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ECOLOGICAL RESTORATION: BETWEEN LAW, POLICY, AND GOVERNANCE

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If I can stop one Heart from breaking
I shall not live in vain
If I can ease one Life the Aching
Or cool one Pain
Or help one fainting Robin
Unto his Nest again
I shall not live in Vain

Emily Dickinson, Poem 919

È difficile fare
Le cose difficili:
Parlare al sordo
Mostrare la rosa al cieco.
Bambini, imparate
A fare le cose difficili:
dare la mano al cieco,
cantare per il sordo,
liberare gli schiavi
che si credono liberi.

Gianni Rodari, 1979

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ECOLOGICAL RESTORATION: BETWEEN LAW, POLICY, AND GOVERNANCE

ABSTRACT

The pressing climate, biodiversity, and pollution crises are showing the limitations of traditional environmental policies, calling for different, more radical interventions. In this context, restoration activities aimed at reconstructing damaged environments have captured the attention of international and national regulatory bodies, and restoration projects have been proliferating. However, despite this trend, ecological restoration remains largely unexplored in terms of its potential for influence and transformation. To fill this gap, this dissertation explores the scientific and ethical foundations of the practice, and their translation into legal norms. Moreover, the research examines the norms and institutions that are likely to facilitate or hinder ecological restoration activities.

Adopting an interdisciplinary approach, this work combines comparative legal analysis with political economic theories to effectively address the research questions identified. Overall, the research demonstrates that the current implementation of restoration activities is scattered, uncoordinated and often inadequate, lacking the capacity to ensure ecological recovery in face of pervasive degradation. Moreover, since ecological restoration is frequently not legally mandated, its achievement is discretionary and reliant on individual public or private initiatives. This situation has implications not only for the effectiveness of restoration efforts but also for the ability of local communities to benefit from rehabilitated ecosystems. This research argues that a combination of policy instruments and incentives should be further studied to stimulate better and more just practices and strategies.

INTRODUCTION

The journey of this Ph.D. in *International and Public Law, Ethics and Economics for Sustainability* has been both challenging and rewarding. Collaborating with peers, researchers, and professors, I felt called to spend time, passion, and abilities in comprehending and addressing some of the most compelling problems of our time, working across disciplines to advance meaningful insights.

While it is relatively straightforward to recognize the detrimental consequences of environmental problems, delving into the root causes of these issues and offering substantial recommendations for informed policy decisions presents a far more intricate challenge. During my Ph.D., I encountered the practice of ecological restoration, a response to ecosystem damage that involves reconstructing ecological functions to create more resilient environments for both human beings and wildlife. This approach, developed to combat localized ecosystem degradation and the significant problem of biodiversity loss, yields benefits that extend to climate change mitigation and adaptation, countering widespread pollution, and can serve the cause of environmental justice. Notably, evidence indicates a direct correlation between the diversity of flora and fauna in ecosystems and the quality and stability of ecosystem services provided to people.[1] Moreover, a biodiverse environment fosters productivity, bolstering the adaptability and resilience of both natural and altered landscapes.[2] Effectively, safeguarding and restoring biodiversity functions as an "insurance" policy in a constantly evolving world.[3] This perspective renders restoration a particularly compelling practice, acknowledging and nurturing humanity's capacity to support life and reverse damage, thus offering hope for a more sustainable future.

In the following chapters, I will delve into the essential scientific, cultural, and ethical facets of ecological restoration, synthesizing the most significant literature on the subject. Then, acknowledging that biodiversity law and policies are quite underdeveloped and understudied, my research aims at contributing to understanding how existing legal frameworks address restoration, and whether they include scientific and social justice considerations. Furthermore,

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[1] Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. C., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A., Kinzig, A. P., Daily, G. C., Loreau, M., Grace, J. B., Larigauderie, A., Srivastava, D. S., & Naeem, S. (2012). Biodiversity loss and its impact on humanity. *Nature*, *486*(7401), 59–67. https://doi.org/10.1038/nature11148.

[2] Dasgupta, P. (2021). *The Economics of Biodiversity : The Dasgupta Review*. https://apo.org.au/sites/default/files/resource-files/2021-02/apo-nid310742.pdf

[3] Loreau, M., Barbier, M., Filotas, E., Gravel, D., Isbell, F., Miller, S., Montoya, J. M., Wang, S., Aussenac, R., Germain, R. M., Thompson, P. W., Gonzalez, A., & Dee, L. E. (2021). Biodiversity as insurance: from concept to measurement and application. *Biological Reviews*, *96*(5), 2333–2354. https://doi.org/10.1111/brv.12756

this thesis examines and evaluates the limitations of legal instruments, exploring other socioeconomic and motivational incentives to facilitate the expansion of restoration efforts.

The legal, scientific, and ethical interdisciplinary focus of this thesis can be encapsulated by the following three research questions:

1. *What are the norms and institutions that support (or hinder) the realization of ecological restoration activities?*
2. *To what extent are these norms and institutions informed by scientific knowledge?*
3. *How do these norms and institutions account for social justice concerns?*

Structure of the thesis and research questions

This thesis is structured around three main building blocks. In Chapter 1, I provide an overview of the most relevant scientific debates around restoration ecology, and I discuss the historical evolution of the practice. This initial descriptive analysis serves to establish the context of the subject matter and helps to delineate some potential trajectories for research in the years to come.

Secondly, Chapter 2 focuses on the legal framework regulating restoration practices as means to combat biodiversity loss. Commencing with an examination of international environmental treaties and initiatives including references to restoration obligations, the chapter then hones in on the legal framework within Europe and Italy, assessing whether regulatory measures at both regional and national levels have addressed the imperative of rehabilitating impaired environments. Through the analysis of legislation and case law, Chapter 2 investigates and reconstructs the framework of restoration obligations at different governance levels. This scrutiny not only reveals the constraints and insufficiencies of current regulations but also underscores the mounting impact of ecological knowledge within legal provisions, alongside prospective avenues for interesting legal developments.

Finally, Chapter 3 takes a different approach and starts from the legacy of institutional economics literature[4] according to which effective norms are not simply the rules dictated by legislative acts. Rather, they are contingent upon the behaviors regularly exhibited by members of a society, shaped by recurrent mutual expectations and cognitive models. From this perspective, legal instruments can be said to effectively generate an institution when they

[4] Aoki, M. (2001). Toward a Comparative Institutional Analysis. *The MIT Press eBooks*. https://doi.org/10.7551/mitpress/6867.001.0001

initiate a process of convergence towards a novel equilibrium characterized by predictable patterns of behavior. More specifically, in Chapter 3 I study the economic nature of damaged environmental goods (restorable goods) and argue that their intrinsic features exert a significant influence on mutual expectations in people's mental models. I suggest that social and psychological factors can either amplify or temper the utilization of a common good and subsequent voluntary contributions towards its restoration, particularly when the two activities are examined in tandem, as opposed to isolation. Beyond the theoretical framework, the advanced hypotheses are corroborated by a game-theoretical experiment which aims at gauging the impact of psychological frames and social norms on individuals' contributions towards the restoration of an environmental good.

Finally, the chapter concludes with the exposition of a few remarks and some personal views that aim at both identifying gaps in existing research and potential areas for further investigation.

Methodology

The methodology employed in this study involves a comprehensive examination of barriers and facilitators influencing the expansion of restorative practices, necessitating a cross-disciplinary approach and the utilization of various related methodologies. The distinct components of the methodology are delineated as follows: in Chapter 1, the multidimensional nature of ecological restoration is expounded, leveraging a rich corpus of scientific literature and knowledge, filtered and questioned in light of ethical concerns. A qualitative and comparative analysis is undertaken in Chapter 2, focusing on legal provisions across international, European, and national spheres. This analysis is rooted in legal scholarship and involves a systematic assessment of regulatory frameworks and case-law. Finally, Chapter 3 harnesses social and economic theories pertaining to public and common goods to delve into the governance of restorative endeavors. This chapter further benefits from experimental economics, which serves as a tool for empirically testing the motivations that drive individuals to contribute towards the restoration of compromised natural resources. The incorporation of experimental economics introduces an empirical dimension to the study, enabling the assessment of individual behaviors in a controlled setting.

In summary, the methodology encompasses a comprehensive exploration across various domains, integrating scientific literature, qualitative legal analysis, and empirical investigation through experimental economics.

Part I – General Analysis

Chapter 1: Introduction to Ecological Restoration

According to the definition given by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, biodiversity loss is the "reduction of any aspect of biological diversity (including diversity at the genetic, species and ecosystem levels) lost in a particular area through death (including extinction), destruction or manual removal".[5]

Since ecosystems are complex networks of species relying on each other for survival, the loss of even one species in this dense network can have a ripple effect throughout the entire structure, leading to potentially serious harm. Despite the consequences of biodiversity loss being clearly undesirable, the speed at which loss in species diversity has happened in recent decades has escalated dramatically, to the point that scientists have started to call it a "sixth mass extinction event",[6] with possibly unforeseen and far-reaching consequences.[7] According to the researchers of the Zoological Society of London who developed the "Living Planet Index" (which tracks changes in the relative abundance of wild species populations over time), globally, we have experienced an average 69% decline in monitored populations between 1970 and 2018.[8]

[5] The definition is given by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). It is an independent body established in 2012 whose mission is to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity. The body assesses the state of knowledge on the state of ecosystems at the planetary level, and it provides policy recommendations for decision-makers.

[6] Ceballos, G., Ehrlich, P. R., & Dirzo, R. (2017). Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(30). https://doi.org/10.1073/pnas.1704949114

[7] While it may be less well-known and visible than other environmental crises, the potential negative effects of ecosystem disruption are no less alarming. A decrease in the diversity of crops and livestock can have a significant impact on nutrient availability, and weaker ecosystems can create a fertile environment for the spread of infectious diseases. It is important to not forget the cultural implications of biodiversity loss. The reduced diversity of plants and animals can impoverish and negatively impact human cultures and traditional knowledge systems.

[8] WWF (2022) Living Planet Report 2022 – Building a nature positive society. Almond, R.E.A., Grooten, M., Juffe Bignoli, D. & Petersen, T. (Eds). WWF, Gland, Switzerland.

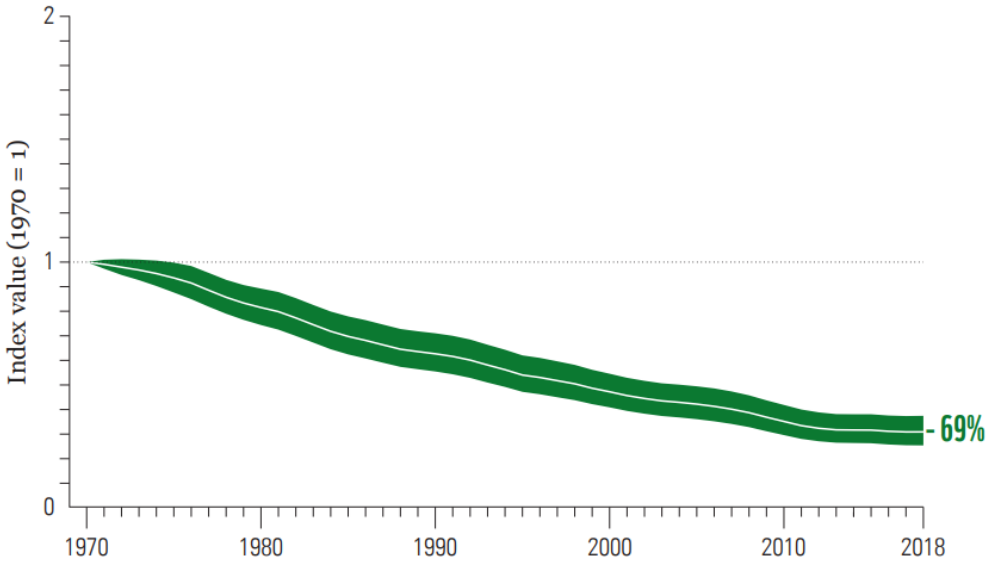

Figure 1. The graph was elaborated jointly by the WWF and the Zoological Society of London utilizing from the Living Planet Index database. It shows the average change in relative abundance of 31,821 populations, representing 5,230 species observed worldwide, and reveals a substantial decline of 69%. The index values are represented in the white line, while the shaded region indicates the statistical certainty surrounding the trend.

Scientists attribute the underlying causes of this extensive phenomenon to a combination of direct drivers, including deforestation, overharvesting, pollution, and intensified agricultural practices, as well as indirect pressures such as population growth and consumption patterns.[9] Furthermore, climate change and pollution, i.e., the other two environmental planetary crises, are exacerbating the rapid decline in biodiversity, setting off a vicious cycle: higher temperatures can diminish species functionality, weakening their ability to acquire nutrients, resist heat or survive pathogen attacks. The diminished functionality of plants species, then, result in their reduced capacity to absorb pollutants and regulate temperature.[10]

Starting from these doom premises, the central focus of this thesis revolves around ecological restoration practices, which precisely intervene in degraded ecosystems to mitigate irreversible loss and uphold their ability to function and be resilient.

[9] IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/zenodo.3831673

[10] Mahecha, M. D., Bastos, A., Bohn, F. J., Eisenhauer, N., Feilhauer, H., Hartmann, H., Hickler, T., Kalesse-Los, H., Migliavacca, M., Otto, F. E. L., Peng, J., Quaas, J., Tegen, I., Weigelt, A., Wendisch, M., & Wirth, C. (2022). Biodiversity loss and climate extremes — study the feedbacks. *Nature*, *612*(7938), 30–32. https://doi.org/10.1038/d41586-022-04152-y

Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. C., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A., Kinzig, A. P., Daily, G. C., Loreau, M., Grace, J. B., Larigauderie, A., Srivastava, D. S., & Naeem, S. (2012). Biodiversity loss and its impact on humanity. *Nature*, *486*(7401), 59–67. https://doi.org/10.1038/nature11148

Etymologically, “restoration” is about “building up again” something that has been damaged or degraded. In this specific environmental context, it refers to the process of returning a damaged or degraded ecosystem to its original functioning, structure, and diversity with the primary objective to curb biodiversity loss and, if possible, reverse it. This process can involve various activities, including removing non-native species, establishing new forests, or reintroducing wildlife, as elaborated in the next chapters.

What adds a particularly intriguing dimension to restoration is its inherent intertemporal or even intergenerational dimension: even if harm was caused in the past, the responsibility for restoring and maintaining healthy ecosystems lies with both present and future generations, opening relevant practical and moral questions. Indeed, restorative practices intervene in existing degraded environments and mobilise a wide array of possible stakeholders: from public administration to communities and individuals, even when there exists no direct correlation between their past action and the harm. In this sense, “restoration” goes beyond the paradigm of the “polluter pays” and insist exactly in those instances where damage has been so pervasive, widespread and accumulated over time that assigning responsibility for recovery becomes an insurmountable challenge.

At the same time, restoration does not fully overlap with a logic of preventive action, i.e., when effort is exerted to prevent a potential future damage. Indeed, restoration starts from an existing condition of disruption where damage has already occurred, and is only preventive insofar as it avoids irreversibility of the original harm.

Since restoration eludes traditional frameworks, it should probably be thought of as a coherent system of interventions and policies that are implemented in degraded environments to repair them, to prevent further breakup, and to set the basis for a more sustainable future management of resources, to the extent that this is biologically feasible.

At this point, the focus naturally shifts to the legal principles and regulations governing the implementation of restoration.[11] On the international front, the formal inclusion of degraded ecosystem restoration as an objective dates back to the adoption of the Aichi Targets in

[11] Palmer, M. A., & Ruhl, J. B. (2015). Aligning restoration science and the law to sustain ecological infrastructure for the future. *Frontiers in Ecology and the Environment*, *13*(9), 512–519. https://doi.org/10.1890/150053
Telesetsky, A., Cliquet, A., & Akhtar-Khavari, A. (2016). *Ecological Restoration in International Environmental Law*. Routledge.

2010,[12] under the legal framework of the 1992 Convention on Biological Diversity.[13] Specifically, Goal 15 stipulated the aim of restoring at least 15% of degraded ecosystems to contribute to climate change mitigation and adaptation, recognizing restoration as a valuable tool against biodiversity loss. The goal, eventually not met, was reflected internally by the European Union in 2011, in the context of the EU Biodiversity Strategy to 2020[14].

A few years later, in 2019, the United Nations General Assembly launched the UN Decade on Ecosystem Restoration (2021-2030)[15], which acknowledges the emergence of voluntary restoration initiatives and aims at "supporting and scaling up efforts to prevent, halt and reverse the degradation of ecosystems worldwide and raise awareness of the importance of successful ecosystem restoration" to "generate the necessary transformational impact at all levels".

Such impetus resonated at the EU level in 2020 when the European Commission launched the EU Biodiversity Strategy to 2030 called "Bringing back nature to our lives"[16], as a component of the European Green Deal[17]. Within this framework, after a few setbacks and delays,[18] a novel "Nature Restoration Law" was published by the European Commission on June 22nd, 2022,[19] which aims at establishing the first legally binding framework for large-scale restoration in Europe.

Despite these developments, key and fundamental questions related to the prioritization of ecosystems, methods for gauging improvements, and strategies for engaging stakeholders and

[12] Aichi Target 15, Convention on Biological Diversity (2010) COP 10 Decision X/2, Strategic Plan for Biodiversity 2011-2020.
[13] Convention on Biological Diversity, 5 June 1992.
[14] European Commission. (2011). *Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, Our life insurance, our natural capital: an EU biodiversity strategy to 2020*. European Commission, Brussels: Belgium
[15] United Nations Decade on Ecosystem Restoration (2021–2030), A/RES/73/284, 6 March 2019.
[16] European Commission. (2020). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. EU Biodiversity Strategy for 2030. Bringing nature back into our lives*. European Commission, Brussels: Belgium
[17] European Commission. (2019). *Communication from the Commission to the European Parliament, the European Council, the Councile, the European Economic and Social Committee and the Committee of the Regions. The European Green Deal*. European Commission, Brussels: Belgium
[18] At first, the law proposal was supposed to be released in March 2022, but since the outbreak of the war in Ukraine it was delayed to June. The decision was justified on the grounds of food security concerns, but the postponement immediately triggered the reactions of citizens, NGOs, practitioners and scholars who warned about the influence of the lobbies and the risk for European biodiversity.
[19] European Commission. *Proposal for a Regulation of the European Parliament and of the Council on nature restoration* (COM(2022) 304 final, 2022/0195 (COD)), available at https://environment.ec.europa.eu/publications/nature-restoration-law_en accessed 15 September 2022

harmonizing social and ecological requirements remain largely unaddressed.[20] While research in the field has expanded significantly, it has predominantly concentrated on the scientific aspects of restoration[21] or delved into its ethical implications.[22] To a lesser extent, scholars have begun to explore community-driven restoration initiatives and land management, but these efforts remain relatively limited in scope.[23]

Within the realm of legal discourse, only a few scholars have so far studied organically the law of restoration: Telesetsky, Cliquet and Akthar-Kavari[24] have advanced an interesting analysis of international environmental law agreements that set the justification for the advancement of an "ecological restoration legal principle". Additional regional and national-level examinations are available: in the European context the work by Schoukens and Cliquet[25] is remarkable, while in Australia scholars like Richardson and Akthar-Khavari[26] have been quite active, and in the US the work developed by Palmer and Ruhl[27] and Telesetsky has been capable of shedding light on the intersections between law and science. However, legal research, by its very nature, tends to be constrained within the confines of existing norms and regulations, and only marginally manages to include broader

[20] IUCN Commission on Ecosystem Management, Society for Ecological Restoration. (2004). *Ecological Restoration – a means of conserving biodiversity and sustaining livelihoods.* IUCN-Folder-005.

Baker, S. (2017). Social engagement in ecological restoration. In: *Routledge Handbook of Ecological and Environmental Restoration*. Eds. Allison, S. K. and Murphy, S. D. New York: Routledge

Richardson, B. J., & Lefroy, T. (2016). Restoration dialogues: improving the governance of ecological restoration. *Restoration Ecology*, *24*(5), 668–673. https://doi.org/10.1111/rec.12391

[21] Among others,

Palmer, M. A., Zedler, J. B., & Falk, D. A. (2016). Foundations of Restoration Ecology. In *Island Press/Center for Resource Economics eBooks*. https://doi.org/10.5822/978-1-61091-698-1

[22] Light, A., & Higgs, E. (1996). The Politics of Ecological Restoration. *Environmental Ethics*, *18*(3), 227–247. https://doi.org/10.5840/enviroethics199618315

[23] Reyes-García, V., Fernández-Llamazares, Á., McElwee, P., Molnár, Z., Öllerer, K., Wilson, S. J., & Brondizio, E. S. (2019). The contributions of Indigenous Peoples and local communities to ecological restoration. *Restoration Ecology*, *27*(1), 3–8. https://doi.org/10.1111/rec.12894

Clément, O., & Malaval, S. (2019). « Végétal local » : une marque au service des acteurs du territoire. *Sciences Eaux & Territoires*, *Numéro 30*(4), 78–79. https://doi.org/10.3917/set.030.0078

[24] Telesetsky, A., Cliquet, A., & Akhtar-Khavari, A. (2016). *Ecological Restoration in International Environmental Law*. Routledge.

[25] Among others, Schoukens, H. (2019). Legal considerations in operationalizing eco-restoration in the European Union. A Sisyphean task or unlocking existing potential?. In *Ecological Restoration Law*. *Concepts and Case Studies*. Eds. Akhtar-Khavari, A., & Richardson, B. J. New York: Routledge.

Cliquet, A. (2020). EU Nature Conservation Law: Fit for purpose. In *Research Handbook on EU Environmental Law*. Eds. Peeters, M., Eliantonio, M. P. Edward Elgar Publishing: 265-279. DOI: https://doi.org/10.4337/9781788970679.00028

[26] Richardson, B. J. (2017). *Time and Environmental Law: Telling Nature's Time*. Cambridge University Press.

Akhtar-Khavari, A., & Richardson, B. J. (2017). Ecological restoration and the law: recovering nature's past for the future. *Griffith Law Review*, *26*(2), 147–153. https://doi.org/10.1080/10383441.2017.1366289

[27] Palmer, M. A., & Ruhl, J. B. (2015b). Aligning restoration science and the law to sustain ecological infrastructure for the future. *Frontiers in Ecology and the Environment*, *13*(9), 512–519. https://doi.org/10.1890/150053

considerations on how people, members of the society where such rules apply, react to them and behave. Herein lies the potential contribution of this dissertation to the ongoing scientific discourse.

In this chapter, I first define and present ecological restoration as a practice, drawing upon examples and relevant information from scientific and institutional definitions. Secondly, I discuss the integration of restorative activities with other traditional approaches to environmental protection, i.e., conservation and preservation. Thirdly, I argue that social and ethical considerations are inextricably linked to the planning and implementation of restoration activities, beyond scientific technicalities. Indeed, restoring the environment is a way of reconnecting people to the (often) broken relationship with their surroundings[28], and this practice can be an interesting scope of application of the notions of responsibility and environmental justice over disrupted ecosystems.

In Part I, the following research questions are answered:

- What is ecological restoration?
- Why do we need ecological restoration?
- What can ecological restoration contribute to adapting to and mitigating the crises in climate and biodiversity?

1. What is Ecological Restoration?

1.1.1 Definitions of Ecological Restoration

In this subsection, a comprehensive exploration of various definitions of restoration is undertaken, with particular emphasis on the scientific perspective, which has predominantly been adopted – albeit to varying degrees – across numerous institutional contexts. This initial exploration and clarification of terminologies are pivotal, given that any assessment of the efficacy of ecological restoration is deeply contingent upon the chosen definition, with huge implications in policymaking.

Let us start from the very beginning. By "environmental degradation" we mean the deviation from the *normal* or desired state of an intact ecosystem, an alteration in species composition, nutrient cycling, and soil properties that can result from natural agents such as fires, floods,

[28] Fischer, J., Riechers, M., Loos, J., Martín-López, B., & Temperton, V. M. (2021). Making the UN Decade on Ecosystem Restoration a Social-Ecological Endeavour. *Trends in Ecology and Evolution*, *36*(1), 20–28. https://doi.org/10.1016/j.tree.2020.08.018

storms, or volcanic eruptions, or are caused by human activities including logging, damming rivers, grazing or intense agriculture.[29]

Even keeping this definition in mind, delving into the concept of an ecosystem's "normal state" introduces additional complexities, as in the ever-changing balance of ecosystems jeopardised by the impact of climate change, this seems to be better understood intuitively than scientifically.[30] In this context, restoration is about a wide array of practices that aim at reversing environmental degradation and consequently enhancing nature's contributions to humanity.[31]

The recovery of damaged ecosystems, in general, can be developed in different contexts such as urban, suburban, agricultural, and industrial landscapes. However, it is evident that implemented restoration initiatives will diverge significantly in their objectives and outcomes, contingent upon the nature of degradation and the specific habitat under scrutiny. In several cases, the application of "passive restoration" measures, which merely alleviate pressures on the ecosystem, allowing nature to initiate its own recovery – such as eradicating sources of pollution or invasive species – proves sufficient to facilitate revival.[32] In other circumstances, however, more active work is needed to help the ecosystem go back to a functioning and balanced state. For instance, restoring urban areas may entail reintroducing native plant species, while re-meandering rivers and dismantling barriers might be imperative for riparian environments.[33] These interventions can all be labelled as restorative practices aiming at improving the ecological quality of ecosystems, and are described with different terms: "rehabilitation", "reclamation", and "recovery", among others. However, they can hardly be compared, not only for the landscape differences but also for their different goals.

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[29] Deviations can assume a very different nature. Degradation can be site-specific, can come from one or more identifiable sources of disturbance, be lawful or unlawful. In these cases would fall the oil-spill in a drilling plant, a river diversion for hydropower production, or the unauthorised leakage of harmful substances into the environment. In several other cases, however, degradation has a diffuse and cumulative character, results from multiple sources that can be known or unknown, and is especially stemming from daily and lawful (or, at times, unlawful) activities. This is the case of heating, driving, or goods production.
See, for example, Stanturf, J. A., Palik, B. J., & Dumroese, R. K. (2014). Contemporary forest restoration: A review emphasizing function. *Forest Ecology and Management*, *331*, 292–323. https://doi.org/10.1016/j.foreco.2014.07.029

[30] Hobbs, R. J. (2016). Degraded or just different? Perceptions and value judgments in restoration decisions. *Restoration Ecology.* Vol. 24(2): 153-158.

[31] Future Earth and GEO BON (2022). *Ecosystem restoration in the Global Biodiversity Framework: A focus on land degradation and terrestrial ecosystem restoration*. Available from https://geobon.org/science-briefs/.

[32] Morrison, E.B., & Lindell, C. (2011). Active or passive forest restoration? Assessing restoration alternatives with avian foraging behavior. *Restoration Ecology. 19(201)*

[33] See, for example, the work carried out by the NGO "Dam Removal, Europe". https://damremoval.eu/

A partial solution to disentangle this complexity involves turning to official definitions provided by international institutions and consulting the technical definitions put forth by the scientific community.

According to Food and Agriculture Organisation (FAO), restoration is "a process that aims to regain ecological functionality and enhance human well-being across degraded landscapes".[34] Notably, this definition underscores the distinctive identity of the FAO, placing significant emphasis on ecosystem resilience and their pivotal role in providing ecosystem services for societal development. On a similar note, according to the United Nations Environmental Programme, ecosystem restoration is the "process of reversing the degradation of ecosystems, such as landscapes, lakes, and oceans to regain their ecological functionality; in other words, to improve the *productivity and capacity* of ecosystems to meet the needs of society. This can be done by enabling the natural regeneration of overexploited ecosystems or by planting trees and other plants". In this definition, even more, the stress is on the link between restoration and increased ecosystem services,[35] and the sole example given is that of reforestation.

A great contribution to the explanation of these practices has though primarily emerged from the field of restoration ecology, the scientific study of repairing disturbed ecosystems through human intervention.[36] In the chaotic proliferation of scientific knowledge on the matter, a key role has been assumed by the Society for Ecological Restoration (hereafter referred to as SER[37]), which, during the 1990s, started to collect and systematize scientific papers and publishing informative reports on restoration ecology that provide valuable insights for both the scientific community and policymakers.

In their latest publication in 2019, the SER presented an updated definition of ecological restoration, as "the process of assisting the recovery of an ecosystem that has been degraded,

[34] FAO, & WRI. (2019). *The road to restoration: A guide to identifying priorities and indicators for restoration monitoring: Revised version*. Food & Agriculture Org.

[35] According to the IPBES, ecosystem services are "the contributions of nature to people, which include the provisioning of goods (e.g. food, water, timber), the regulation of processes (e.g. climate, water purification), the cultural and recreational benefits (e.g. tourism, spiritual and aesthetic values) and the support of life on Earth (e.g. soil formation, pollination).

[36] Vaughn, K. J., Porensky, L. M., Wilkerson, M. L., Balachowski, J., Peffer, E., Riginos, C. & Young, T. P. (2010) Restoration Ecology. *Nature Education Knowledge* 3(10):66

[37] The *Society for Ecological Restoration* (SER) is a global network of more than 4000 members comprising researchers, professionals, practitioners and scientists who aim at exchanging knowledge and expertise on ecological restoration practices and promote restoration policies around the world. As an association, it has been participating to the negotiations of the International Union for the Conservation of Nature (IUCN) and as an observer organisation to the Biodiversity Convention (CBD). SER policy briefs, reports and guidelines contain the most cited definitions of restorative practices. Recently, SER expertise on ecological restoration has been supporting the development of policy statements for the UN Decade on Ecosystem Restoration globally, and in the drafting of the proposal for a Nature Restoration Regulation in the European Union.

damaged, or destroyed", the "intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability" and aiming to "move a degraded ecosystem to a *trajectory* of recovery that allows adaptation to local and global changes, as well as the persistence and evolution of its component species".[38]

This definition prominently underscores key aspects of ecological restoration. Firstly, it stresses that ecological restoration is not a static end product, but rather a dynamic practice and process that unfolds and evolves over time, mirroring the dynamic nature of ecosystems themselves. Secondly, it possesses an intentional facet, distinguishing it from the innate capacity of nature to recover when left undisturbed. Thirdly, ecological restoration is imbued with scientific knowledge, which determines both the reference model and the ecological functions (i.e., energy flows, nutrient cycling) to reconstruct.

Ultimately, restoration entails human engagement in natural processes, occasionally involving the mere elimination of disturbance sources, and at times, necessitating more complex interventions. Where degradation is deep and widespread, however, efforts to recover ecosystems fully turn out to be complex or unfeasible, and other interventions could be preferred. For example, a former coal mine deeply transformed by extractive activities will by no means return to its pristine conditions, but other types of interventions can be nonetheless advisable to improve the health and quality of the area. To clarify this passage, scholars suggest there exists a wide array of interventions that can be referred to as "restorative practices" which develop along a continuum and differ in their ability to positively affect the environment.[39] Among them, we find: (1) reduced societal impacts (especially in the production modes of goods and services); (2) remediation; (3) rehabilitation; and (4) ecological restoration.

Exactly because they are placed along a continuum, these categories are not necessarily contradictory or in competition, but they all contribute to the improvement of ecosystems differently, and show that eventually all ecosystems - with due distinction—can be improved. The subsequent descriptions of each category aim to provide a clearer distinction between

[38] Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., Hallett, J. G., Eisenberg, C., Guariguata, M. R., Liu, J., Hua, F., Echeverría, C., Gonzales, E. K., Shaw, N. L., Decleer, K., & Dixon, K. W. (2019). International principles and standards for the practice of ecological restoration. Second edition. *Restoration Ecology*, *27*(S1). https://doi.org/10.1111/rec.13035

[39] Gann et al., (2019)

ecological restoration and other forms of restorative interventions.

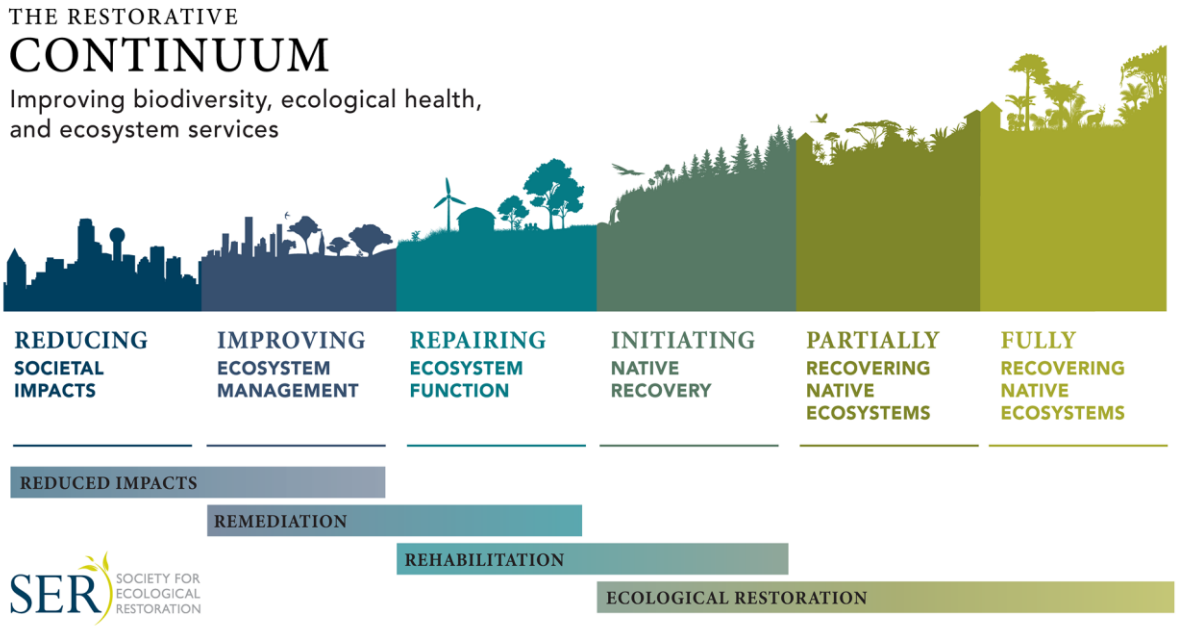

Figure 2 Restoration Continuum: a spectrum of activities that directly or indirectly support or attain at least some recovery of ecosystem attributes that have been lost or impaired.

The concept of *reduced societal impacts* encompasses interventions that modify the production and consumption of goods in ways that inflict less harm on the environment. This category encompasses endeavors like substituting toxic fibers with natural alternatives for clothing production or the employment of technologies to curtail the dispersion of pollutants during goods manufacturing.

Remediation is about the removal of the sources of degradation in polluted areas or the reduction of excess nutrients from land and water. Typically, this activity does not involve any historical cognition of treated ecosystems and is often carried out through the application of proven technologies to avoid harmful conditions and facilitate the recovery of land and waters.

Rehabilitation, though akin to restoration, centers primarily on reestablishing a certain level of ecosystem functionality. These activities are geared towards reinstating equilibrium in water bodies, soils, forests, or animal populations. Often, the resulting equilibrium is different from the original one, but it is still capable of delivering some services. An example of rehabilitation activities are vegetation projects developed in areas that were originally

grasslands: they sequester Co2 emissions and bring pleasant green areas for residents, but if carried out irrespectfully of native species they are to be considered as forms of rehabilitation.

Finally, *Restoration* is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed, and it is reached when the structures and the functionalities of ecosystems show sufficient resilience to normal ranges of environmental stress and disturbance.[40]

In general, the first three categories are regarded as supportive complements of ecological restoration, since they promote ecosystem recovery. Additionally, a few other expressions are often used as synonyms to the previous terms, and they are utilised in pretty specific contexts.

Reclamation is usually referred to as a practice to rescue a given area from a state considered undesirable. Especially in the past, the act of reclamation was realized through converting land to productive purposes, such as draining peatlands to expand agricultural areas or clearing forests for agricultural endeavors.[41] Over time, its scope has broadened, and is usually referred to indicate interventions in particularly degraded land – usually mines, quarries, or wastelands – to render them suitable for human utilization. As an example, former quarries are reclaimed to a condition of safety and stability through the creation of wetlands. The depression is lined with special types of soil, filled with water and surrounded by plants.[42] In this way, the newly formed wetland provides the habitat for plants and animals, as well as mitigating water floods, and provides recreational opportunities.

Another common type of intervention is *rewilding*, which gained recent prominence thanks to initiatives championed by environmentalists like George Monbiot[43] who has extensively supported the practice, often embellishing the scientific data with lyrical and emotional stories of a re-engagement with nature. This practice often involves eliminating physical barriers and reintroducing charismatic species, frequently including large carnivores, into a given ecosystem. These species may have vanished due to human influence. The overarching goal

[40] Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., Hallett, J. G., Eisenberg, C., Guariguata, M. R., Liu, J., Hua, F., Echeverría, C., Gonzales, E. K., Shaw, N. L., Decleer, K., & Dixon, K. W. (2019). International principles and standards for the practice of ecological restoration. Second edition. *Restoration Ecology*, *27*(S1). https://doi.org/10.1111/rec.13035

[41] Chazdon, R. L. (2008). Beyond Deforestation: Restoring Forests and Ecosystem Services on Degraded Lands. *Science*, *320*(5882), 1458–1460. https://doi.org/10.1126/science.1155365

[42] Bradshaw, A. D. (1997). Restoration of mined lands—using natural processes. *Ecological Engineering*, *8*(4), 255–269. https://doi.org/10.1016/s0925-8574(97)00022-0

[43] Among the several writings, Monbiot, G. (2013). *Feral: Searching for Enchantment on the Frontiers of Rewilding.* Penguin Press.

of rewilding projects is to rekindle ecosystem functions and processes, with the reintroduced species catalyzing these dynamics.[44]

This concept was initially introduced in the 1980s, often within expansive protected areas. Its underlying premise is that "nature knows best when it comes to survival and self-governance" advocating that humans create conducive conditions and extend support for natural recovery,[45] for example through the removal of dams and river obstructions.[46] Furthermore, rewilding is frequently coupled with the reintroduction of mega and mesofauna, such as European bisons in the Carpathians, wolverines in Lapland, or Iberian lynxes in Spain, among other examples.[47] While rewilding and ecological restoration share several objectives, they also diverge significantly in critical respects. Notably, rewilding has faced criticism for potentially disturbing local ecosystems and upsetting the existing human-nature balance in already fragile areas, particularly in already delicate areas. Furthermore, it has been challenged for implicitly assuming that human beings are separate from the historical context of the environment.

Revegetation or *afforestation* refers to the process of reestablishing vegetation in areas where it was either lost or disturbed. This practice is gaining momentum across all latitudes, driven by the anticipated benefits it offers in climate mitigation, as newly planted trees aid in absorbing CO2 emissions. Additionally, it contributes to adapting to higher temperatures. While undeniably advantageous in specific contexts, caution is advised, as scientists warn against the potential negative repercussions of afforestation projects undertaken without the use of native species. This is exemplified by monoculture afforestation in regions with native grasslands, where adverse impacts can manifest.[48]

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[44] For a more comprehensive understanding of what rewilding is, see:
Pettorelli, N., Barlow, J., Stephens, P. A., Durant, S. M., Connor, B., Schulte to Buhne, H., Sandom, C. J., Wentworth, J., du Toit, J. T. (2018). Making rewilding fir for policy. *Journal of Applied Ecology.* 55(3), 1114-1125.
Lorimer, J., Sandom, C. J., Jepson, P., Doughty, C. E., Barua, M., & Kirby, K. (2015). Rewilding: Science, Practice, and Politics. *Annual Review of Environment and Resources*, *40*(1), 39–62. https://doi.org/10.1146/annurev-environ-102014-021406

[45] Hall, M. (2010). *Restoration and History: The Search for a Usable Environmental Past*. Routledge.

[46] For all initiatives, see the website "Dam Removal Europe", https://damremoval.eu/.

[47] Ledger, S.E.H., Rutherford, C.A., Benham, C., Burfield, I.J., Deinet, S., Eaton, M., Freeman, R., Gray, C., Herrando, S., Puleston, H., Scott-Gatty, K., Staneva, A., & McRae, L. (2022). *Wildlife Comeback in Europe: Opportunities and challenges for species recovery.* Final report to Rewilding Europe by the Zoological Society of London, BirdLife International and the European Bird Census Council. London: UK.

[48] Seddon, N., Turner, B., Santos, R., Chausson, A., & Girardin, C. a. J. (2019). Grounding nature-based climate solutions in sound biodiversity science. *Nature Climate Change*, *9*(2), 84–87. https://doi.org/10.1038/s41558-019-0405-0

Finally, *regeneration* is a term that carries a certain degree of ambiguity, generally denoting proactive interventions aimed at rectifying past shortcomings and fostering novel value. Frequently, it is accompanied by the descriptor "urban," indicating a focus on revitalizing and enhancing the economic, social, and physical aspects of urban locales. Here, ecosystems are just one facet among the beneficiaries of such interventions, illustrating that the scope of impact extends far beyond ecological considerations.

1.1.2 Preservation, Conservation, and Restoration

As the different definitions already suggest, restoration is not a new concept, and has been present since humans first began interacting with the environment, encompassing practices like crop rotation and species management for medicinal purposes. However, the perception and understanding of environmental damage and restoration evolved over time and became more complex, especially in the US in the late 19th century. This era saw the emergence of two primary schools of thought, each rooted in both technical and ethical considerations: preservation and conservation.[49]

Preservation, as the word suggests, aims at safeguarding and upholding natural resources in their pristine state, prohibiting any form of human intervention. This might involve controlling land usage or preventing development in ecologically sensitive regions. The foundational premise of preservation is that nature possesses an intrinsic value that cannot be replicated, emphasizing that humans should appreciate and cherish its inherent beauty without exploiting it for alternative purposes.

In contrast, the discourse on *conservation* adopts a more flexible standpoint compared to preservation. It centers on formulating actions and policies to effectively manage natural resources, ensuring their sustained availability and preventing depletion.[50] While conservationists also acknowledge the inherent worth of the natural environment to some extent, their approach hinges on the potential of resources to regenerate when managed sustainably. This perspective advocates for the establishment of well-defined regulations governing protected areas and the utilization of natural resources to prevent their exhaustion.

[49] The debate first started between two North American environmentalists: John Muir, Gifford Pinchot. The former supporting preservation and the latter conservation approaches to environmental protection. They started and revamped a critical debate in the US, in a time when Federal land use provisions were drafted, which eventually ended up with President Woodrow Wilson creating the US Forest Service, structured to conserve and manage federal lands and forests, to be backed up with a system of National Parks.

[50] For a critical analysis, see Norton, B. G. (1986). Conservation and Preservation: a Conceptual Rehabilitation. *Environmental Ethics, 8*(3), 195-220

In practical terms, preservationists would advocate leaving a forest undisturbed, prohibiting any human access. Conversely, conservationists would engage in in-depth studies of the forest's ecosystems and endorse regulations that govern activities such as timber harvesting, hunting, or recreational pursuits so as not to damage permanently the resources.[51]

While the debate is still ranging in theory, both approaches have found practical application in various contexts. The preservation strategy has led to the development of a system of protected natural areas and sanctuaries[52] worldwide, safeguarding critical biodiversity.[53] Conversely, conservation has fostered the adoption of sustainable management standards and measures, along with emphasizing the integration of cultural, economic, and social dimensions of human life into environmental protection.[54]

However, these two approaches, if pursued in isolation, might not suffice to address the challenges of the "Century of the Environment".[55] Ecosystems, being dynamic living systems, cannot be simply frozen or cordoned off into isolated enclaves. This is particularly true if remaining areas lack adequate regulation or are subjected to uncontrolled economic development. Additionally, if human beings are seen as threats to the environment whose intervention should be minimized, there is little chance that any change for the good will happen in highly disturbed areas, which are becoming increasingly common.

A more effective approach to managing environmental resources and protecting biodiversity involves complementing traditional policy approaches with ecological restoration. This approach has the potential to usher in a new era in the relationship between nature and humanity—one characterized by more frequent, regulated, and positive interactions. [56]

To be fair, the idea of supporting nature in its recovery is not new. Even before the Industrial revolution, human societies were accustomed to intervening to repair or enhance the functioning of the environment. This ranged from afforestation efforts following natural

[51] Among others, Mace, G. M. (2014). Whose conservation? *Science*, *345*(6204), 1558–1560. https://doi.org/10.1126/science.1254704

[52] Sanctuaries are specific types of protected areas, where human activity is in general limited to provide a secure environment for protected species.

[53] As explained well by Wilson (1992), our knowledge on biodiversity is very limited, and even those natural functions that are apparently only indirectly linked to human wellbeing and consumption can be critical to supporting entire ecosystems and maintaining them can be key for future generations.

[54] Dudley, N. (2008). *Guidelines for Applying Protected Area Management Categories*. IUCN.

[55] Wilson, E. O. (2001). *The Diversity of Life*. Penguin UK.

[56] Woodworth, P. (2017). Can Ecological Restoration Meet the Twin Challenges of Global Change and Scaling Up, Without Losing Its Unique Promise and Core Values? *Annals of the Missouri Botanical Garden*. https://doi.org/10.3417/2017001

calamities to replanting on degraded soils.[57] Yet, the deliberate and methodical practice of ecological restoration emerged only in the 1930s, thanks to the pioneering work of researcher and ecologist Aldo Leopold in the United States.[58] Leopold, a professor overseeing the Arboretum at the University of Wisconsin, carried out targeted interventions in a neighboring area that had suffered significant damage. Through the reintroduction of native species, he aimed to restore the ecosystem to its former state.[59] Leopold's insight stemmed from the recognition that all forms of life are interconnected, and that a meticulous, scientifically informed form of intervention was crucial for revitalizing the planet.[60] His initial experiments, along with subsequent scholarly research and ethical deliberations, established him as a prominent figure in environmentalism and a precursor to the field of restoration ecology.[61]

Since then, a substantial body of scientific literature has flourished, and starting from the 1980s, ecological restoration has experienced significant expansion. This growth has extended to involve the general public in a range of activities spanning from localized interventions to ambitious "megaprojects" such as the extensive prairie restoration efforts in the USA and recent undertakings like river re-meandering and rebouldering initiatives in China[62] and Europe.[63]

While it might be an overstatement to assert that ecological restoration alone can fully reinstate biodiversity or serve as a panacea for climate change, restoration plays an indispensable role within a comprehensive strategy to tackle these pressing challenges. Indeed, while restoration is not the sole answer to climate change and biodiversity loss, the fight for climate change and biodiversity loss cannot make it without restoration.

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[57] Stuart K., A, (2012). *Ecological restoration and environmental change, Renewing damaged ecosystems*. London, Routledge

[58] Aldo Leopold (1887-1948) was an American researcher, writer and conservationist considered one of the founding fathers of environmentalism. In his best known book, “A Sand County Almanac” published in 1949, a collection of essays on conservation and ecology, he stressed the importance of treating land as a community of which humans are a part of.

[59] See the official website: https://arboretum.wisc.edu/about-us/history/. Last access 09/08/2022.

[60] Leopold, A. (2020). *A Sand County Almanac: And Sketches Here and There*. Oxford University Press, USA.

[61] This discipline studies the processes that allows the natural environment to regenerate: through the use of mathematical models, ecological system patterns are modelled and predicted, to support the process of natural environment recovery. The recent debate among scientists on the correct approach to restoration ecology has seen important contributions by Palmer et al. (2016), Higgs et al. (2018); Gann et al. (2019).

[62] Blaustein, R. (2018). Turning desert to fertile farmland on the Loess Plateau. See: https://rethink.earth/turning-desert-to-fertile-farmland-on-the-loess-plateau/

[63] Egoh, B. N., Paracchini, M. L., Zulian, G., Schägner, J. P., & Bidoglio, G. (2014). Exploring restoration options for habitats, species and ecosystem services in the European Union. *Journal of Applied Ecology*, *51*(4), 899–908. https://doi.org/10.1111/1365-2664.12251

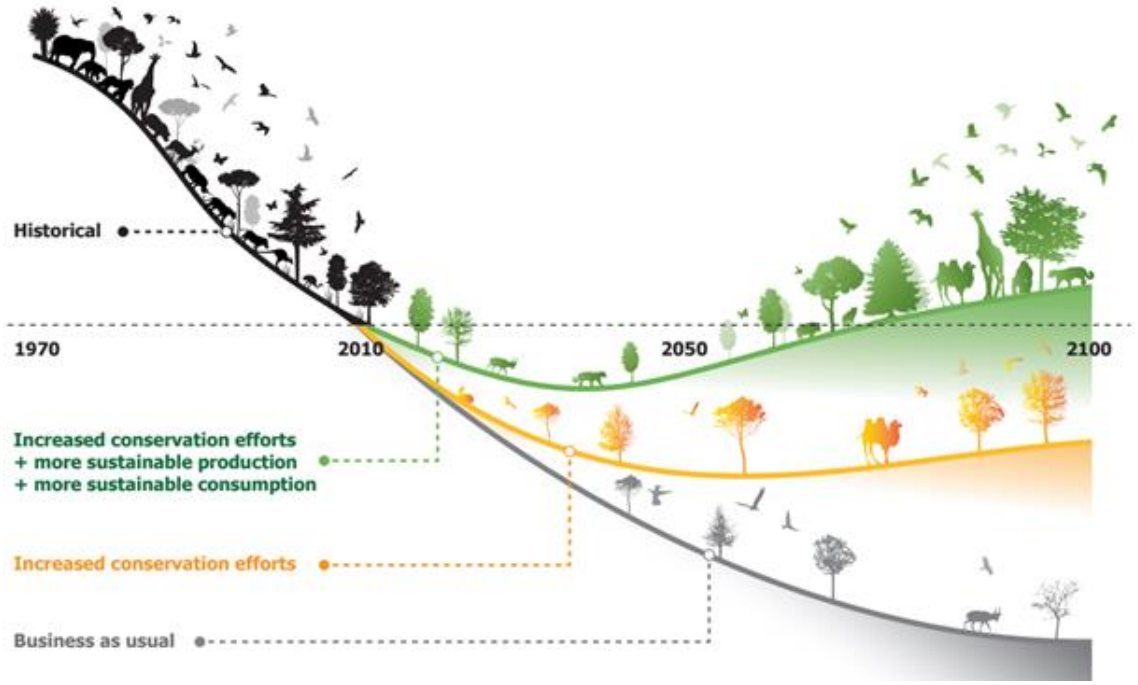

Figure 3: this figure, by Adam Islaam, illustrates the results of a recent study by Leclère et al. published in 2020 on the possible trajectory in global biodiversity under different policy implementation scenarios, and it clearly shows that conservation alone is not sufficient.

In essence, the key takeaway of this subsection is that restorative activities are to be intended as a set of interventions willingly initiated in degraded environments based on sound scientific knowledge, which can differ based on the type of ecosystem and the objectives they aim to reach. Restoration ecology as a practice has been formalized only recently, but human interventions to modify the environment for the better has always been part of human history.

Importantly, restoration should not be perceived as a magical solution capable of rapidly rectifying damage, potentially serving as a rationale for harmful interventions. Instead, it should be viewed as a supplementary intervention that aligns first with conservation endeavors, second with the mitigation of potential harm, and third with the sustainable management of resources.[64]

1.1.3 Approaches to Ecological Restoration

Ever since its emergence, different theorizations of ecological dynamics and interactions have influenced how the practices are planned and designed. From a biological perspective, an ecosystem is considered restored when it possesses adequate biotic and abiotic components to

[64] Jones, H. P., Jones, P. B., Barbier, E. B., Blackburn, R. C., Benayas, J. M. R., Holl, K. D., McCrackin, M. L., Benayas, J. M. R., Montoya, D., & Mateos, D. (2018). Restoration and repair of Earth's damaged ecosystems. *Proceedings of the Royal Society B: Biological Sciences*, *285*(1873), 20172577. https://doi.org/10.1098/rspb.2017.2577

independently sustain its structure, species composition, and community diversity. "Self-sustaining", we should specify, does not equate to being fixed, stable, or resistant to change.[65] On the contrary, ecosystems inherently undergo continual transformation and evolution due to a combination of external and internal factors. and any type of intervention needs to take into consideration such complexity. It is exactly on this layer of complexity that markedly different approaches to restoration developed.

Since ecological restoration is a *dynamic natural process triggered artificially*[66], the traditional approach to restoration requires re-creating an environment that is equal, in terms of ecosystem functions, structure, and species composition, to the ecosystem that existed prior to damage with a backward-looking approach. However, this rigid framework clashes with some intrinsic limits of the search: what is the "original" condition to recreate? How much should scientists go back in time to set a reference? These questions introduce not only technical complexities—such as the challenge of acquiring data when historical documentation is lacking—but also pose profound ontological considerations about how we define and discern human impact as detrimental. Practically speaking, in regions like North America, scientists might be able to trace the ecological effects of European settlers and establish a pre-human baseline for restoration.[67] Nevertheless, this approach raises valid concerns. Should we unquestioningly pursue this trajectory? Shouldn't we also acknowledge the potential influence of Native Americans on the environment? Following this line of reasoning could lead to questionable or at least highly debatable conclusions.

In contrast, certain scientists and practitioners advocate for a shift in the approach to restoration, suggesting that projects should relinquish the goal of resurrecting lost ecosystems and adopt a more forward-looking perspective. Leading this viewpoint is Richard Hobbs and others,[68] who argue that some ecosystems have undergone such profound transformations that they have crossed a critical "threshold" beyond which an alternative equilibrium becomes the only viable solution (referred to as "hysteresis").

Furthermore, they contend that other environmental factors, including extreme climate events and the proliferation of non-native species, have already significantly altered the landscape. In

[65] Palmer et al., 2016.
[66] Higgs, E. (2003). *Nature by Design: People, Natural Process, and Ecological Restoration*. MIT Press.
[67] Allison (2006), 281-286.
[68] Jackson, S. P., & Hobbs, R. J. (2009). Ecological Restoration in the Light of Ecological History. *Science, 325*(5940), 567–569. https://doi.org/10.1126/science.1172977

light of these changes, adhering strictly to historical restoration approaches is not just outdated but could also be impractical due to high costs and uncertain outcomes. [69]

This reasoning turns the perspective upside down because it rejects the historical baseline approach and takes on a future and result-oriented approach, where restoration practices are instrumental to the creation of novel ecosystems.[70] "Novel ecosystems" are profoundly modified environments characterized by unique combinations of species and ecological processes not found in natural ecosystems. These ecosystems typically include non-native species and other alterations arising from human activities, climate shifts, and other influences. These solutions acknowledge that some ecosystems cannot be restored to their previous state, and that the focus should be instead on maintaining ecosystem functions and services in the face of global change. In this sense, novel ecosystems are often implemented under the label of climate adaptation strategies that try to maximise environmental and social benefits, such as afforestation projects that combine carbon sequestration concerns with timber-based products.

Although a more "future-oriented" approach is gaining momentum, some scholars caution that its complete disregard for the past or its purely utilitarian application may inadvertently lead to unforeseeable negative effects. This is because the full dismissal of the past - or its purely instrumental use - combined with inattention to some dimensions of biodiversity that are not directly linked to human well-being may end up fostering a merely utilitarian understanding of the natural environment[71]. For example, the implementation of stabilization activities to protect shorelines from erosion is sometimes carried out introducing alien species or through engineering structures that affect biodiversity negatively.[72]

The ongoing friction between scientific "purism" which is more inclined to separate ecological restoration from other forms of recovery,[73] and the call for upscaling restoration activities[74] is not always easily reconciled. A more pragmatic resolution to this dilemma has

[69] Zweig, C. L., & Kitchens, W. M. (2010). The Semiglades: The Collision of Restoration, Social Values, and the Ecosystem Concept. *Restoration Ecology*, *18*(2), 138–142. https://doi.org/10.1111/j.1526-100x.2009.00613.x
[70] Hobbs, R. J., Higgs, E. S., & Hall, C. (2013). *Novel Ecosystems: Intervening in the New Ecological World Order*. John Wiley & Sons.
[71] Telesetsky et al., (2016)
[72] Gittman, R. K., Scyphers, S. B., Smith, C. S., Neylan, I. P., & Grabowski, J. H. (2016). Ecological Consequences of Shoreline Hardening: A Meta-Analysis. *BioScience*, *66*(9), 763–773. https://doi.org/10.1093/biosci/biw091
[73] Woodworth, (2017)
[74] Aronson, J., & Alexander, S. (2013b). Ecosystem Restoration is Now a Global Priority: Time to Roll up our Sleeves. *Restoration Ecology*, *21*(3), 293–296. https://doi.org/10.1111/rec.12011

emerged in recent scientific literature within the field of restoration ecology, which incorporates the concept of "multiple potential trajectories".

Increasingly, scientists concur on the value of establishing appropriate reference systems based on the pre-degradation state of an ecosystem (or assumptions thereof) using available data and comparative studies. These reference systems aid in planning ecological restoration initiatives, setting targets, and evaluating progress.[75] However, this approach acknowledges the imperative to account for changing global temperatures and shifts in ecological processes.[76] From this standpoint, science is called to move from history as a template to history as a guide.[77] This change in perspective considers extended time frames and underscores the significance of historical continuity,[78] aware that "no matter how much human agency and intention are applied to the practice of restoration design, natural process kicks in and sometimes takes over completely".[79]

1.2 Evaluation of Ecological Restoration

Given the intricate nature of ecological restoration, its diverse approaches, and the ethical underpinnings it encompasses, it is not surprising that evaluating the effectiveness of restoration activities is a complex endeavor.

Specifically, one may come to mixed conclusions depending on the perspective adopted - i.e., legal, scientific, or social - on the issue. The more so because different landscapes with differing features may take different time to recover, depending on multiple conditions that are ecological, but also social and economic.[80]

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[75] Gann et al., (2019)

[76] Kotiaho, J.S., Kuusela, S., Nieminen, E., Päivinen, J., Moilanen, A. (2016). Framework for assessing and reversing ecosystem degradation. Report of the Finnish restoration prioritization working group on the options and costs of meeting the Aichi biodiversity target of restoring at least 15 percent of degraded ecosystems in Finland. *Report of the Ministry of the Environment.* 22.

[77] Higgs, E., Falk, D. A., Guerrini, A., Hall, M., Harris, J. A., Hobbs, R. J., Jackson, S. P., Rhemtulla, J. M., & Throop, W. (2014). The changing role of history in restoration ecology. *Frontiers in Ecology and the Environment*, *12*(9), 499–506. https://doi.org/10.1890/110267

[78] Balaguer, L., Escudero, A., Martín-Duque, J., Mola, I., & Aronson, J. (2014). The historical reference in restoration ecology: Re-defining a cornerstone concept. *Biological Conservation*, *176*, 12–20. https://doi.org/10.1016/j.biocon.2014.05.007
Rohwer, Y., & Marris, E. (2021). Ecosystem integrity is neither real nor valuable. *Conservation Science and Practice*, *3*(4). https://doi.org/10.1111/csp2.411

[79] Higgs, (2003)

[80] Cortina-Segarra, J., García-Sánchez, I., Grace, M., Andrés, P., Baker, S. S., Bullock, C., Decleer, K., Dicks, L. V., Fisher, J. L., Frouz, J., Klimkowska, A., Kyriazopoulos, A. P., Moreno-Mateos, D., Rodríguez-González, P. M., Sarkki, S., & Ventocilla, J. L. (2021). Barriers to ecological restoration in Europe: expert perspectives. *Restoration Ecology*, *29*(4). https://doi.org/10.1111/rec.13346

Hilderbrand et al.[81] have highlighted how numerous "myths" have emerged around ecological restoration projects, promising extraordinary results, that are not only risky to the activities themselves, but could also provide the basis for leeway to exploit resources.

Once again, the primary determinant in assessing the success of restoration projects lies in looking at their intended objectives. The scientific evidence is very heterogeneous: some studies support, for example, that where self-regeneration happened after floods, natural disasters, and fires, the natural process proved more successful than humanly-induced restoration.[82] On the contrary, a meta-analysis on 89 restored sites conducted by Benayas et al.[83], lends substantial support to the effectiveness of restoration initiatives. showing that biodiversity and ecosystem services delivery has increased by 44% and 25% respectively after restoration was implemented. However, the landscape is notably different when it comes to ecosystems which have suffered from heavy disturbances like oil spills. In such scenarios, complete recovery is a rarity, with ecosystems often failing to regain their former state. [84] In such conditions, some support that a valuable alternative to full restoration is the creation of a system equivalent in function: functional replacement is probably easier to reach than taxonomic composition (due to shared ecological functions of many species), with the shortcomings that go with such practices.[85]

Looking ahead, Leclère et al.[86] forecast that we may assist to a positive shift in biodiversity trends by the mid-21st century. This optimistic projection is contingent upon the implementation of actions aimed at preserving existing biodiversity, restoring ecosystems, and pursuing conservation activities with a level of "unprecedented ambition". Echoing this sentiment, the latest 2022 IPCC report on Impacts, Adaptation, and Vulnerability asserts with

[81] Hilderbrand, R. H., Watts, A. C., & Randle, A. M. (2005). The Myths of Restoration Ecology. *Ecology and Society*, *10*(1). https://doi.org/10.5751/es-01277-100119

[82] Crouzeilles, R., Ferreira, M. S. L., Chazdon, R. L., Lindenmayer, D. B., Sansevero, J. B. B., Monteiro, L. J., Iribarrem, A., Latawiec, A. E., & Strassburg, B. B. xN. (2017). Ecological restoration success is higher for natural regeneration than for active restoration in tropical forests. *Science Advances*, *3*(11). https://doi.org/10.1126/sciadv.1701345

[83] Benayas, J. M. R., Newton, A. C., Diaz, A., & Bullock, J. S. (2009). Enhancement of Biodiversity and Ecosystem Services by Ecological Restoration: A Meta-Analysis. *Science*, *325*(5944), 1121–1124. https://doi.org/10.1126/science.1172460

[84] Jones et al., (2018)

[85] Stanturf et al., (2014)

[86] Leclère et al. (2020)

"high confidence" that a combination of conservation, protection, and restoration measures is indispensable in adapting to the climate crisis.[87]

Nonetheless, the reports from international institutions underscore a sobering reality: the cost of inaction far outweighs that of restoration. According to the recent Global Future Technical Report, an estimated 10 trillion USD in global GDP may be forfeited by 2050 if the decline in biodiversity health persists. [88]

Pragmatically, restoration initiatives developed in the next years should encompass both functional and structural objectives, promoting resilience through augmented adaptive capacity while concurrently yielding ecosystem services. This approach, in general, helps alleviate tensions with stakeholders by creating win-win solutions. All these elements bring us to a crucial point: deciding on the goals of ecological restoration is not value neutral, but it necessarily calls into question, beyond science, cognitive, cultural, and ethical considerations.[89] Effectively, one of the most complex things to do is identifying the primary objective of the activity, i.e., whether we want to protect the environment per se or specific ecosystem services for human wellbeing, in a changing world. What should be stressed is that decisions concerning the management of natural resources are inherently value-laden. This awareness should be firmly engrained as we engage in discussions, endorse and execute regulations and establish economic incentives.

1.3 The human dimension of Ecological Restoration

Ecological restoration has developed as a practical branch of restoration ecology, and as seen, its most accepted definition carries a strong scientific underpinning. However, certain pivotal queries arise in the realm of restoration implementation when science remains silent: why should we restore? Where should we restore? And who should restore? As suggested by Diamond, “this goal (of restoration ecology) is not itself a self-evident mandate. It is a choice

[87] IPCC, 2022: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Eds. H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA doi:10.1017/9781009325844

[88] Johnson, J.A., Baldos, U., Hertel, T., Liu, J., Nootenboom, C., Polasky, S., and Roxburgh, T. (2020). *Global Futures: modelling the global economic impacts of environmental change to support policy-making. Technical Report.* https://www.wwf.org.uk/globalfutures

[89] Ehrenfeld, J. G. (2000), Hilderbrand et al., (2005)

based on values, and it is only one of many possible choices"[90]. And these values can be partially contrasting, at times blatantly in conflict, and in any case context-related.[91]

Some scholars have attempted to propose definitions of ecological restoration that could account for the "value" dimension attached to the functions of ecosystems, and highlight how recovered ecosystems reflect benefits to people too.[92] For example, Davis and Slobodkin suggested that "ecological restoration is the process of restoring one or more valued processes or attributes of a landscape".[93] Others, instead, use expressions like "eco-cultural restoration"[94] or "biocultural restoration" to put an emphasis on the efforts, through the restoration of ecosystems, to restore the human relationship with the environment, especially in the case of indigenous or vulnerable communities. Even more radically, then, others like Cairns use the expression "ecosocietal restoration"[95] to indicate the activities that, by means of restoration, hit the very structure of extractive development models.

Although these definitions are good attempts of balancing clarity with effectiveness, they only partially give justice to the vast literature on the topic which spans from psychological contributions to ecological and behavioral economics, sociology, and decision sciences.[96] What they all have in common, though, is that they consider restoration as an attempt to heal disrupted ecosystems and repair the human-nature relationship by bridging – or at least recomposing - the alleged separation between nature and culture. In this sense, it is a practice of hope, its trajectory may also encompass, as we shall explore, the potential for disillusionment, conflict, and inequalities.

Without claiming to be complete, the ensuing paragraphs delve into an examination of select relevant aspects within the ethical and sociological discourse. This exploration illuminates

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[90] Diamond, J. (1987). Reflections on goals and on the relationship between theory and practice. In *Restoration ecology: a synthetic approach to ecological restoration.* Eds. Jordan, W.R., Gilpin, M.E. Cambridge University Press, United Kingdom: 329-336.

[91] For an in-depth analysis of environmental conflicts, see inter alia, Pellizzoni, L. (2011) *Conflitti ambientali. Esperti, politica, istituzioni nelle controversie sociologiche.* Bologna: Il Mulino.

[92] Higgs, E. (2003)

[93] Davis, M. M., & Slobodkin, L. B. (2004). The Science and Values of Restoration Ecology. *Restoration Ecology*, *12*(1), 1–3. https://doi.org/10.1111/j.1061-2971.2004.0351.x

[94] Kimmerer, R. W. (2011). Restoration and Reciprocity: The Contributions of Traditional Ecological Knowledge. In *Human Dimensions of Ecological Restoration: Integrating Science, Nature and Culture.* Eds. Egan, D., Hjerpe, E., Abrams, J. Washingston: Istand Press.
Van Wieren, G. (2013). *Restored to Earth: Christianity, Environmental Ethics, and Ecological Restoration*. Georgetown University Press.

[95] Cairns, J. (2003). Ethical issues in ecological restoration. *Ethics in Science and Environmental Politics*. https://doi.org/10.3354/esep003050

[96] See: Egan, D., Hjerpe, E., Abrams, J. (2011). *Human Dimensions of Ecological Restoration: Integrating Science, Nature and Culture.* Washingston: Istand Press.

how inherent values implicitly guide the establishment of restoration objectives, invariably shaping the very essence of the restoration process. More specifically, three foundational themes are elucidated: (i) the debate around the intrinsic-instrumental value of nature, (ii) the moral dimension of restoration to strengthen a sense of stewardship, and (iii) ecological restoration as an ally to environmental justice concerns.

1.4 Ethics and Ecological Restoration

Although there has been relatively little attention to ecological restoration from philosophers, especially in Europe, the insights that have emerged span a diverse spectrum of themes. These encompass reflections on the value of nature, the intricate interplay between nature and culture, the engagement of local communities as stewards in restoration endeavors, and the profound question of justice within restoration practices.

One early and particularly disapproving perspective on ecological restoration came from American philosophers Robert Elliott[97] and Erik Katz[98] in the 1980s and 90s. They belonged to the movement of ethicists who saw nature as having *intrinsic* value, that is to say, value in itself, independent of human uses. Following this line, they contended that any intervention altering the natural state, even with the intent of creating new value as in restoration, embodied an expression of human arrogance. Not only were humankind increasingly depleting natural resources, but through the myth of restoration human beings were also suggesting they could "fake nature". Central to their argument was the underlying premise of a pronounced divide between the "natural" and the "cultural" or human-conceived.

Furthermore, concerns raised by Elliott and Katz extend to the potential misuse of restoration as a rationale for environmental destruction, opening the door to the problem of "moral hazard". Katz particularly feared restoration was yet another technological fix that "can only represent a misguided faith in the hegemony and infallibility of the human power to control the natural world"[99], another sign of the presumption of human beings who think they can intervene and change the course of nature. To him, a restored environment is an environment that is not "permitted to be free, to pursue its own independent course of development".

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[97] Elliot, R. (1997). *Faking Nature.* London, UK: Routledge.

[98] Katz, E. (1996). The Problem of Ecological Restoration. *Environmental Ethics*, *18*(2), 222–224. https://doi.org/10.5840/enviroethics199618236
Katz, E. (2018). Replacement and Irreversibility: The Problem with Ecological Restoration as Moral Repair. *Ethics and the Environment*, *23*(1), 17. https://doi.org/10.2979/ethicsenviro.23.1.02
Katz, E. (1992). The big lie: human restoration of nature. *Research in Philosophy and Technology.* 29(12) 231.

[99] Katz, E., (1996), 222

Following this first wave of strong skepticism, other philosophers have since offered more pragmatic perspectives, counterarguing in favour of ecological restoration. Notably, thinkers like Light[100], Higgs,[101] and Jordan[102], to name a few, reformulated the relationship between culture and nature, asserting that the distinction between the two is not quite clear-cut, but it is way more blurred than assumed. To substantiate this assertion, they posit that most of existing landscapes are characterized by a hybrid and layered composition. In lieu of indulging in notions of a bygone unadulterated state of nature, these scholars propose a shift in perspective by framing restoration in terms of "natural artefacts." A parallel standpoint is echoed by Allison[103], Soulé,[104] and several other ecologists,[105] who advocate that since nature predates and will outlast us as a species, the concept of restoration, intended as the recuperation of functions and the production of ecosystem services, is rooted in common sense. From this vantage point, they contend that any moral argument is, in essence, misplaced.

Addressing the "moral hazard" argument (advanced by Elliot and Katz) and their fear that ecological restoration would give the green light to destruction, *Lights et al*. offer a counterpoint. They posit that restoration, in fact, exactly goes in the opposite direction, in that it is about nurturing the environment to regain its natural trajectory, freeing it from previously imposed trauma. With this purpose at its core, and through the recursive act of care, human beings exert a "restriction" in their power, restraining control over nature and developing instead a more humbling and caring relationship with the environment, what Light calls "benevolent restoration".[106]

With these premises in mind, ecological restoration is seen in a different light, as it transcends the dichotomy between nature and culture, intrinsic and instrumental value, heralding the potential for a dynamic co-evolution where "both sociocultural and ecological concerns are addressed, with changes in one influencing the other while progressing toward a goal of

[100] Light, A. (2006). Restorative Relationships: from Artifacts to Natural Systems. In: *Healing Nature, Repairing Relationships: Landscape Architecture and the Restoration of Ecological Spaces*. Eds. France, R. Cambridge, MA: The MIT Press.
[101] Higgs, E. (2003)
[102] Jordan, W. R. (2012)
[103] Allison, S. A. (2007). You Can't Not Choose: Embracing the Role of Choice in Ecological Restoration. *Restoration Ecology*, *15*(4), 601–605. https://doi.org/10.1111/j.1526-100x.2007.00271.x
[104] Soulé, M. E. (1986). What is conservation biology? *Bio Science*, 35, 727-734
[105] Hertog, I., & Turnhout, E. (2018). Ideals and pragmatism in the justification of ecological restoration. *Restoration Ecology*, *26*(6), 1221–1229. https://doi.org/10.1111/rec.12680
[106] By "benevolent restoration" he refers to the idea that ecological restoration should be guided by an ethical framework that emphasise the importance of non.human nature and recognises the interdependence of all living things.

mutual benefit for humans and the environment".[107] Hence, ecological restoration is exactly the counterpart of exasperated natural resource extraction, and the fear that it be a form of domination over nature is dissipated.[108]

Ecological restoration in this sense carries a dual positive value, encompassing both the restoration of compromised ecosystem functions (natural value) and the reparation of the human-nature relationship (moral value).[109] Concerning the latter dimension, Jordan[110] makes a very illustrative example: a polluted river may appear indistinguishable from a healthy one to human perception. However, if people engage in restorative activities such as cleaning up or replanting trees along its banks, there arises a tangible opportunity not only for the river's health to improve but also for the volunteers to cultivate a profound connection with the water body. In effect, this engagement prompts a reevaluation of their role as integral members of the Earth's community.

This process does not come without consequences and, interestingly, philosophers like Light have stretched out the concept suggesting that the *act* of volunteering in restoration projects can "stimulate the development of moral norms more supportive of environmental sustainability in general", triggering what the same Light calls *ecological citizenship*.[111] To him, a good ecological citizen is someone who is not merely aware of their rights but is also mindful of the duties and responsibilities that come with being a citizen, and participates and takes action to fulfill them.

In essence, the act of engaging in ecological restoration initiatives transcends a mere restoration of physical ecosystems; it fosters a restoration of the human bond with nature. Following the reasoning, volunteerism becomes a form of "stewardship", a way of performing guardianship responsibility for entities not represented in the decision-making which "involves respect, preservation, and actions toward the betterment of our natural resources

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[107] Gross, M. (2006). Beyond expertise: Ecological science and the making of socially robust restoration strategies. *Journal for Nature Conservation*, *14*(3–4), 172–179. https://doi.org/10.1016/j.jnc.2006.05.004

[108] Higgs, E. (2003)
Oelschlaeger, M. (2007). Ecological Restoration, Aldo Leopold, and Beauty. *Environmental Philosophy*, *4*(1), 149–161. https://doi.org/10.5840/envirophil200741/211

[109] Ladkin, D. (2005). Does "Restoration" Necessarily Imply the Domination of Nature? *Environmental Values*, *14*(2), 203–219. https://doi.org/10.3197/0963271054084911

[110] Jordan, W. R., (2012)

[111] "The goal of ecological citizenship would then minimally be to allow as many members of a community as possible to pursue their own private interests, while also tempering these pursuits with attention to the environment around them" from: Light, A. (2006). Ecological Citizenship: The Democratic Promise of Restoration. In *The Humane Metropolis: People and Nature in the Twenty-first Century City*. Eds. Platt, R. H. Amherst, MA: University of Massachusetts Press

regardless of personal economic gain".[112] With this fiduciary responsibility, the right to use natural resources goes together with the respect for the community of life and the duty to prevent harm.[113] Not only philosophers, but also scholars from different fields and through different methodologies have come to similar conclusions: that participating in restoration projects can strengthen long-term pro-environment attitudes.[114]

In the end, restoration is not a mere technical activity, but a human product[115] rooted in social values and culture. Empirical evidence suggests that restoration is successful only when human needs are clearly stated, recognized, and incorporated into the recovery process, along with recognition of the history of a place[116] and biodiversity goals.[117] As suggested by Higgs, ecological restoration is a dynamic process and the restoration goals are the means, which should however not be completely detached from the ends, intended as the result of restoration.[118] A strict technocratic and damage-control approach, then, not only fails in being inclusive but also risks missing out on the opportunity of fulfilling new social values and relationships with nature.

Despite all these above-mentioned perks, one should never forget that society is much more complex and unjust than it may seem at first glance and any policy intervention will see conflicting parties and their interests clash. Moreover, the reflections reported in the previous paragraphs seem to assume that restoration practices are by default inclusive and spur participation, while in practice restoration efforts are not always carried out in an equitable and effective way. To compensate for these deficiencies, in the next final paragraphs I will

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[112] Lee, M., Hancock, P. (2011) Restoration and Stewardship Volunteerism. In *Human Dimensions of Ecological Restoration: Integrating Science, Nature, and Culture*. Eds. Egan, D., Hjerpe, E., Abrams, J. Washingston: Istand Press.

[113] Bosselmann, K. (2016)

[114] Hull, B. L., & Gobster, P. H. (2000). Restoring forest ecosystems: the human dimension. *Journal of Forestry*, *98*(8), 32–36. DOI: https://doi.org/10.1093/jof/98.8.32

Grese, R.E., Kaplan, R., Ryan, R.L., Buxton, J. (2000) Psychological benefits of volunteering in stewardship programs. In: *Restoring Nature: Perspectives from the Social Sciences and Humanities*.. Eds. Gobster, P.H., Hull, B. Island Press, Washington D.C

Furness, E. (2021). How participation in ecological restoration can foster a connection to nature. *Restoration Ecology*, *29*(7). https://doi.org/10.1111/rec.13430

Baker, S. (2017). *Social engagement in ecological restoration*. In: *Routledge Handbook of Ecological and Environmental Restoration*. Ed. Allison, S. K. and Murphy, S. D. New York: Routledge.

Schild, R. (2018). Fostering environmental citizenship: the motivations and outcomes of civic recreation. *Journal of Environmental Planning and Management*, *61*(5–6), 924–949. https://doi.org/10.1080/09640568.2017.1350144

[115] Woodworth, P. (2013). *Our Once and Future Planet: Restoring the World in the Climate Change Century*. University of Chicago Press.

[116] O'Neill, J., Holland, A., & Light, A. (2008). *Environmental Values*. Routledge.

[117] Hertog et al., (2018)

[118] Egan, D. et al., (2011)

draw from recent literature on environmental justice to shed light on some of the most critical concerns related to the implementation of restoration practices.

1.5 Ecological restoration and Justice

In general, studies have shown that societies characterized by greater inequality are often confronted with elevated rates of biodiversity loss.[119] This relationship can also be read the other way around: poorer habitats, which provide for reduced ecosystem services can magnify existing injustices or even give rise to novel forms of inequalities.[120] In this sense, the relationship between justice concerns and the state of biodiversity is very much tight. Ecological restoration, as a policy and practice intervening to reverse such losses, can be a double-edged sword, at times reducing and at times increasing such forms of injustices. In the next paragraphs, I will further discuss the different dimensions of environmental justice and illustrate by means of example how and why ecological restoration can play a role in addressing them.

Over time, the discourse surrounding social justice has primarily centered on the equitable allocation of resources necessary for human sustenance and well-being.[121] In the last few decades, however, the debate on social justice has been enriched and broadened by the influence of social movements and scholarly contributions, which advocated to include other dimensions in the discussion, acknowledging the key role played by institutions in either perpetuating or rectifying injustices and interrogating policymakers and their decisions.[122]

The convergence of social justice concerns with growing ecological and climate considerations has led scholars to explore three key dimensions of "environmental justice": distributive justice, recognition justice, and procedural justice.

"Distributive justice", in this context, is concerned about how environmental goods (for example, the possibility to access clean water) and environmental bads (for example, exposure to water pollution) are distributed among groups, both in spatial and temporal terms,

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[119] IPBES (2019): *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (Eds). IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/zenodo.3831673

[120] Pickering, J., Coolsaet, B., Dawson, N., Suiseeya, K., Inoue, C., & Lim, M. (2022). Rethinking and upholding justice and equity in transformative biodiversity governance. In *Transformative Biodiversity Governance.* Eds. Visseren-Hamakers, I. J., Kok, M. T. J. Cambridge University Press eBooks (pp. 155–178). https://doi.org/10.1017/9781108856348.009

[121] Rawls, J. (1971). *A Theory of Justice*. Harvard University Press.
Sen, A. (2010). *The Idea of Justice*. Penguin UK.

[122] Young, I. M. (1990). *Justice and the Politics of Difference.* Princeton University Press.

and whether there is fairness and equity in such distribution.[123] If there is ample and growing literature demonstrating that environmental bads often disproportionally affect the poorest and marginalized communities, little is known about the possible effects of restoring damaged environments. Definitely, the recovery of polluted areas has a strong positive distributive potential, and it can be a means of rebalancing distorted conditions: think, for example, about the recovery of dump places situated close to poor neighborhood, or the transformation of abandoned areas into green urban spaces in city peripheries.[124] In these instances, rehabilitating or recovering damaged habitats could be a way to redress past forms of injustice. At the same time, the implementation of restoration activities can become problematic and conflicting, especially when the recovery of a degraded site amounts to a change in land use. A clear example is the restoration of peatlands: in most cases, this activity requires rewetting large areas currently exploited for agricultural purposes with the double advantage of recreating marshes hosting special vegetal and animal species, and absorbing Co2 emissions. However, the cost of restoration of peatlands falls almost fully on farmers, who will most likely suffer the loss of part of their revenues. Similarly, albeit on a different scale, there is a heated debate going on the distributive justice concerns of afforestation activities funded by developed countries and implemented in the Global South (for example in the context of the REDD+ initiative) for climate purposes which risk benefitting affluent countries more than the most unstable ones.[125] Finally, some points can also be made with regards to the crucial intergenerational implications of restoration interventions: the costs paid by present generations for the advantage of future ones could be thought of as too burdensome. Conversely, abstaining from restorative interventions and keeping with a business-as-usual approach which depletes resources can be seen as an unfair treatment of current generations at the expense of future ones.[126]

The second dimension of justice worth exploring is "recognition justice",[127] which is about the ability of institutions to recognize and give value to differences across human groups,

[123] See, among others, Holland, B. (2015). *Allocating the Earth. A distributional framework for protecting capabilities in environmental law and policy*. Oxford: OUP Oxford.

[124] Palamar, C. R. (2010). From the Ground Up: Why Urban Ecological Restoration Needs Environmental Justice. *Nature and Culture*, *5*(3), 277–298. https://doi.org/10.3167/nc.2010.050304

[125] Luttrell, C., Loft, L., Gebara, M. F., Kweka, D., Brockhaus, M., Angelsen, A., & Sunderlin, W. (2013). Who Should Benefit from REDD+? Rationales and Realities. Ecology and Society, 18(4). https://doi.org/10.5751/es-05834-180452

[126] Pickering et al., (2022).

[127] Recognition and representation cover, respectively, the cultural and the political dimension of justice. Fraser, N. (2008). *Scales of Justice: Reimagining Political Space in a Globalizing World*. https://ci.nii.ac.jp/ncid/BB04891821

covering worldviews and cultural values, as well as issues of self-respect.[128] In practice, it is about recognizing that failing to acknowledge or respect given differences across social groups can have negative consequences for the nondominant groups. This dimension is often intertwined with "procedural justice" [129], which is about the fairness of decision-making processes, or the investigation about how the design and implementation of regulation and policies affect the "ability to participate in and influence decision-making processes".[130] In the specific case of restoration, the combination of these two dimensions is crucial because it intersects critical points: the way restoration priorities are set (see previous paragraphs), the affected areas chosen, but also the way local communities are involved in the development and management of the projects themselves. Indeed, the adoption or denial of restorative interventions in degraded areas is the result of strong lobbies and power structural dynamics, where alternative voices are simply silenced. Beyond the power imbalances leading to potential unjust outcomes, we should also bear in mind that too limited consideration of public opinion in decision making substantially decreases the success rate of the chosen projects[131], as well as fueling a sense of illegitimacy of the practice itself.[132]

The literature on this specific subject is so far pretty limited, the philosopher Gretel Van Wieren suggests that justice as a *moral norm* should be used to evaluate the quality of ecological restoration covering both the procedures which precede and accompany the practices, and the substantive redistribution of benefits from recovery.[133] In practice, this would mean that restoration planning and implementation be carried out considering the ex-ante priorities and aspirations of people who experience their impact to avoid that

[128] Martin et al., (2016).
[129] Schlosberg, D. (2009). *Defining Environmental Justice: Theories, Movements, and Nature*. Oxford University Press.
Schell, C. J., Dyson, K., Fuentes, T. L., Roches, S. D., Harris, N. C., Miller, D. L., Woelfle-Erskine, C., & Lambert, M. R. (2020). The ecological and evolutionary consequences of systemic racism in urban environments. *Science*, *369*(6510). https://doi.org/10.1126/science.aay4497
Schlosberg, D. (2004). Reconceiving Environmental Justice: Global Movements And Political Theories. *Environmental Politics*, *13*(3), 517–540. https://doi.org/10.1080/0964401042000229025
Shrader-Frechette, K. (2003). Environmental justice: creating equality, reclaiming democracy. *Choice Reviews Online*, *41*(02), 41–0897. https://doi.org/10.5860/choice.41-0897
Westra, L. (2012). *Environmental Justice and the Rights of Unborn and Future Generations: Law, Environmental Harm and the Right to Health*. Routledge.
[130] Bell, D., Carrick, J., (2017).
[131] Bell, D., Carrick, J., (2017).
[132] Armeni, C., and Lee, M. (2021). Participation in a time of climate crisis. *Journal of Law and Society*, 48(4), 549-572. https://doi.org/10.1111/jols.12320
[133] Van Wieren, G. (2013). *Restored to Earth: Christianity, Environmental Ethics, and Ecological Restoration.* Georgetown University Press.

"remediation agendas" are imposed top-down,[134] or that "universal" solutions are applied in the name of the environment, rendering the differences of some people invisible, and not accounting for the history of the resource itself.[135]

In this phase, justice concerns should cover the recognition[136] of latent values and existing forms of sustainable cultural practices[137], but should also question which voices are being heard and – conversely – which ones are being neglected (representation). Finally, but not less importantly, in case the implementation of restoration practices negatively affects the income and livelihood of some sectors of society, ex post compensation should also be considered.[138]

The value of environmental justice is that it requires discussing "how things are" (descriptive), "why things are how they are" (explanatory), but also "how things ought to be" (normative).[139] In this sense, it seems a valuable lens to analyze practical restoration implementation projects, also in light of the fact that restoration holds a strong potential to reduce, overcome or increase injustices.

1.6 Conclusions

Ecological restoration is simultaneously a concept that is intuitive yet elusive. In essence, it is about bringing back an ecosystem to a previous, better condition. Restoring the environment means focusing simultaneously on degradation and healing, on loss and recovery, on damage inflicted by human activities but also on the possibility of re-starting, and giving back to ecosystems the ability they have been.

Beneath the surface of this expression lies a complex world of diverse and often contrasting scientific approaches - think of rewilding movements, or the systematic supporters of novel ecosystems - biological limitations, and ever-changing environmental conditions. To make everything even more complex, the spatial and temporal scale is daunting: effective

[134] Crossland, M., Winowiecki, L. A., Pagella, T., Hadgu, K. M., & Sinclair, F. (2018). Implications of variation in local perception of degradation and restoration processes for implementing land degradation neutrality. *Environmental Development*, *28*, 42–54. https://doi.org/10.1016/j.envdev.2018.09.005

[135] Coolsaet, B. (2020). *Environmental justice: Key Issues*. Routledge.

[136] Here, we mean the opportunity to see different types of knowledge recognized, as well as different types of cultural priorities valued

[137] Pascual, U., Phelps, J., Garmendia, E., Brown, K., Corbera, E., Martin, A., Gómez-Baggethun, E., & Muradian, R. (2014). Social Equity Matters in Payments for Ecosystem Services. *BioScience*, *64*(11), 1027–1036. https://doi.org/10.1093/biosci/biu146

[138] Think, for example, of cases where agricultural lands are turned into wetlands and do not provide anymore a direct source of income to farmers.
Mansourian, S., & Vallauri, D. (2014). Restoring Forest Landscapes: Important Lessons Learnt. *Environmental Management*, *53*(2), 241–251. https://doi.org/10.1007/s00267-013-0213-7

[139] Walker, G. (2012). Environmental justice: Concepts, Evidence and Politics. Routledge.

restoration requires large-scale interventions (including public and private spaces) and long-term commitments, calling for intergenerational efforts and coordination challenges.[140]
But ecological restoration is more than a technical procedure, it is the attempt to heal the human-nature relationship and amounts to a form of restitution for past forms of exploitation of land and communities. Even more deeply, it is about a different, new understanding of time, values, and empowerment because the value is not simply what was before, but it is what lies in front of us, it is not dispersed in the past, but can be revitalised for the future.

Restoration is all of this at all and at once, and as suggested by William Jordan III, the "challenge of defining restoration is to come to grips with its border-crossing character, the way it frustrates the conventional separation of nature and culture, upsets the way we think about human involvement in precious places, and goes to the heart of the modern, or as some would have it, postmodern, condition. By inhabiting the boundaries of contemporary cultural belief, restoration invites criticism of our technological society."[141]

Designing of laws and policies that are efficient, effective and that take due account of justice concerns becomes then a real challenge at all governance levels.[142] In the next two chapters I will analyse, first, the types of norms developed in the international, European and Italian arena. Then, I will shift my attention to other institutional mechanisms and forms of motivation that can be leveraged to overcome some of the obstacles of restoration implementation.

[140] Pierson, P. (2011). *Politics in Time: History, Institutions, and Social Analysis*. Princeton University Press.
Hall, M. (2010). *Restoration and History: The Search for a Usable Environmental Past*. Routledge.
[141] Jordan, W. R. (2012). *The Sunflower Forest: Ecological Restoration and the New Communion with Nature*. University of California Press.
[142] Palmer, M. A., & Ruhl, J. B. (2015). Aligning restoration science and the law to sustain ecological infrastructure for the future. *Frontiers in Ecology and the Environment*, *13*(9), 512–519. https://doi.org/10.1890/150053

Chapter 2: Ecological Restoration and Law

2.1 Introduction

At first glance, one might believe that the environmental crises could benefit more from botanists, ecologists, and scientists in general, rather than poets, social scientists, and lawyers. However, even the more advanced scientific knowledge would be of little help if confined to laboratories, unreachable, and detached from people's lives.

In the critical boundary between hard and soft sciences, environmental law stands out as one of the most intriguing subjects to investigate. Indeed, an examination of existing environmental rules and regulations (*de iure condito*) reveals how human societies are crystallising their relationship with natural resources, while also illuminating on existing contradictions and shortcomings. At the same time, discussing the development of legal instruments (*de iure condendo*) and their potential to address these discrepancies serves as a valuable exercise in envisioning how environmental regulation can adapt to meet the constantly evolving needs of society.

Environmental law emerged as a discipline to safeguard the natural environment and regulate human interaction with natural resources. Over time, it has encompassed various domains, ranging from air pollution to water quality, including the management of environmental disasters and the establishment of protected areas, among others. While undoubtedly relevant, there seems to be a fundamental disconnection between the phenomenological, spatial and temporal premises of current regulation - and of its ontologies, like the paradigm of sustainable development[1] - and the state of reality in the Anthropocene.[2]

One of the criticisms levelled against sustainable development intended as the "development that meets the needs of the present without compromising the ability of future generations to

[1] For a thorough reconstruction of the evolution and recognition of sustainable development in international law as a normative principle, see:
Bosselmann, K. (2016). *The Principle of Sustainability: Transforming Law and Governance*. New York: Routledge.
Barral, V. (2012). Sustainable Development in International Law: Nature and Operation of an Evolutive Legal Norm. *European Journal of International Law*, *23*(2), 377–400. https://doi.org/10.1093/ejil/chs016
Tladi, D. (2007). Sustainable Development in International Law: An analysis of key enviro-economic instruments. In *Pretoria University Law Press (PULP) eBooks*. https://directory.doabooks.org/handle/20.500.12854/60333
Schrijver, N. J. (2008). *The Evolution of Sustainable Development in International Law: Inception, Meaning and Status*. BRILL.
[2] Kotzé, L. (2017). *Environmental Law and Governance for the Anthropocene.* Bloomsbury Publishing.

meet their own needs"[3] is that, although fascinating, it is quite and open to varying - if not contradictory - interpretations.[4]

More specifically, the way sustainable development policies are designed tend to take the inherited natural environment as a given, disregarding the fact that cumulative damage and diminished ecosystem functionality are intricately linked to the present and future wellbeing of the planet. This "intrinsic temporal bias", as referred to by Richardson, leads sustainability to predominantly focus on current policies to influence the future resource use, without adequately recognizing the importance of addressing past harm.[5] In other words, sustainability addresses the question of "how can we do less harm in the future?", but falls short in considering past damage, and answering the question of "how can we make the system function, and regenerate?". To address this shortcoming, Richardson suggests that restorative practices help balancing the emphasis on future harm reduction with the need for past damage regeneration.[6]

Despite its potential advantages, ecological restoration has yet to receive significant attention within environmental policies.[7] Some reasons for this are rooted in the technical challenges associated with rehabilitating damaged ecosystems.[8] However, other explanations can be traced back to the very foundations of legal systems. In fact, many legal systems maintain a distinct separation between humans (as legal subjects) and nature (as a legal object), where the latter is essentially treated as *terra nullius* capable of limitless self-regeneration.[9] This scarce and instrumental consideration of environmental resources is then reflected in legal provisions, and the "restorative scenario" ends up being highly fragmented and essentially marginal in the broader body of environmental law.[10]

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[3] This is the famous first official definition coming from the Brundtland Report, in 1987.

[4] Bosselmann, K. (2016). The Principle of Sustainability: Transforming Law and Governance. New York: Routledge. Accoding to Bosselmann, a broader understanding of the principle of sustainability, intended as the "duty to protect and restore the integrity of the Earth's ecological system" would then probably come into use.

[5] Richardson, B. J. (2017). *Time and Environmental Law: Telling Nature's Time*. Cambridge University Press.

[6] Richardson, B. J., (2017)

[7] Baker, S. S., Eckerberg, K., & Zachrisson, A. (2014). Political science and ecological restoration. *Environmental Politics*, *23*(3), 509–524. https://doi.org/10.1080/09644016.2013.835201

[8] Ehrenfeld, J. G. (2000). Defining the Limits of Restoration: The Need for Realistic Goals. *Restoration Ecology,* 8(1), 2–9. https://doi.org/10.1046/j.1526-100x.2000.80002.x

[9] Boulet, E. (2021). Restoring land, restoring law. Theorizing ecological law with ecological restoration. In: *From Environmental to Ecological Law.* Eds. Anker, K., Burdon, P. D., Garver, G., Maloney, M., Sbert, C. Routledge :76-89.

[10] Bullock, J. S., Aronson, J., Newton, A. C., Pywell, R. F., & Benayas, J. M. R. (2011). Restoration of ecosystem services and biodiversity: conflicts and opportunities. *Trends in Ecology & Evolution)*, *26*(10), 541–549. https://doi.org/10.1016/j.tree.2011.06.011

Starting from the premise that research on ecological restoration regulation is relatively scarce, this chapter endeavours to examine and discuss the legal underpinnings and justifications for ecological restoration from a multi-level perspective, including International, European and Italian law. The final section of this chapter presents the findings, highlighting inconsistencies and gaps, and arguing in favour of more coherent and ambitious restoration legal tools.

2.2 Methodology

The discourse surrounding ecological restoration law, policy, and governance is intricate and multifaceted, and delving into it necessarily raises many questions. Recognizing the limitations of space and time of a Ph.D. dissertation, the aim of this work is to address a more specific question:

> *"What are the norms and institutions that support or hinder the realisation of ecological restoration activities?"*

Drawing on the premises and the multidimensionality of ecological restoration, as illustrated in Chapter 1, this chapter analyses key International, European, and Italian legal instruments to investigate whether there is a legal obligation to restore damaged ecosystems and, in case, delineate the nature of the restoration required.

Building upon the SER (Society for Ecological Restoration) definition of ecological restoration as the "intentional activity that initiates or accelerates the recovery of an ecosystem concerning its health, integrity, and sustainability", relevant legal instruments will be scrutinized. The examination will cover two primary aspects: (i) the nature and scope of the instrument, and (ii) the type of obligation the norms impose. Furthermore, where feasible, this chapter will delve into considerations about the integration of justice-related concerns within legal texts.

To achieve these goals, the dissertation tests the arguments presented above, beginning with an analysis of the type of obligations present in international legal provisions and their nature. Then, it assesses how key features of ecological restoration are embedded in the law. This analysis draws inspiration from the work by Telesetsky et al.,[11] and examines a representative

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Richardson, B. J., & Lefroy, T. (2016). Restoration dialogues: improving the governance of ecological restoration. *Restoration Ecology*, *24*(5), 668–673. https://doi.org/10.1111/rec.12391

[11] Telesetsky, A., Cliquet, A., & Akhtar-Khavari, A. (2016). *Ecological Restoration in International Environmental Law.* London: Routledge.

sample of treaties, regulations, and legislation. The goal is to verify the existence of restoration obligations within international, European, and Italian legal instruments, and to elucidate the evolution of these obligations over time – adapting in response to scientific progress and mirroring shifts in both global and domestic environmental governance.

To enrich the analysis, primary sources such as legal texts, secondary legislation, and judicial rulings on restoration are utilized. Furthermore, scholarly publications, scientific peer-reviewed articles, and grey literature from renowned institutions, organizations, and NGOs such as the IUCN, IPBES, and IPCC are also considered. The purpose of this analysis is not only to gain a theoretical understanding of ecological restoration law, but also to identify trends and interpretations that may inform the drafting and implementation of regulatory norms at the regional and national levels.[12]

It is worth underlying that this chapter only covers a multi-level analysis, which goes from the International to the national legal frameworks through the regional level, but it does not include a comparative analysis across national legislations. The reasons are essentially linked to space and time constraints: a comparative analysis would require a more precise research question, maybe linked to specific ecosystem ("how is river restoration dealt with in different legal frameworks?", for example, or "how is the regime on protected areas facilitating the restoration of endangered species?"), and this is not the purpose of this dissertation. On the contrary, a broader discussion on the existence of restoration obligations "vertically" is a way of providing the reader with a general overview of the historical and current trends at different governance levels, leaving it to further research a closer scrutiny on the matter. Also, a reasoned selection of normative texts has been compiled, covering the most relevant provisions – in the opinion of the researcher – on the topic.

In undertaking this analysis, diverse methodological approaches are employed, contingent on the level of the legal framework being explored. In the initial phase, a descriptive methodology is adopted to provide a comprehensive overview of international legal provisions related to ecological restoration. In the second part, the focus shifts to European case law and a more analytical approach is used to evaluate how the courts have interpreted and applied restoration obligations in practice. Finally, in the third part, a similar approach is taken to examine Italian laws and court decisions related to ecological restoration.

[12] Palmer, M. A., & Ruhl, J. B. (2015). Aligning restoration science and the law to sustain ecological infrastructure for the future. *Frontiers in Ecology and the Environment*, 13(9), 512–519. https://doi.org/10.1890/150053

2.3. Ecological Restoration in International Law

2.3.1 Introduction

International environmental law is about the set of principles and agreements developed among countries that aim to coordinate efforts to reduce the human impact on the environment and address issues that are beyond the ability of individual states to manage alone, such as climate change, ozone depletion, and the mass extinction of wildlife.[13]

Although states essentially navigate in a condition of perpetual anarchy where no central authority can force any course of action,[14] international law has exerted a substantial influence in sculpting and advancing environmental law, *de facto* guiding its theoretical and practical development, and outlining its boundaries and fundamental notions.[15] Consequently, delving into the evolution of international environmental law can offer valuable perspectives on the integration and assimilation of ecological restoration within regional and national frameworks, both presently and potentially in the future.

Environmental concerns emerged in the international arena especially to address two big issues: first, to regulate competing claims over natural resources and prevent the depletion of valuable species such as whales or fish[16] and, second, to curb pollution and the destruction of transboundary resources like water flows or lakes.[17] While international law has provided partial solutions to these challenges, especially through regional and bilateral agreements, the growing impact of cross-border pollution, climate change, and biodiversity loss are now questioning the very foundations of the global legal system: the notion of state sovereignty and that of state responsibility.

[13] Bodansky, D. (2010). *The Art and Craft of International Environmental Law*. Harvard University Press.
Birnie, P. W., Boyle, A. E., & Redgwell, C. (2009). *International Law and the Environment*. Oxford University Press.

[14] Keohane, R. O. (1984). *After Hegemony: Cooperation and Discord in the World Political Economy*. Princeton University Press.
Reus-Smit, C., & Snidal, D. (2010). *The Oxford Handbook of International Relations*. Oxford University Press.

[15] As explained by Sand, beyond the more traditional horizontal transnational borrowing or transplant of successful legal models, the vertical influence of international environmental law principles has had a prominent role in developing a stratified and multilevel system of regulation.
Sand, P. H. (2017). The Effectiveness of Multilateral Environmental Agreements: Theory and Practice. *International Environmental Law-Making and Diplomacy Review*, 16, 1-26.

[16] Sand, P. (2021). Origin and History. Eds. Rajamani, L., & Peel, J. (2021). *The Oxford Handbook of International Environmental Law*. Oxford University Press.

[17] As an example, the 1909 Boundary Waters Treaty agreed upon by Canada and the United States, at a later stage used in the famous Trail Smelter case.

State sovereignty, and the ability of States to dispose fully of natural resources within national borders is a backbone of international law[18], and was strongly supported by developing States in the aftermath of World War II. Over time, however, the unconditioned access to the environment has been challenged, and States now bear the responsibility of ensuring that activities taking place within their jurisdiction or under their control do not inflict harm upon the environment of other states.[19] Some argue, and likely with good reason, that the no-harm principle articulated by the ICJ in the Trail-Smelter case[20] is not a deliberate act of prioritizing environmental protection over state sovereignty. Instead, it is more an effort to safeguard the capacity to wield sovereignty over one's own territory.[21]

Concurrently, the very notion of absolute and permanent sovereignty over natural resources has experienced further challenge in treaties. For example, the definition of climate and biodiversity as "common concerns of humankind"[22] in their respective treaties has obliged States parties to take protective measures, irrespective of their effects on other states. Indeed, international climate and nature conservation law are permeated by a "clear perception of shared responsibility ex ante",[23] which has somehow replaced the concept of "absolute sovereignty" by "equitable utilization".[24]

A second element of international law to some extent questioned by the current global environmental problems is the concept of State responsibility[25] in cases involving wrongful

[18] State sovereignty has since the Peace of Westphalia been the backbone of public international law and got reinforced in the aftermaths of WWII and the dissolution of colonies when developing countries claimed their right to develop and self-determine. The debate on what constitutes the basis for development started with Chapter IX of the UN Charter.

[19] See for example: Principle 2, Rio Declaration on Environment and Development, 1992

[20] Trail Smelter Arbitration (United States v. Canada), 1938. (International Court of Justice).

[21] Nollkaemper, A. (2009). Sovereignty and environmental justice in international law. In *Environmental Law and Justice in context.* (Eds.) Ebbesson, J., Okowa, P. Cambridge University Press https://doi.org/10.1017/cbo9780511576027.014

[22] Bodansky, D., Brunnée, J., & Rajamani, L. (2017). *International Climate Change Law*. Oxford University Press.
The specific references can be found in the Preamble of the United Nations Framework Convention on Climate Change and in the Preamble of the Convention on Biological Diversity, both from 1992.

[23] Trouwborst, A. (2017). Nature Conservation. In *The practice of shared responsibility in international law*. (Eds.) Nollkaemper, A., and Plakokefalos, I. Cambridge University Press eBooks. https://doi.org/10.1017/9781316227480

[24] Schrijver, N. (1997). *Sovereignty over natural resources: balancing rights and duties.* Cambridge University Press.

[25] It is worth noting that the term "responsibility" is employed within the realm of public international law in the context of liability for wrongful acts resulting from activities not prohibited by international law. The responsibility of States is tied to a strict obligation that arises when a defined form of behaviour is imposed upon an identifiable entity, and corresponds to the entitlement of another entity to demand such conduct. Terms like "duty", or "obligation" are instead more commonly utilised in international law but they lack precise definitions and are invoked when the nature of the obligation and the subjects concerned are not qualified explicitly.

acts and liability for ecological damage.[26] According to Articles 30-31 of the *International Law Commission*[27] *Report* A/56/10, States held responsible for damage are required to cease the harmful act, provide assurances of non-repetition and make full reparation for the injury caused, in the form of restitution.

This provision is applicable to cases of environmental damage, and examples of clean-ups or economic compensation can be found quite easily. However, as noted by the International Commission and state practice, each case is unique, and the institute of *restitutio in integrum* - restoring things to their original state - has rarely proven effective. Indeed, it requires establishing the precise extent of loss (with relevant limits in accounting for lost biodiversity) and determining proportional sentences on the polluter.[28]

Conversely, the notion of strict liability for environmental damage arising from lawful activities remains rather indistinct and is largely confined to specific international frameworks, for example some addressing environmental pollution. In fact, States have been reluctant to establish a comprehensive liability structure for environmental harm and a corresponding compensation system.[29]

As pointed out by Voigt, such damage can occur either accidentally or non-accidentally, and if a causal link can be established, compensation may be sought due to a state's failure to exercise due diligence in preventing environmental harm beyond its national borders.[30] In such scenarios, courts would need to assess whether the state has fulfilled its obligation of

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Moreover, they refer to some broad form of indebtedness linked to treaties and codes of conduct. Schrijver, N. (1997). *Sovereignty over natural resources: balancing rights and duties.* Cambridge University Press. p. 307

[26] Boyle, A., & Harrison, J. (2013). Judicial Settlement of International Environmental Disputes: Current Problems. *Journal of International Dispute Settlement*, *4*(2), 245–276. https://doi.org/10.1093/jnlids/idt011

[27] The ILC is a group of legal experts established by the UN General Assembly. The aim of the ILC is that of codifying and developing international law.

[28] Boyle, A. (2002). Reparation for Environmental Damage in international law: some preliminary problems. In *Environmental Damage in International and Comparative Law: Problems of Definition and Valuation*. Eds Boyle, A., Bowman, M. Oxford University Press: 16-26. 2 Reparation for Environmental Damage in International Law: Some Preliminary Problems

[29] Voigt, C. (2021). International Environmental Responsibility and Liability. In *The Oxford Handbook of International Environmental Law.* 2nd edn. Eds Rajamani, L., Peel, J. DOI: https://doi.org/10.1093/law/9780198849155.001.0001

[30] Reformulated from the Oxford Public International Law website: *due diligence* in international law is about an international minimum standard "whereby a State's conduct is compared to what a 'reasonable' or 'good' government would do in a specific situation." Of course, since it is a standard, it needs to be detailed in each context. A State is not expected to control all private actions that may cause environmental harm, but a due diligence obligation is an obligation of conduct that requires states to "take appropriate steps" to ensure that private persons will not cause such harm". A breach of such obligation will then emerge in case the state fails to "take the necessary, diligent steps towards that end."

conduct to exercise proper care and enact laws to prevent or limit harmful activities, with no obligation to produce a specific result.[31]

When liability is finally established, compensation is awarded to the injured state to cover expenses related to remedying the pollution, or to compensate for any decrease in the value of property due to the pollution. Even in this case, however, legally mandated restoration is focused on human-centred projects, and little consideration is given to broader ecological concerns.[32]

Within this framework, the 2018 ICJ Costa Rica v. Nicaragua/Nicaragua v. Costa Rica case is an important precedent in the field of environmental compensation. The case arose from a territory dispute over a 3-kilometer area of wetland, and the Court found Nicaragua liable for unlawful dredging activities affecting the Costa Rican territory, leading to an obligation of reparation. The significance of this case lies in the fact that, for the first time, the ICJ has decided on a compensation case and recognised that "damage to the environment, and the consequent impairment or loss of the ability of the environment to provide goods and services, is compensable under international law." More specifically, the Court's ruling claimed that "such compensation may include indemnification for the impairment or loss of environmental goods and services in the period prior to recovery and payment for the restoration of the damaged environment."[33]. In practice, the Court emphasised that the ecosystem services provided by biodiversity must be accounted for when determining compensation, and this was justified on the basis that "payment for restoration accounts for the fact that natural recovery may not always suffice to return an environment to the state in which it was before the damage occurred. In such instances, active restoration measures may be required in order to return the environment to its prior condition, in so far as that is possible".[34] Finally, the Court requested that Nicaragua paid US$ 120,000 for the degradation of and loss of environmental goods and services, and that it paid US$ 2,708.39 to cover the

[31] Consider that there are considerable difficulties in establishing the lack of due diligence by one states, because each situation is context-dependent, and the actual ability of a state to pursue and maintain an efficient system of due diligence may vary considerably.
Brunnée, J. (2004). Of Sense And Sensibility: Reflections On International Liability Regimes As Tools For Environmental Protection. *International and Comparative Law Quarterly*, *53*(2), 351–368. https://doi.org/10.1093/iclq/53.2.351
[32] Telesetsky, A. (2013). An emerging legal principle to restore large-scale ecoscapes. In *Rule of Law for Nature: New Dimensions and Ideas in Environmental Law.* Eds. Voigt, C.: 175-190. Cambridge: Cambridge University Press. https://doi.org/10.1017/cbo9781107337961.014
[33] Certain Activities carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua), Compensation Judgment of 2 February 2018, ICJ Reports (2018) 15.
[34] *Ibid*, parr. 43

costs of Costa Rica of restoring its internationally protected Ramsar site[35]: a low amount of money, but a strong stance for *active* restoration measures.

If we can claim that the system of liability and compensation for environmental harm in place at the international level has had its positive impacts, it is also true that it seems to be more worried about allocating costs equitably, than on assigning actual responsibility to polluting states, showing strong inherent limits.[36] First, environmental harm often arises from multiple factors and actors and can be dispersed geographically, therefore it can be difficult to establish causality and assign responsibility. Secondly, harm is often related to lawful economic activities benefitting societies, such as energy production or transportation that cannot be completely prohibited. Thirdly, even when environmental damage and responsibility are identified, the amount and type of compensation required raises complex political, ethical and economic questions,[37] and ends up reducing restoration to just an extension of existing principles and obligations of sustainable development and environmental impact assessment, where "restoration and risks reducing becomes part of a balancing game of numbers".[38]

Considering the failures of many restoration projects and the recognition that environmental damage extends beyond the mere costs of clean-up and compensation, it is clear that a more comprehensive approach is needed. This approach must move beyond an "ex post" response and appreciate restoration as an "ex ante" measure that has the potential to be one of the most important social and economic activities in the Anthropocene. Such an approach would require a shift in focus from simply mitigating environmental harm to actively restoring and enhancing ecosystems, as well as a recognition of the interdependence between environmental, social, and economic factors.

That is what the current dissertation attempts to do: investigating and retracing the existing references and obligations connected to widespread environmental degradation deriving from collective and cumulative action where no liability rule applies.

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[35] *Ibid*, parr. 157

[36] Louka, E. (2006). *International Environmental Law: Fairness, Effectiveness, and World Order*. Cambridge University Press. DOI: doi.org/10.1017/CBO9780511618109

[37] Boyle, A. (2002). Reparation for Environmental Damage in international law: some preliminary problems. In *Environmental Damage in International and Comparative Law: Problems of Definition and Valuation*. Eds Boyle, A., Bowman, M. Oxford University Press: 16-26. https://doi.org/10.1093/acprof:oso/9780199255733.003.0002

[38] Telesetsky, A. (2013). An emerging legal principle to restore large-scale ecoscapes. In *Rule of Law for Nature: New Dimensions and Ideas in Environmental Law.* Eds. Voigt, C.: 175-190. Cambridge: Cambridge University Press. https://doi.org/10.1017/cbo9781107337961.014

In the following paragraphs, a more thorough analysis of how existing principles, soft law instruments and hard law instruments complement, and support ecological restoration will be given.

2.3.2. International Environmental Law Principles

An essential premise is that while the notion of recovery from environmental damage is addressed to in various treaties and legal documents, it is seldom precisely defined. This lack of legal definition should not be surprising though, if we consider that the recognition of the negative consequences of land degradation[39] has only recently gained significant prominence in the global public discourse.

Principles, in this sense, can be of some help. They have typically emerged within international law as instruments of soft law, with the aim of constructing a consensus on strategies and approaches for addressing worldwide environmental challenges, such as pollution, ozone depletion, or climate change. Over time, they have progressively been incorporated into supranational, regional, and national frameworks, functioning as "compasses" that steer the interpretation and application of specific norms, especially in the presence of considerable uncertainty and risk, or in situations where areas of conduct remain inadequately regulated.[40]

At the international level, there is no single legal source of environmental principles; but they are instead distributed across various Multilateral Environmental Agreements (MEAs). Some of them have acquired the status of customary international law and are enshrined in soft law declarations, such as the Stockholm Declaration[41] and the Rio Declaration.[42]

Given this decentralized nature, a closer examination of universally accepted principles within international environmental law serves to contextualize the concept of restoration and provide a framework for analyzing the term in selected treaties.

2.3.2.1. Polluter-pays principle

[39] Montanarella, L., Scholes, R. J., Brainich, A., & Biodiversity, I. (2018). The IPBES assessment report on land degradation and restoration. *Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* https://digitallibrary.un.org/record/3794559/files/2018_ldr_full_report_book_v4_pages.pdf

[40] For a more extensive illustration of the role of environmental principles, see: De Sadeleer, N., (2002). *Environmental principles: from political slogans to legal rules.* Oxford, England: Oxford University Press.

[41] Stockholm Declaration on the Human Environment, in Report of the United Nations Conference on the Human Environment, UN Doc. A/CONF. 48/14, at 2 and Corr. 1 (1972)

[42] Rio Declaration on Environment and Development (The United Nations Conference on Environment and Development, UNCED), adopted in June 1992, A/CONF. 151/26 (Vol. 1)

The first principle that has gained consolidation is the "polluter-pays principle" which is included in the Rio Declaration[43] and is articulated in Principle 16:

> National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Essentially, it requires to redress environmental damage once it has occurred, and to reconstruct altered and damaged equilibra. Its rationale derives from economic theory, and in particular from the notion of "negative externalities" understood as costs borne by society or the environment that should be internalised.[44] From an epistemological perspective, it relies on the assumption that pollutants are exceptions, and that natural resources will eventually find the way to reproduce.

However, this principle has its weaknesses: first, as it is also apparent from the definition, a clear identification of who should bear the costs — the producer, the consumer, or the public authority profiting from development – is not given, with consequent implementation shortcomings. Additionally, as Dupuy and Viñuales[45] underline, what is too often ignored is that internalization of externalities applies on the conditions "(i) that the activity producing the externality is socially desirable, and (ii) that the negative externality remains within the bounds of what can be considered as tolerable". In the absence of a well-defined specification of what is "tolerable", the potential consequence is that any form of damage may be deemed acceptable by policymakers, contingent upon some form of compensation. Particularly in Western societies, questions also arise about whether highly polluting industries like mining still fall under the ambit of "socially desirable" activities, especially in a climate where discussions surrounding ecological transition and the imperative to phase out fossil fuels are heated. Moreover, the a posteriori curative dimension of the polluter-pays principle clashes with reality and makes it totally ineffective when clean-up costs are too difficult to assign or damage is irreparable.

2.3.2.2. Principle of prevention

[43] *Ibid*., Principle 16
[44] Pigou, A. C. (1948). *The Economics of Welfare*. Transaction Publishers.
Coase, R. (1960*).* The Problem of Social Cost. In *Journal of Law and Economics*, Vol. 3: 1-44.
[45] Dupuy, P.M., Viñuales J.E. (2018). *International Environmental Law.* Cambridge: Cambridge University Press.

The principle of prevention was formally introduced in Principle 21 of the Stockholm Declaration[46] and it states that:

> States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Initially, this principle aimed to extend the overarching no-harm principle of international law, shifting the focus from safeguarding solely the interests of the State to the environment itself. The principle of prevention also reflects the idea that preventing damage is more cost-effective than remedying it after the fact. Moreover, in cases where damage carries irreversible consequences, scientific and technological advancements should enable the anticipation and avoidance of irreparable harm. The novelty brought by the Swedish discussion is exactly the pre-eminence given to *pro-active* prevention as preferable to damage reparation, as a recognition of the "often irreversible character of damage to the environment and of the limitations inherent in the very mechanism of reparation of this type of damage".[47]

One may wonder what relationship exists between this principle and restoration, since when recovery is needed damage has already occurred, and thus the principle of prevention has already been violated. Besides this trivial observation, an alternative and interesting reading is the one given by Telesetsky et al.[48] They claim that in the case of extensively degraded areas, restoration amounts to a form of prevention insofar as it avoids that irreversible deterioration occurs, in this sense they are strictly connected. To give an example, in the case of proliferation of particularly damaging non-native algae in certain marine environments, active interventions to eradicate them and avoid irreversible damage and loss of important ecosystem functions can amount to a preventive intervention.

2.3.2.3. Precautionary principle

The emergence of unpredictable, global and collective risks has underscored the limitations of a solely preventive paradigm, prompting lawmakers to establish an "anticipatory model" for addressing potential risks. The formalization of this approach is given with the *precautionary*

[46] Stockholm Declaration, Principle 21
[47] Gabcikovo-Nagymaros Project (Hungary/Slovakia) (1997) Rep 7 (International Court of Justice), 140.
[48] Telesetsky et al., (2016)

principle, which justifies refraining from potentially harmful activities.[49] The fundamental concept is that the absence of complete scientific certainty regarding the effects of certain substances or activities on environmental integrity or human health should not impede decision-makers from adopting precautionary measures.

At its core, the precautionary principle contends that action should be taken to safeguard a given interest from potential risks, even in the absence of definitive scientific evidence. The Rio Declaration[50] has crystallized it in Principle 15 which reads as follows:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Given its broad nature, its application is not straightforward and often requires the joint efforts of competent authorities, technicians, and scientists. In the context of restoration projects, the relevance of the precautionary principle is self-evident, since practitioners are often in the position of making decisions in a condition of scientific uncertainty. Specifically, when designing restorative interventions, scientists must grapple with identifying a reference system. As shown in the previous chapter, the debate on the "historical" vs "forward-looking" management of restoration is fierce in science, and one may wonder if and to what extent a precautionary approach could inform one position or the other. According to Telesetsky et al.[51], a precautionary approach would favor restoration rooted in historical references over those that propose the creation of "novel ecosystems," potentially involving the introduction of non-native species, as a means to avoid further degradation. However, in situations where data and resources are severely limited, the question arises whether restoration projects aiming to establish novel yet more resilient ecosystems should be averted due to the potential risk of unintended consequences. As is often the case, obtaining definitive answers from the precautionary principle proves challenging.

2.3.2.4. Inter-generational equity principle

Of a different nature is the principle of *inter-generational equity*, which is about the fair distribution of quality natural resources between present and future generations. Although

[49] De Sadeleer, N., (2002). *Environmental principles: from political slogans to legal rules.* Oxford, England: Oxford University Press.
[50] Rio Declaration, Principle 15
[51] Telesetsky et al., (2016)

initially expressed only through political declarations, the principle received its first formal articulation in Principle 3 of the Rio Declaration[52], which states that:

> The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

Attention to intra-generational equity is also a concept enshrined, to some extent, in the principle of sustainable development and is reiterated in various conventions. For instance, the United Nations Framework Convention on Climate Change[53] addresses it in Article 3, emphasizing the imperative to "protect the climate system for the benefit of present and future generations of mankind.

Beyond political statements, however, a clearer conceptualization and implementation of this principle remain elusive. In domestic cases, it has sometimes been invoked to guide the issuance of industry permits for resource extraction. Likewise, it is invoked in climate-related litigation to advocate for more stringent policies to reduce CO2 emissions. Similar reasonings are also developed in the so-called “biodiversity litigations”, cases in which plaintiffs complain State’s policies for allowing cumulative damage to natural resources, impinging the ability of future generations to enjoy them. One interesting case is *Notre Affair à Tous et al v. the French State*,[54] still pending, which sees the claimants bringing the French government to Court for failing to meet its obligation to protect biodiversity, especially with reference to pesticides selection and presence in the market, asking for the implementation of adequate compensations that include the re-establishment of impacted species, protection of waters and soils, and support to research.

In the context of restoration practices, beyond its strong ontological justification, the principle of intergenerational equity could serve as leverage for demanding the implementation of large-scale restoration initiatives, particularly in sectors like agriculture, where the adverse environmental impact is less visible. Indeed, by appealing to this principle, advocates of restoration can underscore the necessity of safeguarding natural resources for the welfare and prosperity of future generations.

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[52] Rio Declaration, Principle 3

[53] United Nations Framework Convention on Climate Change (UNFCCC) (adopted on May 9, 1992, and entered into force on 21 March 21, 1994).

[54] Notre Affair à Tous et al v. the French State (2022) (Administrative Court of Paris, France)
For a comprehensive analysis of biodiversity litigation in different countries, see:
Futhazar, G., Maljean-Dubois, S., Razzaque, J., & Razzaque, P. O. E. L. J. (2023). *Biodiversity Litigation*. Oxford University Press.

Prevention, precaution, and, finally, restoration. One may wonder what comes first, to protect the environment. As suggested by Bastmeijer,[55] "most of the serious concerns for biodiversity are caused by accumulative impacts of 'lawful' activities; activities that also grow in number, intensity and geographical scope". Therefore, instead of giving prominence to prevention with respect to restoration, a more dynamic and integrated reading of these principles is more appropriate, one in which they are implemented in parallel, depending on the specific circumstances.

2.3.4. Soft law

The principles of international environmental law offer a foundational framework for restoration, but a deeper understanding can be gleaned from both soft and hard law instruments,[56] which demonstrate – at least to some extent – the willingness of states to converge on crucial global issues. The earliest, though relatively limited, reference to restoration is found in the Stockholm Declaration,[57] where Principle 3 states that "the capacity of the earth to produce vital renewable resources must be maintained and wherever practicable, *restored*, or improved."

Although these two lines may appear simple and obvious, they mark the initial concerted effort by the United Nations to acknowledge the intrinsic connection between human well-being and the regenerative capacity of the natural world and urge States to support the restoration of damaged ecosystems. It does not go unnoticed, however, that the terms "restoration" and "improvement" are used interchangeably and the commitment to restoration is to be put in practice "whenever practicable".[58]

[55] Bastmeijer, K. (2016). *Wilderness Protection in Europe: The Role of International, European and National Law*. Cambridge University Press.

[56] A soft law instrument has not, as such, a legally binding nature. However, being the result of shared agreement on a given topic, it is often influential on states. As highlighted by Alan Boyle, soft law instruments have been particularly significant in the evolution of environmental law-making, and should not be underestimate as means to progress the protection of global environmental goods such as biodiversity.
By hard law instruments, on the contrary, international regimes make reference to binding treaties, which will be examined at a later stage.
See, Boyle, A. (2021). Soft Law. In *The Oxford Handbook of International Environmental Law*. Eds. Rajamani, L., Peel, J. Oxford Handbooks.

[57] Stockholm Declaration on the Human Environment, in Report of the United Nations Conference on the Human Environment, UN Doc. A/CONF. 48/14, at 2 and Corr. 1 (1972)

[58] Telesetsky et al., (2016).

Twenty years later, in the occasion of the United Nations Conference on Environment and Development held in Rio de Janeiro,[59] restoration is more explicitly mentioned in Principle 7 which states that:

> States shall cooperate in a spirit of global partnership to conserve, protect and *restore* the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit to sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

The principle articulated in Rio de Janeiro is lengthy and reflects the intense negotiations and diverse interests of the 172 countries represented in the Conference. We can easily detect the call from Global South countries to introduce the notion of common but differentiated responsibilities, while the obligations on developed states remain less clearly defined. At the same time, the principle highlights a collaborative effort to protect the Earth's integrity through a combination of conservation, protection, and restoration initiatives, but it rests quite unclear whether these policies are intended to be implemented in parallel or in sequence. What is nonetheless remarkable here is that after Rio in 1992 restoration has evolved from serving human needs to becoming a more comprehensive goal of restoring ecosystem integrity, at least on paper.

The Johannesburg Declaration on Sustainable Development, released in 2002, introduced another dimension to the concept of restoration.[60] Building upon earlier declarations, it aimed to contribute to global sustainable development, particularly focusing on poverty reduction and related challenges like chronic hunger and malnutrition. Restoration is mentioned repeatedly in the declaration, associated with the "efficient use of water resources," "fisheries stocks," "flooding and droughts," and "desertification." In this context, restoration is viewed as a tool to address extreme poverty and vulnerabilities, underscoring its role in tackling pressing socio-economic and environmental issues.

[59] Rio Convention, Principle 7
[60] United Nations, New York (2002). Report of the World Summit on Sustainable Development Johannesburg.

The Sustainable Development Goals agreed upon in 2015[61] further contributed to the discourse on the international commitment to advancing restoration. Goal 15, in particular, provides that States:

> Protect, *restore* and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.[62]

Restoration is presented as a pivotal component of environmental management, alongside regeneration and conservation.[63] Moreover, pledges are not attributed to generically recover "natural resources", but explicitly cover water-related ecosystems (Goal 6.6)[64], marine and coastal ecosystems (Goal 14.2)[65], and terrestrial ecosystems (Goal 15.1-2-3).

Although not exclusively focused on restoration, the aforementioned instruments collectively demonstrate the evolving international perspective and framing of restoration. It originated as a means to enhance the contribution of natural resources to human well-being in 1972, then evolved into a broader tool for restoring Earth's integrity in 1992 and was gradually included in declarations on risks and poverty alleviation, serving as a mechanism for adaptation and resilience.

This trajectory culminated in a dedicated document approved by the United Nations General Assembly[66] in March 2019, designating 2021-2030 as the "United Nations Decade on Ecosystem Restoration."[67] Led by the United Nations Environment Program (UNEP) and the Food and Agriculture Organization (FAO), this initiative seeks to "support and scale up efforts to prevent, halt, and reverse the degradation of ecosystems worldwide and raise awareness of the importance of successful ecosystem restoration." It serves as a call to

[61] United Nations General Assembly (2015). Transforming our world: the 2030 Agenda for Sustainable Development, A/RES/70/1
[62] Goal 15, Sustainable Development Goals
[63] Goal 15.1, 15.2, 15.3
[64] By water-related ecosystem, the Goal refers to a wide variety of ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.
[65] By terrestrial ecosystem, the Goal refers to a wide variety of ecosystems, including forests, wetlands, mountains, and drylands. Moreover, it makes specific reference to restoration of land and of soil.
[66] United Nations Decade on Ecosystem Restoration (2021–2030)', UNGA Res. 73/284 of 6 March 2019
[67] The UN Decade on Ecosystem Restoration is a rallying call for the protection and revival of ecosystems all around the world, for the benefit of people and nature. It aims to halt the degradation of ecosystems and restore them to achieve global goals. Only with healthy ecosystems can we enhance people's livelihoods, counteract climate change, and stop the collapse of biodiversity. The UN Decade runs from 2021 through 2030, which is also the deadline for the Sustainable Development Goals and the timeline scientists have identified as the last chance to prevent catastrophic climate change.

governments and stakeholders to intensify restoration efforts in response to the climate and biodiversity crises.

Admittedly, the adopted Resolution acknowledges that "ecosystem restoration is a complement to conservation activities and that priority should be given to conserving biodiversity and preventing the degradation of natural habitats and ecosystems by reducing pressures and maintaining ecological integrity and the provisions of ecosystem services". However, it is important to recognize that these efforts, though significant in raising awareness, sharing knowledge, and consolidating existing projects on shared platforms, may only partially address the root cause of the issue. The challenge lies in addressing development-related activities that contribute to environmental degradation.[68]

2.3.4. Hard law

Despite the innovative effects of the UN Decade on Ecosystem Restoration initiative, as for now, there are no international treaties dealing exclusively with restoration obligations on states, because the recovery of species and degraded ecosystems has never been framed as a self-standing issue. Indirectly, however, several multilateral environmental agreements contain provisions which have to do with restoration, at large.

The earliest commitments in this regard can be observed in species-specific treaties, where parties have demonstrated their intent to coordinate and regulate the exploitation of animal species with significant commercial or cultural value. In the *International Convention for the regulation of Whaling* signed in 1946,[69] for example, parties set out catch limits in whaling as a response to uncontrolled overfishing, so that "increases in the size of whale stocks will permit increase in the number of whales which can be captured".[70]

Similarly, the *Convention on Migratory Species of Wild Animals*[71] (also known as the *Bonn Convention*) adopted in 1979 was agreed to protect migratory birds and wild animal

[68] See the full website and the publicity material systematised in
United Nations. (2021) *Ecosystem restoration playbook: a practical guide to healing the planet*. https://wedocs.unep.org/bitstream/handle/20.500.11822/35858/ERP.pdf?sequence=1&isAllowed=y

[69] International Convention for the Regulation of Whaling, Washington D.C., 2 December 1946, in force 10 November 1948, 161 United Nations Treaty Series 72.

[70] International Convention for the regulation of Whaling, Preamble

[71] Convention on the Conservation of Migratory Species of Wild Animals, Bonn, 23 June 1979, in force 1 November 1983, 19 International Legal Materials (1980).
The Convention was concluded in 1979, and its purpose is that of protecting migratory species and wild animals. Acknowledging their importance, the Convention in its Annexes indicates the list of endangered species and promotes cooperation actions among States.

populations in unfavourable conservation status. Article 3of the Convention provides that State Parties shall endeavour to "conserve and, where feasible and appropriate, restore those habitats of the species which are of importance in removing the species from danger of extinction"[72] and that to accomplish this, they shall "prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling the introduction of, or eliminating already introduced exotic species".[73]

Under its auspices, several agreements were developed, all having a similar structure and pattern of coordinating states in developing measures to maintain the covered species in a favourable conservation status or restore them to such status. This is how gorillas[74], albatrosses[75], European bats[76] or the Saiga Antelopes[77], among others, were monitored and maintained.[78] While restoration objectives within these agreements may be quite vague and open to discretion, they represent significant steps toward coordinated international action to protect and potentially restore species facing threats.[79] These specialized tools demonstrate early attempts to address restoration within specific contexts, where the political dynamics may be less complex compared to broader ecosystem restoration efforts. Larger benefits from restoration, if any, are accidental and definitely do not embody an ecosystem approach.[80]

Besides these treaties that are only concerned about specific species and their closed ecosystems, other instruments have been developed as an object of regulation of specific habitats. Among them, the *World Heritage Convention*[81] was established in 1972 to provide adequate protection to both natural and cultural sites of special interest under the UNESCO umbrella.[82] This instrument has been used to protect the most exceptional places in the world

[72] *Ibid.*, Article 3
[73] *Ibid.*, Article 3
[74] Agreement on the Conservation of Gorillas and their Habitat, Paris, 26 October 2007, 2544 UNTS I-45400.
[75]Agreement on the Conservation of Albatrosses and Petrels, 19 June 2001, 2258 UNTS 257.
[76] Agreement on the Conservation of Populations of European Bats, 4 December 1991.
[77] Memorandum of Understanding concerning Conservation, Restoration and Sustainable Use of the Saiga Antelope (Saiga tatarica tatarica), 24 September 2006.
[78] Agreements developed under its auspices are, among others,
Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS), 24 November 1996, in force 1 June 2001.
Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 16 June 1995, in force 1 November 1999.
[79] The only dispute among the mentioned treaties that has been brought before the ICJ and that raise some political turmoil is the Whaling in the Antarctic case, (Australia v. Japan), 2010. (International Court of Justice).
[80] Telesetsky et al., (2016)
[81] Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris, 16 November 1972, in force 17 December 1975, 11 International Legal Materials (1972) 1358
[82] Francioni, F., & Vrdoljak, A. F. (2020). *The Oxford Handbook of International Cultural Heritage Law*. Oxford University Press.

for their outstanding historical, cultural or ecosystem features.[83] It provides recognition to places with exceptional natural heritage by enlisting them, and by ensuring that their value is maintained over time. Each State party to the Convention shall endeavour, insofar as possible, to "take the appropriate legal, scientific, technical, administrative and financial measures necessary for the identification, protection, conservation, presentation and rehabilitation of this heritage".[84]

Once World Heritage Sites are designated under quite strict criteria, a double responsibility is triggered: first, states which host the sites have a primary responsibility of conserving them by ensuring that they are managed to the highest possible standards, and secondly, the international community also faces a responsibility in providing support through the training of specialists and the establishment of financial assistance.[85] In cases where a designated site is in danger or its integrity is threatened, it can be placed on the "List of World Heritage in Danger." This listing alerts the international community to the risks facing the site and provides a platform for collective intervention and support.

Although restoration as a self-standing concept does not appear in the text of the Convention, the Committee has on multiple occasions recalled it as an overarching practice that can decide the destiny of an endangered site.[86] The case of the Bulgarian site of Srebarna is emblematic: the inclusion of the site on the World Heritage List in 1983[87] acknowledged its exceptional value, but subsequent threats and deterioration led to its placement on the List of World Heritage in Danger in 1992 due to the "deterioration to a status where it has irretrievably lost its characteristics".[88] In response to the challenges faced by the Srebarna site, Bulgaria initiated restoration and mitigation measures,[89] including monitoring the wetland quality, implementing land planning, and enacting new legislation for biodiversity conservation.[90] After some institutional conflict,[91] and recognised improvements, the Srebarna Natural Reserve was formally removed from the List of World Heritage in Danger.[92]

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[83] Redgwell, C. (2008). Art.2 Definition of Natural Heritage. In *The 1972 World Heritage Convention: A Commentary*. Eds. Francioni, F., & Lenzerini, F. Oxford, Oxford Public International Law.
[84] Convention Concerning the Protection of the World Cultural and Natural Heritage, Article 5
[85] Convention Concerning the Protection of the World Cultural and Natural Heritage, Article 16
[86] UNESCO World Heritage Centre. (2021). *Operational Guidelines for the Implementation of the World Heritage Convention*. p. 58.
[87] Decision 7 COM VIII.29, 1983
[88] Decision 16 COM VIII, 1992
[89] Decision 18 COM XII.1, 1994
[90] Decision 22 COM VII.2, 1998
[91] Decision 22 BUR V.A.2, 1998
[92] Decision 27 COM 7A.10, 2003

Not all stories have a happy ending though, at least not through the instrument of the World Heritage List, which is often perceived by States as an intrusion. Recently, the Great Barrier Reef case[93] went down in history, following the refusal by the Australian government to inscribe the area in the List of World Heritage in Danger, as recommended by the IUCN and UNESCO mission on site.[94] Similarly, in September 2023 Venice and its Lagoon avoided entering the List of World Heritage Sites in danger with great exultation from the Ministry and the Major of the city.[95] In its 2020 report, however, the UNESCO had advised the city to take measures and restore saltmarshes in the lagoon, which quality is and health continue to decrease.[96]

In conclusion, it is hard to say whether this instrument has been effective in practice or not, the convention can serve as a platform for international cooperation and support, but its impact is influenced by a range of factors, including political will, institutional capacity, and the willingness of states to implement necessary restoration measures.

Often, the World Heritage Convention goes hand in hand with another important treaty, the *Convention on Wetlands of International lmportance*, also known as the *Ramsar Convention*, negotiated in 1971 in Ramsar, Iran.[97] Its main scope is the protection and wise use of wetlands and waterfowl, and it provides that each state designates suitable wetlands to be included in the List of Wetlands of International Importance.[98] While the convention does not explicitly mention restoration, it includes provisions that indirectly relate to restoration efforts. One such provision is found in Article 4(2) of the convention.

> Where a Contracting Party in its urgent national interest, deletes or restricts the boundaries of a wetland included in the List, it should as far as possible *compensate* for any loss of wetland resources, and in particular it should create *additional nature reserves* for waterfowl and for the protection, either in the same area or elsewhere, of an adequate portion of the original habitat.

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[93] The Guardian. World Heritage Committee agrees not to place Great Barrier Reef on "in danger" list. https://www.theguardian.com/environment/2021/jul/23/world-heritage-committee-agrees-not-to-place-great-barrier-reef-on-in-danger-list, last access January 2023

[94] World Heritage Convention and IUCN. (2022). *Reactive Monitoring mission to the Great Barrier Reef* (Australia).

[95] New York Times. Venice Keeps Off List of Endangered World Sites. https://www.nytimes.com/2023/09/14/world/europe/venice-unesco-danger-list-tourism.html

[96] Report of the joint UNESCO/Icomos/Ramsar Advisory mission to the world heritage property 'Venice and its lagoon' (Italy)

[97] Convention on Wetlands of International Importance (known as Ramsar Convention), Feb. 2, 1971, reprinted in 996 UNTS 245.

[98] *Ibid.*, Article 2(5)

In essence, Article 4(2) of the Ramsar Convention provides a mechanism for compensating for the negative impacts on wetlands, and this compensation may involve restoration efforts. Moreover, in 1999 with the COP 7th, the Parties adopted Resolution VII.17, calling upon all Parties to purse restoration planning and implementation in parallel with wetland protection, and in particular considered that "national planning and legislation on protection and sustainable use of nature, environment and water management should be developed to include obligations or, at least, options for wetland restoration."[99]

These references, although quite interesting and convincing, find little confirmation in reality. Many wetland areas around the world continue to experience conversion, degradation, and loss due to various human activities, such as urban development, agriculture, pollution, and infrastructure projects.[100]

2.3.4.1. United Nations Convention on the Law of the Sea

In a different context, we also find a variety of relevant treaties covering the marine environment, as part of the United Nations Convention on the Law of the Sea (UNCLOS).[101] Following several versions, the latest UNCLOS agreement came into force in 1994, and it is an international convention that sets out the legal framework, the rights and obligations of State Parties on the marine environment, covering several issues, such as fisheries management, navigation rules as well as measures for the protection and conservation of the "living resources".

While the UNCLOS does not directly mention Marine Protected Areas (MPAs), it nonetheless requires that State Parties put in place all the necessary measures to prevent, reduce and control pollution of the marine environment[102], and that they protect and conserve rare or fragile ecosystems.[103]

Explicit reference to restoration is found in two passages: Article 61 and Article 119. In Art. 61, States agree – within their exclusive economic zone – to implement measures that ensure the maintenance of the living resources and that are designed:

[99] Resolution VII.17, Annex, parr. 1.
[100] Convention on Wetlands. (2021). *Global Wetland Outlook: Special Edition 2021*. Gland, Switzerland: Secretariat of the Convention on Wetlands.
[101] United Nations Convention on the Law of the Sea, Montego Bay, 10 December 1982, in force 16 November 1994, 21 International Legal Materials (1982) 1261.
[102] *Ibid*., Article 194(1)
[103] *Ibid*., Article 194(5)

> to maintain or *restore* populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental and economic factors, including the economic needs of coastal fishing communities and the special requirements of developing States, and taking into account fishing patterns, the interdependence of stocks and any generally recommended international minimum standards, whether subregional, regional or global.[104]

Similar wording is also used in article 119, where the concept is reiterated with conservation measures for the living resources in high seas and the harvest of species.[105]

Interestingly, State Parties to UNCLOS have also agreed to take such measures taking into consideration the "effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened".[106]

What we find in this sentence is the willingness of Parties to adopt an approach that does not strictly cover commercial species but also includes those that are incidentally caught through harvesting, an attempt to adopt an "ecosystem approach".[107] Of course, all such efforts go in the direction of restocking some fish populations with particular economic value, and are implemented through a permit system based on an agreed "maximum sustainable yield formula".[108] As noted by *Telesetsky et al.*,[109] as interesting as this might seem, this system suffers key downsides: first, in several instances, maximum sustainable yields are set based on political considerations, and second, in some cases, limiting fishing activity or pure restocking may be insufficient (e.g., in case of highly polluted areas), and more profound interventions may be needed.

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[104] Convention on the Law of the Sea, Article 61(3-4)
[105] *Ibid.*, Article 119(1)
[106] *Ibid.*, Article 61(4)
[107] On the notion of whether the UNCLOS actually takes an ecosystem approach or not, an academic debate is open.
Among those who suggest the UNCLOS takes an ecosystem approach, we find:
Morishita, J. (2008). What is the ecosystem approach for fisheries management? *Marine Policy*, 32(1), 19–26. https://doi.org/10.1016/j.marpol.2007.04.004
Wang, H. (2004). Ecosystem Management and Its Application to Large Marine Ecosystems: Science, Law, and Politics. *Ocean Development and International Law*, 35(1), 41–74. https://doi.org/10.1080/00908320490264382
On the other side, Vito De Lucia in his book distinguishes between narrow and broad ecosystem approach, holding that under the UNCLOS, the "ecosystem approach" is more to be understood as sustainable management of resources, more than actual comprehensive ecosystem approach.
De Lucia, V. (2019). *The "Ecosystem Approach" in International Environmental Law: Genealogy and Biopolitics.* Routledge.
[108] Convention on the Law of the Sea, Article 61(3)
[109] Telesetsky et al., (2016)

On a positive note, in March 2023 State Parties to the UNCLOS have finally reached an agreement on an instrument for the conservation and sustainable use of biodiversity beyond national jurisdiction (referred to as the "BBNJ agreement"). This agreement aims to protect the world's international waters and establish binding legal commitments to restore marine areas.[110]

Before it comes into force, the agreement will need to be formally adopted and ratified by at least 60% of its State Parties, but it is a necessary and much-welcomed step pushed by the High Ambition Coalition for Nature and People[111] to setting up Ocean Sanctuaries across 30% of the oceans and entails commitments to restore coastal ecosystems by 2030.

2.3.4.2. United Nations Framework Convention on Climate Change

When discussing ecosystem restoration, it is essential to consider the political and legal complexities intertwined with another significant environmental crisis: climate change. Following the Rio Convention in 1992, States convened and signed the *United Nations Framework Convention on Climate Change,* which came into force in 1994.[112] Its main aim is to "achieve the stabilization of greenhouse gas concentrations in the atmosphere at a level that prevent dangerous anthropogenic interference with the climate system."[113], and currently sees 195 signatory Parties. While the UNFCCC does not explicitly impose restoration obligations, Article 4(e) commits Parties to:

> (e) Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and *rehabilitation* of areas, particularly in Africa, affected by drought and desertification, as well as floods

Initially, in 1992, the rehabilitation of damaged areas was intended to be limited to the harm inflicted by the direct consequences of climate change, especially in the Global South. However, since then, the sequence of yearly Conferences of the Parties (COPs) has led to

[110] See how the news was reported:
The Guardian. High seas treaty: historical deal to protect international waters finally reached at UN.https://www.theguardian.com/environment/2023/mar/05/high-seas-treaty-agreement-to-protect-international-waters-finally-reached-at-un, last access January 2023
[111] The High Ambition Coalition for Nature and People is an intergovernmental group of more than 100 countries championing a deal of protecting at least 30 percent of the world's land and ocean by 2030. See their website: https://www.hacfornatureandpeople.org/home, last access February 2023
[112] United Nations Framework Convention on Climate Change, New York, 9 May 1992, in force 21 March 1994, 31 International Legal Materials (1992) 849, <http://unfccc.int>
[113] United Nations Framework Convention on Climate Change, Article 2

numerous resolutions and added layers of complexity to discussions about climate change and restoration for mitigation and adaptation. During the latest COP27 held in Sharm-el-Sheikh in November 2022, the COP recognised the

> urgent need to address, in a comprehensive and synergetic manner, the interlinked global crises of climate change and biodiversity loss in the broader context of achieving the Sustainable Development Goals, as well as the vital importance of protecting, conserving, restoring and sustainably using nature and ecosystems for effective and sustainable climate action.[114]

In particular, restoration has found its place among both mitigation[115] and adaptation[116] measures, in the case of ecosystems acting as sinks and reservoirs[117] or integrating water basins restoration into adaptation efforts.[118] Certainly, this double nature of restoration practices was not new to the UNFCCC system: the idea of using forests as carbon sinks through forest conservation and afforestation in developing countries has found widespread interest over time. During COP19 in 2013 the Warsaw Framework for REDD+[119] was adopted, offering methodological and financial guidance for forest sector activities that encourage carbon sequestration and deforestation prevention. This combination of activities presents a potential win-win for climate and biodiversity crises, aiding in habitat and species preservation while also contributing to technology and knowledge transfer. Despite the large and long-term technical and financial assistance accorded, projects are only accepted conditional they are clearly adding up on the status quo and prove to be associated with reduction in carbon emissions. However, criticisms emerged during the early years of REDD+ implementation: research has shown lack of permanence in emission reductions in the long

[114] Decision -/CP.27, Sharm el-Sheikh Implementation Plan, Preamble

[115] Mitigation is about decreasing the amount of emissions released into the atmosphere and in reducing the current concentration of carbon dioxide (CO2) by enhancing sinks. Based on their responsibilities and capabilities, Parties are required to formulate and implement programmes that contain mitigation measures. Among them, there are policies, incentives schemes and investment programmes that cover all sectors, from the use of renewable energy to new technologies with limited emissions or changes in diet. Moreover, they comprehend carbon sinks such as forests and peatlands and CO2 sequestration technologies
Adapted from: Introduction to Mitigation | UNFCCC

[116] Adaptation is about the adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects. It refers to changes in processes, but also practices and structures to moderate potential damages or to benefit from opportunities associate with climate change. They can take several forms, depending on the context where they are developed, and can range from flood defences to drought-resistant crops.
Adapted from: Introduction | UNFCCC

[117] Decision -/CP.27 Sharm el-Sheikh Implementation Plan, Parr. 15

[118] Decision -/CP.27 Sharm el-Sheikh Implementation Plan, Parr. 21

[119] FCCC/CP/2013/10/

run,[120] increased rates of forest loss across borders,[121] as well as uncertainty on the actual "additionality" of projects, i.e., whether they would have occurred even without the initiative. Moreover, studies have shown that there are, potentially, several adverse implications on biodiversity connected with REDD+, when afforestation occurs in areas where non-forest ecosystems would naturally dominate,[122] or where the planting of high carbon value species in place of native ones.[123]

Apart from the REDD+ initiative, which exclusively pertains to developing countries, since 2015, all Parties to the UNFCCC are required to prepare, communicate, and maintain successive nationally determined contributions (NDCs) to support the achievement of the long-term temperature goal.[124] These contributions involve domestic mitigation commitments and are expected to reflect the highest possible ambitions in order to meet national emission reduction targets.[125] As shown by Rong[126], as of December 2022, 124 States Parties to the UNFCCC have included ecological restoration measures in their NDCs, stemming from substantial incremental tree plantings[127] to soil restoration,[128] from peatland and wetland rewetting[129] to riparian restoration[130]. Indeed, Grassi et al.[131] calculated that if the NDCs were fully implemented, forests could transform into net carbon sinks by 2030, sequestering approximately a quarter of the intended emission reductions.

The synergy between restorative practices and climate change intervention is not, however,

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[120] Demarchi, G., Carrilho, C. D., Catry, T., Atmadja, S., Subervie, J. (2022). Beyond reducing deforestation: impacts of conservation programs on household livelihoods. *Working Papers, HAL*.

[121] Roopsind, A., Sohngen, B., & Brandt, J. S. (2019). Evidence that a national REDD+ program reduces tree cover loss and carbon emissions in a high forest cover, low deforestation country. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(49), 24492–24499. https://doi.org/10.1073/pnas.1904027116

[122] Veldman, J. W., Overbeck, G. E., Negreiros, D., Mahy, G., Stradic, S. L., Fernandes, G. W., Durigan, G., Buisson, E., Putz, F. E., & Bond, W. J. (2015). Where Tree Planting and Forest Expansion are Bad for Biodiversity and Ecosystem Services. *BioScience*, *65*(10), 1011–1018. https://doi.org/10.1093/biosci/biv118

[123] For a comprehensive evaluation of the REDD+ programme, see:
Parrotta, J., Mansourian, S., Wildburger, C., Grima, N. (2022). Forests, Climate, Biodiversity and People: Assessing a Decade of REDD+. *IUFRO World Series, 40.*

[124] Paris Agreement, Art. 4(2)

[125] *Ibid*., Article 4(4)

[126] Rong, Z. (2023). *The public trust principle as a possible means to advance ecological restoration in China.* Dissertation Thesis. Ghent University.

[127] UNFCCC (2021), Ethiopia. Updated Nationally Determined Contribution.

[128] UNFCCC (2020), Cabo Verde. Update to the first Nationally Determined Contribution.

[129] UNFCCC (2022), Indonesia. Updated Nationally Determined Contribution.

[130] UNFCCC (2021), Malawi. Updated Nationally Determined Contributions.

[131] Grassi, G., House, J. I., Dentener, F., Federici, S., Elzen, M. G. D., & Penman, J. (2017). The key role of forests in meeting climate targets requires science for credible mitigation. *Nature Climate Change*, *7*(3), 220–226. https://doi.org/10.1038/nclimate3227

limited to mitigation, as underlined in the latest IPCC report on "Impacts, Adaptation and Vulnerability":[132] restoration of forests, terrestrial, freshwater, marine, but also of urban environments is highly recommended to enhance the resilience of ecosystems.

2.3.4.3. United Nations Convention on Biological Diversity

The key treaty that, for the purpose of the dissertation, can illuminate on how restoration is recognized in international law is certainly the *Convention on Biological Diversity* (CBD).[133] Negotiated in 1992, this Convention was initially aimed at laying the groundwork – similar to what later occurred with the UNFCCC – for a framework convention to promote the conservation and sustainable use of biological diversity.[134] With the participation of 196 Parties, the agreement holds significant recognition, although the United States' non-ratification (only signature) stands out.[135]

While highlighting that States have foreign rights over their own biological resources, the Convention, for the first time, acknowleges that the conservation of biodiversity is a "common concern of humanity", somehow bringing forth the idea that biological diversity transcends national boundaries and requires coordination in action.[136] However, similar to most framework conventions, the CBD reflects the concerns of its Parties more than solving problems itself.[137] This is evident in the Convention's mild approach, emphasizing that Parties must take measures "as far as possible and appropriate"[138] and it is replete with soft and general obligations.

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[132] IPCC, 2022: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Eds. H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA doi:10.1017/9781009325844

[133] Convention on Biological Diversity, Rio de Janeiro, 5 June 1992, in force 29 December 1993, 31 International
Legal Materials (1992) 822, <http://www.biodiv.org>

[134] Convention on Biological Diversity (2000). *Sustaining life on Earth: how the Convention on Biological Diversity promotes nature and human well-being.* Secretariat of the Convention on Biological Diversity, Montreal.

[135] Blomquist, R. F. (2002). Ratification Resisted: Understanding America's Response to the Convention on Biological Diversity, 1989-2002. *Golden Gate University Law Review, 32*(4), 5. https://digitalcommons.law.ggu.edu/cgi/viewcontent.cgi?article=1844&context=ggulrev

[136] Convention on Biological Diversity, Preamble

[137] Louka, E. (2006). *International Environmental Law: Fairness, Effectiveness, and World Order*. Cambridge University Press. DOI: doi.org/10.1017/CBO9780511618109

[138] The terminology is repeated in several articles of the convention, in particular in Arts. 5, 6, 7, 8, 9, 10, 11, 14

The Convention explicitly refers to restoration in the context of *in situ* and *ex situ* conservation.[139] Article 8(f) stipulates that:

> Each Contracting Party shall, as far as possible and as appropriate:
>
> (f) Rehabilitate and *restore* degraded ecosystems and promote the recovery of threatened species, inter alia, through the development and implementation of plans or other management strategies.[140]

The wording used in the article is quite lax and does not establish precise obligations for State Parties, which should only "as far as possible" implement either rehabilitation or restoration measures. By the letter of the law, there is no inherent prioritization of one over the other, leaving considerable room for interpretation to individual states. Nevertheless, if the underlying spirit of the law is to "conserve biological diversity"[141], then States have the responsibility to ensure that ecological disruptions do not escalate to a point where recovery becomes impossible.

A second general obligation related to restoration can be inferred from Article 9 on ex-situ conservation which suggests, again, that Parties shall, "as far as possible and as appropriate," and primarily for complementing in-situ measures:

> (c) Adopt measures for the *recovery* and *rehabilitation* of threatened species and for their reintroduction into their natural habitats under appropriate conditions.[142]

Here, again, restoration is viewed more as a tool supporting conservation initiatives, rather than as an independent and self-standing approach deserving specific efforts and commitments.

Lastly, Article 14(2) addresses impact assessment and adverse impacts, requiring each Contracting Party to:

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[139] In Article 2 of the CBD, *in-situ* conservation is defined as the "conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties."
Ex situ conservation is defined as "the conservation of components of biological diversity outside their natural habitats."

[140] Convention on Biological Diversity, Article 8

[141] *Ibid.*, Article 1

[142] *Ibid.*, Article 9(c)

> ‘examine, on the basis of studies to be carried out, the issue of liability and redress, including *restoration* and compensation, for damage to biological diversity, except where such liability is a purely internal matter’.[143]

The issue of liability and redress under the CBD has spurred numerous questions and has been a recurring topic in COP discussions. For example, during COP9 in Bonn in 2008, the Executive Secretary provided a Technical Report[144] where “damage” was suggested to occur when (i) human interventions have a negative effect, (ii) it cannot be redressed through natural recovery. The report also emphasized the importance of establishing baselines or pre-incident evaluations supported by experts, as a reference for subsequent restoration activities. Lastly, the report concluded that primary restoration (on-site measures) should be favored over other forms of redress, such as complementary restoration methods or monetary compensation. This document highlights the increasing inclination to base interventions on scientific knowledge and also advocates for the precedence of restoration over other interventions, yet it does not delve much further than that.

Given the ongoing decline in global biodiversity, the Conference of the Parties has progressively adopted a target-based approach to operationalize its provisions. In 2010, during the COP held in Nagoya, Directorate of Aichi, Japan, the Parties reached an agreement on the Strategic Plan for Biodiversity 2011-2020[145], aiming to curtail worldwide biodiversity loss. Specifically, Target 14 provided that:

> By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are *restored* and safeguarded, taking into account the needs of women, indigenous and local communities and the poor and vulnerable.

Additionally, Target 15 provided that:

> By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks have been enhanced, through conservation and *restoration*, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

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[143] Convention on Biological Diversity, Article 14(2)

[144] United Nations Environmental Programme. (2014). *Liability and Redress in the Context of Paragraph 2 of Article 14 of the Convention on Biological Diversity: Synthesis report on technical information relating to damage to biological diversity and approaches to valuation and restoration of damage to biological diversity, as well as information on national/domestic measures and experiences.* UNEP/CBD/COP/9/20/Add.1

[145] CBD (2010). UNEP/CBD/COP/DEC/X/2. The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets, para. 10(c).

Despite the considerable resources mobilized to meet the Aichi targets, none of them has been fully realized. Targets 14 and 15, in particular, scored particularly badly since the capacity of ecosystems to function has decreased consistently globally.[146]

Overall, the CBD has contributed to expanding the protection of biodiversity as well as promoting an ecosystem approach to biodiversity protection. However, the obligations under the CBD are limited to what State Parties can do "as far as possible or as appropriate", or "subject to national legislation", and it has so far failed to fully achieve its commitments.

Conservation and restoration are merely "promoted" in the CBD, and the lack of precision in defining the obligations allows ample room for interpretation by State Parties, thereby compromising its effectiveness.[147] On the other hand, the broad participation to the CBD and the possibility for States to develop their National Biodiversity Strategies and Action Plans remains a good reason to trust the process. In December 2022, the most recent CBD COP 15 convened, following a two-year delay due to Covid-19 and a relocation from Kunming, China, to Montreal, Canada. This meeting resulted in the agreement on the "Post 2020 Kunming-Montreal Global Biodiversity Framework," a document that heightens the level of ambition in protecting and restoring biodiversity. Despite challenges during the negotiation phase, the increased ambition, target precision, and strong public concerns offer hope for the framework to be a dynamic and impactful document.

2.3.5. Conclusions

Most international environmental treaties – especially those agreed in the 70s, 80s – overlook the concept of restoration. For instance, the agreement that regulates transboundary air pollution[148] is completely silent on any obligation to restore, and the same happens with the Convention on Environmental Impact Assessment in a Transboundary Context[149] which does not account for any cumulative historic loss. Other conventions and agreements, especially covering specific habitats and species, contain provisions that imply restoration, and their elaboration during Conferences of the Parties indicate increasing concern over sparse

[146] Convention on Biological Diversity. (2019). *Global Biodiversity Outlook 5. A final report on progress against the 20 global biodiversity targets agreed in 2010 with a 2020 deadline*.
[147] Fajardo del Castillo, T. (2021). Principles and Approaches in the Convention on Biological Diversity and Other Biodiversity-Related Conventions in the Post-2020 Scenario. In *Biological Diversity and International Law: Challenges for the Post 2020 Scenario.* Eds. Eritja, and T. Castillo. Springer Nature.
[148] Convention on Long-Range Transboundary Air Pollution, (LRTAP), 13 November 1979, into force 16 March 1983.
[149] Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), 25 February 1991, into force 10 September 1997, amended in 2004.

degraded ecosystems. Yet, they say quite a little about the content of a duty to restore, and the key takeaway is that ecological restoration enjoys little self-standing recognition at the legal level in international law. We could probably say – and this is the reading by Telestsky et al., that restoration is regarded as, essentially, an obligation of conduct, that is to say, the commitment to intervene is triggered only in the presence of threatened species or degraded habitats, and it is bound to economic feasibility. Conversely, there seems to be little basis to construe restoration as an obligation of result, intended to attain overall ecosystem integrity, and cumulative human impact tends to be overlooked.

Certainly, the latest UN initiative on the Decade on Restoration is trying to give salience to restoration, showcasing good practices and leveraging on existing programmes and legislation that already exist at regional level (especially in the EU), and at the national level, where the most diverse and interesting laws are developed.

In scholarship, the proposals on how to streamline restoration through technical legal instruments have been several: some suggest negotiating a Protocol to the Convention on Biological Diversity to establish internationally agreed standards for national restoration implementation, while others suggest formulating and discussing an agreed "principle to restore" that could more comprehensively cover different regimes.[150]

Some have been suggesting a new international treaty specifically dedicated to ecological restoration is needed,[151] others, however, lean towards investigating more traditional instruments of international law, and in particular correlate the human right to a healthy environment and the potential of ecological restoration as an instrument to fulfil it. On a similar – yet less anthropocentric – perspective, some other scholars are advancing the argument that there is a strict symmetry between ecological restoration and the rights of nature, and that restorative practices would be intended to repair wrongs to the subject "nature".[152]

Finally, other streams of scholarship are convinced that the transversal nature of restoration would benefit from a more serious and more incisive overlapping of biodiversity restoration

[150] Cliquet, A., Telesetsky, A., Akhtar-Khavari, A., & Decleer, K. (2021). Upscaling ecological restoration: toward a new legal principle and protocol on ecological restoration in international law. *Restoration Ecology*, 30(4). https://doi.org/10.1111/rec.13560

[151] Richardson, B. J. (2016b). The Emerging Age of Ecological Restoration Law. *Review of European, Comparative and International Environmental Law*, *25*(3), 277–290. https://doi.org/10.1111/reel.12165

[152] See, in particular, the most recent work by Hendrick Schoukens.

and other areas of environmental law, especially climate change: back in 2009, Trowborst[153] and several others after him[154] suggested taking more seriously existing UNFCCC provisions on climate change adaptation and biodiversity, maybe intervening to foster connectivity requirements as a form of adaptation. However, despite the intuitive nature of this approach and the several scientific findings[155], the climate and biodiversity regimes continue to run parallel, with integration appearing distant, as underscored by the latest UNFCCC COP27 held in Sharm El-Sheikh in November 2022.

While these suggestions are intriguing and innovative, the primary challenge for international environmental law is finding effective ways to address global and widespread degradation that extend beyond a strict interpretation of national sovereignty. Also, one may wonder whether the international level is the governance level that best suits the design and implementation of restoration rules.

2.4 Ecological Restoration in European Law

2.4.1 Introduction

Europe is a relatively small continent, yet it is highly diverse, ecologically: from the Mediterranean to the Alps, the Scottish peatbogs, and the boreal forest. Europe is also a highly populated region that has experienced a history of intensive pollution connected to its development activities.[156] Centuries of human settlement have led to overexploitation of natural resources, intensified agriculture, the proliferation of grey infrastructure, and various human pressures that have significantly impacted biodiversity across the region.[157] As warned

[153] Trouwborst, A. (2009). International Nature Conservation Law and the Adaptation of Biodiversity to Climate Change: A Mismatch?. *Journal of Environmental Law*, 21(3). 419–442, https://doi.org/10.1093/jel/eqp024

[154] See, for example, Heyvaert, V., & Duvic-Paoli, L. (2020). *Research Handbook on Transnational Environmental Law*. Edward Elgar Publishing.
Alexander, S., Nelson, C. R., Aronson, J., Lamb, D., Cliquet, A., Erwin, K. L., Finlayson, C. M., De Groot, R., Harris, J. A., Higgs, E., Hobbs, R. J., Lewis, R. S., Martinez, D., & Murcia, C. (2011). Opportunities and Challenges for Ecological Restoration within REDD+. *Restoration Ecology*, *19*(6), 683–689. https://doi.org/10.1111/j.1526-100x.2011.00822.x

[155] IPCC, (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* (Eds.). H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama. Cambridge University Press. Cambridge University Press, Cambridge, UK doi:10.1017/9781009325844

[156] Hughes, J. D. (2009). *An Environmental History of the World: Humankind's Changing Role in the Community of Life*. Routledge: New York

[157] For a quick overview of the biodiversity quality status in Europe, check: European Environmental Agency. (2020). *State of nature in Europe: a health check*.
Leclère, D., Obersteiner, M., Barrett, M. H., Butchart, S. H. M., Chaudhary, A., De Palma, A., DeClerck, F., Di Marco, M., Doelman, J. C., Dürauer, M., Freeman, R., Harfoot, M., Hasegawa, T., Hellweg, S., Hilbers, J. P., Hill, S. L. L., Humpenöder, F., Jennings, N., Krisztin, T., . . . Young, L. H. (2020). Bending the curve of

by the Inter-Governmental Panel on Biodiversity and Ecosystem Services (IPBES) in 2019, "more species are threatened with extinction than ever before in history"[158], and this is a call for action at all governance levels: from the international to the national, through the regional level.

According to the latest report by the European Environmental Agency,[159] less than half of all bird species have a good population status in the EU, while almost 40% exhibit poor or unfavourable status. Even species under protection have not fared much better, with only 27% of 1389 protected species being in a satisfactory conservation state.[160] Moreover, three out of four safeguarded habitats demonstrate poor or bad conservation statuses. More concerning still, over a third of habitats within the EU territory continue to deteriorate, showing that progress has so far been insufficient, if not very marginal.

To respond to these challenges, over the last decades the EU environmental policy and legislation have expanded dramatically, and from scattered and uncoordinated that were, have become a sophisticated system of regulation and protection applicable across the continent and covering all sectors of environmental law: from energy to water, biodiversity and waste, air quality and toxic substances. In such a rich landscape, it comes naturally to look at the existing legal and policy frameworks searching for provisions for environmental loss, damage, and restoration. However, delving into this exploration reveals not only a scarcity of literature on the subject—since only a handful of scholars have tackled it[161]—but also an inconsistency between ambitious policy declarations and limited normative provisions.

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terrestrial biodiversity needs an integrated strategy. *Nature*, *585*(7826), 551–556. https://doi.org/10.1038/s41586-020-2705-y

[158] IPBES (2019): *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (Eds). IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/zenodo.3831673

[159] European Environment Agency. (2020). *State of nature in the EU. Results from reporting under the nature directives 2013-2018*, EEA Report No. 10/2020

[160] *Ibid*. p. 35

[161] Among them, at the EU level we can recall:
Born, C., Cliquet, A., Schoukens, H., Misonne, D., & Van Hoorick, G. (2014). *The Habitats Directive in its EU Environmental Law Context: European Nature's Best Hope?* Routledge.
Lopez-Bao V., Fleurke, J., Chapron, G., Trowborst, A. (2018). *Legal obligations regarding populations on the verge of extinction in Europe: Conservation, Restoration, Recolonization, Reintroduction. Biological Conservation. 227*, 319-325. https://doi.org/10.1016/j.biocon.2018.09.027
Schoukens, H. (2019). Legal considerations in operationalizing eco-restoration in the European Union. A Sisyphean task or unlocking existing potential?. In *Ecological Restoration Law. Concepts and Case Studies.* (Eds.) Akhtar-Khavari, A., & Richardson, B. J. New York: Routledge.
Telesetsky et al., (2016).
Vershuuren, J. (2010). Climate Change: Rethinking Restoration in the European Union's Birds and Habitats Directive. *Ecological Restoration.* 28(4), 431-439.

Modeling itself after the United States, Europe has historically addressed environmental damage through liability provisions that empower public authorities to instigate the restoration of impaired environments. However, as noticed by Krämer, the legal and institutional framework developed - especially through the Environmental Liability Directive[162] - falls short of effectively addressing environmental damage.[163] First, as will be later discuss, the directive does not contain any provisions concerning civil law compensation for damage to humans or the environment, but it simply provides for the *restoration of the impaired environment.* Secondly, unlike the US Environmental Protection Agency[164], it lacks a dedicated authority with financial support to actively drive restoration efforts, with clear practical consequences. Lastly, by not imposing an obligation to implement restoration when a clear polluter is absent, it offers minimal incentives for Public Authorities to intervene and restore compromised environments.[165]

If liability provisions are sparse and limited in scope, the situation becomes even more concerning when addressing another, more insidious array of problems: the gradual degradation of the environment, watercourse pollution, species extinction, and air contamination - all problems originating from lawful, legitimate activities.

Of the *mare magnum* of environmental regulation, this section seeks to analyze the most pertinent legal and policy frameworks at the European level that specifically tackle the requirements and obligations to rehabilitate damaged ecosystems. Moreover, it aims to offer insights into the coverage and effectiveness of primary legal provisions related to restoration,[166] the interplay of different actors at multiple European levels, and the systems of economic incentives, especially when confronted with competing policy goals.[167]

The analysis will commence with an exploration of the foundational texts within the EU, followed by an examination of EU soft law instruments, and key regulations and directives.

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[162] Directive 2004/35 on environmental liability with regard to prevention and remedying of environmental damage (ELD), OJ 2004, L 143/56

[163] Krämer, L. (2021). The EU and the system of Environmental Damage: Liability, Restoration and Compensation. In *Environmental Loss and Damage in a Comparative Law Perspective*. (Eds.) Pozzo, B., Jacometti, V. Intersentia eBooks. https://doi.org/10.1017/9781839701191

[164] The Environmental Protection Agency (EPA) is the public authority in charge of protecting human health and the environment. It carries out research on environmental risks, develop regulation and disseminate information. For a more thorough understanding of the type of job carried out by the EPA, see: https://www.epa.gov/

[165] The Environmental Liability Directive in Article 6(3) goes like this: "The competent authority shall require that the remedial measures are taken by the operator. If the operator fails to comply with the obligations laid down in paragraph 1 or 2(b), (c) or (d), cannot be identified or is not required to bear the costs under this Directive, the competent authority may take these measures itself, as a means of last resort."

[166] Schoukens, H., (2017)

[167] Baker et al., (2014)

Due to space constraints, unfortunately, not all legal instruments will be analysed, a selection of them has been made.

2.4.2. Principles of Environmental EU Law

Lately, the European Union institutions have been actively working to position Europe as a global leader in environmental protection, striving to become an environmental champion and frontrunner in international environmental cooperation. However, the journey began differently. Indeed, in the original Treaty establishing the European Economic Community (EEC) there was no explicit mention of environmental protection as a Community concern. Ever since 1957, however, priorities have changed, the Single European Act in 1987 first introduced the Title VII "Environment"[168], and this was at a later stage discussed and amended repeatedly with the Maastricht Treaty and the Lisbon Treaty, progressively introducing the environmental dimension and broadening the scope of European intervention in this area.[169]

The Union's critical role in regulating development activities and protecting the environment is laid down in Article 3(3) of the Treaty of the European Union, which states that the Union shall work at a "high level of protection and improvement of the quality of the environment".[170] Even more explicit is the renowned Article 191(1) of the Treaty on the Functioning of the European Union, where it is enunciated that the EU environmental policy shall contribute to "preserving, protecting and *improving* the quality of the environment".[171]

One may wonder whether these three programmatic commitments are sufficiently supported in the pillars of EU legislation, and as pointed out by Cliquet[172], while the first two - preserving and protecting - are directly addressed by traditional environmental principles of prevention and precaution mentioned in Article 191(2), the third commitment ("improving the quality of the environment") is less formalized and supported by conventional legal tools.

As a matter of fact, the needs to treat damaged ecosystems are only partially covered by traditional environmental principles such as rectification of damage at source or the polluter-pays principle. Nonetheless, both Article 3(3) of the TEU and Article 191 of the TFEU have

[168] Single European Act, O.J. L 169, 29.6.1987, pp. 1-28, Article 130
[169] In particular, with the Lisbon Treaty the European Union committed to actively protect the environment and pursue sustainable development, both internally and externally.
[170] Treaty on the Functioning of the European Union, O.J. C 326 , 26/10/2012 P. 1–390, Article 3(3)
[171] Treaty on the Functioning of the European Union, Article 192(1)
[172] Cliquet, A. (2020).

been interpreted as the legal basis to promote conservation and restoration measures that provide an improvement to ecosystems.[173]

2.4.3. EU Directives

Over the decades, the legislative power in Europe has undergone significant redistribution: competences – especially in key sectors connected to the environment such as agriculture, fisheries and waste – have shifted away from the national to the supranational level. At the same time, the principles of conferral, subsidiarity and proportionality laid down in Article 5 of the TEU[174], impose limits on EU authority, which needs to dialogue with subnational institutions in charge of implementing EU law.[175] Even in the case of restoration, most of the relevant provisions have been made at the EU level and then delegated to Member States, typically through directives. [176]

In Europe, a constellation of directives makes direct or indirect reference to ecological restoration, albeit employing diverse approaches. Some prescribe restoration duties to recover degraded habitats and species, whereas other work *ex ante* by requiring offsets as a conditionality for development projects (in some cases including restoration), or *ex post* as a form of remediation obligation following direct liability in case of structural or accidental damage.

In the upcoming section of the dissertation, the principal EU legal instruments and policies covering the recovery of damaged ecosystems and environments will be analysed. The analysis will particularly focus on their objectives, scope, the type of activities and ecosystems they cover, their monitoring systems, and their time frames.[177] The examination of the legal text is complemented by official reports, guidance documents issued by the Commission, and case law from the Court of Justice of the European Union.

[173] Telesetsky et al., (2016)
[174] Treaty on the European Union, Article 5
[175] Morgera, E. (2013). European environmental law. In *Routledge Handbook Of International Environmental Law*. (Eds) Alam, S., Bhuiyan, J., Chowdhury, T., Techera, E., 427–442. Routledge.
[176] Directives are legislative acts that set out specific goals all Member States are required to achieve in a given amount of time, but they are then free to devise the instruments to achieve them.
[177] Adapted from Prieur, M., Bastin, C., & Mekouar, A. (2021). *Measuring the Effectivity of Environmental Law: Legal Indicators for Sustainable Development*. Peter Lang B.

2.4.3.1. Birds and Habitats Directives

As of today, the European Union does not possess a general instrument to safeguard biodiversity or the landscape. The most relevant instruments are the *Birds Directive* from 1979[178] on the conservation of wild birds, and the *Habitats Directive* from 1992,[179] on the conservation of natural habitats and of wild fauna and flora. They are commonly referred to as the "Nature Directives" because, combined, they establish the first European ecological network of special areas of conservation, serving as the cornerstone for biodiversity protection.

The Directives do not explicitly mention and define "ecological restoration", but this should not come as a surprise considering the time when they entered into force. Nevertheless, the combination of the text analysis and their interpretation given by the Court seems to suggest that indeed the Nature Directives encompass positive restoration obligations for Member States.[180]

Article 1 of the Birds Directive imposes a specific obligation on Member States to take measures to maintain the population of all wild bird species in the EU. To fulfil this, they are required to take measures to *preserve, maintain or re-establish* a sufficient diversity and area of habitats for all bird species to achieve a favourable conservation status (FCS).[181] Practically, Member States are to designate the most suitable territories in number and size as Special Protection Areas (SPAs), manage them in accordance with ecological needs and re-establish destroyed biotopes. Although the term "re-establish" might be open to interpretation, in 2007, the Court of Justice of the EU (CJEU) affirmed that the preservation, maintenance, or restoration of a sufficient diversity and area of habitats is essential to the conservation of all species of birds, therefore restoration became a key intervention Member States need to implement.[182]

In complementarity with the conservation of wild birds, the Habitats Directive aims at contributing towards ensuring "biodiversity through the conservation of natural habitats and

[178] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds, *OJ L* 20, 26 January 2010, replacing the original Birds Directive.
[179] Directive 92/43/EEG of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, *OJ L* 206, 22 July 1992 (hereafter: Habitats Directive).
[180] Telesetsky et al., (2016); Schoukens, H., (2017)
[181] Birds Directive, Article 3
[182] Case C-235/04 (Commission of the European Communities v. Kingdom of Spain), 2007. (Court of Justice of the European Union), para. 23

of wild flora and fauna"[183] and refers to conservation as "a series of measures required to maintain or *restore* the natural habitats and the populations of species of wild fauna and flora at a favourable status".[184]

To achieve this objective, Member States are tasked with designing and establishing Special Areas of Conservation (SACs) "where the necessary conservation measures are applied for the maintenance or restoration, at a favourable conservation status, of the natural habitats and/or the populations of the species for which the site is designated".[185]

Beyond the general intent of the law, Article 6 provides more insightful details on the framework for establishing and maintaining protected areas. Paragraph 1 of Article 6 mandates the obligation to implement conservation measures and management plans to designate protected areas.[186] Although it does not amount to an obligation to establish protected areas in *all* protected habitats or where protected species live, it does require that Member States put an effort and establish them, also keeping into consideration the potential of such areas after restoration.[187] Otherwise the non-designation is to be justified scientifically.

Paragraph 2 of Article 6, instead, introduces an obligation of non-deterioration of natural habitats and the prevention of disturbance to species within Special Areas of Conservation, "in so far as such disturbance could be significant in relation to the objectives of this Directive." In this regard, the directive adopts a strong preventive approach, and despite its somewhat vague wording, it mandates that Member States take all necessary measures to ensure the prevention of any disturbance or deterioration, both within and outside the protected areas, including agricultural, fishing and water management activities.[188]

Following Article 6(3), plans and projects within protected areas must undergo comprehensive evaluation to prevent significant negative effects, and exceptions to this rule

[183] Habitats Directive, Article 2
[184] *Ibid.*, Article 1
[185] Habitats Directive, Article 1(l)
[186] Although it does not set a prioritisation area, it is to be read in conjunction with the list of species included in Annexes, already a priority.
[187] This is one of the criteria present in Annex III - Criteria for selecting sites eligible for identification as sites of community importance and designation as special areas of conservation.
Moreover, it was reaffirmed in:
Case C-281/16, Vereninging Hoekschewaards Landschap, 2017. (Opinion of Advocate General), para, 37.
[188] Case C-127/02, (Landelijke Vereniging tot Behoud van de Waddenzee and Nederlandse Vereniging tot Bescherming van Vogels v Staatssecretaris van Landbouw, Natuurbeheer en Visserij.), 2004. (Court of Justice of the European Union), para. 37.

are granted solely under very stringent conditions.[189] Interestingly, this provision's application extends not only to Natura 2000 sites but also beyond them, in situations where the proposed activity could potentially inflict harm on nearby protected areas.[190] When interpreting this provision, the CJEU has assumed a pretty strict understanding of the precautionary principle, both in assessing projects and in verifying their impact against the conservation objectives of the sites. The *Sweetman* case[191] serves as a noteworthy illustration of the Court's approach, as it ruled against the implementation of a development activity – even if its scale was minimal – due to concerns that it could compromise the whole area's integrity.

Finally, Art. 6(4) stipulates provisions for derogation permits to construct plants within protected areas in cases of "imperative reasons of overriding public interest", and compensatory requirements to ensure that the overall coherence of Natura2000 is protected.[192] This provision is an example of what was previously defined as an *ex-ante* regulation, that requires offsets as a conditionality to development projects.[193]

If the establishment of the Natura2000 network brought substantial change in European conservation – as of today, it covers over 18% of the EU land area and more than 8% of its marine territory – it is essential not to regard protected areas as the sole means to achieve the objectives of the Nature Directives. Indeed, the creation of protected areas is not an end but should and has been read together with Articles 11 and 17 providing for monitoring and reporting obligations. What this means, in practice, is that conservation provisions are responsive to the status of conservation of protected species and habitats. In instances where periodic monitoring yields negative results, supplementary measures become necessary, both

[189] The conditions are that: no alternative solutions are available, that the project should be implemented for imperative reasons of overriding public importance (even of social and economic nature), and that all necessary compensatory measures are taken, making sure there is no net loss for Natura 2000. This is restricted even more in case of priority of natural habitat/species, where only safety and health concerns are allowed.

[190] Case C-418/04, (Commission of the European Communities v. Ireland), 2007. (Court of Justice of the European Union).
Case C-294/17, (Coöperatie Mobilisation for the Environment UA and Vereniging Leefmilieu v. College van gedeputeerde staten van Limburg and College van gedeputeerde staten van Gelderland), 2018. (Request for a preliminary ruling from the Raad van State).

[191] Case C-258/11, (Peter Sweetman and Others v An Bord Pleanála), 2013. (Request for a preliminary ruling from the Supreme Court)

[192] For a critical analysis of the jurisprudence on Art. 6 of the Habitats Directive, see:
European Commission. (2018). Managing Natura 2000 sites – The provisions of Article 6 of the Habitats Directive 92/43/EEC, Brussels.

[193] They constitute "last resort" initiatives and require the implementation of additional measures – often not even in the same place where damage occurs – to reach the overall objective of the Directive. They should not be confused with mitigation measures (which are contextual to the development plan and aim at reducing the impact of the project) and, interestingly, the CJEU has repeatedly taken a restrictive jurisprudential approach on the topic, at times rejecting proposed projects (i.e., the Briels case) based on misplaced mitigation efforts.

within and beyond protected areas.[194] If these provisions were taken seriously, recent research based on sophisticated monitoring systems of protected species could bring additional arguments to the restoration of their habitats.[195]

Articles 12 and 13 of the Habitats Directive are then the most traditional provisions, since they require strict prohibition of deterioration or destruction of animal species listed in Annex IV and their breeding and resting sites. Although there is no direct mentioning of restoration, the norm was interpreted quite broadly in the *Cricetus cricetus* case (called the "Hamster case"), started in 2007 before the CJEU by the Commission against France. Following the claim by the Commission, the Court found that the measures implemented by France 'were not adequate to enable effective avoidance of deterioration or destruction of the breeding sites or resting places of the European hamster'.[196] Consequently, the Court required France to establish more effective measures for conserving the hamsters within the protected areas, which could include the restoration of their habitats.[197] Despite this interesting judgment, such a strict interpretation of Articles 12 and 13 has yet to see broader application and cannot be regarded as establishing a positive obligation to restore habitats and species when they are no longer present.

Interestingly, the Nature Directives incorporate a provision that mandates the avoidance of deterioration and disturbance if such actions undermine the ecological objectives of conservation, applicable even outside the fences of protected areas.[198] Article 4(4) of the Birds Directive stipulates that "outside these protection areas, Member States shall also strive to avoid pollution or deterioration of habitats". The European Commission has further clarified that this encompasses "areas which are the most suitable for the conservation of wild birds,

[194] Case C-209/04, (Commission of the European Communities v. Republic of Austria), 2006. (Court of Justice of the European Union).
[195] See, for example, the recent project tracking the routes of migratory species across and beyond the European territory: https://migrationatlas.org/
Franks, S., Fiedler, W., Arizaga, J., Jiguet, F., Nikolov, B., van der Jeugd, H., Ambrosini, R., Aizpurua, O., Bairlein, F., Clark, J., Fattorini, N., Hammond, M., Higgins, D., Levering, H., Skellorn, W., Spina, F., Thorup, K., Walker, J., Woodward, I. and Baillie, S.R.1. (2022). *Online Atlas of the movements of Eurasian-African bird populations.* EURING/CMS.
[196] Case C-383/09, (European Commission v. French Republic), 2011. (Court of Justice of the European Union), para. 37 and 25.
[197] For an in-depth analysis, Schoukens, H., (2017)
[198] Case C-304/05, (Commission of the European Communities v. Italian Republic), 2007. (Court of Justice of the European Union).
Cliquet, A. (2015). About blanket bogs, brown bears and oak forests: case law of the European Court of Justice on article 6§2 of the Habitats Directive. In *D'urbanisme et d'environnement. Liber Amicorum Francis Haumont.* (Eds.) Born, C. H., Jongen, F. Bruylant, 531–44.

even if they have not been classified as special protection areas, provided that they merit such classification."[199]

Lastly, relevant to the object of this dissertation, the Habitats Directive provides an obligation on connectivity. In practice, this means that restorative measures such as ecological corridors, stepping stones and buffer zones that connect protected areas should be implemented, since they facilitate large-scale ecological processes, especially in times of changing climate.[200] Article 10 establishes that "Member States shall endeavour, where they consider it necessary, in their land-use planning and development policies and, in particular, with a view to improving the ecological coherence of the Natura 2000 network, to encourage the management of features of the landscape which are of major importance for wild fauna and flora".[201] On paper, this provision lays the groundwork for additional efforts to establish ecological corridors between Natura 2000 sites. However, despite a few instances where the CJEU halted development activities due to their interference with protected species corridors,[202] it never went to saying that this provision elicited positive restoration of connectivity obligations.[203]

In summary, the Nature Directives include in their texts - and related jurisprudence - *binding restoration obligations of result* on Member States, within protected areas and towards protected species in bad conservation status. Despite the strict protection they offer, this conservational approach is balanced by the fact that derogations are granted, and compensatory measures adopted when projects, plans, or programs of significant impact are justified for reasons of overriding public interest. Moreover, little if no monitoring exists over compensatory measures and sometimes no serious action follows the judgements, with several infringements being essentially allowed or not acted upon even after judicial condemnation.[204]

Despite these limitations, the Nature Directives have successfully facilitated the conservation of critical European species and habitats, delivering multiple benefits to society that

[199] Case C-96/98, (Commission of the European Communities v. French Republic), 1999. (Court of Justice of the European Union).
[200] Consider that connectivity measures are particularly important for those species whose survival is dependent on movements between habitats.
[201] Habitats Directive, Article 10
[202] Case C-404/09, (European Commission v. Kingdom of Spain), 2011. (Court of Justice of the European Union).
[203] Verschuuren, J. (2014). Connectivity: is Natura 2000 only an ecological network on paper?. In *The Habitats Directive in its EU Environmental Law Context: European Nature's Best Hope? (Eds.)* Born, et al. Routledge, 285–302.
[204] Krämer, L., (2021).

"significantly exceed identified costs."[205] Looking ahead, there are key challenges to tackle, including enhancing coordination among Natura 2000 sites, restoring degraded areas, and adapting to the impacts of climate change. Interestingly, protected areas are likely to be at the forefront of the "ecological transition" debate. The discovery of "rare earths" or "critical raw materials"[206] in various countries, often within protected areas, is likely to fuel discussions on the trade-offs between biodiversity protection and the pursuit of energy transition.[207]

2.4.3.2. Environmental Liability Directive

Second comes the Environmental Liability Directive (also called ELD),[208] the directive which provides the most comprehensive framework for ecological restoration within the broader context of recovery measures following damage to ecosystems. Enacted in 2004, its purpose is twofold: on the one hand it aims a remedying damage to natural resources[209] to baseline condition that would have existed if no damage had occurred[210], and on the other hand it tries to prevent damage altogether.

The ELD establishes a double system of liability. The first one covers environmental damage from activities listed in Annex III[211] triggering liability regardless the establishment of fault or negligence.[212] The second one instead encompasses environmental damage from activities not listed in Annex III, where a fault-based liability framework is applied. In the event of damage, the operator responsible is obligated to inform the competent authority and take practical measures to control, contain, remove, or manage contaminants.[213] The same competent authorities can then require the operator to provide supplementary information on the damage

[205] European Commission. (2016). Fitness check of the EU Nature Legislation (Birds and Habitats Directives) Directive 2009/147/EC on the conservation of wild birds and Council Directive 92/43/EEC. p. 110
[206] The EU Commission President, Ursula von Der Leyen, has repeatedly addressed the topic in announcing strategies for energy transition in the industrial sector. In March 2023, a first proposal on a Regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020 was released.
[207] See, for example:
Euronews, 13 January 2023. Swedish mining company discovers Europe's largest deposit of rare earth elements. Available at:
https://www.euronews.com/green/2023/01/13/swedish-mining-company-discovers-europes-largest-deposit-of-rare-earth-elements
UniGe.Life, 28 April 2021Il titanio e il parco del Beigua. Available at: Il titanio e il parco del Beigua | UniGe.life
[208] Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage.
[209] ELD, Article 1
[210] ELD, Article 3
[211] In Annex III mostly large-scale industrial activities are listed.
[212] ELD, Article 3(1)(a)
[213] *Ibid.*, Article 6(1)

and to take the necessary remedial measures.[214] Alternatively, if the operator fails to address the situation adequately, the competent authority can step in and take remedial measures itself.[215]

From this framework, one might infer the existence of an obligation to restore the environment, initially resting on the operator and subsequently on the competent authority. However, as literature aptly points out, this duty is considerably constrained in practice due to the wide array of exemption clauses.[216]

In addition, when in Article 2(11) "remedial measures" are described,[217] and in Annex II are further detailed, in situ "ecological restoration" is only one among several other possible forms of recovery, being in general less impactful.

The ELD's limited scope and stringent threshold criteria significantly lower expectations about its capacity to effectively combat environmental degradation across the continent.[218] Moreover, as pointed out by Kramer, "Liability provisions have the objective of granting compensation to victims and of preventing, through their deterrent effect, future incidents. Directive 2004/35 does not provide for the compensation of the environment, for example through penalty payments into an environmental fund. It does not hold responsible public authorities that authorise damaging activities or tolerate them by not supervising, monitoring and sanctioning. It is limited as regards the restoration of the impaired environment. It does not give incentives to civil society representatives to identify cases of environmental impairment and enforce restoration, even when public authorities are reluctant."[219]

2.4.3.3. Water Framework Directive

The Water Framework Directive (WFD),[220] adopted in 2000, aims at protecting inland, transitional and coastal surface waters as well as groundwaters, through the regulation of pollutants and the establishment of a river basin governance system. Under the WFD, States are required to prevent the deterioration of the status of all bodies of surface and

[214] *Ibid.*, Article 6(2)
[215] *Ibid.*, Article 6(3)
[216] Exemption clauses are listed in Article 4, ELD
[217] *Ibid.*, Article 2(11)
[218] Telesetky et al., (2016)
Schoukens, H., (2017)
But also: European Commission. (2021). *Improving implementation and the evidence base for the ELD Under the Framework Contract No. ENV D.4/FRA/2016/0003*
[219] Krämer, L. (2018).
[220] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

groundwater,[221] but also to "protect, enhance and restore" all bodies of surface and groundwater[222] and to reach "good ecological status" (GES) everywhere.[223]

The Directive, for the first time, adopted an ecosystem-based approach to water protection, essentially recognizing the interdependency between water and land.[224] Despite this great element of novelty, its innovative power is counteracted – once again - by the several existing exceptions that allow for less stringent environmental standards in several cases. Article 4(5), for example, allows Member States to adopt less strict environmental objectives in the case of heavily modified bodies of water when intervention is deemed "unfeasible or disproportionally expensive".[225] Similarly, Article 4(7) allows derogation from binding obligations to fulfil the directive's objectives in cases of overriding public interest.[226] As observed by Krämer, this element has been exploited largely across Europe, and derogations guaranteed in all Member States. Yet, the European Commission has not challenged any Member State on the legitimacy of derogation use, thus undermining the very purpose of the directive.[227]

Another interesting element of the WFD is its non-deterioration clause embedded in Article 4(1), applicable to all surface water bodies within the European Union. The principle of non-deterioration was systematically ignored by Member States for years, until the German federal administrative Court requested the CJEU to clarify its content. In particular, the question was whether the principle was a general guideline for water management planning or if it could affect the ability of Member States to release permits for projects with potential negative impacts on water quality.[228]

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[221] Water Framework Directive, Article 4.1(i)

[222] WFD, Article 4(1) (a)(ii), 4.1 (b)(ii)

[223] In Annex V of the Water Framework Directive, the quality elements for the classification of ecological status are listed. Beyond the biological elements, there are the hydromorphological, chemical and physico-chemical elements.

[224] Moss, B. (2008). The Water Framework Directive: total environment or political compromise? *Science of the Total Environment*, *400*(1–3), 32–41. https://doi.org/10.1016/j.scitotenv.2008.04.029
Howarth, W. (2005). The Progression Towards Ecological Quality Standards. Journal of Environmental Law, 18(1), 3–35. https://doi.org/10.1093/jel/eqi049

[225] WFD, Article 4(5)

[226] WFD, Article 4(7)
On the excessive use of exceptions, even environmental NGOs expressed their position.
European Environmental Bureau, ClientEarth. (2022). *When the exception becomes the rule Overuse of exemptions from reaching the objectives of the Water Framework Directive due to coal mining and combustion.*

[227] Krämer, L. (2018).

[228] Paloniitty, T. (2016). The Weser Case: Case C-461/13BUND V GERMANY. Journal of Environmental Law, 28(1), 151–158. https://doi.org/10.1093/jel/eqv032

In response, the Court acknowledged the self-standing status of the non-deterioration principle, deeming it integral to fulfilling the overarching obligation to improve surface water quality. In practice, with the *Weser* case ruled in 2015 concerning the construction works in the Weser River, North of Germany, the Court ruled that Member States are prohibited from authorising projects that can deteriorate the quality of water, unless derogation under Article 4(7) applies.[229] However, it should not be believed that this ruling has definitively changed the policy system regarding water quality. Indeed, despite the strong stance taken by the European judges, courts in general tend to show greater attention to negative protection duties (that is to say, the duty to refrain from causing harmful activities), than on enforcing positive non-deterioration obligations.[230]

Despite the positive driving force brought about by the 2000 Water Framework Directive, the emphasis placed solely on the aspect of prevention and damage from pollution, rather than active intervention to restore water quality, has been felt. Indeed, if we consider that the state of degradation of several water bodies in Europe derives from the cumulative impact of industrialization and agricultural practices,[231] a strong and decisive paradigm change in the regulation and permitting of economic activities should be implemented.

2.4.3.4. Other directives and programmes

Beyond the directives discussed above, other instruments in European law include restoration clauses. In the *Floods Directive*[232] adopted in 2007, for example, reference is made to the development of flood risk management plans that should include, where possible, "the maintenance and/or restoration of floodplains"[233], as both a way to mitigate climate change impacts, and a cost-effective measure against increased floods.

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[229] Case C-461/13, (Bund für Umwelt und Naturschutz Deutschland e.V. contro Bundesrepublik Deutschland), 2015. (Court of Justice of the European Union). Para. 43.

[230] Moss, B. (2008).
Voulvoulis, N., Arpon, K. D., & Giakoumis, T. (2017). The EU Water Framework Directive: From great expectations to problems with implementation. *Science of the Total Environment*, *575*, 358–366. https://doi.org/10.1016/j.scitotenv.2016.09.228
European Commission. (2009). *Technical report 040: Common implementation strategy for the Water Framework Directive* (2000/60/EC).
Several scholars have also questioned the correct transposition of the WFD in Member States, such as: Söderasp, J., & Pettersson, M. (2019). Before and After the Weser Case: Legal Application of the Water Framework Directive Environmental Objectives in Sweden. *Journal of Environmental Law*, *31*(2), 265–290. https://doi.org/10.1093/jel/eqz003

[231] European Environmental Agency. (2018). *European waters: Assessment of status and pressures*. No. 7.

[232] Directive 2007/60/EC on the assessment and management of flood risks, L 288/27, 23 October 2007.

[233] Floods Directive, Preamble

Furthermore, the *Marine Strategy Framework Directive*[234], adopted in 2008, is a pivotal piece of legislation that establishes a comprehensive framework for all Member States to take all necessary measures to protect and preserve the marine environment, preventing its deterioration or, where practicable, restoring it.[235] According to the Directive, the measures were supposed to be achieving "good environmental status" (determined over a number of parameters) by 2020, but the goal has not been reached, considering that 40% of coastal water area is failing it.[236]

Even though they do not come in the form of directives, restoration measures are increasingly integrated in the EU's *Common Agricultural Policy* (CAP) and the *Common Fishery Policy* (CFP). The European CAP Reform, ratified in 2021, charted the course for agricultural policies spanning from 2023 to 2027, with an allocation of around 387 billion euros from the EU's budget. The reformed CAP rests upon three pillars: direct payments to bolster farmers' economic viability, intervention mechanisms in market dynamics, and measures for rural development.

Under the reformed CAP, beneficiaries encounter enhanced conditionality, wherein the payments they receive hinge on their compliance with certain stipulations. Each farm is mandated to allocate a minimum of 3% of arable land to support biodiversity, and at least 25% of the budget is dedicated to eco-schemes. These eco-schemes incentivize farmers to adopt practices that align with biodiversity-friendly goals. This is no news to the European realm, where agri-environment schemes offering incentives to farmers have been in place for a while now, with mixed results.[237]

In comparison to the previous reform, which was assessed quite negatively,[238] the current CAP pledges to have higher green ambitions ("no backsliding"). However, the analysis on

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[234] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy, *OJ L* 164, 25 June 2008.
[235] Marine Strategy Framework Directive, Articles 1 and 13
[236] European Commission. (2020). *Report from the Commission to the European Parliament and the Council on the implementation of the Marine Strategy Framework Directive (Directive 2008/56/EC).* European Commission: Brussels, Belgium
[237]Evidence on this payment for ecosystem services (PES) is mixed, since while on the one hand they do result in increased biodiversity, at the same time they also stimulate significant dependency on the provider, and risk being short-termed projects. See, among several:
Dasgupta, P. (2021). *The Economics of Biodiversity : The Dasgupta Review*. https://apo.org.au/sites/default/files/resource-files/2021-02/apo-nid310742.pdf
Batáry, P., Dicks, L. V., Kleijn, D., & Sutherland, W. J. (2015). The role of agri-environment schemes in conservation and environmental management. *Conservation Biology*, 29(4), 1006–1016. https://doi.org/10.1111/cobi.12536
[238] According to the European Court of Auditors, most of the mitigation measures included in 2014-2020 CAP period had low potential to mitigate climate change. Moreover, they found that among the several disincentives

Strategic Plans (CSPs) presented by Member States has been assessed as unsatisfactory by experts[239] and environmental NGOs.[240] In particular, these critics have identified key limitations in the current CAP: limited engagement with environmental and climate objectives (constituting only around 30% of the budget), the presence of subsidies for activities with detrimental effects (especially intensive livestock production), and the constrained reach and scope of green initiatives. Despite the tentative emphasis on fostering 'green' agriculture, the environmental (and societal) challenges tied to intensive practices, soil degradation, and unsustainable water use demand more resolute policies within the agricultural sector.

Lastly, it is worth highlighting the significance of the *Environmental Impact Assessment Directive (EIA).*[241] Initially introduced in 1985, this directive has undergone multiple updates and was eventually consolidated into a single comprehensive act in 2011. It focuses on major building or development projects (such as nuclear power stations, motorways, dams of certain capacity or waste disposal installations for hazardous waste) and its primary function is to outline the requisite procedures for evaluating the environmental repercussions of these projects.[242]

This instrument mainly regulates the procedural side of critically harmful development projects, and in article 9(1), it requires authorities to consider measures to "avoid, prevent, reduce, and if possible, *offset* significant effects on the environment",[243] indirectly supporting the achievement of No Net Loss policy.[244] Despite the strict statement, the outcomes of the Environmental Impact Assessment is not binding for decision-making, and no substantive and

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to climate-positive practices, the CAP supported financially the cultivation of drained organic soils and drained peatlands, responsible for 20% of EU agricultural greenhouse gases. Restoration of peatlands was not only unattractive to farmers, but in general little additional support was given to increase afforestation, agroforestry and conversion of arable land to permanent grassland.
European Court of Auditors. (2021). *Special Report. Common Agricultural Policy and climate Half of EU climate spending but farm emissions are not decreasing*. Vol. 16

[239] Doussan, I., Schoukens, H. (2014). Biodiversity and agriculture: Greening the CAP beyond the status quo? In *The Habitats Directive in its EU Environmental Law Context: European Nature's Best Hope?* (Eds). Born, C., Cliquet, A., Schoukens, H., Misonne, D., & Van Hoorick, G. Routledge. DOI:10.4324/9781315777290-40

[240] Birdlife International, European Environmental Bureau, NABU. (2022). *New CAP unpacked… and unfit.*

[241] Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment Text with EEA relevance

[242] For all other types of projects and constructions, EIA procedures are detailed at the national level.

[243] EIA Directive, Article 9.1 (c)

[244] European Commission. (2011). *Our Life Insurance, Our Natural Capital: An EU Biodiversity Strategy to 2020*. European Commission: Brussels, Belgium
No Net Loss policies essentially mandate that a mitigation hierarchy (avoid, prevent, reduce and offset) is applied in case of new developments/plants that can have an impact on the environment.

enforceable obligations to prevent or offset generic biodiversity loss stems from this Directive.[245]

Additionally, the European Commission has so far provided little guidance regarding the identification and execution of appropriate compensatory measures.[246] As a result, the application of such measures has been relatively mild[247], inadvertently fostering the proliferation of development projects with inadequate consideration for biodiversity preservation.[248]

2.4.4. Biodiversity Policies

Provisions aimed at safeguarding biodiversity are not confined solely to European legislation; they are also bolstered and, in some instances, anticipated through other programmatic instruments, generally referred to as "policies". Differently from specific provisions or regulations that are topic-specific, these types of initiatives strategically have a holistic perspective, and cover different areas of regulation.

The recent European Green Deal (EGD)[249], the ambitious policy launched by the EU Commission in 2019, has introduced elements of considerable novelty to the European landscape, and shows the commitment to transforming – permanently - the economic, institutional, and constitutional architecture of the EU and its Member States.[250]

Within the framework of the EGD, various commitments concerning biodiversity restoration are delineated, like in the case of the 2021 Climate Law[251] which references restoration as a

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[245] Schoukens, H., (2017).

[246] European Commission. (2013). *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment.*
European Commission. (2017). Environmental Impact Assessment of Projects Guidance on Screening (Directive 2011/92/EU as amended by 2014/52/EU). European Commission: Brussels, Belgium

[247] Vaissière, A., Levrel, H., Pioch, S., & Carlier, A. (2014). Biodiversity offsets for offshore wind farm projects: The current situation in Europe. *Marine Policy*, *48*, 172–183. https://doi.org/10.1016/j.marpol.2014.03.023
Ermgassen, S. O. S. E. Z., Baker, J. M., Griffiths, R. A., Strange, N., Struebig, M. J., & Bull, J. L. (2019). The ecological outcomes of biodiversity offsets under "no net loss" policies: A global review. *Conservation Letters*, *12*(6). https://doi.org/10.1111/conl.12664

[248] Damiens, F. L. P., Porter, L., & Gordon, A. (2021). The politics of biodiversity offsetting across time and institutional scales. *Nature Sustainability*, *4*(2), 170–179. https://doi.org/10.1038/s41893-020-00636-9
Moreno-Mateos, D., Maris, V., Béchet, A., & Curran, M. A. (2015). The true loss caused by biodiversity offsets. *Biological Conservation*, *192*, 552–559. https://doi.org/10.1016/j.biocon.2015.08.016

[249] European Commission. (2019). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. The European Green Deal. COM/2019/640 final

[250] Iannella, M. (2022). L'European Green Deal e la tutela costituzionale dell'ambiente. *Federalismi*, Vol. 24.

[251] Regulation 2021/1119/EU of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')

management policy to revitalise carbon sinks such as forests.[252] Most importantly, however, restoration finds its highest recognition in the Biodiversity Strategy for 2030.

After the failure of the previous decade commitments[253] and the limited progress achieved in terms of ecological output,[254] the European Commission opted to raise the bar and set forth an even more ambitious plan.[255] This new strategy entails a commitment to ensure that at least 30% of the EU's land and sea areas are effectively protected and sustainably managed by the year 2030. This commitment applies not only within designated protected areas but also extends to areas outside of these zones. Additionally, a significant step forward is the EU Biodiversity Strategy's pledge to slash the overall use of chemical pesticides by 50% and to transition 25% of the EU's agricultural land to organic farming.

The most groundbreaking development, however, centers around the pivotal role accorded to restoration within the EU's environmental policy framework. This is especially evident in the commitments outlined, including the promise that "the Commission will put forward a proposal for legally binding EU nature restoration targets in 2021 to restore degraded ecosystems, in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of natural disasters."[256]

The proposal on a new *Nature Restoration Law*[257] was presented on June 22nd, 2022, aiming to be the first legally binding provision for large-scale restoration in Europe. Contrary to the traditional approach of EU Institutions regulating environmental matters through Directives, the Commission has this time adopted a centralized approach, by setting forth a *Regulation*, binding and immediately applicable to all Member States, to intervene rapidly and

[252] Climate Law, Preamble, Whereas 23

[253]European Commission. (2011). Our Life Insurance, Our Natural Capital: An EU Biodiversity Strategy to 2020. (COM(2011) 244). European Commission: Brussels, Belgium
Following the initial efforts, the output was very limited, both in terms of ecological quality and in terms of States commitments, since only a few of them presented prioritisation frameworks. Despite the impression that a quantitative target is a self-sufficient objective, the Strategy did not bring the expected results.
European Commission. (2022). *Working Document. Evaluation of the EU Biodiversity Strategy to 2020.* European Commission: Brussels, Belgium

[254] European Environment Agency. (2020). State of nature in the EU. Results from reporting under the nature directives 2013-2018. EEA Report No. 10/2020

[255] European Parliament resolution of 9 June 2021 on the EU Biodiversity Strategy for 2030: Bringing nature back into our lives (2020/2273(INI))

[256] European Environmental Agency. (2022). *Carbon stocks and sequestration in terrestrial and marine ecosystems: a lever for nature restoration?*. EEA Report. No. 5/2022

[257] European Commission. Proposal for a Regulation of the European Parliament and of the Council on nature restoration (COM(2022) 304 final, 2022/0195 (COD))

homogenously across Europe,[258] on the basis that biodiversity conservation and restoration are better dealt with at the regional level.[259]

The law proposal delineates both a comprehensive, legally binding objective of repairing European land and sea areas, as well as some ecosystem-specific targets.[260]

Such legal architecture is particularly interesting because it reflects a recognition of the dynamic nature of ecosystems, spurring efforts to amplify the benefit of protected areas while also increasing connectivity. By setting up specific implementation, monitoring, and reporting procedures, then, it aims at scaling up restorative practices across countries, requiring the Member States to map out "restorable" areas and develop National Restoration plans.

The proposal starts (Article 1) by setting the overarching objective of recovering "at least 20% of the Union's land and sea areas by 2030, and, by 2050, all ecosystems in need of restoration", explained as a necessary contribution to the recovery of land and climate mitigation and adaptation efforts.[261] A second key input is offered by Article 3, where for the first time in the European context a punctual definition of "restoration" is given. For the Commission, restoration is "the process of actively or *passively*[262] assisting the recovery of an ecosystem towards or to good condition, of a habitat type to the highest level of condition attainable and to its favourable reference area, of a habitat of a species to a sufficient quality and quantity, or of species populations to satisfactory levels, as a means of conserving or

[258] This is explained in the Regulation text, page 8. Considering the transboundary dimension of biodiversity loss, the supranational level has been considered the most adequate to regulate it. Secondly, the Commission underlined the need to catalyse synergies and coordinate efforts across the continent, to minimise the risk of free-riding. Finally, this choice was justified as a leverage to make the EU credible at the international level and to "lead by example and by action".

[259] The argument is rooted in Art. 5 of the Treaty on the Functioning of the European Union, and the founding principle of subsidiarity. Interestingly, that same principle was used elsewhere to justify bigger state intervention.

[260] Of the possible different options, the combination of a single overarching legally binding target dragging forward action and additional ecosystem targets has been deemed the most adequate, for further information.
European Commission. (2022). *Working document: Impact Assessment Accompanying the proposal for a Regulation of the European Parliament and of the Council on nature restoration.* European Commission: Brussels, Belgium

[261] Proposal on a Nature Restoration Law (NRL), Article 1

[262] The introduction of both "active" and "passive" activities within the definition of restoration is worth attention. Certainly, this shows the intention of giving legal recognition to relieving activities such as non-management practices and natural processes, so far often overlooked. Moreover, it seems to be adherent to reality to affirm that restoration is about both active and passive interventions. At the same, one may wonder how will impact Member States' choices to prioritize areas of intervention and methodologies. To this end, the issuing of some guidelines clarifying this point could be a good complement to the Law.
Chazdon, R. L., Falk, D. A., Banin, L. F., Wagner, M., Wilson, S. J., Grabowski, R. C., & Suding, K. N. (2021). The intervention continuum in restoration ecology: rethinking the active–passive dichotomy. *Restoration Ecology*. https://doi.org/10.1111/rec.13535

enhancing biodiversity and ecosystem resilience".[263] Such definition is then complemented with a list of restoration measures provided in Annex VII among which we find, for example, rewetting of drained peatlands, removal of the non-native plantation, re-naturalization of river beds, or the increase in agro-ecological management approaches.

Articles 4 and 5 then require the Member States to substantially increase restoration efforts in protected areas identified with the Birds and Habitats Directive,[264] so that at least 90% of their surface are in good condition, and that "there is a continuous improvement of the quality and quantity of the habitats of species under the Nature Directives".[265] Interestingly, from Article 6 onwards the ambitious nature of the proposal emerges, since additional legally binding restoration targets covering non-protected areas are set. The proposal addresses and stipulates objectives for urban ecosystems,[266] river restoration,[267] pollinators[268] and agricultural ecosystems, but also peatlands[269] and, finally, forests.[270]

If these proposed targets were to be realized, then the effective realization of National Restoration Plans and their implementation would depend on the productive dialogue between Member States and European institutions.[271]

While the Nature Restoration law could be considered as the daughter of the Birds and Habitats Directives, it also departs from them considerably. First, it will have immediate efficacy across Europe, avoiding the intermediation of Member States. Secondly, it expands the scope of intervention since it covers all anthropized areas. Thirdly, the proposed law takes a long-term perspective: it is projected to monitor the advancement of restoration practices until 2050 (scientifically credible timing), and thus gives a strong incentive to monitor the state of health of biodiversity across Europe.

Although detailed and quite comprehensive, the Nature Restoration law should not however be considered a silver bullet for solving all environmental degradation problems in Europe. It will not be stressed enough that the law is but an instrument, existing within a broader system

[263] NRL, Article 3
[264] Birds Directive, supra note 182
Habitats Directive, supra note 183
[265] NRL, Article 4
[266] NRL, Article 6
[267] NRL, Article 7
[268] NRL, Article 8
[269] NRL, Article 9
[270] NRL, Article 10
[271] NRL, Articles 12-18

of environmental law provisions, and should not be seen as an alternative to them, but instead as an amplifier. Moreover, beyond the written law, the commitment of the Member States and all spheres of society will prove crucial in the implementation of restorative activities.

After a first lack of approval from the Committees on Agriculture (AGRI) and Fisheries (PECH), in July 2023 the law escaped its fully demise in the Parliament's plenary vote. At this point, the development of negotiations and the voting discussions in the trilogue will decide whether high ambitions objectives are kept intact and whether short-term results will be preferred over long-term ones. The strong opposition shown by some States, political parties and specific lobbies (e.g. from the pharmaceutical or agricultural environment), however, may make the remaining law-making process harder, possibly watering down substantially the objectives of the Regulation.[272]

2.4.4.1. Conclusions

Biodiversity, especially "ordinary biodiversity" has decreased in the European continent in the last few decades,[273] and the Directives in place, especially the Habitats Directive, have been the target of harsh criticism for failing their mandate.

From a preliminary assessment of existing legislation, however, a few interesting results can be drawn. From the conservation perspective, the Nature Directives have succeeded – and this is testified by the case-law brought before the Courts – in giving strict protection to habitats and species listed in Annexes. The Water and Floods Directives, then, have been a necessary step to collect information on the ecological status of waters in Europe and have in some areas been successfully restoring river quality. The ELD, then, has brought additional instruments in regulating ex post restoration in highly damaged environments. Taken together, however, all these instruments together have not been capable of halting the running biodiversity loss, especially in areas that are not strictly protected.

Han Somsen suggested that "the default of EU environmental law is and remains that humans are free to alter environments in any way they see fit, unless these have been purposefully and

[272] The change in presidency of the Council of the European Union may change the political agenda and delay some voting and law-making procedures. Moreover, the EU elections in 2024 appear to be highly influential in the negotiations.
[273] European Environment Agency. (2020). State of nature in the EU. Results from reporting under the nature directives 2013-2018. EEA Report No. 10/2020

specifically protected".[274] What this means is that in the last decades, European institutions have taken a fragmented approach, not only regulating single ecosystems with different instruments, but also setting standards and policy targets (think of the Bonn Challenge, the Aichi targets or the proposal for legally binding restoration targets in Europe) without really clarifying the content of "enhancing the environment". On the one hand, high levels of environmental protection in specific areas were performed, on the other hand the ecological integrity of landscapes was highly compromised. As seen, policies such as the agricultural (CAP) and fisheries policies (CFP) still incentivise harmful practices,[275] and soil, a crucial component of the environment, is still in practice excluded from protection.[276]

If there is no holistically stated purpose, and clarification on what ecological restoration is, even the application of the analysed Directives risks being only randomly implemented. The new Regulation on Nature Restoration proposal goes exactly in this direction, as it adopts a comprehensive approach to regulating actions across different environmental elements in the long-term. Whether Member States will accept it as it is is yet to be seen, but the initiative at least shows the European Commission commitment and determination to continue in this direction.

2.5. Ecological Restoration in Italian Law

2.5.1. Introduction

Restoration provisions have been embedded within various legal frameworks over the years, reflecting the requests from conservation movements, and partly responding to the pressing legacy of industrial activities. In post-unified Germany, for example, efforts were put into initiating large-scale programs of remediation of contaminated sites and restoration of rivers.[277] More recently, several countries have introduced laws on restorative practices:

[274] Somsen, H. (2015). From Improvement Towards Enhancement: A Regenesis of Environmental Law at the Dawn of the Anthropocene. *Social Science Research Network*. https://doi.org/10.2139/ssrn.2705450
[275] Cliquet, A., Decleer, K. (2018). Linking Restoration Science and Law. In *Ecological Restoration Law: Concepts and Case Studies*. (Eds.) Akhtar-Khavari, A., & Richardson, B. J. Routledge.
[276] Cliquet, A., (2017)
[277] As a result of extensive industrial zones and facilities, the environmental condition in the former Eastern Germany was significantly deteriorated, with numerous rivers classified as "ecologically devastated." Following reunification, outdated and heavily polluting facilities were shuttered, and comprehensive rehabilitation initiatives were undertaken, particularly in regions such as the Elbe and Rhine floodplains.
Two elements have been deemed crucial in the rehabilitation of the environment. First, the creation of national parks and reserves encompassing approximately 7% of Eastern Germany emerged as a vital strategy, propelled by the advocacy of Michael Succow, culminating in a pivotal meeting just prior to German reunification. Second, enhanced environmental legislation was instrumental in driving these restoration efforts forward.

countries such as Australia, Brazil, New Zealand, and Belgium have implemented such measures either as responsive actions to local exigencies or as adaptive strategies to address global pressures.

An exploration of constitutions worldwide, as of 2023, reveals that several countries, particularly in South America, have incorporated provisions acknowledging restoration.[278] Brazil, for instance, acknowledges the right to an "ecologically balanced environment," wherein both the State and the community possess the right to safeguard and conserve the environment, including through restorative processes.[279] Similarly, Nicaragua[280] and Costa Rica[281] uphold the right to a healthy environment and the consequent duty to preserve, conserve, and restore it. Ecuador has taken this a step further by acknowledging the inherent rights of nature, including the right of nature to be restored.[282]

Beyond the undoubtedly increasing recognition given to restoration in constitutional texts, a more thorough analysis of national laws is necessary to ascertain whether legislative and administrative bodies effectively translate restoration commitments into actionable measures. The next paragraphs are devoted to discussing the Italian legal system and identify the most relevant provisions covering and regulating restoration.

2.5.2. The Italian Constitution

In February 2022, the Italian Parliament nearly unanimously adopted the Constitutional Law n. 1/2022 (“Modifiche agli articoli 9 e 41 della Costituzione in materia di tutela dell’ambiente”), that gave a crucial boost to the protection of the environment in Italy. Specially, Article 9 stipulates that the Italian Republic “protegge l’ambiente, la biodiversità e

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Larson, M. (1995). Developments in River and Stream Restoration in Germany. *Restoration & Management Notes, 13*(1), 77-83.

[278] South American Constitutions are renowned for the prominent role given to the protection of the environment. Not only are they usually quite recent and very long, but they often incorporate thorough provisions covering the environment, natural resources and biodiversity protection, management and, indeed, restoration. Especially in Constitutions like Ecuador and Bolivia, the heritage of indigenous communities and culture is enshrined in constitutions which recognise nature as a subject of rights, and have “buen vivir” as a guiding principle for the development of decisions. For a more accurate account of the protection of the environment in South America, see:

Acosta, A. (2008). El buen vivir, una oportunidad por construir. *Ecuador debate*. *75*(1).

Gargarella, R. (2017). Constitutionalism of the Global South. *International Journal of Constitutional Law,* 15(2), 571–573. DOI: https://doi.org/10.1093/icon/mox040

Mendes, C. H., Gargarella, R., & Guidi, S. (2022). *The Oxford Handbook of Constitutional Law in Latin America*. Oxford University Press.

[279] Constituição da República Federativa do Brasil, promulgated in 2003, Article 225.

[280] Constitución Política de la Republica de Nicaragua, promulgated in 1987, Article 60.

[281] Constitución Política de 7 de noviembre de 1949 y sus reformas, Article 50.

[282] Constitución de la República del Ecuador, Article 72.

gli ecosistemi, anche nell'interesse delle future generazioni" ("protects the environment, biodiversity and ecosystems, also in the interest of future generations").[283] Article 41, instead, claims that economic private initiatives are free, but they cannot be in contrast with social utility, or against public health, the environment, safety, freedom, and human liberty.[284]

Before 2022, the protection of the environment and ecosystems was exclusively referenced in Article 117(2),[285] modified with the Constitutional Reform in 2001, which assigned strict competence on the subject to the State. This provision was vague and forced Courts to seek grounds for environmental protection in alternative provisions, especially Art. 9(2), on landscape protection, and Art. 32(1), on health.

In the former scenario, the preservation of nature's aesthetic appeal, frequently construed as an outcome of human engagement with the environment, was safeguarded. [286] The latter case, instead, entailed shielding an uncontaminated environment with the anticipation of potential repercussions on human health. Consequently, the constitutional safeguarding of the environment was, for a long time, acknowledged as a "derived" mode of protection, inherently reliant on and always filtered through human needs and development expectations. As a result, nature was not protected *per se*, and especially ordinary biodiversity (or, we could even say, less visually captivating) biodiversity was left without direct protection,[287] always mediated through other rights constitutionally protected.[288]

After years of discussion, the definitive text of Constitutional reform (a mild common ground among different proposals) was almost unanimously approved in 2022, providing the environment, biodiversity and animals with separate, and self-standing protection.[289] Despite

[283] Italian Constitution, Article 9
[284] Italian Constitution, Article 41
[285] Cafagno, M. (2007). *Principi e strumenti di tutela dell'ambiente*. *Come sistema complesso, adattativo, comune.* Torino: Giappichelli.
[286] For a thorough analysis of the legal notion and implementation of the landscape protection, see: Parisi, E. (2023). I moderni caratteri del concetto giuridico di paesaggio. *Federalismi.* N. 17.
[287] Colasante, P. (2020). La ricerca di una nozione giuridica di ambiente e la complessa individuazione del legislatore competente. *Federalismi, 20.*
[288] Whether the protection of the environment in Italy corresponded to a unitary definition of the environment as a public good, a matter of public interest or a Constitutional value rested open to academic discussion. Nonetheless, a consensus emerged regarding the legal practice, which conceived the environment as "a complex system which produces ecosystem services". This perspective did not inherently safeguard the environment in and of itself, but rather in relation to the stipulations and mechanisms that influenced human necessities.
Cafagno, M., D'Orsogna, D., Fracchia, F. (2018). The legal concept of the environment and systemic vision. In: *The Systemic Turn in Human and Natural Sciences: A Rock in The Pond. (Eds.).* Ulivi, L. U. (2018). Springer, 121-148. DOI 10.1007/978-3-030-00725-6_7
[289] Of the several proposals for amendment advanced before the voting, the final decision seems to be a mild common ground: proposals advanced by De Petris et al. (A.S. 212 and A.S. 83) supported the recognition of the

the understandable caution by scholars in assessing its practical relevance, the environment has now – at least on paper - taken the same preeminent position as health, safety, freedom, and human dignity.[290] This seems to suggest that, in some form, human beings and the environment are considered equal legal entities subject to primary policies,[291] and the Constitution is not creating a new individual human right.[292] This perspective is also reinforced by the acknowledged correlation in the Constitution between environmental protection and the welfare of future generations, holding significant potential in the years to come.[293]

A second interesting element of the constitutional reform has to do with the modifications to Article 41, which introduces limits to private economic activities in case of damage to human health or the environment, providing an additional layer of protection to ecosystems. The recent public debates as well as legislative policy development at the European level (think of the EU Green Deal and its "do not significant harm" principle) has emerged prominently, since the public authority has the ambition to address and coordinate economic activities towards sustainability, holding the potential to reshape the way conflicting values are balanced by both policymakers and judicial bodies and possibly reorienting other fundamental considerations.[294]

Stricter environmental protection, together with the conception of economic activities as contingent upon environmental thresholds signify a departure from the limitless capitalistic

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protection of the environment and ecosystems as a "fundamental right of individuals and their communities", but also proposed to insert in the constitution the European principles on the environment, such as the principle of prevention, the precautionary principle and the polluter-pays principle in the form of "responsibility and correction at source", together with the recognition that animals are sentient beings. Now, there is no trace of references to the environment as a right (subjective and collective), nor to environmental protection principles.
For a broader discussion on how constitutions around the world are getting more and more conscious of environmental protection see, among others,
Kotzé, L. J. (2016). *Global Environmental Constitutionalism in the Anthropocene*. Bloomsbury Publishing.
Amirante, D. (2022). *Costituzionalismo ambientale. Atlante giuridico per l'Antropocene*. Il Mulino.

[290] Morrone, A. (2022). L'«ambiente» nella Costituzione. Premesse di un nuovo «contratto sociale». In *La Riforma costituzionale in materia di tutela ambientale.* Editoriale Scientifica.

[291] Fracchia, F. (2021) I doveri intergenerazionali. La prospettiva dell'amministrativista e l'esigenza di una teoria generale dei doveri intergenerazionali. *Il diritto dell'economia*: 55-69.

[292] Fracchia, F. (2022). L'ambiente nell'art. 9 della Costituzione: un approccio in "negativo". *Il diritto dell'economia*. Vol. 107: 55-69.

[293] Consider, for example, the recent case discussed by the German Constitutional Court which recognised the need for a more ambitious climate change law in consideration of future generations.
Bundes-Klimaschutzgesetz (KSG) December 12 2019, Bundesverfassungsgericht, BvR 2656/18 March 24 2021.

[294] This position was hold by the Corte di Cassazione, the highest Administrative Court in Sentenza 8167, Sez VI del 2022, with reference to the link between the Constitutional protection of the environment with the value of private economic initiative.

approach and seem to embrace a strong interpretation of sustainable development,[295] that truly aim at not compromising the ability of future generations to meet their own needs.

Considering that, in general, greater constitutional environmental protection is to be welcomed positively, from the specific perspective of this thesis, the latter argument on "time frames" and future generations is particularly relevant. Indeed, if enhanced emphasis is placed on upholding environmental integrity when discharging economic private activities, then the preventive dimension of restoration may be strengthened. Concurrently, if the constitutional significance of preserving ecosystem services for forthcoming generations is duly acknowledged, this grants additional legitimacy and rationale for advocating restorative practices in the present time.

Let us now move to assess existing primary and secondary law provisions in the Italian legal framework.

2.5.3. Primary and secondary law

At present, the legal mandates and procedures that set up some positive obligation to restore at the domestic level can be essentially narrowed down to three main categories: *ex ante* regulation, introduced to prevent and mitigate foreseen damage, *ex post* regulation, to reduce environmental damage after accidents, and planning mandates.

In the next paragraphs, I will develop a tentative and non-exhaustive analysis of the most relevant provisions on restoration in the Italian legal landscape, starting from the work developed by Benjamin J. Richardson on the classification of national legislation.[296] The final aim is that of developing a reference map on existing legal provisions, showing that moving from a forward-looking system of environmental protection to one including backward-looking restoration is not necessarily easy, and there is a lot to learn from the past.

2.5.3.1 *Ex ante* regulation

In line with the traditional structure of environmental laws, *ex-ante* regulations encompass the body of administrative procedures that govern the release of licences and permits for projects and plans. More specifically, these regulations outline the measures that developers must

[295] Cuocolo, L. (2022). Dallo stato liberale allo "stato ambientale". La protezione dell'ambiente nel diritto costituzionale comparato. *DPCE Online, 52*(2).
[296] Richardson, B. J. (2017). *Time and Environmental Law: Telling Nature's Time.* Cambridge University Press.

proactively establish to reduce, mitigate, or compensate[297] for the damage caused by their projects, within clear temporal and spatial parameters. These measures are primarily preventive in nature and are applicable to all industry categories, although they may be more specific and stringent for particularly impactful activities, such as mining, the timber industry of hydropower plants, among others.

The core regulations can be found in the D. Lgs. 03/04/2006, n. 152 (Codice dell'ambiente)[298], which was developed and organised in compliance with Directive 2001/42/EC[299] and Directive 2014/52/UE[300]. The legislator justified these provisions in the preamble of the law with the objective of ensuring that human activities are compatible with the conditions of sustainable development. This includes compliance with the regenerative capacity of ecosystems and resources, the preservation of biodiversity, and the equitable distribution of the benefits associated with economic activities.

Provided this general justification, the law outlines the various procedures foreseen when issuing permits to develop projects and plans[301] emphasising that these administrative instruments primarily aim to proactively assess the impact of a given intervention on the environment. This assessment encompasses public health, biodiversity, territory, soil, water, air, climate, cultural heritage, and the landscape. However, it is essential to distinguish this general scope from the more specific objective of the law: it imposes procedural obligations, but it does not influence directly the public authority in the interests of environmental protection. Indeed, the main instruments adopted, the *Valutazione Ambientale Strategica, VAS* (corresponding to the Strategic Environmental Assessment)[302], and the *Valutazione di Impatto*

[297] Mitigation and compensation are not the same type of action: Mitigation refers to the reduction or prevention of negative impacts caused by human activities, with the goal of minimising environmental damage in a specific site.
Compensation for environmental harm is, instead, a process where the negative impact on the environment caused by human activities is remedied by providing an offsetting benefit or restoring the environment to its original condition. The goal is to restore the ecological balance and ensure that the damage caused is adequately addressed.
[298] Decreto Legislativo 3 aprile 2006, n. 152, Norme in materia ambientale
[299] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.
[300] Directive 2011/92/EU, as amended by Directive 2014/52/EU on the assessment of the effects of certain public and private Projects on the environment (EIA Directive).
[301] Specifically, we find reference to Valutazione Ambientale Strategica (VAS), the Valutazione d'Impatto Ambientale (VIA), the Valutazione di Impatto Sanitario VIS or the Valutazione d'Incidenza (VInCA), implemented in protected areas.
[302] In Title II, VAS is described and its procedure detailed. It is about the assessment of plans and programs that can have a significant impact on the environment and cultural heritage. VAS is carried out in the *preparatory phase* of the plan before it gets approved, exactly because it aims to identify at an early stage the possible negative impacts to advance alternative solutions.

Ambientale, *VIA* (corresponding to the Environmental Impact Assessment)[303] should help developers and administrators make informed decisions,[304] but they do not introduce any substantial obligations in the evaluation of projects.[305]

The provisions concerning the Environmental Impact Assessment (EIA), though quite detailed, remain silent on the specific mitigation and compensation measures to be implemented. These decisions are left to the discretion of the competent public administration closest to the individual cases. Consequently, the final assessment rests quite discretional on public authorities, and the planning, implementation, and monitoring methods of preventive compensation actions end up being heterogeneous in results, leaving ample room for litigation.[306] Given these circumstances, it is not surprising that there is no clear reference to biodiversity protection within the law concerning mitigation and compensation measures. This problem was partially overcome by the introduction of the technical guidelines developed in 2020[307] requiring consideration of biodiversity and climate aspects in evaluating environmental projects, yet it is to be seen how influential they are.

Beyond the EIA and SEA, additional legislation regulates ex-ante damages within industry specific sectors, which are worth exploring. Among them, the mining sector in Italy stands out as a particularly damaging activity regulated and allowed for reasons of national interests. The main reference in the Italian legal framework goes back to the R.D. 1443/1927,[308] followed by a series of norms[309] that assign competences over legislative power to Regions. Across the country, mines larger than 20 hectares are subject to an environmental impact assessment and, as described in the L. 30/07/1990, n. 221[310] art. 9, when given their licenses, owners are

[303] In Title III, VIA is described and regulated. It is carried out on single projects, and it works as a preventive instrument. The procedure is structured following different steps, and it comprises a preliminary study with the description of measures to "avoid, prevent or reduce and possibly compensate for possible significant and negative impacts" (Art. 22).
[304] D. Lgs. 3 aprile 2006, n.152, Article 4
[305] Delsignore, M. (2018). Codice dell'ambiente e VIA: una disciplina da ripensare? *Rivista Quadrimestrale dell'Ambiente*. Vol. 1. 98-119. This passage was clarified in the Case C-420/11, Jutta Leth v. Republik Österreich, Land Niederösterreich.
[306] Consiglio di Stato sez. IV, 02 agosto 2022, n.6799.
[307] SNPA. (2020). Valutazione di impatto ambientale. Norme tecniche per la redazione degli studi di impatto ambientale. Vol. 28
[308] Regio Decreto, 29 luglio 1927, n. 1443, Norme di carattere legislativo per disciplinare la ricerca e la coltivazione delle miniere nel Regno.
[309] For example:
Decreto del Presidente della Repubblica, 14 gennaio 1972, n. 2, Trasferimento alle Regioni a statuto ordinario delle funzioni amministrative statali in materia di acque minerali e termali, di cave e torbiere e di artigianato e del relativo personale.
Decreto del Presidente della Repubblica, 24 luglio 1977, n. 616, Attuazione della delega di cui all'art. 1 della legge 22 luglio 1975, n. 382.
[310] Legge 30 luglio 1990, n. 221, Nuove norme per l'attuazione della politica mineraria, Article 9

responsible for the “riassetto ambientale” (para. 1) of the exhausted sites, and the associate expenses. In this way, the law operates ex ante: since 2012, all new projects are accepted – among others - conditional on the issuance of rehabilitation plans. This effectively obliges enterprises to restore transformed areas, following what we could define as the "polluter pays principle" or the "user pays principle”.[311] In case of inability or non-compliance by the developer with the rehabilitation plan, the license can be withdrawn. [312]

However, since competence in the mining sector is granted at the regional level, one reason for disappointment is the high level of heterogeneity in rehabilitation obligations across the country. For example, Emilia-Romagna[313] legislation is land-use oriented, and requires rehabilitation based on specific goals: either agricultural (recupero agricolo), ecological (rinaturalizzazione), or socio-economic (recupero a fini legati alla fruibilità pubblica dei luoghi), each with significantly different requirements. Others, like Umbria, are instead more ambitious and require that all plans include both rehabilitation (ricomposizione ambientale) and compensation measures, in the form of additional reforestation.[314]

A different example comes from Regione Veneto[315], which defines the post-extraction activities as aiming at “ricomposizione ambientale”, described in article 9 as the “set of actions to be carried out during the execution of works and their conclusion, intended to restore or reconstruct […] an area functional to the safeguarding of the natural environment, site safety and soil reuse”[316]. The law, quite recent, details the safety parameters to be considered, and requires that the recovery of environmental, landscape, and naturalistic features of the area be carried out with reference to the pre-existent condition, often with an agricultural purpose.

The approaches taken in different regions change vary significantly. As a general trend, the laws require that works are carried out primarily to secure the area (hydrological and geological stability), and most of them link the rehabilitation of former mines to the intended use of the area, such as agriculture or leisure. However, only a few, usually the most recent

[311] See, Telesetsky et al., 2015.
[312] T.A.R. Lazio, Roma, sez. II, 04 febbraio 2022, n. 1328.
[313] Emilia-Romagna, Legge Regionale, 14 aprile 2004, n. 7, Disposizioni in materia ambientale. Modifiche ed integrazioni a leggi regionali.
[314] Umbria, Legge Regionale, 3 gennaio 2000, n. 2 Norme per la disciplina dell'attività di cava e per il riuso di materiali provenienti da demolizioni.
[315] Regione Veneto, Legge Regionale, 16 marzo 2018, n. 13, Norme per la disciplina dell'attività di cava.
[316] *Ibid.*, Article 9.

regional laws, require compensatory measures beyond rehabilitation, and explicit references to the re-establishment of ecological functions through restoration are quite rare.

Despite recent efforts in increasing the level of ambition in restorative practices in former mines, a lot is still to be done. According to the recent report issued by Legambiente[317], there is still too much legal uncertainty regarding the restrictions for issuing mining licenses, which too often rely on discretionary decisions by functionaries. Moreover, legal obligations on restoration plans should be necessary for all types of mines, given their level of ecological disruption, and clear references to environmental compensations should be introduced. Abandoned mines can become critical transition areas for both common and endangered species, but greater effort is definitely needed in the law to strengthen the scientific and ecological requirements for restoration before permits are granted.

2.5.3.2 *Ex post* regulation

In the second category we place *ex post* provisions, meaning the set of rules governing the recovery of polluted and degraded areas and clean-up standards, also called "remediation after damage" laws. These provisions are common across legal systems since they reveal the needs and attempts of polluted societies to deal with their industrial heritage. In general, they are developed around the scheme of the Polluter-Pays-Principles, whereby the costs of recovery interventions in case of damage fall on the polluter, when identifiable, or on the owner at the time of the discovery.[318]

The most relevant provisions in Italian environmental law regulating ex post damage can be found in D.Lgs. 03/04/2006, n. 152,[319] *Titolo V Parte IV,* as implementation of the Directive 2004/35/CE.[320] As general principles, the laws state that (i) the obligation of remediation is independent from the date of the damage, (ii) the main subject of obligation is the polluter, (iii) remediation measures should be put in place only after the approval by competent authorities, (iv) urgent measures are to be actionized immediately, without authorization.

In Article 240 definitions on the type of recovery required are set. "Reparation measures" are "any action or combination of actions including mitigation or provisional measures aimed at

[317] Legambiente. (2021) *Rapporto cave: La transizione dell'economia circolare nel settore delle costruzioni.*
[318] The full applicability of this principle has been confirmed by TAR Sicilia, Catania, Sez. I – 20 luglio 2007, n. 1254.
[319] Decreto Legislative, 3 aprile 2006, n. 152, Norme in materia ambientale.
[320] Directive 2004/35/EC on environmental liability with regard to prevention and remedying of environmental damage, OJ 2004.

repairing, restoring or replacing damaged natural resources or services, or providing an *equivalent alternative* to such resources or services".[321]

"Remediation" is instead the "set of interventions aimed at *eliminating* the sources of pollution and polluting substances, *or* at reducing the concentration of the same in the soil, subsoil and groundwater to a level equal to or lower than the values of the risk threshold concentrations". Additionally, "Environmental restoration" is about the "environmental and landscape restoration interventions, *complementary* to the remediation or permanent safety measures, and they allow the site to be recovered to its effective *intended use*, in compliance with urban planning instruments".

From these definitions it is already possible to get some insights on the type of intervention required as remediation after damage. Indeed, interventions are primarily aimed at eliminating pollution at source or isolating it (if not possible to eliminate it completely), to guarantee safety for human health and the environment. However, the numerous references to land-use destination and urban planning instruments reveal the strong connection between economic costs and potential economic productivity of the damaged area. Effectively, different parameters exist and are applied to evaluate an area, depending on its use: (1) private and public green spaces (stricter), (2) commercial and industrial areas (laxer).

Moreover, these definitions lack references to the overall health of the environment, or biodiversity, and there is no mentioning of ecosystems reconstruction.

D.Lgs. 152/2006, then, details the different steps of the remediation procedure. In synthesis, two possible situations can happen: in case the polluter is identified, s/he needs to put in action preventive measures and, if necessary, remediate the area.[322] However, if the polluter is unknown or defaulting, following art. 253, it is instead the competent public administration that intervenes, putting the encumbrance on the area, as guarantee to get back the money of the expense. In this last case, the final expense will be assessed based on the destination market value of the area.[323]

In ex post legislation, it is possible to find the sets of obligations falling on the polluter or, in case, on the public authority, to recover damaged areas. As illustrated, the goal of remediation is mostly that of controlling, containing and diminishing the contamination in land so that it

[321] D.Lgs. 3 aprile 2006, n. 152, Article 240.
[322] D.Lgs. 3 aprile 2006, n. 152, Article 242-245.
[323] *Ibid.*, Article 253

does not pose significant risk for human health. A second crucial element is that remediation as an activity is strictly linked to the destination of land use, meaning that in several instances low ambitious goals will be set, failing to really achieve full ecological restoration.

In some cases, private injury against human health or property is used to start civil liability litigation to remediate sites. This type of procedure, as interesting as it may seem, requires that the causal link between pollution and health conditions is first established, a quite expensive procedure. Moreover, even when successful, civil liability is directed at compensating victims, more than at reconstructing ecosystem functions, and therefore have limited impact on the empaired environment.

2.5.3.3 Planning mandates

Finally, under the third category, we find the planning norms, comprehending conservation laws and land use planning in general.

Environmental conservation laws are all the laws aimed at preserving rare, threatened or endemic animal and plant species. As seen in previous paragraphs, the European Union, through the Birds and the Habitats Directives committed to protect all wild bird species, habitats, animals and plant species at risk. Within protected areas, a strict set of laws regulate development activities as well as interventions to restore damaged habitats and species. In Italy, in particular, the Directives have been implemented[324] and then amended[325] with the aim of ensuring the "maintenance or restoration, with satisfactory conservation, of natural habitats and wild fauna and flora of Community interest."[326]

A key piece of legislation is the L. 06/12/1991, n. 394 "Legge Quadro sulle aree protette", the legal framework on protected areas.[327] The Law identifies the objectives and guiding principles in protecting the flora and fauna and sets up the institutional systems to implement it. Among its aims is the "b) application of environmental management or *restoration*

[324] Decreto del Presidente della Repubblica, 8 settembre 1997, n. 357, Regolamento recante attuazione della direttiva 92/43/CEE relativa alla conservazione degli habitat naturali e seminaturali, nonché della flora e della fauna selvatiche

[325] Decreto del Presidente della Repubblica, 12 marzo 2003, n. 120, Regolamento recante modifiche ed integrazioni al decreto del Presidente della Repubblica 8 settembre 1997, n. 357, concernente attuazione della direttiva 92/43/CEE relativa alla conservazione degli habitat naturali e seminaturali, nonche' della flora e della fauna selvatiche.

[326] Today, around 11% of the Italian territory is protected, around 10 million people reside in those areas and more than 300 thousand enterprises work there. The regulation of protected areas is understood as a way of executing the constitutional *goal* of protecting the environment, and it is therefore interpreted as an exclusive competence of the State.

[327] Legge, 6 dicembre 1991, n. 394, Legge quadro sulle aree protette.

methods suitable for achieving integration between man and the natural environment, also through the safeguarding of anthropological, archaeological, historical and architectural values and of agro-forestry-pastoral and traditional activities".[328]

When analysing different "Piano Parco" across Italy, the implementation of the expression "restoration" varies consistently: some activities aim at protecting the cultural dimension of the landscape, such as "functional restoration of meadows and grasslands", while others seem to have clear ecological goals such as "experimental reintroduction of animals" (rewilding), or the "promotion and structural restoration of silvo-pastoral systems".

Within the territory of protected areas, no constructions are allowed unless they comply with existing criteria, and if they "negatively affect the ecological, hydrological or hydrogeothermical balance of the area",[329] therefore, projects are subject to the assessment of Valutazione di Incidenza, to decide whether the project can be implemented or not. This requirement finds confirmation in jurisdiction, since in several cases the execution of VINCA procedures has stopped the implementation of new constructions.[330]

However, since the protection of the environment should be balanced against other legitimate rights, the legal regime in protected areas should be considered implying "inedificabilità non assoluta, bensì relativa", ("not an absolute ban on buildability, but a relative one") and evaluations need to be carried out on a case-by-case basis.[331] If no alternative solutions are viable and there exists *imperative* public interest, it is then possible to authorise projects provided adequate compensation measures are advanced.

Not all compensation measures, however, are acceptable. A recent interesting case[332] intervened and stopped the development of a skiing facility in Ovindoli, Abruzzo, based among others on the argument that the proposed mitigation and compensation measures were inadequate, difficult to implement and possibly leading to worsening of the ecological state of the area.[333]

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[328] *Ibid.*, Article 1(3).
[329] *Ibid.*, Article 6
[330] T.A.R. Sardegna, Cagliari, sez. II, 07 aprile 2016, n. 329
[331] T.A.R. Puglia, Bari, sez. I, 17 settembre 2008, n. 2128; T.A.R. Campania Salerno, sez. I, 06 giugno 2012, n. 1225
Constitutional Court, 17 March 2015, n. 38 reiterated that VINCA is to be carried out for any project, no regional guidelines can substitute them.
[332] T.A.R. Abruzzo, L'Aquila, sez. I, 03 gennaio 2022, n. 1
[333] The decision was based on different arguments: (i) the lack of administrative requirements in the Environmental Impact Assessment plan in a ZPS area, (ii) the risk of killing Vipera Ursinii, protected by the Habitats Directive and listed in Annex II of the Bern Convention, (iii) the risk of eliminating host plants of

In general, conservation laws are those regulations determining the establishment and management of protected areas. Their primary goal is that of conserving animal and plant species and habitats, therefore they impose strict limits on human activities. In addition to that, they impose that restoration of degraded areas be carried out both as part of the management of areas (by the public bodies, through specific activities) and by requiring that existing unlawful activities be redressed (obligations on private parties). All in all, they can be considered as the regulations providing for the highest ecological objectives, and areas where full restoration can indeed be achieved.

In addition to what examined in the current text, the category of "conservation laws" could and should probably be replaced and enriched with the broader category of "planning regulation". Indeed, other planning instruments such as urban plans, forestry plans or legal tools such as "river contracts" provide for extremely interesting example of how restorative practices can be implemented by public authorities when designing the management of areas and ecosystems. As interesting as they are, they will most probably be part of the further investigation for future research.

2.6 Conclusions

Law, understood as the set of general rules that a community establishes to govern the actions of its members, has been only partially capable of preventing, mitigating, and reversing the damaging impacts of human activities on the environment. In particular, the activity of deliberately intervening to repair environmental damage - the focus of this dissertation - is still quite underdeveloped.

From the reconstruction offered in this Chapter, biodiversity protection has seen an increased relevance in the last decade at the international level: from the first efforts to protect endangered species and habitats, we can now claim there exists a shared obligation of conduct to carry out restoration interventions, which is however dependent on the presence of threatened species and conditional to economic feasibility.

The latest COPs held under the Convention on Biological Diversity have shown increased awareness on the links between biodiversity loss, climate change and widespread pollution. In

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Vipera Ursinii's preys, thus further degrading the natural habitat of the protected species, (iv) the introduction of anthropical activities could facilitate the contamination between different types of habitats, reducing local plant species, (v) finally and most importantly to us, the proposed mitigation measures (having a scientist to relocate the species during the works) where deemed inadequate, difficult to implement. The proposed recovery activities (hydroseeding and mulching of local hay) were considered likely of causing unwanted effects.

addition, the recent UN initiative on the 2021-2030 Decade on Restoration has been trying to give salience to restoration and scale up restorative projects worldwide, but the reach of international law on the subject, as shown, is still quite limited.

Moving to the European continent, which has a history of strong human impact and accumulated pollution, other interesting insights have emerged. In particular, the Birds and Habitats Directives establish an obligation on Member States to protect endangered species and habitats but also to fulfil, when necessary, the restoration obligation to recover them.

Other directives have also contributed to strengthening the restoration of degraded ecosystems, such as the Water Framework Directive and the Floods Directive, with reference to riparian ecosystems. Despite the timid attempts to stop the loss of biodiversity and reverse it, the results in terms of regenerating areas are unsatisfactory. EU legislation, in the end, still follows a very sectorial logic and continues to allow extraction, degradation, and pollution by default, unless specific prohibition is in place.

To - at least partially - reverse this system, the recent proposal for a regulation on Nature Restoration represents an interesting innovation. In fact, this law has the ambition to unite under a single regulatory instrument the restoration of different ecosystems: not only protected areas but also, and above all, agricultural areas, rivers, forests, and urban ecosystems. The coming months are decisive for the future of the proposed regulation, which has the strong potential to be the driving force for a radical change in the approach to managing diffuse damage. However, it is important to remember that what happens between Strasbourg and Brussels has a lot to do with what the Member States achieve at the national level, which is why the last section of the chapter focuses on the Italian case.

In Italy, as in most legal systems, traces of restoration obligations can be found mainly in three areas: (i) ex ante regulation of potentially impactful activities, with obligations of mitigation and compensation, (ii) ex post regulation of environmental harm, and (iii) planning. Letting aside conservation laws, the legislation is mainly compensatory in nature. When it intervenes ex ante, it addresses individual projects or specific sectors, missing the opportunity to act on a wider scale. All the more so, when it intervenes ex post, it has a strong compensatory nature that insist on individual responsibilities, completely missing to address cumulative and widespread degradation.

As the Chapter shows, some of these problems are attributable to lack of implementation and compliance of the existing law. However, beyond the legal dimension, I argue that the broader

system of restoration policies is too narrowly focused on a strictly protective-compensatory approach that misses the opportunity to involve not only public actors, but also private entities and other stakeholders.

Indeed, the normative framework takes a top-down approach which, at times, may dampen the effectiveness of restoration practices, because the latter involve ethical, social and economic considerations held by a wide variety of stakeholders who, if incentivised correctly, could participate more actively. A comprehensive understanding of restoration policies and their effective implementation requires, beyond the law, the investigation of individual motivations and how they interact with different governance systems, which is the focus of the next Chapter.

PART II – Actors and property rights in Ecological Restoration

Chapter 3: Ecological Restoration and governance: beyond the tragedy of the commons

The second part of the chapter covering the experimental design has been jointly developed with Virginia Maria Cecchini Manara (University of Milan), Pietro Guarnieri (University of Pisa), Lorenzo Spadoni (University of Southern Lazio/Cassino)

3.1 Introduction

As shown in the previous chapter, there is no *grundnorm*[1] preventing the excessive use of natural resources, nor is there a fully-fledged legal framework mandating clear ecological restoration obligations. However, the analysis of current legislation reveals the existence of a constellation of principles, laws and legally protected values which concur to define the legal, social, and economic boundaries of restoration.

As to legal boundaries, conservation laws and their judicial interpretations have contributed to defining the fundamental characteristics and content of restoration, drawing for example a clear line between mitigation and compensation measures.[2] In a different context, ex-ante regulations requiring the formulation of restoration plans for the release of economic activities permits have also played a role, streamlining certain rehabilitation objectives to be reached. For example, in sectors like mining, forestry and waste management, plans for the rehabilitation of industrial sites have become commonplace. These not only define increasingly stringent environmental standards but also influence the economic considerations of private enterprises. Indeed, these legal requirements directly factor into the cost-benefit analysis of, e.g., extractive companies, altering their incentives for conducting their activities responsibly. Similarly, liability provisions have contributed – although with certain limitations – to the determination of "environmental damage" and have compelled public authorities to establish a structured due diligence process for assessing it and subsequently implementing recovery activities. From an economic perspective, they have also influenced firms' incentives to adopt practices aimed at minimizing the risk of environmental damage in the first place. Yet, the systems of laws we

[1] See, in this regard, the elaboration on a "sustainability grundnorm" by Bosselmann, H., (2016).
By "excessive", here, I mean going beyond the ability of such resources to regenerate naturally.

[2] As explained in the previous chapter, with the so-called "Briels case", the EUCJ in 2014 clarified that the measures taken to mitigate the negative effects of a development activity cannot be counted as compensatory measures. Indeed, the point made by the Court is that the protective measures implemented in a project to compensate for the negative effects of the same cannot count in the assessment of the implications of the projects themselves.

have in place still maintain some structural flaws, as ecological objectives are too often unclear or inadequately defined. Furthermore, the implementation of existing laws is limping, and even more so is compliance. Additionally, the territorial scope of current regulations is very much limited to some ecosystems, and completely neglects long-term recovery outcomes, thus lacking scientific validity.

Given this situation of apparent institutional stagnation, the recently discussed proposal for a Nature Restoration Regulation holds significant promise, as it aims to address several of these issues. Nevertheless, for it to be truly effective, widespread societal support and engagement in the sustainable utilization of natural resources are essential. Indeed, we know from economic institutional literature that effective norms are not only the rules dictated by legislative acts. Rather, they are contingent upon behaviors regularly embedded by members of society.[3]

This final chapter therefore takes a different approach from previous ones, as it aims at investigating the root components of the strategic interactions among individuals, with the objective of experimenting modes and instruments capable of motivating actors to restore depleted environmental goods.

The challenge of preventing the depletion of environmental resources, as we will explore in the following paragraphs, is not a new subject in economic research.[4] Economic scholars have long examined, both theoretically and through experiments, the governance aspects of managing public and common goods. However, the specific conceptualization of restoration interventions in economic terms is lacking. For this reason, in this chapter we advance the proposal of a game theoretical framework consisting of two phases: first, the *destruction* phase when the environmental good is depleted (traditional common good game), and second, the *restoration* phase when the good is recovered (traditional public good game). It is worth noting that these two games are well-developed in literature, as stand-alone games. However, we are willing to investigate how the participation to the first affects the behaviour in the second part of the game, and that is why we put them in sequence.

While recognizing the limitations of the proposed experiment, the foundations have been laid here for future developments with additional treatments that can introduce greater complexity to the game, mimicking legislative interventions and property rights relationships.

[3] Aoki, M. (2001).
[4] Ostrom, E. (2008). Institutions and the environment. *Economic Affairs, 28*(3), 24-31
Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press.

The relevance of the work is threefold. Firstly, it helps to analyse the characteristics of what we define as "restorable goods" to better identify the proper incentives that support restoration activities. Secondly, it helps identify and test in an experiment given instruments to elicit joint intentionality which could be further implemented in policymaking.[5] Thirdly, it sheds light on how different restoration decisions may impact the ability to access and benefit from restored ecosystems, with strong equity implications.

The remainder of the Chapter is organised as follows. In Subsection 3.2, we review the definition of public and common goods in the economic theory tradition, providing some examples of environmental goods and services that fall in these categories. Then, in Subsection 3.3 we argue that restorable goods represent a self-standing category in the economic theory tradition, because restoration involves the concatenation of *depletion of a common good* and *generation of a public good*. As such, restorable goods display a peculiar mix of features in terms of nonrivalry and non-excludability that put them at the intersection of the two traditional categories of common and public goods, giving rise to novel institutional puzzles which we describe in a new generic theoretical framework. We formalise this setup in Subsection 3.4 by (i) presenting a novel game-theoretic model that captures the main tradeoffs and (ii) proposing an experimental design that helps answer key policy questions. Finally, we draw conclusions on the Chapter's findings in Subsection 3.5.

3.2 Public and common goods: examples from the natural environment

As discussed in earlier chapters, ecological restoration is most commonly defined as the "intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability", and is "the process of halting and reversing degradation, resulting in improved ecosystem services and recovered biodiversity".[6] This definition, provided by the Society for Ecological Restoration, underscores the twofold objective of restoration practices. Firstly, they aim at restoring the inherent value of nature, re-establishing its health and integrity *per se*. Secondly, the regeneration of ecosystems is instrumental to human well-being: more robust and improved ecosystems provide an array of goods and services such as water or soil formation that directly or indirectly support human life.

[5] Swart, J. a. A., & Zevenberg, J. (2018). Utilitarian and nonutilitarian valuation of natural resources: a game-theoretical approach. *Restoration Ecology*, *26*, S44–S53. https://doi.org/10.1111/rec.12504

[6] Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., Hallett, J. G., Eisenberg, C., Guariguata, M. R., Liu, J., Hua, F., Echeverría, C., Gonzales, E. K., Shaw, N. L., Decleer, K., & Dixon, K. W. (2019). International principles and standards for the practice of ecological restoration. Second edition. *Restoration Ecology*, *27*(S1). https://doi.org/10.1111/rec.13035

In economic terms, these services provided by nature have been described as public goods, since they "are absolutely pervasive, but unnoticed by most human beings going about their daily lives".[7] In practice, human societies have benefited from them essentially free of charge,[8] and exactly because of their nature, they often end up underprovided or overused.[9]

Economic literature has long been interested in the optimal management of environmental resources, and a specific focus on studying goods related to collective action has so far revolved around "the institutions that can be used to provide, produce and allocate these goods".[10] However, little or nothing has been said so far about goods that have already been depleted and need to be restored, what we call "restorable goods".

A typical classification of goods in economic theory that can be traced back to the contributions by Samuelson, Musgrave and Olson,[11] usually distinguishes goods along two dimensions: excludability and rivalry, as shown by the scheme reported below.

	Excludable	Non-Excludable
Rival	Private Goods	Common Goods
Non-Rival	Club Goods	Public Goods

According to this classification, the main features of public goods are that they are both non-excludable and non-rival. Non excludability means that once the resource is provided, it is either too costly or too difficult to exclude non-contributors through physical or institutional boundaries. Non rivalry instead means that one's consumption of the good does not diminish

[7] Daily, G. C. (1997). *Nature's Services: Societal Dependence On Natural Ecosystems*. Island Press.
[8] Brown, T. D., Bergstrom, J. C., & Loomis, J. B. (2007). Defining, valuing and providing ecosystem goods and services. *Natural Resources Journal*, *47*(2), 329–376.
Costanza, R., d'Arge, R., Groot, Rde., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. and Vandenbelt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature, 387,* 253-360
[9] Ostrom, E. (1999) Coping with the Tragedies of the Commons, *Annual Review of Political Science* 2: 493–535
Rose, C. M. (1986). The Comedy of the Commons: Custom, Commerce, and Inherently Public Property. *University of Chicago Law Review*, *53*(3), 711. https://doi.org/10.2307/1599583
[10] Ostrom, E. (2010). Beyond Markets and States: Polycentric Governance of Complex Economic Systems. *The American Economic Review*, *100*(3), 641–672. https://doi.org/10.1257/aer.100.3.641
Ostrom, E. (2003). How Types of Goods and Property Rights Jointly Affect Collective Action. *Journal of Theoretical Politics*, *15*(3), 239–270. https://doi.org/10.1177/0951692803015003002
[11] Samuelson, P. A. (1954). The Pure Theory of Public Expenditure. *The Review of Economics and Statistics*, 36(4), 387. https://doi.org/10.2307/1925895
Ostrom, E., Gardner, R., Walker, J., & Walker, J. (1994). *Rules, Games, and Common-pool Resources*. University of Michigan Press.

the quantity or the benefit available to other consumers. The coexistence of these two features, alongside other physical and technological attributes of the good and the system of property rights, gives rise to widely-studied freeriding problems.[12] Within the context of ecosystem services, a stark but simple example of public good is climate stability: the beneficiaries are all people living in the world, and no one can be excluded, while at the same time the enjoyment of a stable climate by one person does not diminish the availability to all others. Beyond the extremes, most public goods are only partially non excludable and only partially nonrival, and that is the case of a public park, for example, or of a street. In principle, one's access to them does not diminish the availability for other people, but after a given threshold access costs may become higher.

Moving to common goods, often referred to as *common-pool resources*, they are non-excludable but rival, a condition shared by several environmental goods. This means that it is not possible, in principle, to exclude people from benefiting and exploiting the resource, but one's consumption subtracts a part from the amount available to others, or it increases the cost of other people's consumption.[13]

The debate on environmental goods that fall into the broader category of "public goods" was starkly marked by the seminal article published in 1968 by the ecologist Garrett Hardin, who examined their nature and the implications of different management solutions. The American scholar, worried about the increase in size of human population, postulated that the short-term predatory interests of individuals would necessarily lead to resource exhaustion and hyper-consumption (*"the tragedy of the commons"*), unless property rights were attributed and rightfully enforced, or that State-led measures were implemented.[14] This concept was later formalised in a game-theoretic framework whereby rational people make self-interested decisions that negatively affect the aggregate welfare, and was used over and over in scholarship

[12] For a more detailed description of the different types of goods in economics, see:
Faure, M. G., & Partain, R. A. (2019). *Environmental Law and Economics: Theory and Practice.* Cambridge University Press.
Cornes, R., & Sandler, T. (1986). *The Theory of Externalities, Public Goods, and Club Goods*. Cambridge University Press.
[13] *Ibid.*
[14] Hardin, G. (1968). The Tragedy of the Commons. *Science*, *162*(3859), 1243–1248. https://doi.org/10.1126/science.162.3859.1243

to explain, for example, overexploitation in fisheries, or forests, but also air pollution or species extinction.[15]

From this discussion, three main streams of thought emerged: the first suggested that the problem of exploitation and exhaustion of common pool resources could be averted through the implementation and enforcement of property rights regimes.[16] The second advocated more in the direction of allocating full authority to a State-owned regime,[17] while the third group of scholars, among which the figure of Elinor Ostrom stands out, showed that a wide array of more or less informal institutional arrangements can be efficient and effective in governing, providing, and managing public and common-pool resources.

Indeed, Ostrom criticised the seemingly obvious applications of Hardin's tragedy of the commons, holding that such theory could be only applicable to open access resources where no property rights are assigned or when institutional failures occur. On the contrary, it was unable to explain the several instances where free-riding does not emerge, and community-led management of environmental goods is successful.[18]

Following Ostrom's contribution, a great body of empirical literature has developed, both in the lab and on the field.[19] Experiments have investigated the effectiveness of different types of behaviour, for example the ability to communicate among parties[20], or monitoring and sanctioning mechanisms.[21]

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[15] Runge, C. F. (1981). Common Property Externalities: Isolation, Assurance, and Resource Depletion in a Traditional Grazing Context. *American Journal of Agricultural Economics*, *63*(4), 595–606. https://doi.org/10.2307/1241202

[16] Demsetz, H. (1967). Toward a Theory of Property Rights. *The American Economic Review*, 57(2), 347-359

[17] Hardin, G., (1968).

[18] Andersson, K., & Ostrom, E. (2008). Analysing decentralised resource regimes from a polycentric perspective. *Policy Sciences*, *41*(1), 71–93. https://doi.org/10.1007/s11077-007-9055-6

Ostrom, E., Schroeder, L., & Wynne, S. E. (1993). *Institutional Incentives And Sustainable Development: Infrastructure Policies In Perspective*. http://ci.nii.ac.jp/ncid/BA19950290

Godwin, R. K., & Shepard, W. B. (1979). Forcing Squares, Triangles and Ellipses into a Circular Paradigm: The Use of the Commons Dilemma in Examining the Allocation of Common Resources. *The Western Political Quarterly*, *32*(3), 265. https://doi.org/10.2307/447477

Berkes, F. (1990). Common property resources: ecology and community-based sustainable development. *Trends in Ecology and Evolution*, *5*(8), 267–268. https://doi.org/10.1016/0169-5347(90)90075-o

[19] Ciriacy-Wantrup, S. V., Bishop, R. P., & Andersen, S. (2019). "Common Property" as a Concept in Natural Resources Policy. *Natural Resources Journal*, *15*, 713-727

Bromley, D. W. (1992). The commons, common property, and environmental policy. *Environmental and Resource Economics*, *2*(1), 1–17. https://doi.org/10.1007/bf00324686

[20] Cardenas, J. C. (2000). How do groups solve local commons dilemmas? Lessons from experimental economics in the field. *Environment, Development and Sustainability*, *2*, 305–322

[21] Janssen, M. A. (2013). The Role of Information in Governing the Commons: Experimental Results. *Ecology and Society*, *18*(4). https://doi.org/10.5751/es-05664-180404

The prevalence of collaborative dynamics on "tragedy of commons"-like outcomes seems to depend on a few key factors. Firstly, smaller-scale resources are less prone to tragedy of commons depletion dynamics than large-scale ones,[22] even though scarcity is a great deterrent to people's contributions to the good itself.[23] Secondly, an element influencing choices is time-horizon, since literature shows that when interactions are more frequent[24] and trust is encouraged[25] the logic underlying their decision changes substantially and people are more prone to increase their personal contribution.[26] Thirdly, when participants iterate exchanges, other dynamics emerge: deliberation and agreements lead to increased cooperation and reputation comes to surface,[27] mitigating the risk of the tragedy.[28] Finally, another element often emerging from the literature is that when one group of people intervenes before another, the former tends to make a larger use of the good than the latter, this inducing strong position effects.[29]

3.3 Restorable goods: beyond the "tragedy of the commons"

The type of question that we ask in this work lies at the intersection of all the cited strands of literature and relates to cases where the degradation of resources has already taken place, but could potentially be recovered through human intervention. Put differently, restoration involves the concatenation of *depletion of a common good* and *generation of a public good*. In this chain of events, we claim, some of the abovementioned social and strategic incentives arise, which would be however absent should we consider the two blocks in isolation.

Casari, M., & Plott, C. R. (2003). Decentralised management of common property resources: experiments with a centuries-old institution. *Journal of Economic Behavior and Organization*, *51*(2), 217–247. https://doi.org/10.1016/s0167-2681(02)00098-7

Fehr, E., & Gächter, S. (2000). Cooperation and Punishment in Public Goods Experiments. *The American Economic Review*, *90*(4), 980–994. https://doi.org/10.1257/aer.90.4.980

[22] Ostrom, E. (1999). Coping with the Tragedies of the Commons. *Annual Review of Political Science, 2*, 493–535

[23] Isaac, R. M., & Walker, J. J. (1988). Group Size Effects in Public Goods Provision: The Voluntary Contributions Mechanism. *Quarterly Journal of Economics, 103(1)*, 179. https://doi.org/10.2307/1882648

[24] Sugden, R. (1984). Reciprocity: The Supply of Public Goods Through Voluntary Contributions. *The Economic Journal*, *94*(376), 772. https://doi.org/10.2307/2232294

Snidal, D. (1985). The limits of hegemonic stability theory. *International Organization*, *39*(4), 579–614. https://doi.org/10.1017/s002081830002703x

[25] Perrings, C., & Kinzig, A. P. (2021). *Conservation: Economics, Science, and Policy*. Oxford University Press. DOI: 10.1093/oso/9780190613600.003.0008

[26] Axelrod, A. (1984). *The Evolution of Cooperation.* New York: Basic Books

[27] Sacconi, L. Ottone, S. (2015). *Beni comuni e Cooperazione.* Bologna: Il Mulino

[28] Fischbacher, U., & Gächter, S. (2010). Social Preferences, Beliefs, and the Dynamics of Free Riding in Public Goods Experiments. *The American Economic Review*, *100*(1), 541–556. https://doi.org/10.1257/aer.100.1.541

[29] Fischer, M., Irlenbusch, B., & Sadrieh, A. (2004). An intergenerational common pool resource experiment. *Journal of Environmental Economics and Management*, *48*(2), 811–836. https://doi.org/10.1016/j.jeem.2003.12.002

In particular, we believe that two peculiar features concur to define restorable goods: *temporality* and *threshold effects*. The former refers to the fact that the stock of natural resources available to each generation depends on the size of exploitation by previous generations, but also on the resource recovery rate, which may require extensive time. The latter, instead, has to do with the fact that ecosystem services are no longer delivered after a given threshold of interference and, hence, damage is imposed. Conversely, after a given restorative effort is put in place and a threshold is reached, ecosystems start functioning again.[30]

For example, in the case of the management and use of a forest, overharvesting relates to the depletion of the common good, while revegetation interventions represent the provision of a public good. Temporality matters when considering both the rate of harvest and the time of trees' regrowth, while the size and intensity of intervention plays a crucial role for threshold effects in assessing the health of the forest ecosystem.

Moreover, in this example, strategic considerations are key. In fact, the expected development of the revegetation stage influences extraction incentives at first, while revegetation choices are crucially affected by past extraction decisions.

Taking a step back from this specific case, we now introduce a generic extraction-restoration setting that we will replicate in the experiment introduced in Subsection 3.4. To represent the temporal dimension of the problem, we consider three periods of time: t_1 when degradation happens, t_2 when restoration activities are started, and t_3 when the enhanced ecosystem is maintained sustainably.

In t_1, cumulative and repeated damage takes place, with individuals gradually contributing to the widespread environmental harm. Crucially, we consider the situation where harmful activities occur within the boundaries of the law, so that no one can be held formally accountable for the damage. The element of "lawfulness" is crucial because it rules out the possibility of resorting to courts and activating traditional "polluter-pays" procedures. Indeed, the latter constitute legal provisions that require determination of a clear and contextualised causality link between environmental damage and an unlawful and damaging behaviour. Moreover, the cumulative nature of the process implies that it is not possible to identify a single person responsible for the tragedy, since the public bad stems from the behaviour of several actors who generate negative externalities. Each individual contribution may be minimal, but

[30] May, R. M. (1977). Thresholds and breakpoints in ecosystems with a multiplicity of stable states. *Nature, 269*(5628), 471–477. https://doi.org/10.1038/269471a0

when their sum reaches a given threshold, the result is a disrupted ecosystem that is no longer able to provide services and goods.

Moreover, non-excludability implies that the providers of the bad cannot exclude others from it, or, from the opposite perspective, individuals are unable to protect themselves from it, leading to an overall loss in social welfare.[31] Even if aware, polluters may have little incentive in modifying their behaviour and cease polluting, because they may fear others will not do the same and they would still suffer pollution.

In t_2, restoration activities are implemented and environmental degradation is reversed, producing positive externalities,[32] and after a given threshold is reached, recovered ecosystems start again to provide services. Depending on the level of excludability, the restored functions can be beneficial locally, for example in the case of the reintroduction of animal species for hunting, or globally, like in the case of resilient ecosystems and carbon sequestration.[33]

However, the restoration step is also prone to free-riding problems: potential benefits are non-rival and non-excludable in consumption. Therefore, everybody is better off if other people bear the costs of restoration. The final benefits are then conditional on the strategies undertaken by all members of the group, providers and beneficiaries.

At this stage of the process, a key additional challenge whose implications are difficult to assess is that, while environmental damage typically sees no legal boundaries, property rights impose limits to restoration.[34] In practice, restorable goods share some features of public goods when it comes to non-rivalry, but they also exhibit varying degrees of excludability, as they unfold in different property conditions: polluted sites and landscapes can be privately held (with high

[31] Normally, suggested solutions require governmental interventions in the form of taxes, subsidies or implementation of stricter regulation on pollution (for example, in disclosing information) to internalise the negative externality.

[32] In fact, when it comes to restoration, "externalities can be defined as those environmental benefits that are not accounted directly in traditional markets and therefore do not appear in the form of economic returns such as soil protection, carbon sequestration, clean and safe drinking water. In: Baumber, A. (2017). *Restoration and market-based instruments.* In *Routledge Handbook of Ecological and Environmental Restoration.* Eds. Allison, S. K. and Murphy, S. D. New York: Routledge. https://doi.org/10.4324/9781315685977

[33] Benefits, we should specify, can be ecological, economic but also social (relational good, reciprocity, but also food security).
Martin, D. C., & Lyons, J. (2018). Monitoring the social benefits of ecological restoration. *Restoration Ecology, 26*(6), 1045–1050. https://doi.org/10.1111/rec.12888

[34] Several authors have been discussing the growing mismatch between environmental problems and the limits of existing legal systems. Among them:
Biermann, F. (2014). *Earth System Governance: World Politics in the Anthropocene*. https://muse.jhu.edu/chapter/1396058/pdf

degree of exclusion), or can be managed commonly (facing the risk of short-termism and the tragedy of the commons), or be held as club goods (asking for specific entry requirements).

Finally, back to the timeline, in t_3, restored ecosystems are maintained over time, and they resemble common goods, being partially rival and non-excludable. Here, again, the risk of overconsumption and of free-riding is present, but can be counterbalanced with an adequate institutional setting.

Having outlined the generic setting of the restoration problem, we now discuss how the dynamic nature of restorable goods and the biological conditions of chosen ecosystems give rise to novel economic insights and institutional puzzles. To this end, we build on previous Chapters of this thesis and on Ostrom's legacy, embracing the perspective that human beings have a motivational structure which is more complex than usually represented in standard economic models, and that individual values and community norms (reputation, norm conformity, responsibility, intrinsic pro-environmental motivation, among others) constitute key motivational factors driving human behaviour.[35]

To better grasp some of these factors, we set up a game-theoretic model that allows for a formal representation of the relevant strategic interactions between actors and for the study of different types of equilibrium. We define the latter either through classical game theory methods, i.e., based on the assumption of self-interested and perfectly rational players, or in the behavioural game theory framework, in which utility functions and payoffs can be redefined in order to represent players' motivational complexity. For the latter, we leverage the notions of framing and mental models, borrowed from cognitive psychology, to represent the mutual expectation of bounded rational players.

Specifically, we assume that a sense of responsibility for resource exhaustion, intrinsic motivation, and other psychological frames may elicit pro-environmental and cooperative social norms.[36] In turn, these factors may contribute to making restoration more salient than other alternative actions.

For this reason, we propose an experiment to test how agents contribute to the restoration of a public good depending on whether they have previously taken part in its degradation or not; secondly we vary the level of attainable restoration of an ecosystem (high or low); and finally

[35] Ostrom, E., (1990)
[36] Lindenberg, S., & Steg, L. (2007). Normative, Gain and Hedonic Goal Frames Guiding Environmental Behavior. *Journal of Social Issues*, *63*(1), 117–137. https://doi.org/10.1111/j.1540-4560.2007.00499.x

we propose to use the same experimental setting to understand how different property right structures and governance systems may affect the behavioural patterns.

3.4 An experiment on ecological restoration

Given the lack of a consistent set of restoration obligations in the regulatory framework, and the difficulties in applying them beyond protected areas and over a long period of time, our research question is intended to investigate how the history in the use of a resource is relevant with respect to the decision to restore it. Effectively, the degradation of an environmental good comes before its restoration, and this peculiarity offers interesting behavioural insights. With our design, we study a common pool resource problem jointly with a public good one, holding that individual behaviour in restoration activities is peculiar because of the intersection of coordination, psychological effects and temporality affecting social norms and guiding final choices. Finally, we complement it with a post-experimental questionnaire that tests for the salience of social norms in this specific setting.

We run an economic experiment to measure the individual willingness to restore a common pool of resources previously subject to exploitation, and provide for a strategic interaction setting where participants face a social dilemma. Participants receive an initial endowment and are matched in groups of three; the experiment consists of two stages: in the first stage, they play a common pool resource game (CPG, extraction game) where they are asked to individually decide how much they want to extract from the common pool, increasing their payoffs proportionally to their level of extraction. In the second stage, participants are instead asked to participate in a public good game (PGG, public good game), where they need to decide how much they want to contribute to restore the deteriorated common good through their endowments. The final payoffs depend on how much individuals receive from extraction, the costs they incur while contributing to restoration, and the returns from the unexploited resource in both stages of the game.

To make the game more realistic and increase the salience and consistency of the restoration narrative, we framed the experiment in terms of decisions about the management of a forest, from which participants receive fresh air: in the first decision, players can choose to cut trees and gain from timber extraction, while in the second decision they can choose to plant new trees.

We set up four possible *conditions*, which make the structure of decisions vary. In the first condition, participants perform both the Common Pool Game (CPG) and the Public Good Game (PGG) through a direct-response method.[37] This concatenation of the two games constitutes our baseline condition, which we abbreviate by BL.

The second condition features the same concatenation of a common pool resource game and a subsequent public good game. However, in the second condition the second stage is played through the strategy method, meaning that participants make conditional decisions for each possible set of levels of forest. This is called "strategy method" and we denote it by SM.

In the third condition, participants perform just the common pool game, namely extraction of timber from the forest (Only Extraction, OE), and know that another group of three participants will be asked to take the decision about restoration.

Finally, in the fourth condition participants receive an exploited resource from another group and only participate in the second decision, i.e., the public good game where the restoration of the forest takes place (Only Restoration, OR).

Moreover, we introduce in the design of the game a *treatment* whereby the return from restoration of the degraded good varies, can either be low or high. This is done by distinguishing between the possibility of planting *trees* that provide the same amount of fresh air as the trees that were in the forest from the beginning (treatment H), or to plant *seedlings* that produce less fresh air than the original trees (treatment L). In the treatment H, the marginal per capita returns (MPCRs) to an uncut and to a restored tree are equal, while in treatment L the MPCR of a tree "saved" in the Common Pool Game is higher than that of a seedling restored in the Public Good Game. This feature of the experimental design captures that the ability to provide ecosystem services of an integral ecosystem cannot be lower than a newly restored ecosystem. For example, a young forest will be less capable of capturing CO2 than a prosperous, intact, native forest.

Considering heterogeneous returns also allows for the study of the role of a broader system of institutions in complementing existing incentives in situations where full restoration is ecologically impossible. Governments, for example, can play a role as a multiplier of restoration initiatives, in the form of incentives to undertake environmentally-beneficial activities, tax

[37] Brandts, J., Charness, G. (2011). *The strategy versus the direct-response method: a first survey of experimental comparisons.* Experimental Economics, 14, 375-398.

breaks, facilitated access to credit, or the regulatory system for Payment for Ecosystem Services schemes.[38]

	First round	Second round	Treatments
Baseline (BL)	CPG	PGG	HI / LO
Strategy Method (SM)	CPG	PGG SM	HI / LO
Only Extraction (OE)	CPG	-	HI / LO
Only Restoration (OR)	-	PGG	HI / LO

Table 1: summary of the different conditions of the experiment

Considering the strong relevance of the "history" of the good, we identify several possible psychological effects that could foster restoration (or reduce extraction) like responsibility, guilt,[39] a sense of loss for lost nature and conditional cooperation,[40] but also institutional ones, like reciprocity.[41] Indeed, if participants experiencing both the extraction and the restoration phase contribute more than the ones only contributing to restoration, one hypothesis is that a sense of responsibility emerges. However, the opposite may also happen: if the "second generation" contributes more, we may conclude that intrinsic motivation – regardless of any responsibility – is a key factor.

We propose testing which of the two narratives finds empirical support by comparison of the Baseline and the Only Extraction conditions. Differences in extraction intensity among the two conditions may be informative about the effect that all previous social and psychological considerations have on the depletion of a resource. Moreover, in terms of policy applications, the findings can be informative about both the intergenerational dimension of the problem and the "type" of group to involve in a restoration project. For example, if exposure to restoration dampens extraction, it may be effective to involve local communities – i.e., those that are often directly responsible for extraction – in restorative practices. On the contrary, should

[38] Baumber, A., (2017)

[39] On the different reasons to leverage restorative practices, see:
Clewell, A. F., & Aronson, J. (2006). Motivations for the Restoration of Ecosystems. *Conservation Biology, 20*(2), 420–428. https://doi.org/10.1111/j.1523-1739.2006.00340.x
Jordan, W. R. (1990). Two Psychologies. *Ecological Restoration, 8*(1) 2. DOI: https://doi.org/10.3368/er.8.1.2

[40] Holland, A. (2015). *Nature and Our Sense of Loss*. In: Restoring layered landscapes: history, ecology, and culture. Eds. Hourdequin, M., Havlick, D. G. : 54-72. New Tork: Oxford Academic.
DOI: doi.org/10.1093/acprof:oso/9780190240318.003.0004

[41] Rodríguez-Sickert, C., Munger, M. C., & Cárdenas, J. C. (2008). Institutions influence preferences: Evidence from a common pool resource experiment. *Journal of Economic Behavior and Organization, 67*(1), 215–227. https://doi.org/10.1016/j.jebo.2007.06.004

participation in restoration lead to breach of trust phenomena, thus enhancing extraction in the first place, restoration should be better extended to a broader set of agents not directly involved in extraction.

Taking a complementary perspective, we also consider the possibility that restorative activity be driven by specific ethical considerations, such as a strong intrinsic motivation linked to a peculiar vision of the human-nature relationship.[42] This could be evidenced if people who are not responsible for resources depletion – the "second generation" – contributes more to the recovery of the area than the other group. A closer analysis of the role of intrinsic motivation is crucial, because we know from literature that such motivation is very effective, and can be boosted through education, training and, even more, fortified by strong and reliable institutions.[43] At the same time, if frustrated, it can be detrimental to the effectiveness of project implementation.[44]

In this respect, we believe that the comparison between the Baseline and the Only Restoration conditions is informative about the relative importance of social considerations and intrinsic motivations for restoration. Indeed, observed differences in restoration intensity should reveal how much people who are *not* responsible for damage are willing to contribute to providing restorative action and to enjoy renewed ecosystem services relative to people who were responsible for the damage in the first place.

Moreover, the Strategy Method (SM) is informative about individuals' preferences in a strategic setting, conditioned on other participants' decisions. Considering there is quite robust literature on how the environment influences individuals' behaviour, this condition allows us to draw some insights on understanding how the intensity of damage in a given environment affects their willingness to restore.[45]

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[42] Norris, J. H., Bowers, K., Murphy, S. D. (2017). Ecological Restoration in an Urban Context. In *Routledge Handbook of Ecological and Environmental Restoration*. (Eds.) Allison, S. K., & Murphy, S. D. Taylor & Francis.

[43] Martin, P. J. (2016). Ecological restoration of rural landscapes: stewardship, governance, and fairness. *Restoration Ecology*, *24*(5), 680–685. https://doi.org/10.1111/rec.12411

[44] Wainaina, P., Minang, P. A., Nzyoka, J., Duguma, L. A., Temu, E. A., & Manda, L. (2021). Incentives for landscape restoration: Lessons from Shinyanga, Tanzania. *Journal of Environmental Management*, *280*, 111831. https://doi.org/10.1016/j.jenvman.2020.111831

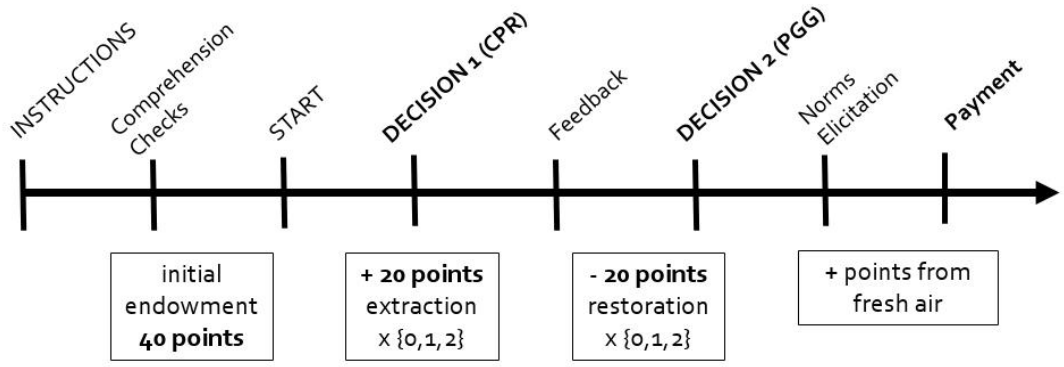
What this study shows is that intrinsic and indirect motivation can bring higher benefits than extrinsic monetary benefits. In their study, they show that the delivery of direct cash incentive to individuals and communities involved in restoration projects risk "crowding out" intrinsic non-monetary motivation, with overall unsatisfying results.

[45] Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, *58*(6), 1015–1026. https://doi.org/10.1037/0022-3514.58.6.1015

Finally, the treatment High/Low returns is relevant because it illustrates the extent to which the efficiency in restoration intervention affects people's willingness to contribute to the recovery.

3.4.1 Experimental design

We set up a two-stage game, where participants are asked to make decisions about the management of a forest. We first ask them to decide how much they want to extract from a common pool resource (Common Pool Game), cutting trees to get timber. Second, we ask them to make a decision about how much they are willing to contribute to plant new trees (Public Good Game). The key conceptual innovation of this setting lies in the concatenation of the two strategic games, which allows for a joint test of agents' behaviour in two situations where contrasting incentives exist on the same natural resource.



Every agent is assigned to a group of three (N=3) people and endowed with 40 points. She decides how many trees to cut from a common pool, the minimum being 0 and the maximum 2. We formally denote this extraction decision by $e_i \in \{0, 1, 2\}$, where *i* indexes players. The private benefit from cutting one tree is 20 points, representing the value of the timber per tree. However, each tree that is left uncut provides fresh air, whose benefit accrues to everyone in equal amounts. This setting defines a Common Pool Game (CPG) and embeds the main features of several models tested starting from Ostrom.[46] Specifically each player's payoff positively depends on the number of trees individually extracted but negatively on the aggregate level of extraction, due to the negative externality induced by cutting trees. In fact, every tree cut provides for a private benefit to the individual cutting it in the form of timber, but reduces for everyone, which we take as a proxy for ecosystem services and the natural ability of common-pool resources to renovate.

[46] Ostrom, E., Gardner, R., Walker, J. (1994). *Rules, games and common-pool resources.* University of Michigan Press, Ann Arbor.

Provided with complete information in all treatments where restoration is at stake, players face a second choice, and can decide to use their endowment to plant trees (if assigned to the H treatment) or seedlings (if assigned to the L treatment), at the cost of 20 points per tree/seedling. We denote by $c_i \in \{0, 1, 2\}$ the contribution in terms of the number of trees/seedlings that the player *i* plants in the forest, contributing to restoring the public good. In this second stage, a player's payoff from restoration negatively depends on the individual number of trees planted, and positively on the aggregate level of restoration when accounting for fresh air.

Given the structure of the game, the payoff of player *i* is equal to:

$$U_i = Y + e_i + \beta\,(P - \sum_{j=1,\dots,i\dots,n} e_j) - c_i + \alpha_{pgg}(\sum_{j=1,\dots,i,\dots n} c_j) + \alpha_{eg}\,(P - \sum_{j=1,\dots,i,\dots n} e_j) \quad (1)$$

where Y is the homogeneous initial endowment, i or j index participants, n denotes the group size, and P the common pool resource. Agent i derives utility from her own extraction decisions e_i and from a fraction $\beta < 1$ of unextracted common pool resource $(P - \sum_{j=1,\dots,i\dots,n} e_j)$ in the first stage and from a fraction $0 \leq \alpha_{eg} < 1$ of the same quantity in the second stage of the game. In contrast, the payoff declines with the cost of restoration c_i borne by the same individual and increases by a fraction $0 < \alpha_{pgg} \leq \alpha_{eg}$ of the total restoration effort put in place by the community, i.e., $(\sum_{j=1,\dots,i,\dots n} c_j)$.

Individuals aim to maximise their total payoff U_i and their optimal extraction and restoration strategies give rise to the Nash equilibrium, which can be derived by backward induction. If $\alpha_{eg} + \beta < 1$, the equilibrium features full extraction in CPG (first stage) and null contribution to restoration in PGG (second stage). More formally,

• CPG: $e_i = 2 \;\forall\, i = 1, \dots, n$ if $\alpha_{eg} + \beta < 1$

• PGG: $c_i = 0 \;\forall\, i = 1, \dots, n$

The described equilibrium features over-extraction and under-restoration compared to the socially optimal allocation, because individual participants do not internalise the negative effect of their own extraction decisions on others' payoff, and, symmetrically, do not fully internalise the social benefits from restoration.

As explained before, we assign participants to four conditions. In the first condition, (Baseline, or BL), the same participants play both games in sequence (CPG and PGG). In the second

condition (Strategy Method, or SM), agents play CPG first, and subsequently play the PGG conditional on all the possible levels of extraction from the first stage. In the third condition (Only Extraction, or OE) agents only play the extraction game (Common Pool Game) and benefit from timber extraction, knowing that another set of participants will play the restoration Public Good Game taking the residual trees in the forest as given from the previous stage. Finally, the fourth condition (Only Restoration, or OR) only plays the restoration game (Public Good Game), knowing that they inherit a common pool resource previously exploited by a different group.

For each and every condition, two possible treatments are possible: high (H) or low (L) marginal per capita return (MPCR) to restoration. The treatments of the experiment are obtained by normalising β = 0 and varying the marginal per capita return (MPCR) of restoration of the public good (i.e. α_{pgg}) relative to the return provided by the trees left uncut in the forest from the extraction stage (i.e., α_{eg}). Specifically, in the H treatment – i.e., where trees are planted in the second stage – the two MPCR are equal, $\alpha_{pgg} = \alpha_{eg}$, while in the L treatment – i.e., where seedlings are planted in the restoration stage – we impose $\alpha_{pgg} < \alpha_{eg}$.

The comparison between the two treatments allows us to grasp a key ecological feature, and to assess whether a change in efficiency of the resource impacts on individuals' consumption preferences. Indeed, one would expect that with lower MPCR individuals are more careful and extract less, while with higher MPCR individuals perceive substitutability among goods and extract more.

3.4.2 Pre-registered research questions and behavioural hypotheses

This design captures key features of different environmental degradation problems and inquiries four different hypotheses that we pre-registered:

(i) whether and to what extent subjects' **contribution** to a common resource in a Public Good Game differ if they have participated or not in their extraction;

(ii) whether and to what extent subjects' **extraction** to a common resource in a Common Pool Game differ if they contribute to restore it;

(iii) whether and to what extent subjects' contribution in a Public Good Game performed after an extraction decision in a Common Pool Game changes under a **strategy method**;

(iv) whether and to what extent **changes in the marginal per capita return** (MPCR) of the resource changes the subject's willingness contribution to restore in a Public Good Game.

Before going to the empirical results, we will now proceed to examine possible empirical realisations of previous theoretical hypotheses and related explanations.

As to the first hypothesis, the participation in a previous extraction stage may lead to either higher or lower contribution to the public good compared to the case where the public good game occurs in isolation. A theoretical driver for a strong contribution to the provision of the public good is a sense of responsibility originating from the fact that players have benefitted from shared resources in the past, and feel socially or morally compelled to reconstruct them. Alternatively, should agents in our two-stage setting contribute less (or equally) than in the case of a single-stage public good game, we may infer that intrinsic motivation is the main driver of such contribution. By intrinsic motivation we mean types of context-independent prosocial and pro-environmental behaviour.

As to the second hypothesis, a similar logic applies: the participation in a following restoration stage may generate higher or lower extraction in the first stage of the game compared to the case where the latter occurs in isolation. A theoretical driver of lower extraction if restoration is expected to follow is that participants internalise *ex ante* part of the harmful consequences of their current behaviour, and are thus induced to limit extraction. In contrast, the presence of restoration in the future may also lead to overexploitation of the common pool resource in the first stage. Indeed, participants may be myopically overconfident about the effectiveness of future restorative efforts.

As to the third hypothesis, we aim to examine how aggregate outcomes from the first extraction stage may influence agents' contribution decisions outside the observed equilibrium. To do so, we elicit restoration strategies for each possible aggregate condition of the forest, irrespective of which of them determines equilibrium actions based on agents' beliefs. From this condition, we may observe that contribution to the public good is either increasing or decreasing in size. In the former case, we would observe greater restorative efforts as more trees are not extracted, mutually enhancing prosocial behaviour. On the contrary, if restorative efforts decrease as the number of trees left decreases, we may observe that this behaviour is driven by scarcity concerns: if people observe great depletion they may feel more compelled to contribute; while if they see greater abundance, private incentives not to contribute may dominate.

Lastly, we examine whether returns to restoration influence the willingness to contribute. In this case, we envisage two possibilities: the first is, of course, that larger returns to restoration induce more intense effort. The second is that people remain unresponsive to such incentives because, for example, private incentives to full extraction and null restoration dominate independently from restoration returns.

Different psychological factors could be influencing participants' choices over the management and restoration of the forest. In our experiment we focused on social norms and elicited empirical and normative expectations[47] through a post-experiment questionnaire incentivised by the payment of extra bonuses. The cross-analysis of participants' normative statements and their choices allows us to get more robust explanations on the results.

The first question (denoted by NB) is framed to elicit participants' Normative Belief: "To what extent do you believe that planting in decision 2 is what one ought to do?".

The second question (denoted by Majority) builds on the first one and asks about participants' normative expectations on other participants' belief: "In your opinion, how has the majority of participants who faced the same decision tasks as yours replied to the previous question?".

The third question (denoted by NE) elicits the empirical belief of participants: "To what extent do you believe that 'The majority of participants has chosen to plant in Decision 2'"?

Finally, the fourth question (denoted by EE) covers participants' Empirical Expectation: "In your opinion, how has the majority of participants who faced the same decision task as yours replied to the previous question?"

For all questions, possible answers are presented on a 4-point likert scale from 1 ("not at all") to 4 ("completely").

[47] Bicchieri, C., & Xiao, E. (2009). Do the right thing: but only if others do so. *Journal of Behavioral Decision Making*, *22*(2), 191–208. https://doi.org/10.1002/bdm.621
Bicchieri, C., & Chavez, A. K. (2010). Behaving as expected: Public information and fairness norms. *Journal of Behavioral Decision Making*, *23*(2), 161–178. https://doi.org/10.1002/bdm.648

3.4.3. Experiment's implementation

The experimental sessions were coded using the open source software for economic experiments oTree[48] and they were run on Prolific, the UK platform for online experiments[49] during the month of April 2023, observing 1080 participants (135 per subscription).[50]

This sample size was computed using the software G*Power for the t-test and rounded up to complete 45 groups of 3 participants per condition. This number was set to detect effect sizes of 0.25 at a significance level of 5% with a power of at least 0.8 (computed for the Wilcoxon-Mann-Whitney test).

When subjects entered the platform, they needed to enter an identification number and were randomised into one of the 8 groups (4 conditions times 2 treatments) with uniform probability. Each participant then could see the general instructions of the experiment and answer a few questions assessing her understanding of the experiment's mechanisms. Finally, each participant had access to the experiment. For the empirical analysis, no sample restriction was applied and only observations relative to subjects not concluding the experiment were excluded.

3.4.4. Results

In the next paragraphs, we describe the experimental results. We first compare extraction rates between the Baseline and the Only Extraction conditions. Next, we move to the analysis of mean restoration rates in the Baseline and in the Only Restoration conditions. Finally, we examine the relevance of normative beliefs and empirical expectations for the determination of observed decisions.

3.4.4.1 Comparison between Baseline (BL) and Only Extraction (OE)

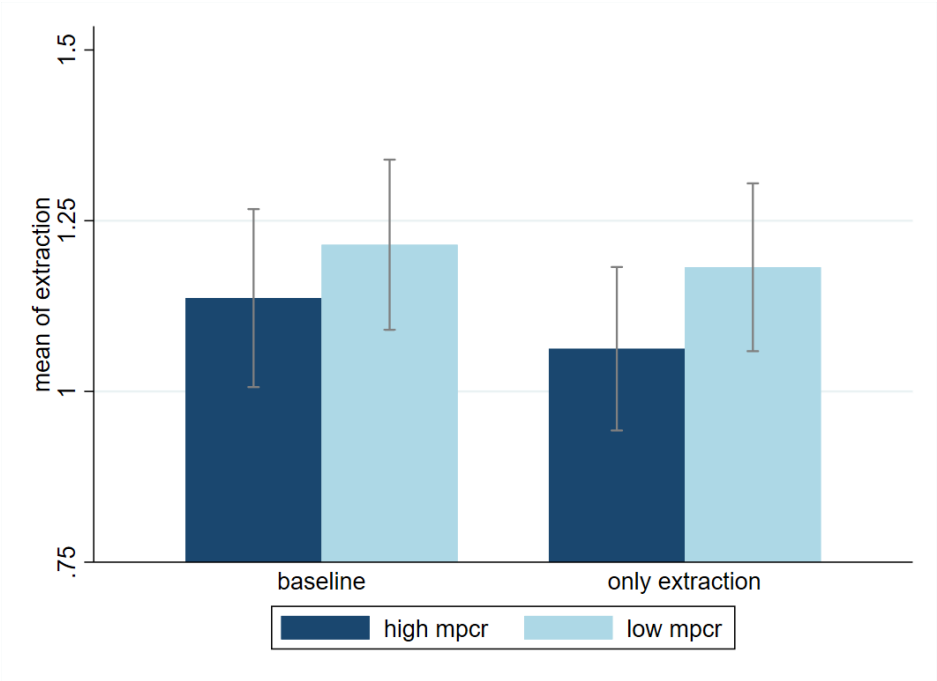
In Graph 1, we depict the mean extraction rate in the two conditions BL (left bars) and OE (right bars) and for the two efficiency treatments "High MPCR" and "Low MPCR", differentiated by the dark and light blue colours, respectively. Firstly, we see that full extraction

[48] Chen, D. L., Schonger, M., & Wickens, C. (2016). oTree—An open-source platform for laboratory, online, and field experiments. *Journal of Behavioral and Experimental Finance*, *9*, 88–97. https://doi.org/10.1016/j.jbef.2015.12.001

[49] Palan, S., & Schitter, C. (2017). Prolific.ac—A subject pool for online experiments. *Journal of Behavioral and Experimental Finance*, *17*, 22–27. https://doi.org/10.1016/j.jbef.2017.12.004

[50] The experiment was restricted to participants located in the UK, aged between 18 and 40, who had previously completed at least 10 studies on Prolific with an approval rate of at least 90%.

(2 trees) is reached in neither case, meaning the Nash equilibrium hypothesis is not confirmed. Secondly, there seems to be no difference between the two conditions for each efficiency level.



Graph 1: Mean of extraction by two treatments: Baseline (BL) and Only Extraction (OE)

This evidence is confirmed by the Tobit regression analysis assuming for the uncensored outcome variable $Extraction_i$ the following relation

$$Extraction_i = \beta_0 + \beta_1 Condition_i + \beta_2 MPCR_i + X_i\theta \qquad (2)$$

where $Extraction_i$ is the number of trees extracted by individual i; β_0 is a constant term; $Condition_i$ is a dummy variable taking value 1 if individual i participates in both extraction and restoration stages of the game and 0 if the subject is enrolled in the extraction stage only; $MPCR_i$ is a dummy variable taking value 1 if individual i is exposed to high returns from restoration and 0 otherwise; and X_i is a vector of individual i's answers to the beliefs questions. In a robustness analysis, available upon request, we also allow for heterogeneity in the effects of $MPCR_i$ depending on $Condition_i$. As we find this term not to be statistically different from zero, we omit it from the main discussion.

The first row of Table 2 shows that across specifications the estimated β_1 coefficient is never statistically different from zero, exactly capturing that average extraction is statistically equivalent across conditions. The second row of the table similarly captures that agents exposed

to low returns to restoration do not display statistically significant differences in extraction relative to people facing higher returns.

DV: extraction	(1) extraction	(2) extraction	(3) extraction	(4) extraction	(5) extraction
condition	0.114	0.107	0.116	0.107	0.103
	(0.126)	(0.149)	(0.118)	(0.143)	(0.162)
low_mpcr	-0.132	-0.127	-0.151	-0.144	-0.140
	(0.374)	(0.391)	(0.300)	(0.319)	(0.333)
ee		0.0238		0.143	0.149
		(0.821)		(0.222)	(0.205)
ne		0.110		0.283**	0.266**
		(0.306)		(0.015)	(0.022)
majority			0.0286	-0.0904	-0.0945
			(0.758)	(0.400)	(0.383)
nb			-0.308***	-0.407***	-0.395***
			(0.002)	(0.000)	(0.000)
donate					-0.000165
					(0.701)
self_risk					0.0597*
					(0.083)
N	550	550	550	550	550

Note. Dependent variable. *extraction* variable ranging 0, 1, 2.
Significance of coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: BASELINE + ONLY EXTRACTION: Tobit regressions of restore as dependent variable

Moreover, if we just focus on participants enrolled in the BL condition, we can examine how subsequent restoration decisions relate to extraction across individuals. As extraction and restoration are both endogenous decisions at the individual level, our objective here is to explore their correlation rather than documenting a causal relationship among the two. To do so, we estimate a Tobit model on the BL participants only and assume the following conditional mean to the uncensored outcome

$$Extraction_i = \beta_0 + \beta_1 Restore_i + \beta_2 MPCR_i + X_i\theta \quad (3)$$

where $Restore_i$ represents the number of trees restored by individual i and all other variables retain the same meaning as in the previous equation. The second column of Table 3 reports β_1 estimates, which captures an economically strong and statistically significant negative relation between extraction and restoration. Individuals more prone to restoration are also those who, on average, extract less to start with. The estimated effect remains remarkably stable independently from the inclusion of relevant individual attributes / beliefs in the vector X_i , and

especially so when we control for variation in individual behaviour that is correlated with individual propensity to altruistic behaviour and risk aversion (semi-last and last rows).

DV: extraction	(1)	(2)	(3)	(4)	(5)
low_mpcr	-0.121	-0.112	-0.115	-0.123	-0.103
	(0.568)	(0.595)	(0.590)	(0.561)	(0.626)
restore	-0.471***	-0.590***	-0.489***	-0.464***	-0.494***
	(0.001)	(0.000)	(0.006)	(0.008)	(0.005)
ee		0.186		0.174	0.175
		(0.215)		(0.309)	(0.310)
ne		0.166		0.259	0.244
		(0.252)		(0.106)	(0.131)
majority			0.154	-0.00164	-0.00127
			(0.224)	(0.991)	(0.993)
nb			-0.118	-0.227	-0.212
			(0.411)	(0.149)	(0.177)
donate					0.000292
					(0.631)
self_risk					0.0555
					(0.236)
N	283	283	283	283	283

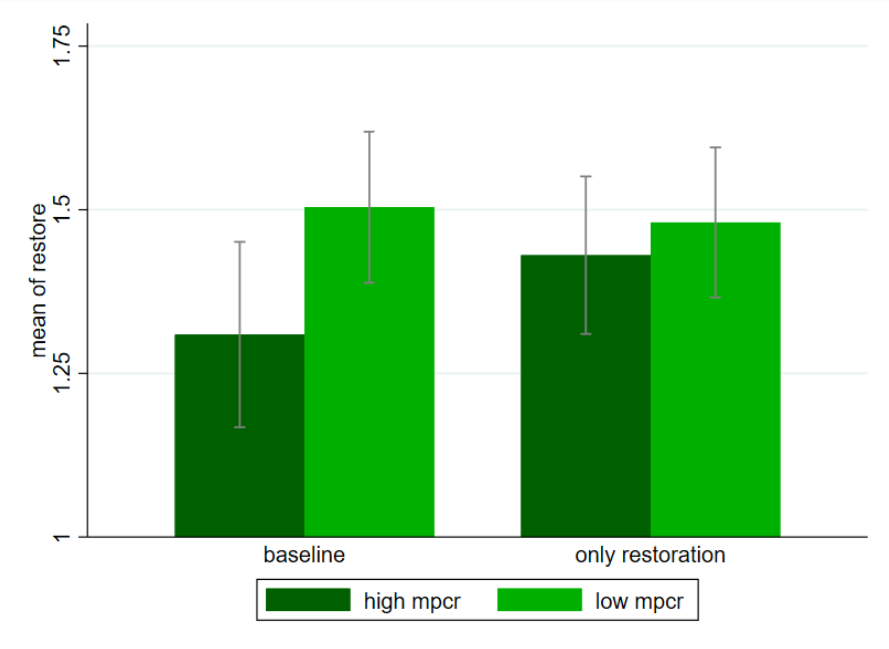
Note. Dependent variable. *extraction* variable ranging 0, 1, 2.
Significance of coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: BASELINE: Tobit regressions of extraction as dependent variable

3.4.4.2. Comparison between Baseline (BL) and Only Restoration (OR)

Having examined the effects of the two-stage structure of the game on extraction, we now proceed to discuss the results from the comparison between BL and OR in the public good game (PGG).

We start with some descriptive comparison of average restoration rates across conditions and returns to restoration, which are depicted in the Graph 2 below.



Graph 2: Mean of restoration by two treatments: Baseline (BL) and Only Restoration (OR)

We obtain a couple of interesting insights from the plot. Firstly, the Nash equilibrium is not reached in neither BL (depicted on the left) nor Only Restoration (bars on the right) and irrespective of the returns to restoration faced (dark green for high returns and light green for low returns). Under all circumstances, average restoration is positive, ranging between 1,25 and 1,5. Secondly, individuals exposed to low returns to restoration seem to restore slightly more, especially in the BL condition, even though this difference is not statistically significant.

To test these and additional insights more formally, we proceed by estimating a Tobit model where the uncensored outcome is assumed to depend on explanatory variables according to

$$Restoration_i = \beta_0 + \beta_1 Condition_i + \beta_2 MPCR_i + X_i\theta \qquad (4)$$

where $Restoration_i$ is the number of trees restored by individual *i*; β_0 is a constant term; $Condition_i$ is a dummy variable taking value 1 if individual *i* participates in restoration only and 0 if the subject is enrolled in both extraction and restoration stages (BL); $MPCR_i$ is a dummy variable taking value 1 if individual *i* is exposed to high returns from restoration and 0 otherwise; and X_i is a vector of individual *i*'s answers to the beliefs questions. In a robustness analysis, available upon request, we also allow for heterogeneity in the effects of $MPCR_i$ depending on $Condition_i$. As we find this term not to be statistically different from zero, we omit it from the main discussion.

The first row of Table 4 shows that across specifications the estimated β_1 coefficient is negative and statistically significant, suggesting that individuals enrolled in restoration only tend to exert a greater contribution to replanting the forest than individuals who previously contributed to extraction too. As to the second row, it shows that differences in returns to restoration once again do not appear to be an important driver of restoration effort. Indeed, estimates of the β_2 coefficient remain not statistically different from zero across specifications.

DV: restore	(1)	(2)	(3)	(4)	(5)
condition	0.131*	0.144**	0.145**	0.153**	0.158***
	(0.094)	(0.049)	(0.017)	(0.010)	(0.008)
low_mpcr	0.160	0.148	0.124	0.115	0.138
	(0.492)	(0.496)	(0.491)	(0.511)	(0.428)
forest_left	-0.0432	-0.0262	-0.000139	-0.00589	-0.00748
	(0.495)	(0.652)	(0.998)	(0.896)	(0.868)
ee		0.902***		0.452***	0.435***
		(0.000)		(0.003)	(0.004)
ne		0.252		-0.610***	-0.612***
		(0.103)		(0.000)	(0.000)
majority			0.678***	0.539***	0.524***
			(0.000)	(0.000)	(0.000)
nb			1.163***	1.376***	1.364***
			(0.000)	(0.000)	(0.000)
donate					0.000794
					(0.128)
self_risk					0.0649*
					(0.091)
N	544	544	544	544	544

Note. Dependent variable. *restore* variable ranging 0, 1, 2.
Significance of coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: BASELINE + ONLY RESTORATION: Tobit regressions of restore as dependent variable

Finally, to quantify the relation between previous extraction decisions and subsequent contribution to restoration, we restrict our attention to the BL sample only and we estimate a Tobit regression assuming that the uncensored outcome variable takes the form

$$Restore_i = \beta_0 + \beta_1 Extraction_i + \beta_2 MPCR_i + X_i\theta + \varepsilon_i \quad (5)$$

which is the counterpart of regression (3) where the role of extraction and restoration is inverted. Of course, the correlation is strong and negative as previously found, confirming that participants that extract more in the first stage of the game tend to restore less in the subsequent

public good game. As pointed out above, however, we do not necessarily interpret the documented empirical relation as causal, because both extraction and restoration decisions are endogenous within individual.

DV: restore	(1)	(2)	(3)	(4)	(5)
low_mpcr	0.374	0.347	0.371	0.348	0.358
	(0.348)	(0.334)	(0.224)	(0.246)	(0.227)
extraction	-0.957***	-0.951***	-0.648***	-0.597***	-0.626***
	(0.001)	(0.000)	(0.003)	(0.006)	(0.003)
other_forest	-0.0603	-0.0113	-0.0363	-0.0232	-0.0181
	(0.668)	(0.928)	(0.725)	(0.818)	(0.854)
ee		1.176***		0.387	0.374
		(0.000)		(0.125)	(0.135)
ne		0.472*		-0.473**	-0.455**
		(0.057)		(0.042)	(0.044)
majority			0.941***	0.796***	0.755***
			(0.000)	(0.001)	(0.001)
nb			1.309***	1.476***	1.460***
			(0.000)	(0.000)	(0.000)
donate					0.00165*
					(0.058)
self_risk					0.107
					(0.116)
N	283	283	283	283	283

Note. Dependent variable. *restore* variable ranging 0, 1, 2.
Significance of coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: BASELINE: Tobit regressions of restore as dependent variable

3.4.4.3. Relevance of normative beliefs and expectations

We conclude the empirical analysis by commenting on the role of normative drivers emerging from previous regressions results in Tables 2-3. Expectations that other people consider restoration desirable from a normative perspective and that other people will indeed positively contribute to restoration play a mixed role in our analysis, exerting a seemingly positive effect on both restoration and extraction decisions. In contrast, positive normative beliefs about the role of restoration play a more prominent role, significantly increasing restoration effort. The positive coefficients on the variable *nb* (normative belief) in Tables 4 and 5 (restoration tables) capture this result. Moreover, the positive coefficients on the variable *majority* in the same tables suggests a similar importance for expectations about restoration decisions by the majority of other participants. The more individuals expect the others to contribute, the more they in

practice restore. Overall, this evidence suggests that, beyond individual economic incentives, both intrinsic motivations captured by own normative beliefs as well as social factors represented by expectations on others' behaviour crucially shape individual decisions in the game studied.

3.5. Conclusions

Ecological restoration practices, although extremely important in our times, still lack a clear recognition within the environmental legal framework and subsequent systematic implementation. For this reason, in this last chapter of the dissertation a closer investigation of the situational choices of individuals facing the possibility to restore a damaged environment were investigated. Specifically, we presented the design and results of an economic experiment carried out in April 2023 where we investigated the root components of the strategic interactions among individuals, with the objective of developing a preliminary experiment on the modes and instruments capable of motivating actors to restore depleted environmental goods.

From the extraction part of the game, we learn that first of all, individuals do not play their dominant action, meaning there is no full extraction. Secondly, the figure of how much people extract (or not extract) does not seem to be dependent on the fact that they will have the possibility to restore, and on what is the return to restoration activities. However, this does not mean that restoration does not matter, because we observe that people who hold a normative belief favourable to restoration extract less in the first stage. Our interpretation of these empirical findings is that while restoration matters, overall, it is not that important for participants to know who will restore. Moreover, the fact that extraction choices do not seem to be strongly related to MPCR suggests that other social or ethical mechanisms are in place, beyond economic incentives and efficiency concerns. This interpretation finds confirmation in the fact that we also observe, from BL sample, that those who restore the most in the second stage of the game, extract less to start with.

From the restoration part of the game, we get similar insights. Firstly, individuals exert a positive restorative effort, i.e. individuals do not play in their own self-interest. As in the case of extraction, economic incentives represented by returns to restoration do not seem to be a strong driver of this deviation from the predicted Nash equilibrium, as they do not induce significant differences in terms of contribution to the public good. In contrast, normative beliefs seem to be key in this case too: a favourable attitude towards restoration as well as the expectations that the majority of other participants share the same normative beliefs

substantially increases the contribution to the public good. Again, this pro-environmental sentiment is confirmed by the fact that restoration is negatively correlated with extraction intensity across individuals. We also observe that participation in OR leads to marginally higher contribution to the public good than in the BL sample. Together with the fact normative beliefs are a key driver of higher restoration, the latter finding well aligns with our previous discussion that such a situation may arise if intrinsic pro social and pro environmental motivation matter more than the external context in driving individual behaviour.

Although the presented version of the game is very preliminary and can only offer limited behavioural insights, we believe this still represents a relevant first step in the field which deserves further development.

4. Thesis' Final Remarks

This thesis has investigated the scientific, legal, and socio-economic aspects of ecological restoration, which constitute one of the most promising approaches to slow down and possibly reverse what scientists consider to be one of the biggest challenges of the century, biodiversity loss.

Ecological restoration involves the process of returning a degraded ecosystem to its original functioning, structure, and diversity. It is, though, a very peculiar activity, because it holds a strong intertemporal and intergenerational dimension where even if harm was caused in the past, the responsibility to restore and maintain healthy ecosystems falls on the present and future generations. Moreover, it is a type of intervention that goes beyond the traditional paradigm of the "polluter pays" because it addresses instances where damage has been so pervasive and widespread that it is impossible to determine who should bear the costs of recovery.

In light of this complexity, consistency of international, regional, and national regulations appears fundamental, alongside with a tight connection with existing scientific knowledge and considering economic, social, and ethical considerations. Therefore, I start in Chapter 1 by providing an overview of the scientific content of ecological restoration, putting it into historical perspective. In particular, what I describe is that, over time, two distinct approaches to restoration have emerged. The first is often referred to as "backward-looking" because it aims at exactly replicating some environmental conditions that existed prior to human interference. However, this approach faces several limitations. Firstly, it is often impossible to establish what the exact "initial conditions" are. Secondly, even when this is possible, it may not be feasible to achieve them, because the environmental damage has been so large and pervasive that it is irreversible, or because of changing circumstances (for example, climate change). The second approach, which emerged in contrast with the previous one, is restoration to create "novel ecosystems", that is to say ecosystems that have been significantly altered, and are composed of species combinations and processes that may not be found in natural ecosystems. This approach has its own downsides, because it is strongly anthropocentric and because, if taken to an extreme, could actually be a cause of further biodiversity loss. Alongside the heated scientific debate on how to establish the baseline for restoration and what ecological goals to pursue with this activity, a strong ethical debate has also emerged. Some ethicists, like Elliott and Katz, labelled restoration as an act of "faking nature" strongly criticising it, while others, more generously, see the practice as a way, finally, to overcome the duality of nature/culture in favour

of a more harmonious relationship between humankind and the environment. This ongoing and transdisciplinary debate reveals that ecological restoration is more than a technical procedure, but it rather calls into question community values, beliefs, as well as social justice concerns.

In the attempt to better understand how communities - broadly defined - regulate restoration practices and what type of value and priorities they give to them, in Chapter 2 I focused on studying and analysing the most relevant provisions at the international, European and Italian level that deal with restoration. The international scenario is quite varied, on the one hand it is possible to find quite strong species-specific protection, on the other hand, the recognition of a true and meaningful "obligation to restore" is far from reached. Some treaties, like the Convention on Biological Diversity, contain the seed of a promising first-step for a broader recognition of a state obligation to restoration, but as for now very little progress has been made. In European law, instead, more concrete findings emerged: the strong system of protected areas across the continent has allowed key ecosystems to avoid overexploitation. Moreover, the Nature Directives contain a clear obligation to restore damaged ecosystems and species under a regime of strict protection, as confirmed by extensive case-law. Beyond the positive examples of protected areas, however, European legislation suffers from excessive fragmentation and a lack of coordination among objectives, and therefore the loss of biodiversity continues unabated. To counteract this trend, the European Commission proposal on a Regulation on Nature Restoration represents an absolute element of novelty in the European landscape, since it provides for specific obligations of ecological restoration for all Member States, covering not only protected areas but also other types of ecosystems that are currently unprotected, but are heavily impacted by human activities. The approval of this law also depends heavily on the interests of the Member States, their priorities, and the existing status quo. In Italy, for instance, restoration obligations can be found mainly in three areas: (i) ex ante regulation of potentially impactful activities, with obligations of mitigation and compensation, (ii) ex post regulation of environmental harm, and (iii) planning regulation. Apart from conservation laws that constitute a special niche, most of existing legislation has a compensatory nature, meaning that it is activated upon very localised damage, is bound to liability, and lacks a comprehensive perspective. What seems to be missing, moreover, are some instruments that move from a strictly protective logic to a more incentivizing one, working towards converging interests.

To best design and implement them, an inquiry on the individual motivations for restoration is needed, and is part of Chapter 3. Starting from existing literature on environmental public and common goods, together with my co-authors, I develop a theoretical argument for the existence

of a peculiar category of goods: *restorable goods*. The latter feature two distinctive characteristics. Firstly, they have an intrinsic intertemporal dimension, meaning that they first get overexploited and consumed, and at a later stage they are reconstructed. Secondly, they have threshold dimension, meaning that up to a certain point ecosystems, although used, function, but once the threshold is reached the provided services cease to exist. Considering this analysis, we set up a game theoretical model capturing the two above-mentioned features to investigate whether and to what extent intrinsic motivation, a sense of responsibility for past wrongs and other social norms matter in capturing individuals' willingness to contribute to restore a damaged good. What we find is that economic incentives and efficiency concerns are not the sole drivers to individuals' choices, but that other social and ethical mechanisms are in place. Normative beliefs play a crucial role, because a pro social and pro environmental attitude, together with the expectations that one's beliefs are shared by the majority of people, substantially increases individuals' contributions to the public good.

The two main takeaways from this dissertation are the following. Firstly, the regulatory framework on restoration, fragmented and often unclear, needs more integration and could benefit from stronger obligations to restore. Secondly, I emphasise that, while this is certainly advisable, some dimensions of restorative practices respond to a different logic than that traditional of the world of law. Indeed, from the evidence advanced, it seems that individuals' behaviour and willingness to contribute to restoration is not so much affected by direct economic incentives, but respond more promptly to intrinsic normative beliefs. Further research is definitely needed to better clarify how and to what extent institutions – intended largely as rules, actors, shared agreements as well as economic instruments – can elicit such pro-environmental normative beliefs complementing and supporting legal instruments for a better, more just and widespread restoration of our ecosystems and of our communities.

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