paris Agreement — such as carbon trading and offsetting — can create regimes were the world's most powerful industrial nations and cooperations can purchase the right to pollute by investing in mitigation projects of the global south. Hence, the law's inability to grasp the concept of hyperobjects, isn't solely a passive shortcoming or misconception, but is actively part of a politics of "un-grasping": a refusal to confront the colonial legacies and capitalist power structures embedded within the global economy.

3. INTERNATIONAL AND EUROPEAN LEGAL FRAMEWORKS: LAW'S STRUCTURAL INABILITY TO CONFRONT THE CLIMATE HYPEROBJECT

International and European climate governance is often presented as a story of progress. Policymakers frequently cite instruments such as the Kyoto Protocol, the Paris Agreement, the EU Emissions Trading System (EU ETS), the European Climate Law and the European Green Deal as evidence that environmental law is finally responding to scientific warnings. Yet when these legal frameworks are evaluated against the material reality of accelerating climate change and persistent air pollution, a striking gap appears between ambition and outcome. Despite decades of climate diplomacy, global greenhouse gas emissions continue to rise (UNEP, 2023), while air pollution remains one of the most harmful environmental threats to human health in Europe (EEA, 2025). Ecosystem degradation continues at a rapid pace, and none of the major global or regional climate instruments have succeeded in reversing or even stabilizing these trends.

This difference is not simply the result of political hesitation or inadequate implementation. It reveals a deeper structural tension: modern environmental law is not built to govern a phenomenon like climate change. As Morton describes climate change functions as a hyperobject; a phenomenon so temporally stretched, spatially distributed and causally complex that it exceeds the scales and categories around which legal systems are organized.

Law presumes that harms are traceable, temporally bounded and territorially contained. The climate hyperobject, by contrast, operates across centuries, crosses borders effortlessly and manifests in fragmented, indirect and often invisible ways. Its effects are cumulative, dispersed and unevenly distributed, making it extremely difficult for law to assign responsibility or impose meaningful control.

By approaching the existing legal frameworks through the hyperobject lens, structural limitations are exposed. International treaties and EU legislation often appear ambitious on paper, but they govern only the visible fragments of the hyperobjects such as emissions inventories, concentration levels and carbon prices, while leaving untouched the political and economic systems that continue to fuel climate instability and air pollution. This chapter therefore examines the main instruments of international and European climate law not only in terms of their normative content but also in terms of their practical effects and their failure to confront the scale of the climate crisis. The goal is to show that these frameworks do not tame the hyperobjects; they simply help societies to live with it a little longer.

3.1 International Climate Law: Cooperation without Transformation

International climate governance developed within the framework of the United Nations Framework Convention on Climate Change (UNFCCC). Over three decades, states negotiated a series of multilateral agreements intended to create a coordinated global response to climate change. The two most influential instruments in this regime are the Kyoto Protocol and the Paris Agreement. Although they differ significantly in structure, and legal form, both reveal the same structural limitations: they support cooperation, but they do not require the broader economic changes needed to genuinely slow climate change (Bodansky, 2016).

3.1.1 The Kyoto Protocol: Market Mechanisms in a Burning Planet

The Kyoto Protocol (UNFCCC, 1997) is often portrayed as the first binding climate treaty. It required industrialized countries listed under Annex B to reduce their collective emissions

and introduced three flexible mechanisms: International Emissions Trading, the Clean Development Mechanism (CDM) and Joint Implementation; designed to help states achieve these reductions “cost-effectively” (Böhringer, 2003). In practice, the Protocol reconstruct the climate crisis as a market problem. Emissions were transformed into tradable units, and states could comply with their targets without necessarily reducing domestic fossil-fuel use.

Seen through the lens of the climate hyperobject, Kyoto’s approach created a profound shift. Rather than confronting the fossil-dependent economic order responsible for rising emissions, Kyoto added a new financial abstraction layer to it. Pollution was no longer primarily a physical activity but a numerical one. A ton of carbon could be emitted in one country and compensated through a paper credit generated elsewhere, even when the environmental benefits of the credited reduction were uncertain or non-existent (Maamoun, 2019). This logic did not confront the scale, complexity or distributed nature of the hyperobject. Instead, it artificially compressed climate reality into a set of quantifiable units that could be exchanged on global markets.

Weaknesses of the Kyoto system such as overallocation of allowances, ‘hot air’ credits in post-Soviet states and carbon leakage, were not technical malfunctions. They were predictable outcomes of transforming atmospheric stability into a tradable commodity (Grunewald & Martínez-Zarzoso, 2016). Wealthy countries maintained fossil-intensive lifestyles while purchasing cheap credits generated in the Global South, where many CDM projects caused ecological disruption or social displacement. Kyoto therefore entrenched a form of climate neo-colonialism: the Global North outsourced mitigation burdens to regions already disproportionately affected by extraction, pollution and environmental injustice.

Although the Protocol demonstrated that multilateral climate cooperation was possible, it failed to slow global emissions. Its legacy lies less in environmental improvement than in institutionalizing the idea that pollution may continue forever as long as it is priced and offset. Kyoto managed the symptoms of the hyperobject but did not confront its structural drivers.

3.1.2 The Paris Agreement: Voluntary Ambition in a Weak System

The Paris Agreement (UNFCCC, 2015) represents a shift from Kyoto's top-down architecture to a bottom-up system. States submit Nationally Determined Contributions (NDCs) outlining their climate plans, and these contributions are reviewed and updated through periodic global stocktakes (Bodansky, 2016). This model has been celebrated for achieving near-universal participation. However, the reason Paris succeeded diplomatically is also the reason it is structurally weak: it imposes no binding obligation to meet the NDCs, no sanctions for non-compliance and no mechanism to force states to align their domestic policies with the Agreement's temperature goals.

This agreement achieves global cooperation by abandoning enforceability. Yet the hyperobject operates on spatial and temporal scales far beyond the priorities of domestic politics. Governments respond to electoral cycles, energy-security concerns and economic pressures. When taking a look at the USA, this becomes especially potent: the USA formally withdrew from Paris in 2020 under the presidency of Trump, rejoined in 2022 under Biden and has now once more initiated a withdrawal set for early 2026 under Trumps second term (Congressional Research Service, 2021). A single change in policy can completely alter an entire countries approach toward climate protection, which automatically postpones existential climate action by at least one political cycle. The benefits of strong climate action, however, often materialize decades after leaders leave office and may occur in regions other than the state undertaking the action. Paris does nothing to resolve this fundamental mismatch. The hyperobject continues to expand, while the legal system relies on transparency and peer pressure as its main enforcement tools.

Climate finance further exposes this structural weakness. Developed countries pledged to mobilize USD 100 billion per year to support mitigation and adaptation in developing countries. However, contributions remain inconsistent, and much of the reported finance is delivered as loans or repurposed development aid (OECD, 2023). This reinforces global inequalities, as developing countries, already disproportionately harmed by climate

impacts, take on new debt to finance adaption measured made necessary by emissions they did not produce.

Paris therefore regulates delay. According to UNEP (2023), current NDCs put the world on a path far from the 1.5°C goal. Even though the Agreement recognizes the urgency of climate change, it does not challenge the fossil economy that drives it. Paris does not discipline the hyperobject; it organizes global diplomatic rituals around it.

3.2 The European Dimension: Regional Climate Governance in a Fragmented System

Within the European Union, climate governance is often portrayed as more ambitious and comprehensive than its international counterpart. The EU presents itself as a global climate leader and has indeed constructed one of the most far-reaching supranational legal architectures for climate action. Yet when examined closely, these instruments reveal similar underlying limitations. They rely heavily on market mechanisms, long-term targets and complex regulations, while leaving intact the political and economic structures that drive both greenhouse gas emissions and air pollution. Although the EU has more capacity to legislate and enforce its rules compared to the international system, its governance remains bounded by the same structural constraints: it attempts to regulate the hyperobject through tools designed for discrete, localized environmental harms rather than planetary-scale destabilization.

3.2.1 The EU Emissions Trading System: A Market for Pollution

The EU Emissions Trading System (EU ETS), established through Directive 2003/87/EC (European Parliament & Council, 2003), is frequently described as the flagship instrument of European climate policy. It builds directly on Kyoto's flexible mechanisms and is the largest carbon market in the world. The system operates by establishing a cap on total emissions in certain sectors and allowing companies to buy and sell emission allowances within that cap. Studies indicate that the ETS has contributed to emission reductions in

covered sectors, particularly in the power sector where switching from coal to gas and renewable energy has been economically incentivized (Klimko & Hasprová, 2025).

Yet the ETS also illustrates the deeper problem of treating atmospheric stability as a market good. The system reframes emissions as legal and legitimate as long as actors possess sufficient allowances to cover them. In effect, the ETS creates a lawful space for pollution, making ongoing emissions politically tolerable and economically manageable (Ellerman et al., 2010). Rather than directly confronting fossil-fuel dependence, the ETS enables it to continue in a financialized form. Through this mechanism, pollution becomes something that can be purchased and neutralized financially, even though its physical effects remain distributed, cumulative and long-lasting.

Seen through the hyperobject lens, this marketisation of emissions reveals a structural mismatch. Climate change is not a discrete environmental problem but a planetary-system transformation. Nevertheless, the ETS still approaches carbon emissions as a separate unit, lifted out of their wider ecological reality. This abstraction hides the fact that the burning processes that release carbon dioxide are the same processes that generate harmful air pollutants such as NOx, SO_2 and particulate matter. EU law separates climate regulation and air-quality regulation into different legal instruments, even though ecologically they are inseparable. This legal fragmentation reflects administrative convenience rather than environmental reality.

3.2.2 The Urgenda Foundation vs. The State of the Netherlands: Human Rights and Climate Obligations

The Urgenda case represents one of the most influential moments in European climate governance. In Urgenda Foundation v. State of the Netherlands, the Dutch Supreme Court ruled that inadequate climate action violated Articles 2 and 8 of the European Convention on Human Rights, which protect the rights to life and private life (ECLI:NL:HR:2019:2007). The Court required the Netherlands to reduce its emissions by at least 25% compared to 1990 levels. This decision was grounded in scientific assessments, international obligations under the UNFCCC and the precautionary principle, and demonstrated that courts can hold

governments accountable when political institutions fail to protect the public from climate-related harm (Meguro, 2020).

Urgenda reframed climate change not only as an environmental issue but also as a matter of fundamental rights. It showed that courts can expand the interpretation of existing human-rights norms to include long-term environmental risks. However, the broader impact of the judgment is more limited than often assumed. Although the Netherlands eventually achieved the required reduction, subsequent analyses have shown that the COVID-19 pandemic and economic slowdowns were major contributors to the reduction in emissions, rather than structural policy changes alone (Mayer, 2023). The case therefore illustrates both the potential and the limits of judicial intervention. Courts can order states to meet certain targets, but they cannot redesign energy systems, restructure industries or transform consumption patterns. Their power is inherently reactive and bounded by the territorial logic of the nation-state.

Urgenda thus exposes the governance gap: national courts may recognize the urgency of climate change, but their jurisdiction is confined within borders, while the hyperobject goes beyond them. Even the most progressive judicial decisions remain limited by the scale mismatch between legal authority and planetary processes. The case provides an important way to hold actors accountable but cannot replace the need for broad systemic change.

3.2.3 The Aarhus Convention: Procedural Rights without Substantive Transformation

The Aarhus Convention (UNECE, 1998) and its implementation in EU law through Regulation 1367/2006 (European Parliament & Council, 2006) are frequently celebrated for strengthening environmental democracy by granting the public rights of access to information, participation in decision-making and access to justice. In practice, the Convention has improved transparency in environmental governance, requiring authorities to disclose environmental data, involve stakeholders in decision-making processes and provide judicial review mechanisms for environmental disputes. These procedural rights

have enabled individuals and environmental organisations to challenge environmentally harmful decisions and have thus contributed to a more participatory form of governance.

Yet when assessed through the lens of the climate hyperobject, the limitations of Aarhus become clear. The Convention empowers citizens to observe and contest environmental decisions, but it does not provide them with substantive rights capable of preventing environmental harm. Participation does not guarantee influence, and greater transparency does not necessarily translate into better environmental outcomes. Courts reviewing Aarhus-based claims often focus on procedural defects rather than substantive environmental impacts, meaning that harmful projects may proceed even when public participation has occurred. Moreover, air pollution and greenhouse gas emissions frequently cross-national borders, yet the participatory rights granted under Aarhus remain territorially constrained. Citizens may participate in local or national processes, but they cannot intervene in decisions in neighboring jurisdictions that may ultimately affect the air they breathe.

Aarhus therefore exposes a central contradiction of environmental governance in the Anthropocene, as law expands procedural access without altering the underlying economic structures that drive ecological harm. Procedural environmental rights allow the public to witness the hyperobject more clearly, but they do not enable them to materially restrain it.

3.3 The European Climate Law: Binding Targets with Structural Loopholes

The European Climate Law (European Parliament & Council, 2021) is often presented as one of the EU's most ambitious climate measures. By making climate neutrality by 2050 legally binding and setting an intermediate target of a 55% reduction in emissions by 2030, the law appears to impose obligations far stronger than those contained in the Paris Agreement. It also establishes a European Scientific Advisory Board on Climate Change to provide independent scientific input into EU policymaking. At first glance, this regulatory architecture appears promising.

However, a closer examination shows that the Climate Law's binding force is more limited than it appears. While the law sets targets, it provides broad discretion to Member States regarding the measures they adopt to achieve them. Member States may rely on carbon sinks, removals and other flexible accounting mechanisms, allowing significant emissions to continue into the foreseeable future. Enforcement of these obligations depends largely on infringement actions initiated by the European Commission, yet the Commission's willingness to litigate climate inaction varies widely across political cycles. As a result, the Climate Law's "binding" nature is undermined by its own structural design.

Furthermore, the Climate Law operates within the same long-term temporal framework that has characterized international climate governance. It anchors climate neutrality in the distant year 2050, allowing present-day emissions to persist under the assumption that future technologies or negative-emission strategies will compensate for them. This temporal displacement mirrors the hyperobject's own structure, where the most severe impacts of emissions unfold decades or centuries after they are produced. The Climate Law therefore institutionalizes a form of deferred responsibility that fails to respond adequately to the immediacy of climate risks.

Although the Climate Law represents a significant development in EU governance, it ultimately reinforces the same logic that characterizes international climate law: ambitious long-term goals paired with weak short-term obligations. Its conceptualization of the climate crisis remains rooted in incrementalism and market-compatible transitions, rather than the systemic transformation required to address the hyperobject.

3.3.1 The European Green Deal: Green Growth and Lithium Colonialism

The European Green Deal (European Commission, 2019) positions itself as a transformative agenda intended to align the EU's economic model with climate neutrality. Its vision integrates climate, energy, biodiversity, mobility, agriculture and industrial policy, and it has been widely promoted as a blueprint for a sustainable future. However, the Green Deal is grounded in the ideology of green growth—the belief that economic growth can continue

while ecological impacts decrease through technological innovation, efficiency improvements and renewable energy systems.

When examined from a critical perspective, the Green Deal reveals significant contradictions. Although it aims to reduce the EU's carbon footprint, it simultaneously deepens the EU's dependence on extractive supply chains in the Global South. The large-scale expansion of renewable energy infrastructure, electric vehicles and battery storage technologies requires vast quantities of minerals such as lithium, cobalt, nickel and rare earth elements. These resources are primarily extracted in regions with weak labor protections, limited environmental safeguards and long histories of colonial exploitation. Reports consistently document the social and ecological damage associated with mining these materials, including water depletion, toxic contamination, land dispossession and human rights abuses (OECD, 2023).

This dynamic has been described as a form of green colonialism. While the EU reduces its territorial emissions and improves its local air quality, it externalizes environmental harm to other parts of the world. The atmosphere does not recognize political borders, and emissions associated with mineral extraction, transportation and processing contribute to global climate change regardless of where they occur. The Green Deal therefore reproduces existing global inequalities by shifting the material burdens of decarbonization onto communities in the Global South, while the benefits of the transition accrue primarily within Europe.

Moreover, the Green Deal frames environmental degradation as a problem that can be solved through technological innovation and market incentives, rather than by questioning high levels of consumption, mobility or material throughput. This framing reflects a deep alignment with economic growth imperatives, rather than a willingness to confront the structural roots of ecological crisis. The EU thus positions itself as a climate leader while remaining dependent on the very extractive practices that fuel environmental harm and social injustice.

3.3.2 Green Anarchism and the Limits of Sustainable Development

Green anarchism offers a critical lens on the idea of sustainable development, which suggests that economic growth and ecological protection can advance together. Instead of focusing on how growth can become greener, green anarchist thinkers question whether genuine ecological stability is possible within systems built on continual extraction and expansion (Clark, 2013). This critique is powerfully extended by the concept of the metabolic rift, which describes the systemic rupture in the nutrient cycles between human societies and the natural world, driven by industrial capitalism's demand for accumulation. From this perspective, sustainable development does not confront the climate hyperobject but attempts to manage its symptoms, thereby reshaping it to fit within a growth-oriented model, that inherently reproduces the rift it intends to mend.

This tension comes into sharp focus when we turn to the European Green Deal. The EU often presents itself as a climate pioneer, yet its transition leans heavily on minerals like lithium and cobalt sourced from the Global South, materials frequently extracted under exploitative and environmentally destructive conditions (Alves, 2022). In practice, these supply chains reproduce familiar patterns of inequality: Europe's "green" achievements are built on ecological damage and social costs borne elsewhere (Light & de-Shalit, 2003).

From the perspective of green anarchism, the Green Deal's vision of sustainable development looks far less radical than its rhetoric suggests. It does not dismantle the economic structures that fuel the climate crisis; instead, it relocates their burdens beyond Europe's borders. What appears as progress is, in reality, a redistribution of harm. This contradiction is crucial, because it exposes the deeper limitations of the European legal framework and sets the stage for questioning whether such instruments can ever confront the climate hyperobject in a meaningful way.

3.3.3 The "Regulatory Chill"

The international legal landscape for climate change resembles a fragmented mosaic of overlapping treaties, regimes and initiatives. The UNFCCC, Paris Agreement and Kyoto

Protocol coexist with regional schemes like the EU Emissions Trading System and a multitude of bilateral agreements. This fragmentation creates regulatory complexity, gaps and contradictions. More critically, climate law often operates in direct conflict with other established legal regimes, particularly international economic law. World Trade Organization (WTO) rules can challenge subsidies for renewable energy or border carbon adjustments. Bilateral investment treaties have been used by fossil fuel corporations to sue governments for enacting climate policies that devalue their assets, a practice known as "regulatory chill" (Kyla Tienhaara, 2017).

Furthermore, domestic policy coherence is frequently lacking. While governments proclaim climate ambitions, their agricultural, energy, transport and trade policies often run counter to these goals. Persistent subsidies for fossil fuels, which according to the International Monetary Fund (IMF) amounted to $7 trillion in 2022 (IMF Climate Change | Fossil Fuel Subsidies, 2022), actively incentivize the very consumption that climate laws seek to curtail. This policy incoherence reflects deeper, conflicting interests where short-term economic growth, energy security and industrial competitiveness consistently trump long-term environmental sustainability.

The legal framework itself contains an abundance of flexibility mechanisms that can become loopholes. While principles like "common but differentiated responsibilities and respective capabilities" (CBDR-RC) (Patricia Galvo Ferreira, 2025) are founded on equity, acknowledging the greater historical responsibility of developed nations, they can be strategically invoked to delay ambitious action. Similarly, market-based mechanisms like emissions trading and offsetting, while economically efficient in theory, can in practice allow polluters to avoid direct emission reductions at source by purchasing credits of questionable environmental integrity.

3.3.4 Interim Conclusion: Governing the Drippings, not the Hyperobject

Across the international and European legal frameworks examined, a striking pattern emerges. Although these instruments appear ambitious and comprehensive on paper, they

govern only fragments of the climate hyperobject without addressing its structural causes. The Kyoto Protocol sought to reduce emissions through market mechanisms, yet it ultimately enabled states to outsource mitigation efforts and continue emitting through financial abstractions (Maamoun, 2019). The Paris Agreement institutionalized global participation but did so by abandoning binding commitments and relying on long-term diplomatic cycles that cannot match the spatial and temporal scale of the hyperobject (Bodansky, 2016). The EU Emissions Trading System created a monetized space for pollution and allowed the fossil economy to persist under the appearance of regulatory discipline (Klimko & Hasprová, 2025). Even landmark judicial decisions such as Urgenda succeeded more in exposing governance gaps than in achieving structural transformation (Mayer, 2023).

Procedural instruments such as the Aarhus Convention expanded transparency and public participation, yet these procedural gains did not translate into substantive environmental protection or structural change (UNECE, 1998; European Parliament & Council, 2006). The European Climate Law formalized long-term climate neutrality but embedded it within a framework of technocratic incrementalism that defers action to the distant future (European Parliament & Council, 2021). Finally, the European Green Deal positioned the EU as a global climate leader while entrenching new forms of extractivism and ecological inequality through its dependence on critical minerals from the Global South (European Commission, 2019; OECD, 2023).

Taken together, these legal frameworks reveal a profound mismatch between the scale of the hyperobject, and the capacities of the legal tools deployed to address it. They regulate emissions, air quality thresholds and carbon prices, but leave untouched the political economy of fossil capitalism, global extractive supply chains and growth-dependent development models. The effect is not the mitigation of the hyperobject but its stabilization as a long-term condition of governance. Law in the Anthropocene thus becomes a form of adaptation, helping societies to coexist with climate breakdown rather than preventing or reversing it. This tension sets the stage for the overall argument of this handbook: that new,

more radical forms of legal thinking are needed—forms capable not only of governing externalities but of transforming the systems that generate them.

4. FOCUS: AIR POLLUTION

Air pollution has emerged as one of the most serious environmental problems of the 21st century posing significant risks to human health (WHO, 2024). It describes the contamination of the atmosphere by harmful gases, dust and smoke, which interfere with the natural composition of air (WHO, 2024). According to Data of the WHO, about 99 % of the global population breathes air that has exceeded safe pollution limits.

4.1 Causes and Effects of Air Pollution

Air pollution is caused by a blend of human activity and natural events, each releasing contaminating gases (pollutants) into the atmosphere. In its simple form, an air pollutant is understood as any substance that does not naturally occur in the atmosphere (Washington University Law Review, 1968). These pollutants are usually divided into two groups: primary and secondary pollutants. Primary pollutants are chemicals that get released directly from a specific source, making it possible to trace them back to their point of emission.

Secondary pollutants do not originate directly from a single source but are created through Photochemical reactions in the atmosphere.

These reactions lead to the formation of smog, a complex mixture of ozone and fine particulates, which can seriously affect major metropolitan areas (exemplary: New Dehli, p.21), by degrading air quality, endangering public health and corroding infrastructure. (Washington University Law Review, 1968). For humans, this fine particulate matter is especially significant, as its tiny particles enter the respiratory system through inhalation and can contribute to respiratory diseases, cardiovascular problems and even cancer (Manisalidis et al., 2020).

This in turn also significantly affects the economy: A study by the OECD shows that the economic cost of air pollution in Europe, lies by 0.8% decrease in GDP per 1µg/m3 increase

in fine particulate matter (Dechezlepretre, 2019, p. 3). The effects on human health resulting in reduced availability and performance of labor, while the corrosion of infrastructure damages essential resources.

Beyond the labor market, pollution also directly harms natural production inputs. Air pollution, for instance, contributes to water pollution through atmospheric deposition of acids, heavy metals and nitrates. In agriculture and forestry, pollutants reduce yields by damaging crops and trees, while particulate matter diminishes solar radiation and thus lowers the output of photovoltaic systems. These effects increase costs, reduce revenues, and deter investment in affected regions.

4.1.1 The Flint Water Crisis

A great example of the direct human and economic consequences of such resource contamination is the 2014 water crisis in Flint Michigan.

In 2014, the city of Flint in Michigan changed its water source to the Flint River in an effort to cut costs, but the untreated river water proved highly corrosive and caused lead to leach from aging pipes into the drinking supply. As a result, thousands of children—estimated between 6,000 and 12,000—were exposed to dangerous levels of lead, leading to long-term developmental and neurological harm. The crisis also triggered an outbreak of Legionnaires' disease that claimed at least twelve lives, making it one of the most severe public health disasters in recent U.S. history (NRDC, 2025).

The case not only highlighted the grave effects of pollution but also showcased neo-colonial aspects in environmental protective decision-making. The population of the town, consisting of mostly African American residents, disproportionately carried the cost of the pollution and called out the acute imbalance and unfairness in regard to the effects of climate change: "[we] did not enjoy the same degree of protection from environmental and health hazards as that provided to other communities" (Ray, 2025). This systemic neglect of a predominantly black community for economic expediency mirrors the resource extraction and inequitable burden-shifting that define neo-colonial practices.

4.1.2 The Intractable Challenge of Global Equity

Neo-colonialism often lies at the heart of the political impasse in climate negotiations. The concept argues that the global economic structures established during the colonial era persist, allowing wealthy, industrialized nations to maintain indirect control over developing countries through climate policy. The global distribution of historical responsibility for past emissions, current emissions and vulnerability to climate impacts is profoundly unequal. Developed countries, responsible for the majority of historical emissions, have built their wealth on a fossil-fuel-based economy. Developing countries rightly demand the right to development and argue that they cannot be expected to bear the same mitigation burden without substantial financial and technological support from the industrialized world.

The repeated failure of developed countries to e.g. deliver on their promise of mobilizing $100 billion annually in climate finance for developing nations (Liane Schalatek, 2021) has eroded trust and slowed progress. Disputes over "loss and damage", compensation for climate impacts that are no longer avoidable through adaptation (Hannah Mcneish, 2024) further highlight these equity tensions.

The dynamic mirrors traditional colonial patterns: the Global South, rich in natural resources and "carbon space" in the atmosphere, is pressured to forgo its own industrial development to solve a crisis primarily caused by the Global North. This maintains a form of ecological and economic subjugation. The unmet promises of climate finance, coupled with stringent conditions for accessing funds, can trap developing nations in a cycle of debt and resource extraction, forcing them to export raw materials at low prices to service debts, all while being denied the fossil-fuel-powered development path their critics once enjoyed. This neocolonial dynamic fundamentally erodes the trust and solidarity necessary for a truly cooperative global response.

4.2 Legal Framework and Policies

Legal frameworks regarding air pollution emerged as national regulations before air pollution was recognized as an international concern. Later evolving into transnational

guidelines based on cooperation between nations. The transition began with foundational national laws such as the UK Clean Air Acts and the US Clean Air Act, which established critical precedents for state-led environmental control. Their principles and successes helped forge the understanding that transnational cooperation was not just beneficial, but essential, laying the groundwork for modern international agreements and shared guidelines.

4.2.1 The UK Clean Air Act

One of the first national legislations on air pollution was formed in the UK: the "Clean Air Acts" from 1956-1968. These were a response to rising air pollution concerns such as the Great Smog of London and intended to regulate national air quality standards. In December 1952 London was covered in a Smog due to cold temperatures and increasing coal burning. In 1956 the UK responded with a series of laws that banned black smoke emissions and pushed factories and residents to use smokeless fuels and later North Sea gas. The outcome of this was a drop of black smoke and sulfur dioxide concentrations (Palivka, 2018). These pioneering laws demonstrated that legal intervention can and should be used to improve environmental risks. However, while it did lead to an immediate public health victory and acted as a catalyst for a global movement, the Clean Air Acts treated air pollution as a local problem to be solved by dispersing it higher and wider, simply exporting pollution downwind and ultimately contributing to acid rain in Scandinavia and Northern Europe (POST, 1995), which exemplifies the importance of treating air pollution as a transnational concern.

4.2.2 The US Clean Air Act

While the UK Clean Air Acts of 1956–1968 marked the beginning of modern air-quality regulation, one of the most influential global frameworks emerged in the United States with the Clean Air Act of 1970, which fundamentally transformed environmental governance. It empowered the newly created Environmental Protection Agency (EPA) to set national air-quality standards for pollutants harmful to human health and the environment. These include particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, and

lead. To achieve these standards, each state must design a State Implementation Plan (SIP), making the Act not only a framework for environmental protection but also a tool for federal-state cooperation (EPA Journal, 1990).

A feature of the Clean Air Act is its broad scope: unlike earlier coal-focused laws, it regulates both stationary sources (such as power plants and factories) and mobile sources like motor vehicles. Over time, amendments expanded the law to address hazardous pollutants, acid rain, and ozone-depleting substances, showing its ability to adapt to evolving scientific knowledge. The Act is widely considered a success in reducing pollution levels and preventing millions of premature deaths while the U.S. economy continued to grow (EPA Journal, 1990).

However, despite its landmark achievements, the Clean Air Act is not without significant criticism. A major concern being the “grandfathering” problem: older industrial facilities remained exempt from the stricter emission standards that applied to newly built plants (GAO, 2006, p.2). This not only created a powerful disincentive to modernize/replace aging highly polluting plants but also allowed the polluting infrastructure to continue operating for decades, frequently in or near marginalized communities—once again raising significant environmental justice concerns . Additionally, regulatory processes were slow, often delayed by legal disputes and lobbying from industries challenging stricter controls. Critics argue that enforcement is uneven across states and that the law still struggles to effectively regulate emerging pollutants linked to climate change, such as greenhouse gases, without constant political and judicial battles (GAO, 2006, p. 4).

4.2.3 The UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP)

The UNECE acted as the first international legal framework on air pollution and was established in 1979. The convention defined air pollution as:

> Art. 1(a) “the introduction by man, directly or indirectly, of substances or energy into the air resulting in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems and material property and

> impair or interfere with amenities and other legitimate uses of the environment, and "air pollutants" shall be construed accordingly".

It aimed to protect the nature and fight the problem. The convention establishes key principles to foster cooperation and prevent conflict. These include the precautionary principle (Art. 6) and the principle of information exchange and consultation (Art. 4, 5, 8), which obligates states to consult one another when activities risk causing significant transboundary pollution.

This was the beginning of international framework on climate change and catalyzed more laws regarding the hyperobject. Resulting in the latest and arguably biggest legal framework on air pollution worldwide – the European Green Deal – which has been extensively covered in previous chapters.

4.3 Data on Air Pollution

The collection of reliable air pollution data is fundamental for assessing air quality, identifying its sources and evaluating public health risks. While innovative monitoring methods enable more precise health assessments, a significant challenge remains: the drastic disparity in data availability between developed and developing nations undermining a coherent global understanding of the crisis. (Shairsingh et al., 2023).

4.3.1 Availability of Data

The 2022 WHO ambient air quality database, 2022 update: status report provides a global overview of air pollution levels for PM10, PM2.5 and NO22 between 2010 and 2019. It includes 6,743 human settlements across 117 countries. Included are small towns (<100 residents) up to megacities with over 30 million inhabitants (p.3). Most of the data is sourced from ground-based monitoring stations and national environmental reports. Europe shows the highest coverage with data from 3,654 settlements (p.3), followed by the Western Pacific region (1,693), the Americas (781), and Southeast Asia (398). The lowest

[2] PM10, PM2.5, NO2 are all examples of secondary pollutants.

coverage is in Africa, which data from only 59 settlements. This reflects a critical lack of data in many African and low-income nations. Especially the South and East Asia region, being one of the most densely populated in the world, known for exposure to high levels of air pollution, still shows major data gaps for the region (Verma, 2023).

The collection of reliable data however, faces key challenges. The nature of collection if often decentralized and inconsistent, in nations like Australia and Brazil, monitoring is often the responsibility of individual cities rather than a centralized federal body, complicating standardization (Shairsingh et al., 2023). Further difficulties arise from the wide variation in measurement and reporting methods, a disparity driven by factors such as the prohibitive cost of reference-grade equipment and divergent regulatory standards (Shairsingh et al., 2023).

4.3.2 Importance of Air Quality Data

The increasing availability of air pollution data is critical for enabling long-term air quality improvements. Enhanced data collection makes it possible to conduct vital health impact assessments and to evaluate the efficiency of policy interventions – tasks that would otherwise be unfeasible (Shairsingh et al., 2023). In recent years, methodological advances, such as the integration of satellite observations and low-cost sensors, have significantly improved the granularity and spatial coverage of monitoring over time (Shairsingh et al., 2023).

Nonetheless, a persistent and critical challenge is the severe scarcity of reliable data from many regions, particularly across Africa (Fuller, 2022). The disparity is especially problematic given that air pollution is a global issue requiring uniform, high-quality data for effective governance. The lack of standardized monitoring, especially in low-income regions, impedes the collection of accurate and comprehensive datasets. Alarmingly, it is often the countries that contribute most significantly to global air pollution that collect the least amount of data. (Smith, et al., 2025).

Consequently, global visualizations and analyses are frequently rendered incomplete or misleading, obscuring the true scale of the crisis. Addressing this fundamental gap by expanding and standardizing monitoring capacity in under-resourced nations is therefore an essential prerequisite for an effective, coordinated global response. Because of this missing data, graphs and visualizations are often incomplete or incorrect, which makes it difficult to understand the true extent of air pollution. In the future, data collection in these countries must be expanded in order to address the problem effectively.

4.3.3 Data Comparison regarding air pollution today and in the past

The onset of industrialization and the introduction of the first factories marked a turning point in air pollution and its data. Historically, the main concern was heavy, visible emissions from discrete, identifiable sources. (Smith, 2018). Nowadays, the problem is often characterized by invisible, spatially dispersed pollutants formed through complex chemical reactions in the air. (Davies, 2021).

The comparison shows a clear change, from a time of acute, localized dangers (SO2, CO) to a one of chronic, widespread dangers (PM2.5, O3). The evolution constitutes a form of slow violence (Nixon, 2011), inflicting deferred, attritional harm on populations and ecosystems over the long term. While regulatory frameworks have proven relatively effective in controlling primary, point-source emissions, contemporary pollutants present a more complex governance challenge due to their intricate atmospheric chemistry and secondary sources (Davies, 2021). Consequently, future mitigation efforts must prioritize preventing the emission of the initial gases that lead to the formation of PM 2.5 and O3 (Smith, 2018).

4.4 Strategies to Manage and Reduce Air Pollution

The WHO has published a list of numerous proven strategies that can significantly reduce air pollution (WHO, 2024). Including:

1. Industry Sector: Use of cleaner technologies to lower smokestack emissions; the reuse of methane from waste cites for use as biogas.

2. Transport Sector: Promotion of clean power generation; investment in efficient public transit systems; transition to low-emission and cleaner vehicles.
3. Energy: Expanding access to affordable clean household energy solutions for cooking, heating and lighting; transitioning to combustion free power sources such as solar, wind or hydropower.
4. Waste Management: Focus on waste reduction, sorting, recycling and reuse. Environmentally friendly methods like anaerobic digestion, which converts organic waste into biogas, provide low-cost and sustainable alternatives.
5. Health-care: It is important to put health services on a low-carbon development path can support resilient and cost-efficient service delivery and reduce environmental health risks for patients and health workers.

5. CASE STUDY: NEW DEHLI

The severe air quality crisis in New Delhi, India, perfectly illustrates how current climate governance, especially in regard to air pollution, has failed in a spectacular way. The case highlights how traditional legal and regulatory tools, created for local and predictable problems, are not effective for environmental issues that are global and highly complex. Once more, the concept of the hyperobject (Morton, 2013), slow violence (Nixon, 2011) and techno-managerialism (Swyngedouw, 2011) articulate why air pollution in New Delhi cannot be solved with outdated, reactive, locally focused legal approaches. More crucially, the failures of governance observed in New Delhi are not anomalous but reflect deep-rooted global structural deficiencies: policy voluntarism, institutional fragmentation, and over-reliance on technical solutions that ignore deeper political-economic drivers.

5.1 The Crisis Under a Critical Lense: Hyperobjects, Slow Violence and Techno-Managerialism

The air crisis in New Delhi embodies the core characteristics previously mentioned critical lenses:

1. Hyperobjects:

The air crisis in New Dehli embodies the hyperobject's core characteristics, revealing a fundamental mismatch with legal systems. Its non-locality challenges territorial sovereignty, as pollution is a cross-border issue originating from agriculture burning in neighboring states, such as Punjab or Haryana, creating a governance gap where no single jurisdiction has the authority to enact necessary structural reforms (Guttikunda et al, 2014, p.3-4; Jha et al., 2017). Its viscosity manifests in a complex network of causes–from economic pressures on farmers, who in turn burn their fields, to regional energy dependence on coal burning plants– the simplistic command-and-control laws fail to address because they target isolated symptoms rather than the interconnected system. (Guttikunda, et al., 2014). Finally, its phased temporality leads to reactive policy cycle, where governance is reduced to short-term techno-fixes during acute smog episodes.

2. Slow Violence:

New Dehli's catastrophic smog is a primary site of slow violence (Nixon, 2011). Each annual cycle of catastrophic smog is not an isolate event, but a phased manifestation of the larger systemic crisis driven by fossil fuel dependence and industrial agriculture. The resulting public health emergency–marked by soaring rates of respiratory illness and premature death–constitutes slow violence's central paradox: a crisis of such scale and regularity becomes normalized, perceived as a seasonal inevitability rather than a sustained political and ecological failure.

3. Techno-Managerialism:

New Dehli's governance exemplifies post-political techno-managerialism (Mouffe, 2005; Swyngedouw, 2010), reducing a systemic crisis to a cycle of administration fixes Interventions like recurring temporary school bans (Guttikunda, et al., 2014, p. 12), "odd-even" vehicle schemes, and smog towers are reactive technical correctives that manage acute symptoms while avoiding the political conflict externalizing the regional drivers of the metabolic rift (Forster, 1999; Marx 1867/1976, p. 637). The result is a self-perpetuating

cycle of emergency measures that sustains, rather than challenges, the growth-oriented systems producing the pollution.

5.2 The Regulatory Deficit: Law as a Reactive Control Valve

Despite the complex nature of the air quality crisis, the Indian legal system has effective tools at its disposal. It uses a combination of formal law and judicial activism. Laws such as the Air Prevention and Control of Pollution Act 1981 set strict air quality standards and grant enforcement agencies far-reaching powers. Nevertheless, the crisis persists due to a significant enforcement gap. Regulatory agencies often lack the technical capacity or political will to enforce compliance against powerful industrial and agricultural lobbies.

The most effective legal response has come from the Supreme Court of India. The court has interpreted the right to clean air as an integral part of the constitutional Right to Life in Article 21 (Jain, 2015). This judicial activism compels the executive branch to implement emergency measures and holds it accountable for inaction.

Although the judiciary plays a crucial role in preventing a complete collapse of regulation, its interventions are, as already explained, only reactive. While the court can mandate government action, it lacks the institutional capacity to design and implement the complex structural reforms required – such as creating alternatives to straw burning – or to coordinate the necessary transformation of the energy sector across state jurisdictions. The court acts as a control valve for the Hyperobject and confirms that the political and legislative system is failing to find a long-term solution.

5.3 Critical Dissection: The Need for Legal Reimagination

The crisis in New Delhi forces us to take a critical look at the situation in order to define a new legal response. The governance failures in New Delhi mirror global structural deficiencies: the fragmentation of sovereignty, the voluntarism of enforcement, and the reliance on superficial techno-fixes. Current law views the atmosphere primarily as a repository for pollution (Gupta, 2010). As long as certain limits are observed, it is considered acceptable to release pollutants into the air. This means that human economic activity is

given greater importance than the health of the air system itself. A fundamental legal reorientation must move away from the centralized, growth-oriented model that currently shapes environmental policy.

It is crucial to note that the phenomenon observed in New Delhi is not an isolated, unique failure on the part of India, but should be seen as a microstudy of the macrostructural deficits of international and regional environmental regimes (Gurjar, 2021). The fragmentation of state responsibility for crop burning in Punjab reflects the voluntaristic nature of global agreements such as the Paris Agreement, where Nationally Determined Contributions are based on self-policing and lack strong enforcement mechanisms (Franzius, 2017). Similarly, the tendency of the Indian regulatory system to prioritizing economic growth over systemic change, as seen by the long-standing dependence on coal, mirrors criticism of market-based instruments such as the EU Emissions Trading System, which is often accused of reinforcing techno-managerialism and commercializing the hyperobject rather than addressing the systemic, structural causes. The failure to enforce local laws is the local manifestation of a global pattern of regulatory weakness and political avoidance.

A transformative approach would require a rethinking of the ontology of the atmosphere. If we take an object-oriented perspective, the atmosphere must be granted its own legal status or a recognized “right to a clean atmosphere” (Tam, 2020). The goal would then no longer be to determine what concentrations of pollutants are tolerable for humans, but to preserve the atmosphere as a healthy, independent ecosystem whose integrity is actually protected by law. Such recognition would also take into account the deep interdependence of the economy, society, and ecology (Darpö, 2021).

The frequent use of so-called techno-fixes, short-term technical measures, such as smog towers or traffic restrictions, is viewed especially critically by green anarchism. The state, which is closely linked to industrial capitalism, often resorts to such superficial solutions instead of addressing the root causes. This avoids necessary changes such as systemic degrowth or confronting powerful economic sectors such as agriculture or the coal industry

(Schneider, 2020). A truly fundamental legal realignment would therefore have to think outside the centralized, growth-oriented state model and focus more on decentralized, community-based, and ecologically oriented forms of decision-making.

In order to tackle the hyperobject of air pollution, the law must evolve from its current reactive nature to a proactive system management approach. This requires the establishment of regional emission budgets rather than local limits that apply across multiple states. The introduction of market-based instruments, such as subsidies for technologies, to address the economic causes, can also contribute significantly to improvement rather than simply banning the practice.

Finally, the concept of environmental justice must be integrated to ensure that the costs of remediation do not fall disproportionately on vulnerable urban populations, while the benefits of polluting industries are enjoyed by distant elites.

6. CONCLUSION: TOWARDS A MORE RESILIENT LEGAL FRAMEWORK

The persistent shortcomings of international environmental law are structural rather than incidental. A legal architecture designed for sovereign, compartmentalized problems cannot adequately regulate a crisis that is planetary in scale, intergenerational in impact, and expressed through deeply interconnected phenomena such as climate change, biodiversity loss, and ambient pollution. Features like voluntary pledges, weak enforcement mechanisms, and internally inconsistent policy frameworks are not isolated defects but symptoms of this underlying mismatch. This systemic failure is compounded by a persistent governance gap, where political cycles are misaligned with ecological timescales, and sovereign interests are privileged over the integrity of shared global systems.

Meaningful governance therefore requires a fundamental paradigm shift. This includes replacing voluntarism with binding and enforceable obligations, ensuring that domestic policy across all sectors coheres with climate objectives, and developing legal doctrines capable of addressing diffuse, cumulative, and slow-onset harm. It also entails expanding legal standing to include future generations and ecologically critical systems.

Meaningful governance therefore requires a fundamental paradigm shift. This includes replacing voluntarism with binding and enforceable obligations, ensuring that domestic policy across all sectors coheres with climate objectives, and developing legal doctrines capable of addressing diffuse, cumulative, and slow-onset harm. It also entails expanding legal standing to include future generations and ecologically critical systems. Such a shift demands reimagining core principles of state responsibility and liability, moving beyond the model of the transboundary harm to embrace concepts of planetary trusteeship and collective ecological duty. This legal evolution must be underpinned by a new political economy that internalizes ecological costs and actively dismantles the financial and regulatory structures sustaining fossil fuel dependence and unsustainable resource extraction.

Such transformation faces considerable barriers, from entrenched political short-termism to the overwhelming scale of the ecological crisis, which often produces institutional paralysis. The profound intertemporal and intergenerational dimensions of the challenge lack clear precedent in international jurisprudence, creating a vacuum of accountability. Furthermore, the distributional inequities embedded in the current global order, where those least responsible for the crisis bear its gravest consequences, pose a formidable obstacle to building the necessary consensus for transformative action. The very architecture of international law, rooted in the consent of sovereign states, is ill-suited to mandate the deep, coordinated economic restructuring that scientific consensus deems essential.

Although international negotiations remain essential for coordination and resource mobilization, their effectiveness ultimately depends on this deeper conceptual evolution. The legitimacy of environmental law now rests on constructing frameworks as adaptive and complex as the crisis they seek to govern. Bridging the widening gap between scientific urgency and legal response is imperative, managing symptoms without confronting systemic causes is no longer tenable. The path forward requires moving beyond a governance model that merely mitigates discrete harms to one that actively stewards the

stability of the Earth system itself. This is not only a technical or legal challenge, but an existential test of global institutional imagination.

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CHAPTER SIX. RETHINKING REGULATION: GREEN ANARCHISM AND THE LIMITS OF CONVENTIONAL ENVIRONMENTAL INSTRUMENTS

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1. INTRODUCTION

Environmental governance relies on a diverse array of regulatory approaches to address the growing complexity of ecological challenges. These approaches generally fall into four categories: command and control mechanisms, market-based instruments, information-based procedural instruments, and liability and compensation mechanisms. Command and control tools impose direct obligations on polluters through standards, permits, and enforcement measures to prevent environmental harm. Market-based instruments take a different approach. Rather than prescribing actions, they rely on economic incentives to influence environmental behavior. Information-based and procedural instruments, by contrast, prioritize transparency, public participation, and access to environmental information, empowering citizens and civil society to play an active role in governance. Finally, liability and compensation mechanisms focus on assigning responsibility and providing remedies for environmental harm. Together, these instruments form the conventional toolkit for addressing environmental degradation. Legal scholarship typically presents them as complementary and effective, and they are widely relied upon by regulators, courts, and policymakers. Yet the dominant literature often understates their structural limitations, including weak or uneven enforcement, persistent centralization of authority, and limited integration of community knowledge and participation. These constraints matter for understanding why environmental regulation frequently fails to meet its stated objectives, and they also raise questions about how legal systems can better address accelerating ecological crises.

This paper argues that these limitations become clearer when environmental law is examined through a green anarchist theoretical lens. Green anarchism challenges hierarchical governance models and questions the assumption that environmental protection should be directed from above through centralized institutions. Rather than

treating environmental harm as a problem to be managed through technical regulation, green anarchist theory emphasizes decentralization, community autonomy, and relational forms of ecological stewardship (Hachey, 2024). Applying this framework allows for a reassessment of the assumptions embedded in conventional regulatory approaches, including their reliance on top down authority, financial incentives, and retrospective remediation.

Across all four categories, the paper employs green anarchist theory to illuminate the deeper institutional dynamics that shape environmental governance. Beginning with the command and control approach, Section 2 examines command and control regulation at the international and EU levels, using examples such as Trail Smelter, the ICJ Climate Advisory Opinion, and EU air quality enforcement. Section 3 then analyzes market based instruments, including the Kyoto Protocol's Clean Development Mechanism and the EU Emissions Trading System, highlighting both their efficiency benefits and their tendency to commodify nature and reproduce structural inequalities. Turning to the information based approach, Section 4 will evaluate the Aarhus Convention and EU Environmental Impact Assessments, and questions whether participatory mechanisms genuinely empower the public or simply formalize existing hierarchies. Lastly, Section 5 turns to liability and compensation regimes at the international and EU levels, focusing on the Civil Liability Convention and IOPC Funds system and the EU Environmental Liability Directive, and evaluates their reactive nature and limited preventive capacity.

2. COMMAND AND CONTROL MECHANISMS

The Command and control approach is a common method used to protect the environment, and it continues to shape how governments respond to environmental issues and harm (Wolff, 2022). This model operates on the idea that the state can protect the environment by setting legally binding rules and requiring individuals, industries, and public authorities to comply. These rules can take many forms, including emission limits, mandatory pollution

control technologies, permitting requirements for industrial activities, or bans on substances and practices (Birnie et al., 2021). Common examples include limits on sulphur dioxide and nitrogen oxide emissions, and prohibitions on dumping hazardous waste into waters. As these rules are binding, they allow states to establish minimum environmental standards that may be applied consistently across sectors and regions (Dupuy & Viñuales, 2018).

Unlike market based or informational instruments, command and control provides governments with regulatory power, enabling them to intervene to prevent harm and signal normative commitments to environmental protection (Wolff, 2022). This direct authority is particularly vital in situations where environmental risks are immediate or where regulated actors have limited incentives to reduce pollution voluntarily. For instance, strict emission limits and mandatory installation of pollution control devices were central to significant reductions in urban smog and industrial water contamination (Ross et al., 2012). Similarly, bans on ozone depleting substances under domestic legislation played a critical role in supporting global efforts to restore the ozone layer (United Nations Environment Programme [UNEP], 2019). These examples show why command and control continues to be seen as a necessary and powerful regulatory tool. It provides a clear framework, supports enforcement through predictable rules, and helps address environmental harm even when scientific uncertainty or economic pressure makes voluntary action uncertain (Wolff, 2022).

Yet, despite its prominence, command-and-control mechanisms have increasingly been criticized for falling short of their environmental objectives, particularly when applied to complex, transboundary, or deeply structural ecological harms such as climate change (Wolff, 2022). This section argues that although command-and-control is foundational to environmental law, its effectiveness is limited by rigid institutional structures, weak enforcement, and a persistent reliance on state-centric, hierarchical assumptions that inadequately reflect ecological interdependence. We assert that command-and-control ultimately proves insufficient in achieving meaningful environmental protection, both

internationally and within the European Union. The approaches' limitations become especially visible when evaluated through a Green anarchist lens.

This section proceeds in three parts. First, we examine command and control from an international perspective through two key examples: the International Court of Justice Advisory Opinion on Climate Change (International Court of Justice [ICJ], 2025) and the Trail Smelter Arbitration of 1938 and 1941 (Trail Smelter Arbitration, 1938/1941). These cases reveal significant enforcement and compliance shortcomings for the command and control approach on the international stage. Second, we turn to the European Union and consider Commission of the European Communities v. Ireland, Case C-494/01 (Court of Justice of the European Union [CJEU], 2005). This case shows how the EU's institutional structure strengthens oversight but still encounters challenges that are inherent to command and control regulation. Finally, we apply a Green anarchist lens to assess the broader limitations of this regulatory model (EBSCO, 2025). This perspective highlights how centralization and state dominance can undermine meaningful environmental protection and restrict more participatory and community based approaches. Taken together, these examples from both the international and EU level demonstrate how the command and control approach remains influential but is not sufficient on its own to address the scale and complexity of contemporary environmental problems.

2.1 The international Perspective

From an international perspective, the command and control approach obligates states to prevent environmental harm, comply with agreed upon standards, and exercise due diligence in monitoring activities within its jurisdiction. Unlike command and control at the domestic level, which relies on legislatures, administrations, and direct enforcement tools, command and control on the international level depends on treaties, customary international law, and decisions of international bodies (Dupuy & Viñuales, 2018). These mechanisms establish duties for states that rely on voluntary compliance, operate within a decentralized international system, and lack strong enforcement mechanisms. Despite these weaknesses, command and control remains central to international environmental

law as it is one of the few tools available to articulate minimum standards of conduct and to hold states accountable (Dupuy & Viñuales, 2018). To understand how this model functions in practice, we will examine two historic examples where the approach was used with some success and one that reveals its limitations at the international level.

The Trail Smelter Arbitration, decided in 1938 and 1941, is often described as the foundation of modern international environmental law (Trail Smelter Arbitration, 1938/1941). The dispute arose when a Canadian smelting operation in Trail, British Columbia emitted sulphur dioxide fumes that crossed the border into Washington State, causing damage to crops, forests and private property. After negotiations proved unsuccessful, the United States and Canada agreed to submit the dispute to arbitration (Trail Smelter Arbitration, 1938/1941, pp. 1924-29). The tribunal was asked to determine whether Canada was responsible for the transboundary pollution and, if so, to decide what measures should be taken to prevent further harm. The tribunal concluded that Canada was indeed responsible because states have a duty not to allow activities within their territory to cause serious injury to the territory of another state. This obligation later became known as the no harm rule. It also imposed specific operational limits on sulphur dioxide emissions to prevent future harm (Wood, 2007, pp. 637-645).

Trail Smelter demonstrates how command and control can function effectively at the international level when the harm is concrete, traceable, and confined to a narrow set of activities. The tribunal not only assigned responsibility but also mandated specific regulatory measures, which closely aligned with domestic command and control techniques. Canada accepted the decision and implemented the required controls, showing that international mechanisms can achieve meaningful environmental protection when states consent to binding adjudication and when the dispute is manageable in scale and complexity (Wood, 2007, p. 641). Even so, the case exposes several weaknesses in the international command and control model. Compliance depended entirely on voluntary cooperation. Trail Smelter also involved only two states and a single industrial facility, which made causation easier to prove and address (Wood, 2007, pp. 639-42). In modern day

environmental disputes, these same conditions rarely exist. Issues such as climate change or biodiversity loss involve many actors and forms of harm that cannot be resolved through narrow, bilateral solutions. Trail Smelter therefore illustrates both the strength of command and control in ideal circumstances and the narrow circumstances under which it can operate successfully (Dupuy & Viñuales, 2018, p.5).

The challenges revealed by Trail Smelter are further emphasized when examining more recent attempts to apply command and control to global environmental problems. The International Court of Justice Advisory Opinion on Climate Change serves as a valuable example. The request for an opinion came from small island states seeking clarification of the obligations of states to address climate change. By bringing this question to the Court, the requesting states sought authoritative guidance on whether existing international law imposes concrete duties to reduce greenhouse gas emissions (ICJ, 2025) The Court reaffirmed several long standing principles, including the obligation to prevent significant transboundary harm, the duty to exercise due diligence, and the need for cooperation. However, the Court did not convert these principles into specific emission limits or quantified duties of result. Instead, it framed them as general duties of conduct, leaving it to states to decide what measures are appropriate (Odermatt, 2025). This outcome does not reflect judicial unwillingness so much as it reflects the structural limitations of command and control at the international level (Stockholm Environment Institute [SEI], 2025). Climate change involves cumulative emissions from almost every state, and the causal links between individual contributions and specific harms are complex. The international system lacks both a centralized regulatory authority and the enforcement tools required to impose binding global standards. As a result, the Court could only describe broad obligations without prescribing concrete regulatory measures (ICJ, 2025).

The contrast between Trail Smelter and the ICJ Advisory Opinion illustrates the broader tension that defines command and control in the international system. Trail Smelte*r* shows that the model can be effective when the problem is narrow, the responsible party is identifiable, and the states involved accept binding adjudication (Trail Smelter Arbitration,

1938/1941). In such cases, tribunals can impose clear, technology based controls similar to those used in domestic environmental law. The ICJ Advisory Opinion shows the opposite scenario, where the scale and complexity of the environmental problem overwhelm the command and control framework. Without a powerful central authority capable of enforcing specific standards, international law struggles to extend command and control beyond general principles (SEI, 2025). Together, these cases demonstrate that the international legal system relies heavily on command and control to articulate expectations for state behaviour, but falls short of the structural capacity needed to transform these expectations into enforceable obligations. The result is a form of regulation that is normatively significant but operationally limited, particularly for the types of global environmental challenges that define the current state of global environmental issues.

2.2 The European Union Perspective

Command and control regulation has formed the core of environmental law within the European Union (EU). Command and control mechanisms rely on binding standards, prescriptive rules, and enforcement mechanisms to ensure environmental protection across EU Member States. The effectiveness of these mechanisms within the EU depends not only on legislative design, but also by the jurisprudence of the Court of Justice of the European Union (CJEU), which has played a pivotal role in clarifying, strengthening, and enforcing these obligations (Méndez-Pinedo, 2021). This section examines the structure and purpose of command and control mechanisms in EU environmental law, explores their main regulatory tools, and illustrates their operation through key CJEU case law.

At its core, there are four main categories of command and control mechanisms that are prevalent within the EU: environmental quality standards, emission and discharge limits, technology requirements, and permit systems enforced through inspections and sanctions (Baldwin et al., 2012). These command and control techniques are reflected through EU directives and regulations which bind all Member States. While EU directives and regulations impose binding minimum environmental standards, Member States retain

discretion to adopt stricter rules under Article 193 of the Treaty on the Functioning of the European Union (TFEU).

The EU's reliance on command and control mechanisms reflects both environmental and internal market objectives. From an environmental standpoint, harmonized standards prevent Member States from adopting overly lax standards that could harm health, ecosystems, or climate (Khalique et al., 2025). With that said, command and control mechanisms also serve an important economic function; if every Member States had varying environmental rules, companies in countries with stricter laws would face higher costs and be at a competitive disadvantage. This could lead to what is often referred to as "environmental dumping", where countries lower their environmental standard to attract investment or keep industries competitive (Andersen et al., 2018). Therefore, command and control mechanisms are not only an attempt to more effectively protect nature but also, a mechanism of market integration and legal harmonization within the EU.

Environmental quality standards (EQS) are one kind of mechanism frequented by the EU. EQS are legal thresholds that define the minimum acceptable state of the environment in a particular area rather than regulating individual polluters directly (Baldwin et al., 2012). For instance, Directive 2008/50/EC, otherwise known as the Ambient Air Quality Directive, is an EU directive that sets objectives and measures for reducing emissions of harmful air pollutants and improving ambient air quality in the EU. More specifically, this Directive outlined the maximum concentrations of nitrogen dioxide or particulate matter allowed in urban air. Since it has been made effective, several EU member states have been sued for violating these established limits. In fact, in February of 2018 in Commission v. Poland (C-335/16), Poland was found guilty of violating these emission limits. EQS and its enforcement form the backbone of the EU's command and control system because they impose results-based obligations. Member States must achieve the specified environmental outcome rather than merely attempting to do so. The CJEU has repeatedly emphasized that EQS create binding legal obligations, enforceable by the European Commission and by individuals affected by poor environmental conditions (Ghavanini, 2023).

In the case of Janecek v. Freistaat Bayern (“Janecek”), a Munich resident lived in an area where EU air pollution limits for particulate matter (PM10) were repeatedly exceeded. Janecek argued that the German authorities were failing to adopt a short-term action plan despite repeated predictable PM10 exceedances. Article 9(3) of Directive 96/62/EC required Member States to draw up short-term action plans when there was a risk that EU air pollution limit values or alert thresholds would be exceeded. In Janecek, the particulate exceedances were governed by Directive 1999/30/EC but the obligation to adopt short-term action plans still derived from Article 7(3) of Directive 96/62/EC. The CJEU held that this obligation created an individual right from residents like Janecek to demand that the competent authorities put such short-term plans in place. Ultimately, EQS operate at the top of command and control systems in setting legally binding outcomes. This judicial approach strengthens command and control in ensuring that environmental quality rules are effective, justiciable, and capable of producing uniform high standards across the EU.

Another instrument of command and control mechanisms within the EU are emission limit values (ELVs) (He et al., 2021). Where EQS focuses on the state of the environment, ELVs regulate the amount of pollution that each individual facility is legally allowed to release. This is exemplary of command and control regulation as they impose direct, enforceable limits on polluters. The EU’s most comprehensive regime for controlling industrial pollution is the Industrial Emissions Directive 2010/75/EU (IED). The IED applies to large, pollution-intensive sectors such as energy production, metal processing, waste incineration, chemical manufacturing, food processing, and others. Under the IED, industrial installations must operate in accordance with a permit, and that permit must include ELVs that set the maximum allowable concentration or quantity of pollutants an installation may release (Liu et al., 2017). These ELVs must be based on Best Available Techniques (BAT), which establish the best available techniques for meeting environmental standards.

The case PreussenElektra AG v. Schhleswag AG, involved a German energy installation regulated under the IED. The core legal issue was how strictly Member States must adhere to BAT conclusions when granting or revising permits. A German operator sought conditions

that deviated from BAT-based ELVs, and the German authorities allowed such deviations through a flexible interpretation of the IED. The CJEU held that permit conditions must be consistent with BAT conclusions, and Member States cannot use their permitting discretion to weaken or disregard BAT-based emission levels. They further found that derogations from BAT are allowed only in exceptional, narrowly defined circumstances and that Member States cannot use derogations systematically or broadly to undermine the environmental objectives of the IED. In essence, the Court made clear that BAT conclusions have binding force and represent the minimum level of environmental protection. The CJEU's approach ensures that ELVs are treated as floor standards, preventing Member States from weakening environmental protections through overly flexible permitting.

Environmental technology standards are another command and control mechanism used by the EU. Technology standards are regulatory tools that require industrial operators to use certain techniques, equipment, or performance levels to reduce pollution. Traditionally, these standards mandate the installation of specific technologies, ensuring uniform compliance across facilities. However, a central innovation of the IED is its approach to technology standards, particularly through the BAT system. Rather than requiring operators to install a specific type of filter, scrubber, or machine, the BAT framework adopts a performance-based approach (Blind et al., 2023). Rather than dictating a particular technology, BAT frameworks specify the emission levels and environmental performance that an installation must achieve. Operators are free to choose the technology or process that allows them to meet those performance targets, provided it reflects the best available techniques currently in use across the EU. This demonstrates a hybrid command and control model in that it allows the flexibility of innovation while also establishing the binding standards.

Permit systems form a core component of the EU's command and control framework, operating as legally binding tools through which Member States regulate, monitor, and enforce compliance with environmental standards. Waste law has historically produced some of the most influential command and control case law (Zhang et al., 2024). The Waste

Framework Directive (75/442, now codified in Directive 2008/98) has given rise to several landmark infringement actions. One case being Case C-494/01 Commission v Ireland ("Ireland"). Ireland established that environmental obligations under EU law are not mere formalities but they require robust enforcement by Member States, and the failure to do so can lead to the Commission's intervention. Ireland involved a series of complaints made against multiple countries within Ireland between the 1990s and the early 2000s concerning various violations regarding waste disposal. The CJEU ultimately found widespread and systemic failures to enforce waste disposal rules, including unlicensed landfills and inadequate permitting. The Court rejected Ireland's argument that national administrative limitations justified non-compliance, affirming that Member States are strictly liable for failures of enforcement. The case highlights a defining feature of EU command and control mechanisms; the duty of supervision and enforcement is as binding as the substantive environmental standards themselves.

Taken together, these mechanisms demonstrate that command and control regulation remains the backbone of EU environmental law, combining binding standards with strong judicial oversight to secure meaningful compliance. Through environmental quality standards, emission limits, technology-based, and permit and enforcement systems, the EU has constructed a comprehensive regulatory architecture aimed at delivering consistent levels of environmental protection across all Member States. The CJEU's jurisprudence reinforces this architecture by ensuring that these obligations are not merely aspirational but legally enforceable, conferring rights on individuals and limiting Member State discretion where it threatens environmental objectives. Ultimately, the EU's command and control model functions not only as a tool of environmental governance but also as a mechanism for ensuring regulatory harmonization, market fairness, and uniform protection throughout the EU. Having outlined the structure and operation of command and control mechanisms at the EU and international level, our discussion now turns to a critical examination of their effectiveness and its limitations through a green anarchist lens.

2.3 Command and Control Through a Green Anarchist Lens

From a green anarchist perspective, command and control mechanisms embody the same structural dynamics that underpin political and economic domination (Leeson, 2014). Centralized bureaucracies, whether that be national environmental agencies or EU institutions, assume authority over local communities, natural resources, and industrial actors. These bureaucracies impose uniform standards, emission limits, and permitting requirements, oftentimes with little input from those directly affected by environmental degradation (Söderholm & Sundström, 2025). While command and control techniques aim to protect ecosystems, green anarchists argue that the top-down enforcement model replicates coercive hierarchies that are part of the ecological problem; humans governing nature from a position of authority rather than engaging in decentralized, mutualistic stewardship (Söderholm & Sundström, 2025). It is inherently contradictory to expect the institutions that created and continue to perpetuate ecological and environmental disasters to be the ones to also solve them.

Green anarchist thought emphasizes autonomy, self-organization, and local knowledge as essential to ecological sustainability (Morris, 2014). In this framework, command and control's reliance on uniform standards, such as EU air quality limits or emission thresholds under the IED, can be criticized for ignoring local environmental contexts and community needs. For instance, a regulation that mandates a single maximum emission level across diverse regions may be over restrictive in areas with low industrial density and insufficiently protective in areas with concentrated pollution. By privileging generalized scientific metrics and bureaucratic enforcement, command and control can marginalize local actors and diminish opportunities for participatory ecological management.

Furthermore, command and control mechanisms often rely on punitive enforcement such as fines, permit revocations, and infringement proceedings to achieve compliance. While some may argue this is effective in incentivizing adherence to legal standards, this coercive element exemplifies a green anarchist critique of environmental governance as inherently authoritarian. Environmental protection, in this view, should emerge from voluntary

cooperation, mutual aid, and shared responsibility, rather than from fear of sanctions imposed by distant authorities. For example, the Court of Justice of the European Union's decisions in its waste management case against Ireland in Commission of the European Communities v. Ireland, demonstrate the power of centralized enforcement, but also illustrate how local communities are rarely empowered to participate meaningfully in shaping solutions.

Despite these critiques, green anarchists do not deny the ecological necessity of pollution control or resource management. Rather, they argue that command and control mechanisms are insufficiently relational and socially just (Söderholm & Sundström, 2025). Sustainable environmental outcomes, from this perspective, require governance models that are horizontal, adaptive, and rooted in local knowledge, rather than strictly top down. Practices such as community-managed forests, participatory water management, and cooperative energy production exemplify the alternatives envisioned by green anarchist thought.

Analyzing command and control environmental regulation through a green anarchist lens reveals fundamental tensions between hierarchical authority and ecological ethics. While command and control systems achieve measurable reductions in pollution and establish enforceable environmental rights, they do so at the cost of reinforcing centralized power structures and limiting community agency. From this perspective, the EU's command and control approach, rigid standards, permitting systems, and formal enforcement, highlights both the ecological successes and social shortcomings of state-centered environmental governance. Green anarchism invites a reimagining of environmental law that prioritizes decentralized stewardship, participatory decision-making, and autonomy for communities in relation to their ecosystems.

From a green anarchist perspective, the solution to the limitations of command and control mechanisms lies in replacing hierarchical, state-driven regulation with decentralized, community-based ecological governance. Rather than uniform standards imposed by centralized authorities, environmental protection would be organized through locally

grounded assembles, cooperative resource-management groups, and mutual-aid networks that directly steward the ecosystems they inhabit. Drawing on principles of autonomy and self-organization, green anarchists propose horizontal structures in which decisions about land use, pollution limits, and conservation practices emerge from participatory deliberation informed by lived ecological knowledge rather than more distant bureaucratic methods (Morris, 2014). This approach favours restorative and relational practices over punitive enforcement systems. In this model, ecological responsibility is cultivated through collective stewardship and shared obligation, rejecting coercive sanctions in favour of voluntary coordination and reciprocal accountability. Ultimately, the green anarchist solution replaces top-down environmental law with adaptive, place-based governance that empowers communities to shape ecological outcomes in ways that reflect their specific environmental realities and ethical commitments.

3. MARKET-BASED INSTRUMENTS

Environmental management seeks to address ecological challenges and promote sustainable development through a variety of regulatory approaches. As discussed in Section 2.1, command and control regulation remains central to environmental law but often limits flexibility. In contrast, market-based instruments (MBIs) represent an alternative regulatory strategy that relies on economic incentives and price signals to influence environmental behaviour. MBIs operate on the assumption that actors will modify their conduct when pollution becomes financially costly and cleaner alternatives become comparatively advantageous. Scholars describe MBIs as instruments that “harness market forces,” since they encourage private actors to internalize environmental harms and respond strategically to changing costs (Stavins, 2001).

Several types of MBIs have been developed, including pollution taxes, emissions trading systems, liability rules, and deposit-refund systems (Baumol & Oates, 2012; Eskeland & Jimenez, 1992; Laubinger et al., 2022). Environmental taxes increase the cost of polluting activities, encouraging firms and consumers to reduce emissions when doing so becomes cheaper than paying the tax. Tradable permit schemes, such as cap-and-trade systems,

establish an aggregate emissions limit and allow firms to buy or sell allowances so that reductions occur where they are most cost-effective. Liability rules assign financial responsibility for environmental harm to polluters after damage occurs, incentivizing safer practices ex ante (Jutta, 2004). Deposit-refund systems combine an upfront surcharge with a refund upon appropriate disposal or return of products, motivating consumers to reduce littering and improve recycling (Laubinger et al., 2022). Together, these instruments illustrate the diverse ways in which MBIs influence behaviour indirectly by altering the economic incentive structure.

These instruments share a common goal of aligning environmental objectives with economic decision making by shifting the costs of pollution onto those responsible for it. MBIs offer significant strengths. When well designed, they reduce pollution at the lowest aggregate cost by encouraging firms with lower abatement costs to undertake more substantial reductions, which equalizes marginal abatement costs across the economy (Mazaheri et al., 2022). Additionally, MBIs can create dynamic incentives, prompting firms to invest in cleaner and more efficient technologies whenever doing so reduces their financial burden. Taxes, in particular, provide clear and predictable price signals that guide long-term decision making and directly operationalize the polluter pays principle (Baumol & Oates, 2012).

Despite these benefits, MBIs highlight potential flaws. First, MBIs can lead to the commodification of nature by transforming ecological functions into tradable or taxable units, a process that risks oversimplifying complex ecological relationships (Leeson, 2014; Morris, 2014; Brunnéè Jutta, 2012). MBIs can also generate unequal social and political outcomes, such as pollution hotspots in lower-income communities, particularly when emissions trading allows polluters to concentrate emissions geographically (European Environment Agency, 2021). Moreover, permit prices can fluctuate unpredictably, which undermines firms' ability to plan long-term investments. Taxes may create regressive effects by placing a disproportionate burden on low-income households (Mazaheri et al., 2022). These limitations demonstrate that although MBIs promote efficiency, they do not

always ensure environmental justice or robust ecological protection. These shortcomings contribute to the broader governance gap identified in the previous section, which highlights the difficulty of achieving environmental protection solely through economic or hierarchical regulatory mechanisms. Having outlined the conceptual foundations, strengths, and weaknesses of MBIs, it is necessary to examine how this regulatory approach functions in practice, where institutional and global inequalities shape outcomes.

3.1 The International Perspective

At the international level, market-based instruments (MBIs) are used to encourage states and private actors to reduce pollution through financial incentives rather than prescriptive rules. International MBIs typically take the form of carbon taxes harmonized through international agreements, cross-border emissions trading systems, and global offset markets created under mechanisms such as the Kyoto Protocol's Clean Development Mechanism (CDM) (World Bank, 2018, pp. 10-15). These instruments were designed to reduce emissions where costs were lowest, thereby achieving global mitigation at a lower aggregate cost than uniform domestic regulation (Dupuy & Viñuales, 2018).

A central example is the Kyoto Protocol's CDM, which allowed industrialised countries to meet part of their emissions reduction commitments by purchasing Certified Emission Reductions (CERs) generated by mitigation projects in developing countries (UNFCCC, n.d.-a; Lim & Lam, 2014). In theory, this structure promoted cost efficiency, encouraged green investment, and enabled technology transfer by allowing developing countries to attract climate finance. By 2014, the CDM had registered over 8,000 projects and mobilised more than USD 130 billion in investment (World Bank, 2018, p. 18). It also demonstrated proof of concept at global scale, showing that a transnational carbon market could operate across more than 100 participating countries (Black, 2018).

However, this system also exposed significant governance weaknesses. Numerous scholars and institutional studies highlight substantial shortcomings. Research shows that a significant share of CDM projects failed to generate real, additional, or permanent

emissions reductions (Michaelowa & Michaelowa, 2017; Deriaz, 2025; UNFCCC, n.d.-b). Additionality testing proved technically complex, and weak verification frameworks in lower-income countries contributed to methodological inconsistencies (Hallegatte & Gemenne, 2024). This aligns with findings in other developing countries. For example, industrial facilities in India participating in pilot emissions-trading schemes reported inaccurate emissions data in more than 70% of cases, undermining environmental integrity (Stockholm International Water Institute, 2016). These issues are also reflected in the World Bank's assessment of Kyoto mechanisms, which identifies "environmental integrity" and "low demand due to weak political will" as major structural barriers (World Bank, 2018, pp. 23-32). Furthermore, as Temper et al. purports, international carbon offsetting enabled wealthy states and corporations to continue emitting while outsourcing mitigation responsibilities to the Global South (2022). This dynamic entrenched "carbon colonialism," reproducing inequalities by allowing high-emitting economies to delay domestic decarbonisation (Bachram, 2004; Kulovesi & Oberthür, 2021). Between 2013 and 2020, more than half of the emissions reductions counted by EU Member States toward their climate commitments were acquired as offsets from developing countries, enabling continued domestic emissions in the Global North (Zhang & Maruyama, 2021).

Taken together, the CDM illustrates both the potential and the limits of international MBIs. On one hand, they can mobilise large-scale climate finance, enable cooperation, and promote cost-effective mitigation across jurisdictions. On the other hand, they risk reinforcing structural inequalities, generating questionable emissions reductions, and allowing wealthy states to defer meaningful domestic climate action. These tensions reveal that while MBIs can support global climate governance, they often fall short when underlying power asymmetries, institutional weaknesses, and commodified approaches to environmental protection remain unaddressed.

3.2 The European Union Perspective

Within the European Union, market-based instruments (MBIs) operate under a coordinated legal and institutional framework that enables binding implementation across Member

States. The EU's focus MBI is the European Union Emissions Trading System (EU ETS), a cap-and-trade scheme designed to reduce greenhouse gas emissions cost-effectively by allowing firms to buy, sell and bank allowances within a declining emissions cap (Kotzampasakis & Woerdman, 2024). This centralized structure contrasts with international systems by enforcing reduction targets uniformly within the EU's internal market. The EU ETS is accompanied by secondary instruments such as harmonised energy taxation frameworks and producer responsibility schemes that extend carbon pricing logic into sectors beyond direct emissions trading (Kotzampasakis & Woerdman, 2024; Müller, 2021). As the world's largest regional carbon market, the ETS has played a major role in the EU's decarbonisation strategy. It covers major sectors including power generation, industry, and aviation within the European Economic Area, and sets a progressively declining emissions cap that allocates or auctions allowances annually (Laing, 2013; Heiaas, 2021). The system's legal objectives emphasize cost-effectiveness, economic efficiency, and coherence between climate goals and EU internal market policy (Kotzampasakis & Woerdman, 2024). Practically, it has driven emissions reduction through fuel switching and investment in renewables, contributing significantly to the EU's electricity sector, which saw a more than 40 percent reduction in emissions between 2005 and 2020 (Laing, 2013; Heiaas, 2021).

However, the EU ETS also demonstrates the limits of market-based instruments even within a well-developed regulatory system. In its early years, too many allowances were allocated and carbon prices remained very low, which meant firms had little financial incentive to reduce emissions (Laing, 2013; Müller, 2021). Later reforms, such as the creation of the Market Stability Reserve, helped stabilize prices, but the system continues to perform unevenly across different sectors and Member States.

The aviation sector illustrates this uneven performance. Although aviation was integrated into the ETS in 2012, research shows that emissions did not decline as expected. One study found that fuel use increased between 2012 and 2018, which suggests that the ETS has limited impact in sectors where demand for services remains high even when prices rise (Heiaas, 2021). Distributional concerns also remain significant. Member States that rely

heavily on coal, such as Poland, experience higher economic and social costs when carbon prices increase. In addition, carbon pricing can have regressive effects because it places a comparatively heavier financial burden on low-income households and regions (Kotzampasakis and Woerdman, 2024; Müller, 2021). Gaps in sectoral coverage further limit the ETS's overall impact. While the system applies to electricity production, heavy industry, and flights within the European Economic Area, it does not cover road transport, buildings, or agriculture. These sectors are managed through separate taxes and regulatory measures (Kotzampasakis and Woerdman, 2024). Recent proposals to extend carbon pricing to buildings and road transport reflect an attempt to create a more complete system, but they also raise concerns about administrative complexity, political resistance, and the risk of increasing energy costs for vulnerable groups (Müller, 2021). Overall, these challenges show that while the EU ETS has reduced emissions and encouraged some technological change, it cannot by itself guarantee fair or socially balanced climate outcomes. Without additional policies that address equity, participation, and distributional impacts, the ETS will continue to prioritize cost efficiency over broader social and environmental goals.

3.3 Market-Based Instruments Through a Grenn Anarchist Lens

The shortcomings identified in the international and EU contexts become more apparent when market-based instruments are examined through a green anarchist lens. As outlined in Section 2.1, green anarchism challenges governance models that rely on centralized authority and capitalist market structures. When applied to MBIs, this framework shows how carbon markets, taxes, and offset mechanisms continue to depend on economic logics and institutional hierarchies that contribute to ecological degradation (Toro, 2021).

From this perspective, MBIs treat pollution as an activity that can be priced rather than prevented. By converting emissions into tradable units or taxable behaviours, MBIs risk legitimizing continued pollution as long as actors can afford to pay for it. Dunlap argues that this transforms environmental harm into a financial calculation, encouraging strategic compliance rather than meaningful changes to production systems or consumption patterns (2022, pp. 8–10). This structure reinforces unequal power relations, since well-

resourced firms and high-income states can purchase allowances or offsets while economically marginalized communities disproportionately experience environmental harms (Hughes, 2015). Green anarchist critiques also highlight how MBIs frame nature as an economic asset. By reducing ecosystems to market variables, MBIs obscure the intrinsic value of natural systems and the social relationships communities maintain with their environments (Toro, 2021). This narrow framing limits more transformative approaches that challenge growth-driven economic models. It also centralizes authority in experts, regulatory agencies, and corporate actors, which can displace community governance and weaken local decision-making power (Dunlap, 2022).

Contrary to common assumptions, green anarchism does not reject environmental regulation outright. Instead, its critiques point toward alternatives that decentralize authority and strengthen community autonomy. Hughes argues that environmental justice requires decision-making structures that operate at scales meaningful to affected communities, supported by horizontal networks rather than top-down institutions (2015). Based on this, MBIs could be complemented by reforms such as community-run monitoring systems, participatory environmental councils, and local veto rights for high-impact industrial projects. Additionally, procedural safeguards that require distributional impact assessments before any pricing scheme is implemented could help avoid pollution hotspots. Pairing MBIs with non-market governance structures offers further potential. Approaches such as commons-based resource management and polycentric governance allow multiple centres of authority to share responsibility for oversight, reducing dependence on market logic and centralized state control (Toro, 2021). Together, these reforms highlight that while MBIs can support efficient emissions reductions, they cannot resolve structural inequalities on their own. A green anarchist perspective highlights the need to combine MBIs with governance models that foreground community participation, equity, and ecological integrity. When supported by decentralized institutions and local oversight, MBIs have greater capacity to contribute to socially just and environmentally sustainable outcomes.

4. INFORMATION-BASED & PROCEDURAL INSTRUMENTS

Information-based procedural instruments are being used more and more as a fundamental tool for environmental governance, in addition to command and control and market-based procedures. Instead of placing direct requirements on polluters, these tools work by increasing transparency, guaranteeing public access to environmental information, and promoting meaningful public engagement in decision-making. The release of environmental reports, industrial emissions registries, environmental labeling programs, and corporate transparency requirements for sustainable practices are just a few of the many tools they include (Mwebaza, 2020). These tools establish mechanisms for public oversight and accountability, encouraging adherence to environmental standards and enabling citizens and civil society to influence outcomes by mandating authorities and private actors to disclose environmental data and involve stakeholders early in the decision-making process.

The overarching objectives of information-based procedural instruments are twofold. First, they promote accountability by making the actions of governments, corporations, and regulators visible and subject to scrutiny. Second, they empower citizens and civil society to engage meaningfully in environmental governance, transforming environmental decision-making from a technocratic or bureaucratic exercise into a participatory process. At the international, regional, and national levels, environmental procedural rights, which include access to information, public participation, and justice, have been acknowledged as crucial for sustainable development, sound governance, and the successful execution of multilateral environmental agreements (Mwebaza, 2020; UNEP, 2023). By giving communities a useful framework to check compliance, make legal claims, and share local knowledge, these rights improve democratic government and environmental conservation. Additionally, they ensure that environmental management is transparent and socially equitable by empowering marginalized groups, fostering consensus, and preventing corruption (Mwebaza, 2020; van Erp et al., 2023).

Information-based tools change the emphasis from top-down regulation to a model where knowledge, participation, and legal recourse form the foundation of accountability by incorporating procedural rights into environmental policy. This shows how important information is to attaining effective environmental governance at several levels. The following sections will delve further into these instruments, first from an international standpoint, analyzing the functioning of international procedural rights frameworks with an emphasis on the Aarhus Convention. This is followed by an analysis of EU-specific mechanisms like Environmental Impact Assessments and their function in fostering responsibility, involvement, and openness within Member States.

4.1 The International Perspective

The Aarhus Convention ("the Convention") is considered to be an information-based procedural instrument as it ensures public access to environmental information, participation in decision-making, and access to justice. Accordingly, the Convention provides an ideal focal point for this section as it illustrates a developed procedural regime that places a central role to access to information in environmental law (United Nations, 1998). The Convention was adopted in 1998 and entered into force in 2001. As of now, a total of 48 states and the entire EU are legally required to abide by the Convention. The Convention is structured around three pillars: access to information, public participation, and access to justice (United Nations, 1998). The instruments borne out of the Convention focus on transparency, public participation, and access to environmental information, rather than imposing prescription obligations on polluters. The goal of the Convention is to enhance compliance, promote accountability, and empower citizens to influence environmental outcomes (European Commission, 2020).

The first pillar of the Convention governs access to information, as outlined in Articles 4 and 5. Under this framework, public authorities are required to proactively provide environmental information and provide citizens with the right to request such information without justification. This includes data on pollution, industrial risks, and environmental assessments. The Convention specifies that information be accessible, timely, and

presented in a format understandable by the public. The second pillar, public participation, as outlined in Articles 6 to 8, promotes the public's right to participate in environmental decision-making processes. This includes early consultation on proposed plans or policies, access to relevant documents, and consideration of public comments before decisions are finalized. The third pillar, access to justice, as outlined in Article 9 of the Convention, is intended to ensure that individuals and organizations can challenge the public authorities' failures to comply with the Convention's provisions or with national environmental law. Courts or review bodies must be available to examine failures related to access to information, participation, or compliance with environmental law.

A concrete example of the Aarhus Convention's international application is the submission by Lithuania against Belarus regarding the building of a nuclear power plant in Belarus (ACCC/S/2015/2). Lithuania submitted the complain to the Aarhus Convention Compliance Committee (ACCC), which is the body established under the Aarhus Convention to review alleged failures by Parties to comply with their procedural obligations. In their complain, Lithuania alleged that Belarus failed to provide timely and adequate access to environmental information and to ensure meaningful public participation in the decision-making process. The ACCC found Belarus to be non-compliant with the Convention, highlighting shortcomings in both the dissemination of environmental information and mechanisms for engaging the public. This case demonstrates how the Convention functions beyond the EU, providing a formal international mechanism for oversight and accountability. More broadly, it underscores the importance of robust access to information systems: without clear, timely, and accessible environmental data, citizens and other Parties cannot fully participate in governance processes or hold authorities accountable, reinforcing the central role of information-based procedural instruments in global environmental governance.

4.2 The European Union Perspective

At the EU level, information-based procedural instruments are operationalized through various mechanisms. Examples include the Environmental Information Directive (Directive

2003/4/EC), which guarantees public access to environmental information held by public authorities, the Public Participation Directive in Environmental Planning (Directive 2003/35/EC), which ensures that citizens can participate in decisions on plans and programmes affecting the environment, and the Access to Justice provisions under the Environmental Impact Assesment (EIA) and Strategic Environmental Assessment (SEA) Directives, which allow individuals to challenge environmental decisions in court. Other instruments include pollution registries, reporting obligations for industrial emissions, and corporate disclosure requirements under the EU Non-Financial Reporting Directive. Among these, EIAs stand out as a particularly comprehensive mechanism, integrating information disclosure, early public participation, and judicial review into a single procedural framework. For the purposes of the European Union perspective on information & procedural based mechanisms, the focus will be on EIAs as they provide a concrete example of how information-based instruments operate in practice to ensure the environmental considerations are fully incorporated into project decision-making within EU Member States.

The EIA Directive 2011/92/EU is a piece of European Union legislation designed to ensure that projects likely to have significant effects on the environment are assessed before they are approved or implemented. Its main purpose is to integrate environmental considerations into the decision-making process for certain public and private projects, thereby promoting sustainable development and protecting the environment. It requires Member States to assess projects likely to have significant environmental effects before they are approved, ensuring that environmental considerations are systematically integrated into decision-making. The Directive operationalizes the Aarhus Convention principles by guaranteeing public access to environmental information, early participation in consultations, and opportunities to provide input on proposed projects. EIAs must evaluate potential impacts on ecosystems, human health, and cultural heritage, and authorities are obliged to consider alternatives and mitigation measures. By codifying these procedural rights, the Directive promotes transparency**,** accountability, and informed

governance, making it a central tool for implementing environmental policy and safeguarding citizens' participatory rights within the EU.

The case of *Altrip* (C-72/12) demonstrates the EIA Directive in action before the CJEU. In *Altrip*, the German authorities approved a major planning project prior to carrying out a proper EIA. German law, however, made it very difficult for individuals to bring such challenges unless they could prove that the procedural mistake directly affected their personal rights. Consequently, a German resident sought to challenge the approval of the planning project at the CJEU. The CJEU ruled that individuals must have access to courts when alleging that Environmental Impact Assessments (EIA) were improperly carried out. *Altrip* demonstrates that participation and judicial review must operate in tandem. Public involvement becomes meaningless without the ability to contest irregular or unlawful decisions.

4.3 Information-Based & Procedural Instruments Through a Green Anarchist Lens

The green anarchist critique of information-based and procedural environmental instruments can be analyzed through the lens of their three central principles: access to information, public participation, and access to justice. This critique argues that while these instruments aim to enhance transparency, accountability, and citizen engagement, in practice they often remain constrained by centralized control, technical complexity, and institutional hierarchies, limiting their effectiveness in empowering communities and promoting genuine ecological stewardship.

Access to information, assumes that making environmental data available to the public ensures transparency and informed decision-making. In practice, however, the data is often produced and controlled by governments or corporations in highly technical formats that communities cannot easily interpret. For example, the Volkswagen Dieselgate scandal revealed that despite formal reporting requirements, Volkswagen manipulated emissions data so that vehicles appeared compliant under test conditions while actually exceeding pollution limits on the road (Hotten, 2015; Lang, 2019; Nieuwenhuis & Wells, 2015). Green

anarchism suggests that centralized information systems can serve corporate and governmental interests rather than supporting ecological accountability or community empowerment (Green Anarchy, 2013). Community-controlled monitoring systems, such as local air-quality sensors and open public databases, are suggested as alternatives to ensure that environmental data is both accessible and actionable.

Public participation, another key principle of information-based and procedural instruments, is intended to allow citizens to influence environmental decision-making through consultations and access to relevant documents. However, green anarchist analysis highlights that participation often occurs after key decisions have already been made, limiting its impact. In the aforementioned Dieselgate case, local communities and the public had no meaningful involvement in monitoring or regulating vehicle emissions, leaving oversight concentrated among corporate engineers, national regulators, and technical experts (Lang, 2019). Internationally, the Lithuanian submission against Belarus under the Aarhus Convention demonstrated a similar problem: Belarus failed to engage the public meaningfully in decisions about a nuclear power plant, effectively sidelining stakeholders despite formal consultation requirements (ACCC/S/2015/2). Green anarchists argue that effective participation requires early engagement, the ability to challenge project plans, and mechanisms ensuring community input influences final decisions (Green Anarchy, 2013). Green anarchists argue that genuine participation requires early engagement, the ability to challenge project plans, and meaningful consideration of community input in final decisions.

The third key principle to information-based and procedural instruments, access to justice, provides legal avenues for individuals or organizations to challenge failures in environmental governance. Green anarchists contend that judicial review alone cannot overcome the structural centralization of power. Legal mechanisms often favor those with resources, expertise, and familiarity with bureaucratic procedures, which can prevent marginalized communities from asserting their rights effectively. Alternative forums, such as local environmental review panels or simplified legal procedures for community groups,

are suggested as ways to make access to justice more equitable and directly connected to ecological outcomes (Green Anarchy, 2013).

Overall, the green anarchist critique emphasizes that while information-based and procedural instruments are valuable tools, they are insufficient on their own to ensure true ecological stewardship. Without decentralization, meaningful participation, and community-driven oversight, these mechanisms risk becoming formalistic exercises that reinforce existing power structures rather than empowering citizens to protect the environment. By integrating decentralized monitoring, earlier and more influential participation, and accessible justice mechanisms, these tools can better fulfill their intended goals while addressing the limitations highlighted by green anarchist perspectives.

5. LIABILITY & COMPENSATION MECHANISMS

Liability and compensation mechanisms are a core component of environmental governance because they determine who bears responsibility when environmental harm occurs. These mechanisms operate primarily in an ex-post manner by allocating legal and financial responsibility after damage has already taken place. They also generate crucial information about risk, causation and ecological loss, which can influence both regulatory design and the behaviour of operators. At their foundation, liability regimes seek to ensure that environmental damage is remediated and that the costs of harm are not externalised onto the public. This reflects the Polluter Pays Principle, which is recognised across international environmental law and embedded in major liability regimes, particularly in marine pollution law (Chen, 2012, pp. 4–6).

At their core, liability and compensation mechanisms establish the legal responsibility of an operator or polluter to remediate environmental harm and compensate affected parties for losses. Their goals are twofold: first, to restore damaged natural resources or replace their ecological functions; and second, to provide financial compensation to individuals, communities, or states that have suffered economic or environmental loss (Zhou et al., 2022). These mechanisms also play a preventive role. By enforcing the Polluter Pays

Principle, they encourage operators to adopt safer practices, develop stronger risk-management systems, and comply with environmental standards (Zhou et al., 2022).

Despite these important functions, liability mechanisms face well-known limitations. Because they operate ex post, they respond only after environmental harm has already occurred, which is especially problematic when damage is irreversible or when restoration is technically difficult. Scholars also highlight structural barriers, including difficulties in proving causation, quantifying ecological damage, and addressing long-term or diffuse harms, which can lead to protracted litigation and delayed recovery (Chen, 2012, pp. 13–16). At the same time, liability regimes have notable strengths: they create clear lines of responsibility, provide compensation when other regulatory tools fall short, and allow public authorities, courts, and scientific experts to coordinate remediation efforts (Chen, 2012).

To understand the practical operation of these mechanisms, the next sections examine their application at two regulatory levels. The international regime for oil pollution, which includes the Civil Liability Convention and the International Oil Pollution Compensation Funds, provides a structured framework for compensating victims of major marine spills. In contrast, the European Union's Environmental Liability Directive offers a broader system focused on restoring damaged natural resources within the EU. Together, these examples show how liability functions across different governance contexts and illustrate both the strengths and inherent limits of relying on ex post environmental accountability.

5.1 The International Perspective

At the international level, liability and compensation mechanisms form a key component of global environmental governance because they provide a unified legal framework for determining responsibility and distributing financial consequences when severe environmental harm occurs across jurisdictions. These mechanisms are particularly important for marine oil pollution, where damage often affects multiple states, local communities, and shared ecosystems. International instruments ensure that victims receive

compensation even when the polluter's financial responsibility is limited and help enforce the Polluter Pays Principle in situations where domestic remedies alone would be insufficient.

The international liability regime for oil pollution relies primarily on the International Convention on Civil Liability for Oil Pollution Damage (CLC) (1992) and the International Oil Pollution Compensation (IOPC) Funds (1992). The CLC establishes strict liability for shipowners and sets maximum financial limits for compensation. When the damage exceeds these limits, or when shipowners are unable to meet their legal responsibility, the IOPC Funds provide additional compensation. Both instruments cover pollution damage resulting from spills of persistent oils in the territory, including the territorial sea, of any State Party. Together, they create a multi-layered system that aims to ensure prompt, adequate compensation and the remediation of damaged natural resources.

The Shosei Maru oil spill is a clear example of both the utility and the limitations of this international framework. On 28 November 2006, the Japanese tanker Shosei Maru collided with the Korean cargo vessel Trust Busan three kilometres off Teshima in the Seto Inland Sea (Gainesville Sun, 2006). The collision caused heavy fuel oil and bunker diesel oil to escape into the sea from a damaged cargo tank and a bunker tank, resulting in pollution along approximately five kilometres of shoreline. The spill also affected seaweed cultivation farms and their supporting structures. Cleanup operations lasted several months and involved manual techniques to remove bulk oil, high-pressure washing to eliminate remaining stains, and coordinated vessel-based dispersant application at sea (IOPC Incident Report, 2009). The total cost of cleanup and compensation was assessed at about 5.494 million SDR. However, under the 1992 CLC, the shipowner's maximum liability amounted to 4.51 million SDR. The shipowner's insurer, the Japan P&I Club, paid this full amount, but a financial shortfall remained because the damages exceeded the CLC limit. In accordance with the international regime, the 1992 IOPC Fund compensated the outstanding amount within the Fund's limit (IOPC Incident Report, 2009).

The IOPC Funds are financed through annual contributions imposed on any entity receiving more than 150,000 tonnes of crude or heavy fuel oil in a Member State of the 1992 Fund (IOPC Funds, 2025). Because contributions vary depending on the amount of oil received each year, the system spreads responsibility across the oil industry rather than placing the entire burden on a single polluter. The Funds' principal role is to pay compensation to those who have suffered pollution damage in Member States when full recovery is not possible from the shipowner under the CLC. (IOPC Funds, 2025). Eligible claimants include individuals, private organisations, companies, partnerships, public authorities and states. In the Shosei Maru case, the IOPC Fund acted exactly as intended by bridging the financial gap and ensuring that all losses were covered.

This example shows how international liability and compensation mechanisms support effective remediation by providing financial resources for cleanup and natural resource restoration. They also uphold the Polluter Pays Principle by ensuring that the costs of environmental harm do not fall on victims or governments (Kontovas et al., 2010). However, the Shosei Maru incident also highlights the structural limitations of these tools. International liability mechanisms operate only after environmental damage has already occurred, meaning they do not prevent harm, including damage that may be irreversible. The capped liability under the CLC illustrates the risk that statutory limits can be insufficient in major spills, placing pressure on supplementary compensation systems (Veklych et al., 2020). Additionally, the process of pursuing compensation can be long and costly, sometimes delaying recovery and diverting resources away from urgent environmental response. The complexity of managing claims, quantifying ecological harm and coordinating multiple institutions further underscores the challenges of relying on ex post financial remedies to address large-scale environmental disasters (Veklych et al., 2020).

Ultimately, the international liability and compensation framework plays an essential role in allocating responsibility and ensuring that victims of transboundary oil pollution receive adequate compensation. The Shosei Maru case demonstrates both the strengths of this

model, such as prompt compensation and shared financial responsibility, and its limitations, including capped liability, high operational complexity and its entirely reactive nature.

5.2 The European Perspective

At the European level, liability and compensation mechanisms operate within a harmonised legal and institutional framework. The central instrument is the EU Environmental Liability Directive (ELD), which establishes a unified regime for preventing and remedying environmental damage across Member States (European Commission, 2025). Unlike the international oil pollution regime, which focuses primarily on compensating economic losses resulting from tanker spills, the ELD aims to secure the direct restoration of damaged natural resources. Its scope includes harm to protected species and habitats, water, and land, and it applies regardless of whether environmental damage crosses national borders. This broader orientation reflects the EU's commitment to implementing the Polluter Pays Principle across all sectors where environmental risks arise (European Commission, 2025).

The Kokemäki River accident in Finland provides a clear example of how the ELD functions in practice. In 2014, a metallurgical plant accidentally released large quantities of nickel, cobalt, ammonia, and sulphates into the river due to a combination of human error and technical failures. The spill caused extensive ecological damage, including the death of millions of mussels (Eye on the Arctic, 2014; Finland Times, 2014). Among the affected species was Unio crassus, a freshwater mussel protected under the EU Habitats Directive. Authorities determined that the incident caused significant damage to protected species, habitats, and surface water within the meaning of the ELD (Finland Times, 2014). Following the spill, the company immediately began environmental monitoring and cooperated with regional and national authorities. Finnish authorities ordered comprehensive remedial measures under the ELD, and although the company appealed certain aspects of the decision, the courts confirmed that it was obligated to carry out both monitoring and restoration actions (Eye on the Arctic, 2014). These measures remain ongoing, reflecting the long-term nature of ecological recovery and the significant obligations placed on operators under the Directive.

The Kokemäki River case offers several lessons about the operation of the ELD. First, the Polluter Pays Principle was clearly applied. The company, rather than the public, bore the cost of remediation and monitoring. Second, the case highlights the reactive nature of liability mechanisms (AAE Discussion Paper, 2022). Action occurred only after environmental damage had already taken place, which is particularly problematic for biodiversity losses that may be irreversible. Third, both authorities and the company engaged in institutional learning following the accident. Public authorities improved crisis protocols, communication systems, and inspection procedures, while the company upgraded risk assessments, alarm systems, and automation to prevent similar incidents in the future (AAE Discussion Paper, 2022).

At the same time, the case reveals important weaknesses. Like the international regime, the ELD is fundamentally reactive. It only requires action after harm has occurred, which is particularly problematic when damage involves biodiversity loss that may be irreversible. The Kokemäki incident also highlights practical challenges in proving and quantifying environmental damage, especially when applying the Directive's "significant damage" threshold (AAE Discussion Paper, 2022). Moreover, legal and administrative processes can be lengthy, delaying ecological recovery. These limitations echo the structural issues visible in the international system, although the EU's framework aims to address environmental restoration more directly than international compensation funds (Veklych et al., 2020).. Whereas international mechanisms, such as the Civil Liability Convention and the IOPC Funds, prioritise prompt compensation and often rely on fixed financial limits, the ELD focuses on ensuring restoration of natural resources rather than simply compensating economic loss (Veklych et al., 2020). The Kokemäki River case demonstrates this emphasis: the operator was required to undertake extensive ecological restoration, not merely pay for cleanup costs. However, both systems face a common challenge. Liability is triggered only after environmental harm has occurred, and the adequacy of financial responses remains a point of concern (Kontovas et al., 2010). As seen in the Shosei Maru oil spill, financial ceilings can be insufficient to cover full ecological harm. Conversely, the Kokemäki

case illustrates the difficulty of quantifying and restoring damage even when no financial limit applies (Eye on the Arctic, 2014).

Overall, the EU Environmental Liability Directive remains a central tool for enforcing environmental accountability. It operationalises the Polluter Pays Principle, allocates responsibility clearly, and supports the restoration of degraded ecosystems (Kontovas et al., 2010). Yet, as the Kokemäki River case demonstrates, the effectiveness of liability mechanisms is constrained by their ex-post nature, scientific uncertainties, and procedural delays. For these reasons, liability must be complemented by stronger preventative regulation, regular inspections, and continuous institutional learning to better protect environmental resources before irreversible harm occurs.

5.3 Liability and Compensation Mechanisms Through a Green Anarchist Lens

A green anarchist perspective raises several concerns about liability and compensation mechanisms as tools for environmental protection. As discussed in Section 2.1, green anarchism is sceptical of approaches that rely on centralised authority and after-the-fact interventions. Liability regimes are a clear example of this. They respond to environmental harm only once the damage is done, and they do so through financial and legal processes that green anarchists argue uphold, rather than challenge, the structures responsible for ecological degradation (Toro, 2021).

From this perspective, liability frameworks risk normalising environmental harm by translating it into compensable monetary loss. When pollution or habitat destruction is addressed primarily through payments for remediation or compensation, industrial actors may treat ecological damage as a calculable business expense rather than something that should be prevented altogether. Dunlap (2022) notes that this approach reinforces development models that accept large-scale ecological disruption as inevitable, so long as it can be managed through institutional channels. Green anarchist critique also focuses on the centralisation of decision making within state agencies, courts, insurers, and technical experts. These bodies determine when damage counts as “significant,” what remediation

is required, and how responsibility is allocated. As a result, affected communities often have little influence over recovery processes, even though they live with the consequences. This reflects a broader pattern in environmental governance that, according to Toro (2021), sidelines local knowledge and diminishes community autonomy. Liability systems tend to reinforce this dynamic by prioritising legal and administrative procedures over participatory decision making.

While critical of existing liability systems, green anarchist perspectives also point toward constructive alternatives. Strengthening local oversight can reduce dependence on after-the-fact compensation and foster more proactive forms of environmental protection. Green anarchist scholarship also encourages replacing top-down remediation processes with collaborative models grounded in local knowledge and shared stewardship (Bell, 2020). Even if liability and compensation mechanisms remain necessary for addressing unavoidable harms, a green anarchist lens suggests that they must be complemented by governance approaches that prioritise prevention, community autonomy, and ecological integrity.

6. CONCLUSION

This paper has examined four central approaches to environmental governance and has shown that, while they remain essential components of contemporary regulatory systems, each contains structural limitations that restrict their ability to address accelerating ecological crises. Evaluating these instruments through a green anarchist perspective has made those limitations clearer by highlighting how hierarchical structures, centralized authority, and top down decision making can undermine ecological protection and marginalize community voices.

Beginning with command and control mechanisms, the analysis demonstrated that although these tools create enforceable standards and have achieved important successes at the international and EU levels, they often suffer from weak enforcement and rigid structures that do not adapt well to complex or diffuse environmental problems. Market

based instruments were shown to provide economic efficiency and flexible pathways to emissions reduction, but their reliance on pricing mechanisms risks commodifying nature and reinforcing ecological and social inequalities. Information based and procedural tools were found to enhance transparency and public participation, yet in practice they often replicate existing hierarchies and offer limited influence over final decisions. Finally, liability and compensation regimes were shown to allocate responsibility and support remediation, but their ex-post nature and technical complexity limit their preventive capacity.

Taken together, these findings suggest that conventional environmental instruments remain indispensable but insufficient. A green anarchist lens reveals that their shortcomings are rooted not only in technical design but also in deeper institutional assumptions about how environmental protection should be governed. Addressing contemporary ecological challenges requires complementing these traditional tools with governance practices that decentralize authority, empower communities, and prioritize prevention and ecological stewardship. By pairing existing regulatory mechanisms with more participatory and locally grounded forms of governance, environmental law can better respond to the complexity, urgency, and relational nature of environmental harm.

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CHAPTER SEVEN. NATURE IN THE SYSTEM: WRESTLING WITH THE INTEGRATION & CONTROL PARADOX

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1. INTRODUCTION

The relationship between modern societies and the natural environment is shaped by a series of paradoxes that challenge how we conceptualize sustainability and integration as pillars of contemporary development. Europe, despite its pioneering role in formulating environmental policies with global impact, also reveals the "dark side" of these advancements: every improvement entails social, economic, and ecological costs that highlight the historical complexity of human–nature interactions. This chapter aims to critically examine these tensions, situating them within a system that seeks both to integrate and to control environmental dynamics in constant transformation.

To this end, we focus our analysis on three industrial sectors essential to modern life: transport, energy, and agriculture. Through these areas, we explore the dual nature of efforts to achieve sustainable development and meet the Sustainable Development Goals, showing how environmental policies can generate significant benefits while simultaneously producing negative impacts that still demand attention. This examination is complemented by a review of major international agreements and European legal frameworks—such as the Renewable Energy Directive and the European Green Deal—that guide global climate action, as well as territorial case studies that reveal the effects of ecological transitions on Indigenous peoples and vulnerable groups, underscoring the importance of incorporating environmental justice into policy design.

In the second part, we delve deeper into several paradoxes associated with sustainability, selected for their relevance and close connection to the sectors under study. Each paradox illustrates how policies that appear effective, or even nearly perfect, can nevertheless generate unintended consequences, exposing the structural contradictions that accompany ecological transitions. By explaining the logic behind each paradox, analyzing its effects, and

proposing potential mitigation strategies, this chapter seeks to offer a deeper understanding of the challenges we face in advancing toward a truly sustainable, just, and coherent development model.

2. LEGAL FRAMEWORK

2.1 Transportation and Sustainability: A Legal Perspective

Transportation has historically been an essential sector for the development of human civilization and remains a fundamental pillar for its subsistence. As society has evolved, it has become indispensable across multiple domains, including agriculture, food production and distribution, student transportation, and virtually all areas of human activity. In a context shaped by globalization and increasing international connectivity, mobility has become a rapid and accessible phenomenon: a single flight can carry us thousands of kilometers, crossing continents in a matter of hours.

Consequently, we aspire for this system to be increasingly comfortable and efficient. We seek aesthetically appealing cars, luxurious vessels, and ever-faster airplanes. However, this aspiration often leads us to overlook a fundamental question: Is our pursuit of inexpensive, convenient, and nearly flawless transportation truly sustainable? Furthermore, what can be done from a legal standpoint to promote and ensure sustainability within the sector?

Before addressing these issues, it is necessary to define the concept of sustainable transport and to understand the scope of so-called clean mobility. According to the United Nations Development Programme (UNDP), sustainable transport consists of "...mobility systems that seek to minimize greenhouse gas emissions and environmental impacts, while ensuring safety and affordability, improving energy and resource efficiency, and providing equitable access to mobility for all" (UNDP, 2025).

Within this sector, clean and sustainable mobility constitutes one of the European Union's key climate objectives. EU regulations aim to promote more environmentally responsible mobility while ensuring connectivity across the Union. Nonetheless, international standards have not yet been fully met. Therefore, the following sections will examine the legal

measures adopted to advance sustainable transport, as well as the actual effectiveness of these approaches in achieving the goals set by the international community.

2.1.1 Maritime

When referring to aquatic transportation, the focus is primarily on the movement of goods and people. Shipping has several environmental consequences, including the release of greenhouse gases, underwater noise pollution, and oil spills (Walter TR et al., 2019). According to the International Maritime Organization (IMO), carbon dioxide emissions from the maritime sector accounted for about 2.2% of global human-induced emissions in 2012. If no significant measures are implemented, these emissions could increase by 50% to 250% by 2050 (International Maritime Organisation [IMO], 2015). Looking ahead, the International Energy Agency (IEA) projects that ammonia could supply around 45% of the shipping industry's fuel needs by mid-century (Mehta, 2023).

2.1.1.1 Regarding transportation of goods

The International Maritime Organization (IMO), a specialized agency of the United Nations, is tasked with ensuring the safety, security, and efficiency of shipping, as well as preventing pollution caused by vessels (Marine Environment Protection Committee, 2023). Their Fourth IMO GHG (greenhouse gas) Study 2020 study states that CO2 emissions are increasing and that CO2 is the primary contributor to shipping’s climate impact. The main reason behind the rise is the steady growth in global maritime trade. Looking ahead, if no further actions are taken, shipping emissions are projected to increase significantly, potentially reaching 90% to 130% of the 2008 levels by 2050 (IMO, 2021).

Shipping goods by sea is much more cost-effective than using air or land transport (Stopford, 1997). Maritime transport handled around 80% of global trade in 2021. Despite IMO implementing a global sulfur cap on marine fuel in 2020, intended to cut sulfur emissions from ships by 77%, cruise ships continue to release substantial amounts of this harmful pollutant. The same Transport and Environment report reveals that, in 2022,

Europe's 214 cruise ships emitted more sulfur than one billion cars, producing over four times the sulfur emissions of all the cars in Europe combined. (UNCTAD, 2023).

2.1.1.2 Regarding transportation of people

In 2024, Friends of the Earth, a network of environmental organisations, assessed 21 major cruise lines based on their environmental impact and reported that exposure to wastewater-contaminated waters can cause harm to both humans and maritime life (Friends of Earth, 2024). The International Council on Clean Transportation (ICCT) estimated that scrubber washwater for the entire shipping sector is at 10 gigatonnes per year, and notes that cruise ships account for about 15% of scrubber discharges (ICCT, 2021).

The International regulation MARPOL Annex IV is in place to prevent marine pollution caused by ships' sewage. These rules require vessels to have either a sewage treatment system, a commuting and disinfecting mechanism, or a holding tank (MARPOL IV, 1973).

The Clean Water Act makes it unlawful for any individual or entity to release pollutants from a point source into waters classified as part of the United States, including territorial seas. Such discharges are only allowed if they comply with a National Pollutant Discharge Elimination System (NPDES) permit or are otherwise permitted under the provisions of the Act (EPA, 2025).

Another environmental concern linked to the cruise industry is the underwater noise pollution. The Convention on the Conservation of Migratory Species has recognized ocean noise as a possible danger to marine animals, noting that certain intense, impulsive sounds can be powerful enough to cause immediate harm or even death to marine species (CMS). A report from 2019 revealed that noise pollution can drive away fish and marine predators from their habitats (PHAROS4MPAs, 2019).

2.1.1.3 Solution and development

Two major trends are shaping innovation in maritime transport: sustainability and digitalization. According to a 2025 report by WIPO, there has been a steady rise in patent

filings related to maritime transportation, with most innovations focusing on sustainable propulsion technologies, followed by advances in communication and security systems. Shifting to greener propulsion methods is essential for meeting decarbonization goals. However, the report highlights that scaling up production and making carbon-neutral fuels economically viable remain significant challenges (World Intellectual Property Organization).

The IMO study highlights that meeting the 2050 greenhouse gas reduction targets will be challenging if relying solely on energy efficiency improvements and reducing ship speeds. A significant portion of CO2 emission reductions will need to come from adopting low-carbon alternative fuels. If energy-saving technologies, renewable energy integration, alternative fuel use, and speed reductions are implemented on all new ships starting from 2025, the shipping industry could achieve both the intermediate and long-term goals outlined in the Initial IMO Strategy (IMO, 2021).

2.1.1.4 International and EU Regulations

The International Convention for the Prevention of Pollution from Ships (MARPOL), adopted on 2 November 1973 is the primary global agreement focused on preventing marine pollution caused by ships, whether from routine operations or accidental incidents (MAROL, 1973).

Directive 2005/35/EC (European Parliament and Council, 2005), as updated by Directive 2009/123/EC (European Parliament and Council, 2009), addresses violations of MARPOL standards (Annexes I and II) related to pollution from ships. It states that any deliberate or grossly negligent breach, whether in EU coastal waters or on the high seas, must be properly addressed and may be treated as a criminal offence. The Directive enforces effective, proportionate, and deterrent penalties to discourage illegal discharges. It also promotes cooperation between port State authorities, allowing legal actions to be initiated at the next port of call. Additionally, it encourages collaboration among Member States to detect illegal

pollution and trace it back to the responsible vessel. The European Martime Safety Agency (EMSA) supports this effort through tools like CleanSeaNet.

CleanSeaNet is a satellite-based monitoring system that helps EU countries detect and track illegal discharges at sea. It identifies suspected oil spills and links them to specific vessels, supporting enforcement actions against polluters (European Maritime Safety Agency).

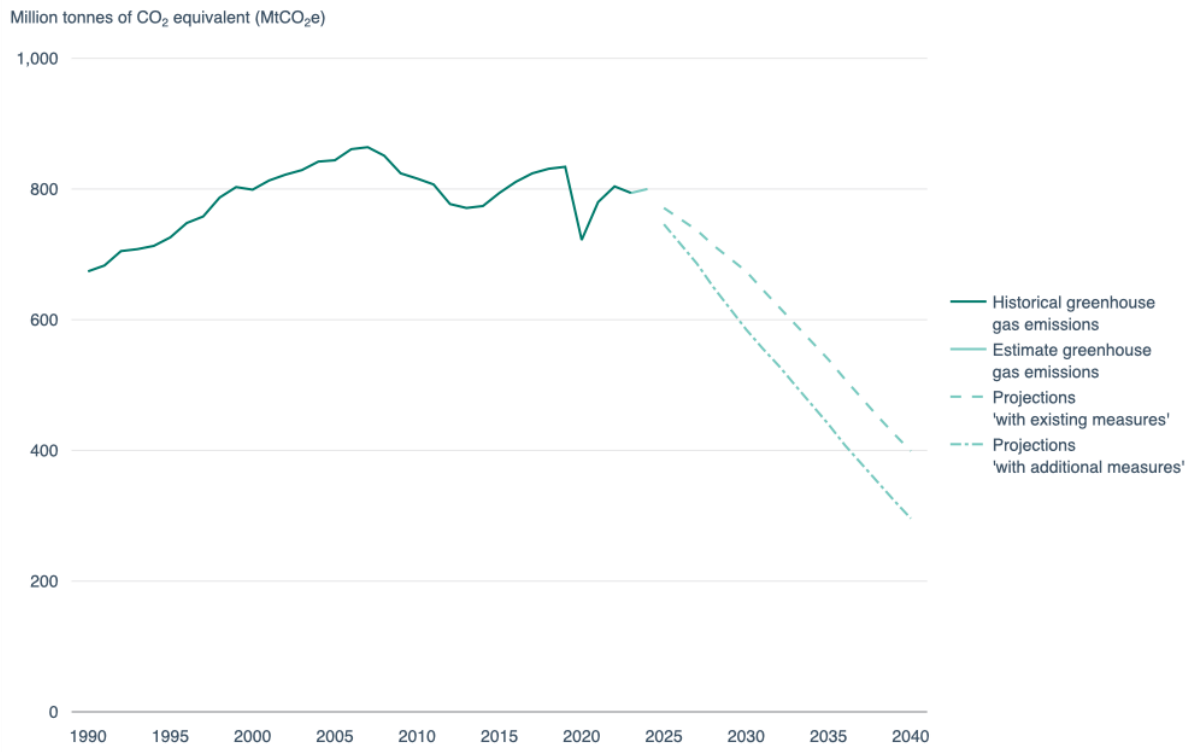
Directive 2002/84/EC aims to enhance the enforcement of EU laws concerning maritime safety, pollution prevention from vessels, and the living and working conditions on ships (European Parliament and Council, 2002).

Directive 2019/883/EC sets out a framework aimed at consistently reducing marine pollution by obligating Member States to ensure that suitable waste reception facilities are available in all ports, including marinas and recreational harbours. It also mandates that all vessels, such as fishing boats and leisure craft, dispose of their waste at these facilities before leaving the port (European Parliament and Council, 2019).

The FuelEU Maritime Regulation seeks to reduce greenhouse gas emissions from vessels by progressively mandating a decrease in the greenhouse gas intensity of the energy consumed on board. It also requires passenger and container ships to achieve zero-emission operations while moored at EU ports starting in 2030 (European Commission 2021).

2.1.2 Land Transoprtation

According to the European Environment Agency [EEA] (2024), road transport alone accounted for up to 73.2% of the EU's transport-related emissions in 2022.



To reduce this figure, numerous legal mechanisms have been implemented at both European and global levels - with more underway.

Among the most notable are the EU Emission Trading System (ETS) and its successor ETS 2, the EU Climate Law [Directive (EU) 2021/1119], and several United Nations resolutions, including the "Sustainable Transport Decade" and the 17 Sustainable Development Goals (SDGs).

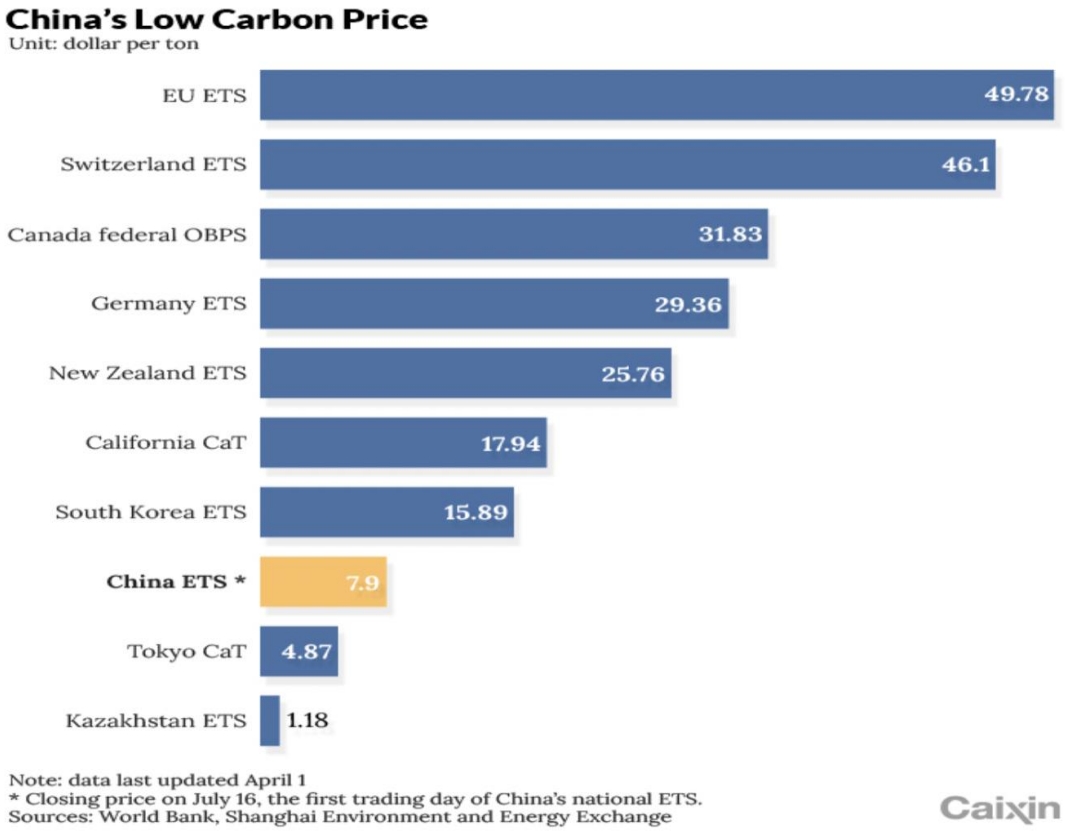
We will first consider the European legal framework before moving to the global context.

2.1.2.1 Legal Framework on the European Level

The Emission Trading System (ETS) Directive, an indirect outcome of the Kyoto Protocol, has been active since 2005, following its initial introduction in 2003. Its foundation lies in the *cap-and-trade* principle. The cap represents "the limit set on the total amount of GHG that can be emitted by installations and operators covered under the scope of the system."*(European Commission [EC], 2005)* The trade component refers to the allowances

that can be purchased and exchanged among different entities, enabling them to produce a specific amount of greenhouse gases.

Following several reforms, most notably Directive (EU) 2023/955, which created a Social Climate Fund to support vulnerable citizens during the transition, the system has proven effective. Reports indicate that the EU's emission levels in 2025 are 50% lower than in 2005, with the current goal being a 67% reduction by 2030. While ETS is not the only existing carbon market in the world, according to statistics published by Caixin Global, the European Union applies the highest price on carbon out of all of them. Other markets, such as China's, show a different approach, choosing instead to focus on green-tech rather than cutting emissions in bulk, preferring to protect their economic competitiveness. (Du Caicai et al. 2021).



The European Union Climate Law, while not focused exclusively on transportation, enshrines the targets agreed upon under the European Green Deal, approved in 2020. The

first objective mirrors that of the ETS: achieving a 55% reduction by 2030, followed by 90% by 2040, and ultimately carbon neutrality by 2050.
Carbon neutrality means that all emissions generated within the EU, by member states, companies, and individuals, would be balanced by the amount of CO_2 removed from the atmosphere.
This regulation also led to the creation of additional financial instruments supporting the green transition, such as the Just Transition Fund and the EU Solidarity Fund.

Having explored the key measures adopted within the European Union, we can now turn to those developed at the global level.

2.1.2.2 Legal Framework on the Global Level

In 2023, the UN General Assembly announced the first-ever Decade of Sustainable Transport, to take place between 2026 and 2035. This decision marks a global starting point, encouraging coordinated international efforts to transition toward more sustainable modes of transportation and to generate new ideas and strategies addressing this challenge.

Alongside this announcement, the UN member states reaffirmed their commitment through Resolution A/78/148, titled “Strengthening the links between all modes of transport to achieve the Sustainable Development Goals.” The resolution calls on the UN Department of Economic and Social Affairs to provide assistance and collaborate with regional commissions and actors. Ideally, this framework will serve as a global roadmap, fostering cooperation and uniting efforts across nations.

Finally, the United Nations Sustainable Development Goals (SDGs) outline 17 targets addressing global priorities such as hunger, equality, and environmental protection. For the issue of sustainable transport, the most relevant goals are:

- Goal 7 – Affordable and Clean Energy

- Goal 9 – Industry, Innovation, and Infrastructure

- Goal 11 – Sustainable Cities and Communities

- Goal 13 – Climate Action

2.1.2.3 Conclusion

As we can see, there is a clear global effort to shift towards a more sustainable future when it comes to transport, mainly through market-based instruments such as the ETS. The question is, is this actually enough? Are the institutions that pass these policies taking into consideration possible side effects? We will be looking into this further down in this chapter, when we reach the topic of paradoxes.

2.1.3 Aerial Transportation

Aerial transportation is a key element of global mobility, enabling the fast movement of people, food, and essential supplies. It supports international trade, humanitarian operations, and everyday travel, making it fundamental to modern life. However, its expansion raises important environmental concerns. Aircraft emissions contribute to climate change and air pollution, while noise and fuel consumption affect surrounding ecosystems. Balancing efficiency with sustainability is one of the aviation sector's central challenges for the coming decades. *(Sources: IEA; Our World in Data)*

2.1.3.1 Regardin air tramsportation of people

Passenger air travel remains strong in 2025. Airports are expected to handle about 9.9 billion passengers, a 4.8% increase from 2024, reflecting global mobility recovery and growing demand *(Aviation Week; ACI World)*. International tourism continues to expand, with projections of 4.22 billion international passengers, an 8.3% rise compared to recent years *(TRBusiness)*. Business travel, though smaller than pre-pandemic levels, remains a major component of global air mobility *(ACI World)*.

Air travel has also become more accessible thanks to low-cost airlines and efficient booking tools. The general public increasingly chooses air travel for medium- and long-distance routes because it is faster and often cheaper than alternatives *(IATA)*. At the same time, a

small group of very frequent flyers mainly wealthy individuals and celebrities contribute disproportionately to air traffic. Figures like Taylor Swift illustrate this trend, with private jet use for rapid city-to-city travel becoming more common (Forbes).

Innovation is reshaping the future of passenger mobility. Electric vertical takeoff and landing aircraft (eVTOLs) are being developed for short, urban routes. The first commercial air taxi operations are expected to appear mid-2020s, with wider adoption in the 2030s *(ACI World; Aviation Week)*. These technologies aim to reduce road congestion and create new forms of sustainable urban transportation. As regulations adapt and infrastructure grows, urban air mobility is expected to become a significant addition to traditional aviation.

2.1.3.2 Environmental Impact

Aviation has a major environmental footprint due to high energy consumption and emissions. In 2023, the sector emitted nearly 950 million tonnes of CO_2, corresponding to 2.5% of global energy-related emissions, now over 90% of pre-pandemic levels (IEA).

Non-CO_2 pollutants nitrogen oxides, water vapor, and particulates further intensify aviation's climate impact. These emissions contribute to contrails and cirrus clouds, which trap heat and can have a warming effect equal to or greater than CO_2 emissions (T&E; Académies nationales). As demand for flights increases, aviation remains one of the fastest-growing sources of environmental pressure (Our World in Data).

Noise pollution and airport expansion also present challenges for surrounding populations and ecosystems. Although modern aircraft designs aim to limit these impacts, rising traffic levels make mitigation increasingly complex.

The aviation sector is therefore exploring solutions such as sustainable aviation fuels (SAF), more efficient aircraft, improved air traffic management, electrification, and global carbon-pricing mechanisms. These measures require significant investment and international coordination to deliver meaningful reductions

2.1.3.3 Regarding food and supplies

Air freight is essential for transporting perishable and high-value goods. Fresh fruits, vegetables, seafood, flowers, pharmaceuticals, vaccines, electronics, and critical industrial parts depend on rapid delivery to maintain their value and integrity. This speed allows consumers worldwide to access seasonal or specialized goods and ensures that medical or emergency supplies can be delivered promptly during crises.

Economically, air freight supports global trade, helping industries maintain production lines and avoid delays that could lead to significant financial losses. Its role in global logistics is therefore critical despite its relatively small share by volume.

2.1.3.4 Environmental Impact

The environmental cost of air freight is significant. It accounts for about 9% of global transport CO_2 emissions *(ICCT)*. Its carbon intensity 570 to 1,580 g CO_2 per tonne-km is far higher than maritime shipping (15–30 g per tonne-km) *(Alimentarium)*, making it one of the most carbon-intensive forms of transport.

Between 2019 and 2023, air freight emissions rose 25%, with the United States alone responsible for over 40% of global cargo emissions *(The Guardian)*. This surge reflects rising e-commerce demand, global supply chain volatility, and the expansion of cargo-only fleets during the pandemic.

Efforts to reduce air freight's footprint include optimizing routes, modernizing fleets, improving aircraft load factors, and developing sustainable fuels. However, meaningful decarbonization remains challenging due to the sector's dependence on long-distance, high-speed transport.

2.1.3.5 Regulatory Solutions Reducing Aviation's Environmental Impact

1. <u>National Measures: Spain</u>

Spain has implemented several policies to align its aviation sector with national and EU climate goals, including the Action Plan for the Aviation Sector, which targets CO_2 reductions

through optimized flight-route planning, enhanced air-traffic management, and a phased increase in sustainable aviation fuels (SAF) in line with EU 2030 and 2050 objectives. Spain participates in ReFuelEU Aviation, mandating progressively higher SAF shares at airports—reaching 70% by 2050 using biofuels and synthetic fuels—while discouraging domestic short-haul flights where rail alternatives under 2.5 hours exist to favor lower-emission options. Additional measures encompass a 2025 luxury aviation tax on private jets and premium-class flights (jointly with France) to curb high-impact emissions and fund environmental initiatives, alongside the Climate Change and Energy Transition Act, which requires sector-specific emissions-reduction plans and promotes low-emission zones in cities over 50,000 inhabitants.

2. European Measures: The European Union

At the EU level, aviation regulation emphasizes pricing emissions, promoting clean fuels, and sector modernization through the EU Emissions Trading System (EU ETS), which requires airlines on intra-European routes and flights to/from Switzerland to monitor, report, and offset emissions since 2024. The ReFuelEU Aviation Regulation (2023/2405) mandates gradually increasing sustainable aviation fuel (SAF) shares from 2025 to cut the sector's carbon footprint significantly, while the European Aviation Strategy advances sustainable fuels, innovative aircraft technologies, and efficient air-traffic systems to balance connectivity with environmental gains. Supporting these efforts, the European Aviation Environmental Report (2025) delivers key data on emissions, noise, and energy efficiency for policymaking, complemented by broader EU Climate Action initiatives like carbon-pricing, renewable targets, and long-term strategies steering aviation's green transition.

3. International Measures: ICAO and Global Frameworks

Given aviation's global nature, international coordination through the International Civil Aviation Organization (ICAO) proves essential for consistent environmental progress, setting worldwide standards for aircraft emissions, noise, and sustainable development via Standards and Recommended Practices (SARPs). ICAO's Carbon Offsetting and Reduction

Scheme for International Aviation (CORSIA) mandates airlines to offset emissions above 2020 levels, with its compulsory phase starting in 2027, while global sustainable aviation fuel (SAF) initiatives target 5% emissions cuts by 2030 through broad adoption. The 2022 Long-Term Aspirational Goal (LTAG) further commits international aviation to net-zero emissions by 2050, demanding collaboration among governments, manufacturers, and airlines.

2.2 Legal Framework within Energy Sector

2.2.1 Energy Fundamental and Environmental Impacts

Cambridge dictionary defines energy as “the power from something such as electricity or oil that can do work, such as providing light and heat” (Cambridge University Press, 2025). Generally, energy is divided into categories that depend on how the energy has been produced. Renewable- or green energy and non-renewable energy, made from finite resources. Renewable energy sources are made from natural resources that are constantly and naturally renewed and include wind-, solar- hydro- and bioenergy among others. The non-renewable energy comes primarily from fossil fuels and nuclear fuels, that take millions of years to form and that will eventually run out if we continue using them.

Energy as most other things have an environmental impact and there are a few environmental issues that come with both energy production and consumption. These issues include climate change, water-, thermal- and air pollution and solid waste disposal (European Environment Agency, 2025). There is a major difference between renewable and non- renewable energy when it comes to these issues since the majority of these harmful effects come from the energy recovery process from fossil fuels.

2.2.2 The energy union strategy & the sustainable global energy transition

The energy union centers around how EU countries and the commission should cooperate in order to meet the energy targets that are set for 2030 and 2050 and how energy policies should be integrated in the EU. The official energy union strategy was created and published in 2015 and aims at giving EU consumers, households and businesses energy on the right

terms. Namely affordable, secure, sustainable and competitive energy (Erbach, 2015). The commission monitors the progress of the energy union yearly and makes sure that the implementation is done correctly and that the goals of the strategy are achieved. There are five main dimensions of the energy union: security, solidarity & trust; a fully integrated internal energy market; energy efficiency; climate action & decarbonizing the economy; and lastly research, innovation and competitiveness. The energy union has a special task force, launched in 2025, that works to integrate & strengthen the energy and electricity systems within the EU. There is a specific regulation for the governance of the energy union and climate action (EU2018/1999) that is a part of the clean energy for all Europeans package. The commission evaluated and published a report on how the regulation is functioning in practice in 2024, concluding that the regulation has helped in keeping the EU on track to meet its targets (European Commission, Directorate-General for Energy, 2025).

The sustainable global energy transition focuses on a shift in energy production, distribution and consumption. It aims to reduce the dependency on fossil fuels and build a system that is centered on the use of renewable energy sources. An important part of the energy transition is the just transition concept that emphasizes equity and inclusion. This is in accordance with the just transition mechanism, that ensures fairness and inclusion for the sectors most affected by the energy transition. The transition involves both opting for renewable energy sources and enhancing the efficiency of energy production and usage with the help of different technologies. There are a few priorities within the sustainable energy transition. Apart from the already mentioned points about ensuring a just transition and scaling up renewable energy production there is also focus on the decarbonization of sectors that rely majorly on fossil fuels, increasing energy storage to match the current needs, accelerating the energy efficiency measures through the introduction of new energy efficient solutions, adopting new financing mechanisms that address risk factors & using the new digital tools and AI to help in any way possible (UNDP Climate Promise, 2025).

2.2.3 EU laws within the energy sector & the clean energy for all Europeans pack

The clean energy for all Europeans package was part of a revision of EU's energy policy in 2019 to help with the decarbonization of the European energy system. This was done partly to deliver on the commitments by the EU on the Paris Agreement to reduce greenhouse gas emissions. This was one of the main actions done to implement the goals from the energy union strategy. The package consists of eight different regulatory instruments. Three of the main ones; the energy performance of buildings directive, the renewable energy directive & the energy efficiency directive together with the European green deal will be explained a bit more below (European Commission, Directorate-General for Energy, 2025).

The European green deal is notable single law but instead a bigger strategy for climate neutrality with specific legislation on energy. This pillar of the legislative framework is called the clean energy transition, and renewable energy plays an important part in that. The production and use of energy is one of the biggest contributors to the EU's greenhouse gas emissions, accounting for more than 75% of the total emissions. There are three main principles included in the clean energy transition that are aimed at reducing greenhouse gas emissions and simultaneously enhancing life quality for the citizens of the EU. The first principle is ensuring a secure and affordable energy supply, the second principle is developing an integrated, interconnected and digitalised EU energy market and the third principle is prioritizing energy efficiency, energy performance of buildings and developing a power sector based largely on renewable energy. The first two principles have a few different action plans and strategies to support them and make the clean energy transition as smooth as possible. These are the energy system integration strategy, the hydrogen strategy, the offshore renewable energy strategy, the renovation wave, the methane strategy and the transeuropean networks for energy. The third principle is implemented by the three directives that were mentioned in the previous section, the RED, EED and EPBD (European Commission, 2025).

The renewable energy directive sets specific targets on the amount of energy that should come from renewable energy sources. The directive has been revised a few times because

of the need to quicken the clean energy transition. The last revision was made in 2023 and entered into force in November that same year. The current binding target is at least 42.5% renewable in the energy mix by 2030. Together with the RED the commission also published corresponding recommendations and guidelines. Renewable energy is less costly and mostly produced within the EU which reduces the dependency on energy from external suppliers. According to stats reported by Eurostat, the share of renewable energy sources within the EU's overall energy consumption increased from 12.5% in 2010 to 24.6% in 2023 showing that the introduction of the directive has led to positive changes. The country within the EU with the highest share of renewables in its consumption year 2023 was Sweden with 66.4% renewable energy in its consumption (European Commission, Directorate-General for Energy, 2025).

The energy efficiency directive sets binding energy efficiency targets for the entirety of the EU. The latest revision, made in 2023, raises the EU's ambition on energy efficiency significantly and requires at least an 11,7% reduction in energy consumption by 2030, compared to the projections of the EU energy usage year 2020. This directive establishes an important principle of the EU energy policy; energy efficiency first. This means taking stricter measures in specific sectors, such as public buildings, industry and heating. The directive aims to improve the efficiency and therefore cut emissions and reduce the overall use of resources leading to a lower level of pollution. This contributes to the 2030 target of reduction of greenhouse gas emissions by at least 55%. Since this directive has been revised, the different countries within the EU have set indicative national contributions based on their national circumstances. As a part of the energy efficiency directive there is also an annual energy savings obligation, a stronger focus on diminishing energy poverty and empowering consumers by raising awareness and providing information. A new aspect of the directive that was introduced through the 2023 revision was the obligation to monitor and report energy performance data (European Commission, Directorate-General for Energy, 2025).

The energy performance of buildings directive requires EU buildings to improve their energy performance, aiming to become near-zero-energy buildings. The meaning of near-zero-energy buildings is that the building has a very high energy performance and that the building's energy needs get met by mostly renewables. There are four focus areas of the directive: renovation, decarbonization, modernization & digitalization and financing & technical assistance. The directive was revised in 2024 and will need to be taken into national laws by 2026. The directive also supports renovation programs as a step to improve building efficiency and reduce heating and cooling emissions. The renovation requirements focus on the worst performing buildings within each state. Setting requirements for development of renovation strategies and minimum energy performance standards (MEPS) for old buildings. Together with the renovations the directive also encourages smart building technologies with smart controls, meters and automations among others. This directive has also been revised and the newest revision accelerates the phaseout of fossil fuel boilers and other fossil fuel heating systems. The aim is to shift these to solar thermal, heat pumps, district heating and deep energy retrofits. This one is an important framework with great environmental significance for the overall energy consumption since buildings account for approximately 40% of the overall energy use in the EU and also account for about 50% of EU’s gas consumption according to Eurostat energy balances and EEA Greenhouse gas inventory 2023. 75% of the buildings in the EU have poor energy performance, which makes improving the energy performance of existing buildings key to save energy. In some cases, ineffective energy performance of buildings can also lead to local air pollution, from gas, coal or oil boilers (European Commission, Directorate-General for Energy, 2025).

2.3 Suistnable Agriculture: Regulatory Framewoek and Future Directions

2.3.1 Introduction to Suistanable Agriculture

Agriculture is not merely an economic activity, it is a multidimensional system that shapes the environment, economy and society simultaneously.

From an economic perspective, agriculture provides food, employment, and contributes significantly to GDP and rural development. It represents both a source of livelihood for millions of farmers and a strategic economic sector influencing trade and national food security.

2.3.1.1 Definition of Sustainable Agriculture

The concept of sustainable agriculture integrates environmental, social, and economic dimensions of farming.

According to the FAO (1989), sustainable agriculture is “The management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations (Hardaker, 1997).”

In this sense, sustainable agriculture is not a fixed model but a guiding framework. It adapts to local environmental, economic, and cultural conditions, recognizing that solutions differ between regions and farming systems. It also embodies an ethical dimension: a commitment to intergenerational equity, ensuring that future generations inherit productive soils, clean water and a stable climate.

2.3.2 EU Policy, Treaties and International Agreements

Environmental and agricultural policies cannot be developed in isolation. Agriculture relies fundamentally on soil, water, biodiversity and climate stability, and conversely agricultural practices have profound environmental implications.

2.3.2.1 EU Policy Frameworks

The integration of environmental policy into agriculture is most visibly realised through EU policy frameworks that translate the treaty's abstract principles into binding instruments and operation mechanisms.

The Common Agricultural Policy, first established in 1962, originally pursued economic and social goals under Article 39 TFEU - namely productivity, income stability and market balance. However, successive reforms have progressively “greened” the CAP, making environmental performance a legal condition for financial support.

The modern CAP rests on several key mechanisms that integrate environmental principles into farm support:

- Conditionally sets the baseline rules farmers must follow to receive CAP payments replacing the former cross-compliance system. It consists of Statutory Management Requirements (SMRs) and Good Agricultural and Environmental Conditions (GAECs), together ensuring that public support promotes sustainability and responsible land use (Department of Agriculture, Food and the Marine, 2022).

- Eco-schemes, introduced by the CAP Strategic Plans Regulation 2023-2027, offer voluntary payments for environmental services such as carbon farming, agroforestry, extensive grazing to reduce wildfire risk or organic production (Department of Agriculture, Food and the Marine, 2023).

- Agri-environment-climate measures (AECMs) support longer-term sustainability projects - e.g., restoration of fire-degraded soils or terrace maintenance in erosion-prone regions (Federal Ministry of Agriculture, Food and Regional Identity, 2019).

The 2023-2027 CAP marks a major institutional shift: Member States must now prepare national CAP Strategic Plans (Agriculture and Rural Development, n. d.), approved by the European Commission, outlining how they will meet EU environmental targets. This flexibility allows regional adaptation, but it also raises legal questions of uniformity and accountability under Article 11 TFEU´s integration obligation.

The European Green Deal, announced in 2019, is the EU´s overarching framework for achieving climate neutrality by 2050. It establishes the integration of environmental policy across all sectors, including agriculture, as a guiding legal and political principle.

Within the Green Deal, the Farm to Fork Strategy represents the agricultural dimension of this transformation. It envisions a fair, healthy and environmentally friendly food system and introduces measurable targets to operationalize sustainability:

- 50% reduction in pesticide use and risk by 2030 (EIP-AGRI, 2022), aligning with the precautionary principle in Article 191 TFEU.

- 25 % of EU farmland under organic farming by 2030 (European Environment Agency, 2025), promoting biodiversity and soil health.

- 50% reduction of nutrient losses by 2030 (Agriculture and Rural Development, n. d.), while maintaining soil fertility, through integrated nutrient management and reduced fertilizer dependency.

The strategy also recognizes the link between soil health, climate adaptation and food security, addressing land degradation and desertification risks aggravated by drought and wildfires in southern Europe.

The EU Soil Strategy for 2030 is for the first time introducing a comprehensive soil governance framework. It seeks to achieve land-degradation neutrality by 2050, consistent with SDG 15.3 and explicitly links soil restoration to post-fire resilience and sustainable land management.

The EU Soil Strategy identifies agricultural intensifications, pesticide overuse and land abandonment as primary causes of erosion and fertility loss and calls for integration with CAP eco-schemes and climate policy. It also paved the way for the Proposal for a Soil Monitoring and Resilience Directive, which introduces harmonized soil-health indicators, national monitoring obligations and reporting duties for Member States - marking the first binding EU legislation on soil protection (European Environmental Bureau & ClientEarth, 2023).

2.3.2.2 International Agreements and Global Context

European Union agricultural and environmental policies do not exist in isolation. They form part of a broader international legal architecture that frames sustainability, food security and land protection as global public goods. The EU´s internal strategies are therefore shaped and legitimized by international commitments under the United Nations and other multilateral frameworks.

The Sustainable Development Goals (SDGs), adopted in 2015 as part of the 2030 Agenda for Sustainable Development, the Sustainable Development Goals (SDGs) provide the global normative framework for balancing economic growth, social inclusion and environment protection.

For agriculture, four SDGs are particularly relevant (United Nations, n. d.):

- SDG 2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture

- SDG 6 - Ensure availability and sustainability management of water and sanitation for all

- SDG 13 - Take urgent action to combat change and its impacts

- SDG 15 - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss

The EU´s Green Deal, Farm to Fork Strategy and EU Soil Strategy for 2030 explicitly reference these SDGs as guiding principles.

The United Nations Convention to Combat Desertification (UNCCD), adopted in 1994 and entered into force in 1996, represents the first legally binding international agreement addressing land degradation and desertification, particularly in arid, semi-arid and dry sub-humid areas. Both the EU and its Member States are Parties to the Convention.

The UNCCD´s Article 5 obliges Parties to adopt national strategies and legislative measures promoting sustainable land management and soil conservation (United Nations, n. d.). For the EU, these obligations are reflected in its Soil Strategy for 2030, the forthcoming Soil Monitoring and various Rural Development Programmes under the CAP (European Commission, 2021).

The Food and Agriculture Organization (FAO) and the Organization for Economic Co-operation and Development (OECD)**,** as a soft-law instrument developed by international organizations, also play a growing normative role in shaping EU and Member State policy.

- The FAO's Voluntary Guidelines for Sustainable Soil Management (2017) encourages governments to adopt integrated approaches to soil conservation, focusing on prevention of erosion, salinization and contamination (Food and Agriculture Organization of the United Nations, 2017). These guidelines directly inform the technical content of the EU Soil Monitoring Directive (2023) proposal.

- The FAO Code of Conduct for Pesticide Management (2014) supports EU pesticide legislation by establishing principles for safe use and minimizing environmental harm (Food and Agriculture Organization of the United Nations & World Health Organization, 2014).

- The OECD Principles on Green Growth (2011) and OECD-FAO Guidance for Responsible Agricultural Supply Chains (2016) influence EU trade and sustainability standards, particularly under the Farm to Fork and deforestation-free supply chain regulations.

2.3.2 Hotly Debated Agricultural Issues

Integrating environmental principles into agriculture becomes most visible in areas where law and practice collide. Issues such as pesticide use, soil degradation and fires, and water management reveal the ongoing tension between agricultural productivity and environmental protection.

2.3.2.1 Pesticides and herbicides

Pesticides are chemicals used to kill or control harmful organisms such as insects, weeds, fungi, bacteria, and rodents. While essential for boosting modern agricultural productivity, they also pose environmental and public health risks. The main categories include insecticides, herbicides, fungicides, rodenticides, and bactericides. Farmers use pesticides to prevent crop damage, increase yields, maintain food quality, and protect stored grains. Since the mid-20th century, pesticide use has greatly increased food production and helped reduce diseases spread by pests.

The main problem with pesticide use is that, while they increase food production, they also create serious environmental, health, and social risks. Pesticides spread beyond their target pests, contaminating air, water, soil, and food. Human exposure—especially among farmworkers—can cause poisoning, hormonal disruption, neurological and reproductive problems, developmental issues in children, and cancer. Environmentally, pesticides reduce biodiversity, harm pollinators like bees, degrade soil health, and contaminate ecosystems. Over time, pests develop resistance, forcing the use of stronger chemicals and creating a harmful cycle. Socially and economically, farmers—often with limited training—face high risks and increased dependence on pesticide-based agriculture controlled by large companies. Overall, pesticide use raises concerns about sustainability, ethics, and long-term viability, highlighting the need for safer and more sustainable farming alternatives.

The controversy surrounding the use of pesticides and herbicides in agriculture arises from the tension between their role in boosting crop yields and supporting large-scale food production, and the serious risks they pose to human health, the environment, and the long-term sustainability of farming. Long-term exposure has been linked to cancer, hormonal and neurological disorders, and reproductive problems, especially among farmworkers. Environmentally, these chemicals contaminate air, soil, and water, reduce biodiversity, harm pollinators, and degrade soil fertility. Their intensive use has also created resistant “superweeds” and “superpests,” leading to even greater chemical dependence. Economically, a few multinational corporations dominate the pesticide and seed market,

increasing farmers' vulnerability and inequality, particularly in developing regions. The central debate questions whether agriculture can meet global food needs without heavy reliance on these chemicals and whether more ecological and regenerative farming models can offer a safer, more sustainable path for the future.

Current legal and policy debates on pesticides and herbicides revolve around scientific uncertainty, public health concerns, environmental protection, food security, and economic interests. In the EU, regulations are highly contested. Cases like glyphosate show tensions between scientific assessments, political decisions, and public pressure, while bans on substances such as neonicotinoids and chlorpyrifos illustrate restrictive approaches when risks are clear. The EU's Green Deal and Farm to Fork strategy aim to cut pesticide use by 50% by 2030, though implementation varies across member states.

Internationally, conventions such as Rotterdam and Stockholm regulate hazardous chemicals, but many countries with weaker regulations still use pesticides banned in Europe, raising ethical concerns. National policies differ widely, with some governments tightening restrictions and others granting emergency authorizations that undermine bans.

Legal disputes are frequent: NGOs challenge approvals, companies contest bans, and emergency authorizations generate controversy. Overall, the debate reflects a balance between maintaining agricultural productivity and protecting health and biodiversity. Reducing dependency on chemical pesticides will require stronger regulation, international cooperation, investment in alternatives, and political commitment.

2.3.2.2 Soil degradation and fires

Soil degradation and wildfires are increasingly interlinked environmental and agricultural challenges, particularly in Mediterranean regions such as Spain, Portugal and Italy. Fires destroy vegetation cover, leading to severe soil erosion, loss of organic matter, and long-term declines in fertility and water retention. Around 60-70 % of European soils are currently degraded (EU Science Hub, 2023), and between 43 and 83 million hectares of EU

and UK agricultural land - 23-44 % of the total - are at risk of further soil organic carbon loss (EU Science Hub, 2025).

This degradation threatens agricultural productivity, carbon sequestration capacity, and ecosystem resilience. Degraded soils are also more vulnerable to renewed fires, creating a vicious feedback loop between land abandonment, vegetation accumulation and fire recurrence.

The controversy stems from conflicting priorities in agricultural, environmental, and land management policies.

- Land-use paradox: while rewilding and land abandonment may help biodiversity recovery, they often increase fire risk by allowing biomass accumulation. In contrast, maintaining active agriculture, terraced fields or grazing systems can reduce fuel loads but may conflict with conservation objectives.

- Fire as both threat and management tool: controlled or prescribed burns and traditional grazing are legally used to reduce fire risk, yet they raise liability, biodiversity and air quality concerns. Balancing these competing values remains a challenge across Mediterranean and other fire-prone landscapes.

- Economic and governance conflicts: restoration after fires is expensive and responsibility is often unclear - should farmers, local authorities or the state bear the cost? This uncertainty is heightened by overlaps between agricultural law, forestry law and environmental protection law, which frequently distribute obligations across different jurisdictions.

- Short-term productivity vs. long-term sustainability: farmers face pressure to maximize yields despite soil exhaustion, while policy increasingly demands ecological restraint. This tension exposes the paradox of integration - environmental objectives are formally integrated into agricultural law, yet economic incentives often push in the opposite direction.

Current legal and policy developments show growing awareness of the link between soil health, climate adaptation and agriculture.

- The Common Agricultural Policy (CAP) Strategic Plans Regulation (EU) 2021/2115 conditions subsidies on compliance with Good Agricultural and Environmental Conditions (GAEC), including soil cover maintenance, erosion prevention and crop rotation.

- The proposed EU Soil Monitoring Law (2023) introduces, for the first time, a legal framework to achieve land degradation neutrality by 2050, complementing the EU Soil Strategy for 2030.

- National and regional policies (e.g. Spain´ s wildfire prevention framework, Portugal's rural land management program) now include measures to maintain terraces, promote grazing in fire-prone zones, and finance soil restoration.

- The EU LIFE programme (Infrastructure and Environment Executive Agency, n. d.), such as LIFE REFOREST in Galicia (Santi74bb, 2021), have demonstrated effective post-fire soil restoration through the use of biochar, composted organic matter and replanting with native species.

2.3.2.3 Water managment

Global water demand has increased sixfold over the last century and continues to rise by about 1% annually due to population and economic growth (Koncagül et al., 2020). Water scarcity threatens food and energy security, ecosystems, and geopolitical stability (Bernauer & Böhmelt, 2020). Climate change further reduces water availability, making sustainable allocation increasingly urgent.

Although Europe was traditionally perceived as water-abundant, many regions, especially in Southern and Central Europe, now face recurrent droughts and declining water supplies (WAREG – European Water Regulators, n.d.). Water scarcity is therefore not only an

ecological issue but also a legal and governance challenge requiring robust regulatory systems.

The controversy arises precisely because water scarcity intensifies competition among sectors for a single constrained resource. Any decision on prioritisation has significant consequences for agriculture, urban supply, industry, energy systems, and natural ecosystems.

Agriculture is particularly vulnerable: reduced water availability leads to lower yields, livestock stress, rising food prices, and in extreme cases land degradation and desertification. This affects farmers' livelihoods and the broader supply chain, increasing socio-economic instability. At the same time, water is indispensable for industry, public health, and environmental protection. These competing needs create significant political and social friction (WAREG – European Water Regulators, n.d.).

Current legal and policy debates centre on how to allocate and manage water sustainably through improved monitoring, pricing, and long-term planning. Environmental law provides tools such as conservation programmes, efficiency standards, water metering, digital monitoring, and economic instruments.

Technological solutions including desalination, advanced irrigation, and water recycling can reduce pressure on water resources but work only when embedded in strong regulatory frameworks and supported by adequate financing (Falkenmark et al., 2019; Vörösmarty et al., 2010; European Environment Agency, 2021).

Regulatory reforms such as pricing mechanisms, efficiency standards, and digital metering rely on accurate data collection to track compliance and adjust policies as conditions change. Which is also illustrated by several significant cases.

- Doñana, Spain – Overextraction for agriculture caused severe aquifer decline. The European Court of Justice (C-559/19) found Spain in breach of the Water Framework

Directive and Habitats Directive for failing to monitor and control illegal irrigation (European Commission, n.d.; Court of Justice of the EU, 2021).

- Colorado River Basin, USA – Climate-driven megadrought exposed the weaknesses of the century-old "Law of the River," based on unrealistic allocation assumptions. States now face severe shortages and federal emergency interventions (Udall & Overpeck, 2017; Milly & Dunne, 2020; U.S. Bureau of Reclamation, n.d.; Vanham et al., 2021).

- Murray–Darling Basin, Australia – Excessive extraction and ecological collapse led to major reforms under the Water Act 2007 and the Basin Plan (2012), introducing Sustainable Diversion Limits, mandated environmental flows, and stronger enforcement (Murray–Darling Basin Authority, n.d.; Wentworth Group of Concerned Scientists, 2017).

These examples highlight the necessity of coordinated legal, technological, and policy action to ensure sustainable water management in the face of climate change and rising demand.

2.3.3 Principles of International Law and the Future of Suistanable Agriculture

This chapter explores how global legal norms influence agricultural governance and how emerging contradictions between productivity and sustainability push policymakers toward new, innovative solutions.

2.3.3.1 Principles of International Environmental Law and their Relevance ti Agriculture

The principle of integration requires that environmental concerns be embedded into agricultural policies, reflected in the EU´s Common Agricultural Policy through eco-schemes and conditional payments that link subsidies to sustainable practices. This aligns directly with SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production) and SDG 15 (Life on Land) (United Nations, n. d.).

The precautionary and polluter-pays principles guide agricultural regulation in areas such as pesticide use, fertilizer management and soil conservation - ensuring prevention of harm and accountability for pollution. Meanwhile, the principles of common but differentiated responsibilities and intergenerational equity stress that sustainable agriculture must be equitable, balancing present needs with those of future generations. Together, these principles frame agriculture not only as an economic activity, but as a legally regulated environmental system essential for long-term sustainability.

2.3.3.2 Innovative Legal and Policy Approaches

While sustainable agriculture faces multiple structural paradoxes - balancing productivity, ecology and justice - legal and policy innovation offers pathways to reconcile these competing objectives. Across EU and globally, new frameworks are emerging that expand the traditional scope of agriculture law to include ecosystem services, digital tools and community-based governance.

Payment for Ecosystem Services (PES) mechanisms compensate farmers or landowners for maintaining ecosystems that provide public benefits - such as carbon sequestration, soil fertility or biodiversity conservation. Rather than punishing degradation, PES incentivizes stewardship by recognizing the economic value of ecosystem functions (Le et al., 2024).

In the EU, such mechanisms are increasingly integrated into the Common Agricultural Policy (CAP) through eco-schemes and agri-environment-climate measures (AECMs). For example, Member States may reward farmers who restore wetlands, maintain hedgerows or reduce fertilizer use.

Outside the EU, Costa Rica´s PES Programme (United Nations, n. d.) is a landmark model, credited with reversing deforestation and generating rural income by paying landholders for carbon storage and watershed protection. The concept is supported globally by the OECD, FAO and UNEP, which recognize PES as a key tool for achieving SDG 15 (Life on Land) and SDG 13 (Climate Action).

Regenerative agriculture emphasizes soil health restoration, carbon sequestration and biodiversity enhancement through techniques such as minimal tillage, crop rotation and composting. In contrast, circular agriculture focuses on closing resource loops - reusing organic waste, recycling water and minimizing inputs.

The European Green Deal and the Farm to Fork Strategy explicitly support these models by encouraging sustainable nutrient management and reducing dependency on synthetic fertilizers. The Circular Economy Action Plan (European Union, 2022) complements this vision by promoting resource efficiency and waste reduction across the food system.

The digitalization of agriculture is reshaping environmental compliance and sustainability governance. Satellite imaging, drones and AI-based soil sensors enable precise monitoring of agriculture practices, improving both productivity and transparency.

Under the CAP 2023-2027, the Area Monitoring System uses Copernicus satellite data to verify farmers´ adherence to eco-conditionally and GAEC standards (Copernicus, n. d.). This innovation reduces administrative burdens while enhancing environmental accountability.

At the same time, the rise of digital tools raises data governance challenges, particularly regarding ownership, privacy and access to soil and farm data. The EU Data Governance Act (Regulation (EU (2022/868))) introduces a framework for data-sharing and trust mechanism essential for equitable transition in agriculture (OECD, 2025).

Globally, initiatives like the FAO´s Global Soil Partnership (GSP) (Food and Agriculture Organization of the United Nations, n. d.) promote open soil information systems, helping countries improve land management and combat degradation.

Agroecology integrates ecological science with traditional farming knowledge to design resilient, low-input food systems. It emphasizes biodiversity, ecosystem interactions and community participation - positioning farmers as custodians rather than exploiters of land.

In legal context, agroecology aligns with Article 37 of the Charter of Fundamental Rights of The EU (European Union, n. d.), which recognizes environmental protection as a

constitutional principle and with international soft law such as the FAO´s 10 Elements of Agroecology (2018).

Parallel to this the “Rights of Nature” movement - pioneered by Ecuador's 2008 Constitution (Articles 71-74) (República del Ecuador, 2008) and Bolivia's Law of Mother Earth (Law No. 071/2010) (Villavicencio-Calzadilla, 2025) - challenges anthropocentric legal systems by granting ecosystems legal personhood, While not yet adopted in EU law, such framework inspire debates on ecological contributions and the legal recognition of soils and rivers as rights-bearing entities.

3. PARADOXES

3.1 Green Paradox

3.1.1 Understanding the green paradox

The green paradox refers to an outcome in which climate policies such as carbon taxes, which are aimed at reducing carbon emissions, instead have the opposite effect: emissions increase, at least for some period of time (Jensen, 2015). More recently, the term green paradox has been used to more widely describe unintended outcomes of climate policies. A green paradox arises if climate policy backfires and the environmental problem worsens.

The culprit is the reaction on the supply side of the fossil fuel market. Fossil fuel owners enjoy scarcity rents and maximize their profits by deciding when to extract their coal, oil, or gas reserves (Jensen, 2015). If new green policies are announced, fossil fuel owners might worry that their fuel will be worth less in the future. Therefore, they extract and sell more fuel sooner. This rush to sell before new rules start is a core part of the green paradox.

There are two theoretical outcomes from green paradox: weak green paradox and strong green paradox. The weak green paradox happens when climate policies are announced before they actually take effect, which leads to a result where current emissions go up but the sum of extracted fossil fuels doesn’t necessarily add up. On the other hand, a strong green paradox happens when that rush to extract increases the total amount of fossil fuels used. This means that even cumulative damages can get worse than they would without

the green policy. Whether the policy leads to weak or strong green paradox effects depends on market responses, policy details, technological changes, and future prices.

3.1.2 The relation between renewable energy and green paradox

If fossil fuel owners expect renewable energy will soon be cheaper, they start extracting and selling more fossil fuels sooner to get a profit while they still can. That means CO2 emissions go up today. But as renewables get cheaper and start being used sooner, fossil fuels use in the future goes down. The overall effect on global warming isn't clear. On the other hand, if renewables are still expensive, people will use up almost all the fossil fuels eventually, and environmental welfare (green welfare) drops. If renewables get cheap, it becomes worthwhile to leave some fossil fuels in the ground instead of extracting all of them. That's better for the environment. The timing of switching to renewables and how much fossil fuel is left unexploited matters a lot.

Van der Ploeg and Withagen (2012) find that in market economies where the environmental costs of fossil fuel use are not fully accounted for, policies like subsidies for renewables or expectations of lower future renewable costs can cause fossil fuels to be depleted more quickly, increasing near-term CO_2 emissions and climate damages. However, if renewables become cheap enough relative to fossil fuels and their social costs, more fossil fuels will be left unexploited, ultimately reducing environmental harm; thus, the impact of green policies depends on how effectively they address the true social cost of carbon and whether they encourage true substitution away from fossil fuels.

3.2 Energy transition paradox

The energy transition paradox refers to the conflicting situation of the need to move away from fossil fuels and non-renewable energy sources while simultaneously recognizing that we are becoming increasingly reliant on these energy sources to sustain our lifestyle and economy. We cannot simply swap out the non-renewable energy sources to renewable ones since the demand for energy is growing at a rapid pace with the different societal

changes that are occurring, and because of different economic and social dimensions that need to be taken into account (Energy Sustainability Directory, 2025).

There are multiple factors that promote the switch to renewable energy sources; new scientific evidence, public awareness and multiple governmental policies. On the environmental side of this the scientific evidence has never before been clearer. Continuing to burn fossil fuels to generate energy is not sustainable because of the large amount of greenhouse gases that gets released, driving climate change with all of its catastrophic consequences. These consequences have also been more visible to the general public now compared to before, with the extreme weather events as one visible manifestation. There are also the specific concrete sustainable goals that are globally agreed-upon, such as the Paris agreement. In order to be able to meet these targets to limit global warming the switch to renewable energy needs to be made faster than we are currently doing. Besides this the new technological advancements that have been made within the renewable energy sector do make the transition easier to accomplish. Cleaner energy options are becoming more reliable and also more cost-efficient in many regions (Cieślik, R, 2025)

On the opposite side of this there are the facts that we have a lot of existing infrastructure built for non-renewable energy sourcing, all of the economic dependencies on fossil fuel industries, the always growing energy demand of our current society that has recently been even higher due to developing economies going through industrialization and wanting to improve their living standards. This side of things shows the complexity that needs to be handled when making larger systemic changes. Meeting the growing demand with only renewable energy is currently looking very challenging. The infrastructure aspect of things also connects to the economic aspects of the energy transition. We have invested an immeasurable sum of money in fossil fuel based energy systems. This leads to a ’lock-in’ effect because the old system has had so much invested into it, it still works and the new system would require new investments. Fossil fuel based energy also has an established market and large industries reliant on the energy that it creates. The transition in energy production also put nations that still rely on non-renewable energy for revenue and export

in a difficult position. Furthermore there are still certain intermittency and reliability concerns with renewable energy sources since many of them are inherently variable. The switch requires a type of energy storing and energy grid management that we haven't fully developed yet. This becomes another more practical issue with renewable energy (Xiao, Li, et al. 2024).

The paradox is explained by the existence of barriers and market failures, including:

- Low or artificially reduced energy prices: When energy is cheap, efficiency investments appear less profitable. This worsens when prices fail to internalize environmental costs or when distorting subsidies keep prices artificially low.

- Uncertainty and Irreversibility: The difficulty of recovering investments if expected savings do not materialize introduces risks that discourage efficiency improvements.

- Information Failures: Asymmetric or incomplete information and behavioral biases- such as vauling upfront costs more than long- term savings- limit efficiency adoption.

- Principal-Agent Problems: The investor is not always the one who receives the benefits, as in the case of landlords and tenants.

- Financial market imperfections: Long-term, uncertain-return investments often face financing obstacles, particularly for smaller actors.

- Cultural and awareness barriers: Many consumers undervalue energy savings or lack the knowledge needed to adopt efficient practices.

This paradox helps explain why, despite technological solutions, socio-environmental conflicts persist and deepen. As efficiency reduces costs and increases access to energy, it often stimulates greater consumption, intensifying pressure on ecosystems and territories.

A key element in understanding environmental paradoxes is the Jevons Paradox, formulated in the 19th century by William Stanley Jevons. His central thesis posits that increases in the efficiency of a resource do not reduce its consumption; rather, they may increase it. Jevons observed that, as team engines became more efficient, England´ coal consumption rose instead of falling.

Contemporary examples reinforce this logic:

- Expanding highways to reduce congestion often attracts more vehicles, reproducing traffic problems.

- Technological improvements in electronic devices reduce consumption per unit, but increasing power, capabilities, and usage elevate overall demand.

Thus, the Jevons Paradox shows that efficiency alone cannot solve environmental problems; in fact, it may encourage higher resource consumption. The central conclusion is clear: without a real reduction in consumption, it is impossible to address the climate and ecological crisis.

3.3 Control Entropy Paradox

The Control–Entropy Paradox, developed by Hlabisa (2025), explains how efforts to create order and stability in environmental governance inevitably generate new forms of disorder elsewhere in the system. When lawmakers and regulators build low-emission transport regimes, for example, they do so through energy- and material-intensive infrastructures, monitoring systems, and enforcement mechanisms, which displace entropy onto other sectors, territories, or social groups rather than eliminating it. Hlabisa (2025) uses this thermodynamic lens to argue that transport, as a sector built on vast flows of energy and materials, sits at the centre of what might be called governance metabolism and entropy externalization: carbon-neutrality pledges in aviation or shipping may cut visible emissions in core regions, yet offset schemes and new infrastructures often shift land-use change, ecological damage, or social conflict to peripheral areas.

This logic is grounded in basic thermodynamics. The second law tells us that the entropy of an isolated system tends to increase over time, meaning that energy becomes progressively more dispersed and less available for work (LibreTexts, 2025). Entropy is often described as the number of possible micro-configurations of a system, which is why it is commonly associated with disorder or randomness (Wikipedia, 2025). In practice, no social-ecological system is perfectly isolated, so whenever a transport network maintains a highly ordered, low-entropy state—smooth traffic, predictable flows, stable infrastructure—it typically does so by exporting entropy beyond its own boundaries, whether to other regions' environments, public budgets, or marginalized communities.

Research on transport governance illustrates this trade-off. Studies on "transportation entropy," such as work on entropy-based traffic signal control, show that tightly synchronized traffic-light systems can reduce local uncertainty in flows but at the cost of higher overall energy use, rigidity, and vulnerability to disruption when conditions change (e.g., accidents, extreme weather). By contrast, adaptive or self-organizing traffic systems accept more local variability yet often produce a more resilient and efficient network, aligning with Hlabisa's (2025) claim that trying to suppress all uncertainty can backfire by increasing systemic fragility. A similar point appears in Cao and colleagues' analysis of environmental regulation and technological volatility, where they argue that "fighting entropy" through increasingly tight rules consumes additional resources and can generate new inefficiencies or instabilities in innovation pathways (Cao et al., 2022). Yin, Liu, and Gu (2022) add another layer by showing how climate and environmental regulations may trigger green-paradox-type dynamics in which firms accelerate emissions before new rules bite or relocate pollution to less regulated jurisdictions, again echoing the idea that more control can produce new forms of disorder.

For transport law and policy, the Control–Entropy Paradox therefore marks a clear limit to purely centralized, command-and-control strategies. The task is not simply to push tailpipe emissions down in a given city or corridor, but to ask where the associated energetic, material, and social costs of control are being pushed, who absorbs the extra entropy and

at what scale. This suggests a shift in sustainability metrics towards indicators that track entropy displacement, governance metabolism, and threshold sensitivities across sectors and territories, drawing on thermodynamic thinking rather than relying only on local environmental performance. It also supports a move towards more flexible, adaptive, and participatory governance arrangements, such as decentralized, data-driven traffic management, cross-sector coordination between transport, energy, and land-use planning, and justice-oriented impact assessments that treat some degree of uncertainty as a resource for learning and resilience instead of something to be eliminated at all costs.

3.4 Justice Paradox

3.4.1 Understanding of justice paradox

Energy justice is about the fair distribution of the benefits and burdens of energy production, distribution, and consumptions. The justice paradox in the energy sector points to situations where policies or actions intended to promote justice can actually create new inequalities, contradictory outcomes, or unintended negative consequences. Justice paradox can emerge in several ways: when policies encouraging a shift to renewable may benefit society overall but harm fossil fuel dependent communities by causing job and income loss, when making clean energy affordable and accessible to everyone fails, when only certain groups participate in decisions or benefit from new energy technologies. Any energy transition must involve all affected communities, balance climate goals with social inclusion, ensure affordability and accessibility, explicitly address inequities in process and outcome (Ren et al., 2025).

The concept of a justice paradox describes situations in which policies, reforms, or actions that are intended to promote justice, sustainability, or equity inadvertently create new inequalities or reinforce existing ones. In other words, even well-intentioned solutions can generate unfair outcomes. This paradox often emerges because social, economic, and environmental systems are deeply interconnected, and interventions in one area can unintentionally harm certain communities, landscapes, or livelihoods. Scholars note that justice paradoxes appear particularly often in environmental governance, where policies

designed to increase sustainability can shift burdens to vulnerable groups (Schlosberg & Collins, 2014).

When applied to agriculture, the justice paradox becomes especially visible. Agriculture is simultaneously a source of food, income, cultural identity, and ecological pressure. Modern agricultural systems produce large environmental impacts, including soil degradation, water pollution, loss of biodiversity, and greenhouse gas emissions (FAO, 2021). Therefore, governments and international institutions often introduce reforms aimed at making agriculture more sustainable such as encouraging organic production, reducing chemical inputs, promoting large-scale efficiency, or transitioning to climate-smart farming (IPCC, 2019). While these measures are designed to deliver long-term environmental and social benefits, they can unintentionally generate short-term or even long-term disadvantages for farmers, rural workers, or marginalized communities.

3.4.2 General Types of Justice Paradoxes in Agriculture

In agriculture, several types of justice paradoxes commonly appear, where policies aimed at improving sustainability, protecting the environment, or supporting farmers unintentionally create unfair outcomes (Pe'er et al., 2020). The sustainability paradox occurs when environmental policies like reducing pesticides, lowering emissions, or promoting organic farming impose higher financial and administrative burdens on small farmers than on large agribusinesses, leading small farmers to struggle or go bankrupt while big companies benefit (FAO, 2021).

The technology paradox arises as modern farming technologies—such as precision agriculture, digital tools, and automation—intended to reduce pollution and increase efficiency become accessible only to wealthy farms, deepening inequality and eroding small farms' competitiveness (IPCC, 2019). Similarly, the land-use paradox sees policies protecting nature, forests, and biodiversity restrict land use or rezone agricultural areas, potentially displacing rural communities, reducing farmland availability, or enabling land-grabbing by large companies (IPCC, 2019).

The food security paradox emerges when strategies to boost production or prioritize profitable export crops undermine local food access, such as pushing farmers toward exports over community food needs, paradoxically increasing food insecurity (FAO, 2017). The market and subsidy paradox involves subsidies meant to aid farmers primarily benefiting large producers, widening economic gaps for smallholders (Matthews, 2018). Finally, the climate transition paradox affects policies promoting climate-friendly practices like reducing livestock or fertilizer use, which protect the planet but cut rural incomes, limit traditional methods, and cause job losses in dependent regions (FAO, 2016).

3.4.3 How the Justice Paradox Manifests

The justice paradox in agriculture manifests across three primary dimensions. Distributional injustice involves the unequal spread of costs and benefits, where policies reducing pollution or promoting sustainable technologies burden small farmers disproportionately while society reaps environmental gains (Pe'er et al., 2020). Procedural injustice stems from unequal decision-making participation, as national or EU-level reforms often exclude small farmers, local communities, or Indigenous groups despite affecting them most.

Recognitional injustice fails to account for differences in farming communities, cultures, and capacities, with "one-size-fits-all" policies ignoring diversity—what's feasible for wealthy farmers proves impossible for smallholders (Schlosberg, 2007). These factors mean environmental or societal improvements can ironically exacerbate inequality, creating a core contradiction where long-term justice grows alongside short-term injustice.

3.4.4 Concrete Examples of Justice Paradoxes in Agriculture

3.4.4.1 Sustainabilty Paradox: EU Green Policies and Small Farmers

One concrete justice paradox can be seen in the European Union's sustainability reforms, such as the European Green Deal and the Farm to Fork Strategy. These policies aim to reduce pesticide use, restore biodiversity, expand organic farming, and lower greenhouse gas emissions (European Commission, 2020). Although these measures provide

environmental benefits for society, they impose disproportionately high financial and administrative burdens on small and medium-sized farmers.

Small farmers must invest in new technologies, adapt their production methods, and undergo costly certification processes. Large agribusinesses, by contrast, have more capital, better access to loans, and dedicated staff to manage administrative requirements. As a result, well-intentioned environmental reforms may lead to land concentration and the disappearance of small family farms (Pe'er et al., 2020).

This example also illustrates procedural injustice: policy design at EU level tends to involve powerful agricultural lobbies more than smallholders, limiting the participation of those most affected (Schlosberg & Collins, 2014). At the same time, recognitional injustice emerges when policymakers overlook differences in regional farming conditions, making compliance easier for wealthy farms in favourable regions but difficult or impossible for small farms in marginal areas. This combination of distributional, procedural, and recognitional inequalities makes EU sustainability reforms a clear justice paradox.

3.4.4.2 Food Security Paradox: Biofuels and the "Food vs Fuel" Conflict

A second well-documented justice paradox is the rapid global expansion of biofuel production. Governments have promoted biofuels to reduce greenhouse gas emissions and dependence on fossil fuels, presenting them as a tool for climate justice and rural development (Searchinger et al., 2008). However, converting farmland and forests into biofuel plantations has produced severe unintended consequences.

Biofuel expansion increases competition for land and water, displaces small farmers and Indigenous communities, accelerates deforestation, and contributes to biodiversity loss (FAO, 2013). Large corporations benefit most from biofuel markets, while local communities bear environmental and social costs. At the same time, increasing demand for biofuel crops drives up global food prices, making basic foods less affordable for vulnerable populations (Clapp, 2014). This demonstrates clear distributional injustice.

Procedural and recognitional injustices also arise when land acquisitions occur without fair consultation or respect for the cultural and territorial rights of affected communities (IPCC, 2019). Therefore, although biofuel policies aim to create a greener and more just energy system, they paradoxically undermine food security, rural livelihoods, and social justice.

4. CASE STUDY

4.1 Water Use as a Legal and Environmental Challenge

The following water-law case studies show how legal frameworks designed to control and allocate scarce water resources can unintentionally produce paradoxical outcomes such as overuse, ecological degradation, and social conflict. They reveal how efforts to impose order on rivers and aquifers often shift problems across sectors, territories, and communities rather than resolving them.

4.2 The Hydroelectric Paradox in the Brazilian Amazon

One of the most emblematic territorial paradoxes in Latin America is the hydroelectric paradox of the Brazilian Amazon, a region with vast water resources and considered a strategic area for hydroelectric generation.

Despite producing large quantities of “clean” energy, this model has not proven sustainable nor has it benefited local populations equitably. Large dams -such as Belo Monte, Tucuruí and Jirau- supply electricity mainly to industrial and urban centers in southern and southeastern Brazil. This creates a profound paradox: the Amazon generates energy, but it is not the primary beneficiary of it.

Key impacts and inequities of Amazonian hydroelectric dams include severe environmental damage, such as flooding thousands of hectares of forest, altering rivers such as the Xingú and Madeira, affecting ecological cycles and fisheries, and generating methane emissions from decaying organic matter that undermine the “clean” nature of hydroelectric energy.

Despite this large-scale infrastructure, many Indigenous, rural and riverine communities near the dams lack stable access to electricity, with high levels of energy poverty persisting.

Intended economic advantages show unequal territorial distribution, as electricity flows primarily to distant industrial hubs rather than producing regions, while employment opportunities remain temporary and fail to foster structural development.

Traditional ways of life suffer significant losses, with river ecosystem alterations harming fishing, hunting, and subsistence economies, alongside forced displacements that spark territorial conflicts.

This case therefore illustrate a territorial justice paradox, green energy and industrial growth in Brazil's core regions depend on concentrating environmental degradation, hydrological disruption, and social costs in Amazonian territories inhabited largely by indigenous, rural, and riverine communities.

4.3 The Lithium Paradox: Freshwater in Exchange for Clean Energy

In the global transition toward renewable energy and electric mobility, lithium has become a strategic resource- the so- called "white gold". Essential for batteries in electric vehicles, mobile phones and energy storage systems, its extraction reveals deep socio-environmental and geopolitical tensions.

The lithium Triangle- Argentina, Bolivia and Chile- Hosts some of the world´ s most important deposits, yet extraction processes generate conflict due to intensive water use, disruption of fragile ecosystems and insufficient consultation with Indigenous communities.

The scale of extraction highlights the paradox: producing one ton of lithium from brine requires approximately 2.2 million liters of water. In arid regions such as Chile´s Atacama Salt Flat, this process directly competes with agriculture, livestock raising and local water needs.

Global production underscores these tensions: Australia leads at 86,000 tons, followed by Chile (44,000 tons), China (33,000 tons), Argentina (9,600 tons), and Zimbabwe (3,000 tons). This reveals the core paradox—pursuing clean technologies via extractive methods that spawn socio-environmental conflicts, inequalities, and ethical dilemmas.

The lithium boom also shows a territorial paradox, global demand for clean technologies is supported by very heavy water use, environmental damage, and controversial decisions in remote salt-flat regions, where indigenous communities and local farmers end up carrying most of the costs.

5. CONCLUSION

The attempts to integrate transport, energy and agriculture shows that environmental law often reduces visible problems in one place while shifting costs to other territories, social groups or ecosystems. Our case studies on water governance, Amazonian hydropower and the lithium boom frameworks focus on narrow indicators such as local emission cuts or sectoral efficiency rather than on the behavior of whole systems. Instead of solving crises, fragmented control can displace entropy and deepen inequality.

To move beyond these paradoxes, sustainability metrics must be redesigned to track where energy, material and water burdens are moved, and who carries them, not only whether a single sector looks “clean”. Environmental law should explicitly combine thermodynamic insights about limits and entropy with principles of environmental and climate justice, and it should be implemented through cross-sector, multilevel governance. Framing Chapter 7 as the closing piece of the handbook underlines this message: only by seeing these sectors together, and by treating uncertainty and interdependence as central, can future legal frameworks support truly sustainable and fair transitions.

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A Living Manual for a Discipline in Motion

In the age of the Anthropocene, environmental law can no longer be taught through static textbooks that become obsolete the moment they are printed. This book is the direct result of a groundbreaking educational project at the Universitat Autònoma de Barcelona, where the classroom was transformed into a polyphonic e knowledge.

Departing from traditional memorization, this work emboises a radical shift toward open pedagogy It presents a "living" artifact co-created by students who acted as active cartographers of legal networks rather than passive consumers. By integrating rigorous legal doctrine with contemporary theoretical lenses-such as hyperobjects, the Stack, and post-normal science, this project challenges the law's capacity to govern systemic and diffuse risks.

Designed as a renewable resource under an open access framework, this manual is intended to be revised and updated by successive generations. It serves as both a practical guide and a testament to a teaching praxis that prepares future jurists to navigate the uncertainty and complexity of today's socio-ecological challenges with critical agency and collective responsibility.