Managing environmental mining legacies in the Andean region

Analysis, challenges and lessons learned

MAURICIO PEREIRA
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Editors

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Summary

Extractive activities have historically characterized the Andean region. They have driven development and created economic benefits but, at the same time, have caused environmental impacts that pose risks for the health of the population and the environment, especially when operations are not properly closed.

The lack of common definitions and regulations on environmental legacies in the region, together with the absence of national legislative frameworks in several countries, makes it difficult to identify the parties responsible for those legacies and, consequently, to manage and finance actions for controlling them. In that context, this book provides an overview of the current state of environmental legacies in the Andean region and presents a compilation of definitions, regulatory frameworks, challenges, experiences and notable cases involving the remediation and valorization of contaminated sites. It also offers reflections and recommendations for the management of environmental legacies in Argentina, Chile, Colombia, Ecuador, Peru and the Plurinational State of Bolivia.

The study explores the concepts of preventive and corrective environmental legacy management and emphasizes the importance of keeping up-to-date public inventories of contaminated sites. It also discusses the allocation of responsibilities and the financing options available for remediation activities. From the perspective of international law, it examines the state of the regulations and institutions that currently exist in the region. It notes that although few specific regulations on the management of environmental legacies have been adopted, countries have begun to reverse this trend: primarily through preventive legislative enactments that require environmental assessments to be conducted before embarking on investment projects.

The book also acknowledges the difficulty of funding remediation actions. Accordingly, it describes various financial instruments used internationally, together with financial mechanisms that could be adapted for dealing with environmental legacies and contaminated sites.

Finally, it proposes that environmental liability remediation should be geared towards controlling the risks posed to people and the environment and should involve effective, timely and transparent community participation. It argues that remediation can contribute to increasing the economic value of contaminated sites, create jobs, expand land use possibilities, provide urban and social benefits and improve the protection of nature.

Foreword

The challenges facing Latin America and the Caribbean include overcoming the trap of low capacity for growth and transformation, reducing inequality and increasing social mobility, and strengthening institutional capacity and advancing towards more effective governance, in a context marked by growing environmental and climate pressures. In this scenario, environmental mining legacies, namely the negative consequences of past or inactive mining operations, pose one of the most difficult barriers to sustainability. This is particularly true in the Andean region, where mining has been a driving force for development but has also generated cumulative legacy impacts in the absence of adequate regulatory frameworks and sufficient institutional capacity to manage them.

Mining generates significant tax revenues, drives investment and sustains a substantial volume of exports in several countries of the region. However, it has historically been carried out under differing environmental standards, leaving behind contaminated sites, tailings, waste rock piles and abandoned mines that pose risks to human health and ecosystems. There are an estimated 12,000 environmental mining legacies in the Andean region, although gaps in inventories and methodologies mean that the actual figure could be higher. This is a clear indication of the urgent need to strengthen public policies aimed at remediation, prevention and integrated management of these legacies.

This book, *Managing environmental mining legacies in the Andean region: analysis, challenges and lessons learned*, offers a comprehensive overview of the state of these legacies in the region and analyses trends in key concepts such as risk, responsibility, resilience and preventive and corrective management. It also includes a review of various international examples

—cases from Germany, Australia, Canada and the United States— where robust regulatory frameworks, risk-based inventories, dedicated funds for orphan legacies (i.e. when the responsible party cannot be identified or does not exist) and intergovernmental coordination mechanisms have been developed. These experiences show that effective mining governance is built on clear rules, coordination between institutions, transparent information and sustained financing.

The study highlights the importance of specific legislation on environmental mining legacies, strengthening environmental impact assessments and closure plans, and consolidating accessible and up-to-date inventories. It shows that remediation mechanisms require continuity over time and that the existence of orphan legacies calls for stable and diversified financial instruments. The lessons learned from other countries reaffirm that resource stability is a prerequisite for efforts that could last years or even decades.

Institutional coordination —both across sectors and levels of government— is essential to ensure regulatory consistency, efficient resource allocation and effective implementation of remediation actions, especially in contexts where transparency, access to information and community participation are critical to the legitimacy and sustainability of interventions. Addressing environmental mining legacies requires not only remedying the impacts of the past, but also preventing future ones through strong institutions, adequate control mechanisms, comprehensive legal frameworks, structural financing and active collaboration between governments, communities and the private sector. The report also emphasizes the importance of incorporating climate considerations and circular economy criteria into remediation planning.

With this book, the Economic Commission for Latin America and the Caribbean (ECLAC) reiterates its commitment to strengthening institutional capacities, promoting coherent productive and environmental policies and building natural resources governance focused on sustainability, inclusion and the well-being of current and future generations.

José Manuel Salazar-Xirinachs
Executive Secretary
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Introduction

The life cycle of productive activities, including mining, involves several stages that undeniably contribute to the economic and social development of Latin American and Caribbean countries. In many cases, however, inadequate closure and post-closure processes can result in environmental legacies that leave a negative legacy for present and future generations.

This study focuses on the mining sector and provides an analysis of the various elements that should be taken into account in managing and remediating environmental mining legacies. In particular, it describes the regulatory and institutional conditions in selected Andean countries —Argentina, Chile, Colombia, Ecuador, Peru and the Plurinational State of Bolivia— which have long mining traditions and numerous environmental mining legacies.

It presents an overview of the definitions and concepts used internationally regarding environmental legacies, risk and resilience. It also includes an analysis of issues such as the allocation of responsibilities and preventive and corrective approaches to environmental management. The study is part of the project "Regional cooperation for the sustainable management of mining resources in the Andean countries (MinSus)", through which the Sustainable Development and Human Settlements Division of the Economic Commission for Latin America and the Caribbean (ECLAC), together with the German Federal Institute for Geosciences and Natural Resources (BGR) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), aim to ensure that mining activities are carried out sustainably and in harmony with neighbouring communities.

The institutional frameworks and environmental regulations in the Andean region are relatively recent, while environmental mining legacies have been created throughout history, parallel to the development of an activity with origins that date back to pre-Columbian times. The permanent risk that this legacy poses to human health and the environment has prompted the recent adoption of a preventive approach to forestall the creation of new legacies, which includes strengthening the regulations governing mining site closures and environmental impact assessment processes for new investment projects.

However, the actual remediation of existing mining environmental mining legacies has been delayed, mainly because of the absence of a specific regulatory and institutional framework that would allow States to provide resources for remediating, restoring and rehabilitating contaminated sites when the party responsible for creating the legacy cannot be identified.

This publication acknowledges the economic importance of the mining sector in the Andean countries. It also presents an analysis of the relationship between mining activities and the emergence of legacies, outlines the existing inventories, and highlights the importance of expanding cadastres and increasing the transparency of information.

With reference to the current regulatory and institutional framework for mining in the Andean region, the document includes a review of the legislation governing environmental legacies in general and environmental mining legacies in particular, and of other legal frameworks that could prevent their emergence and generate synergies to control risk factors. The main elements that should be included in legislation governing environmental mining legacies are also outlined. To that end, guidelines based on international definitions and legislation are presented, which emphasize the importance of systems for assigning responsibilities.

One of the main limitations for managing environmental mining legacies is the lack of funding. The study therefore incorporates an analysis of the various sources available, both public and private, as well as those offered by international assistance. On the basis of the financial mechanisms in place in the countries with the longest traditions of managing environmental mining legacies, suggestions for developing a financing strategy are offered.

Lastly, several successful cases of environmental mining legacy remediation in countries of the Andean region and other regions are presented. In this way, the study outlines lessons learned on issues related to voluntary removal, the reprocessing of tailings, legacy stabilization and secondary mining.

The book is divided into seven chapters, in addition to this introduction. Chapter I sets out the concepts and context of environmental legacies. Chapter II shows the importance of mining and the origin of mining environmental legacies in selected Andean region countries. Chapter III includes a review of the regulatory and institutional framework that governs mining. Chapter IV presents an analysis of environmental legacies from the viewpoint of comparative law. Chapter V provides a closer look at the mechanisms available for financing mining environmental legacy remediation. Chapter VI describes successful cases of legacy remediation and secondary mining. Lastly, chapter VII contains the study's conclusions and recommendations.

Chapter I

Environmental legacies: concepts and context

This chapter presents the main definitions that apply to environmental legacies in the region and highlights the need to find common ground in that regard. It also refers to key elements in the management of environmental legacies, such as risk analysis, and it discusses the importance of assigning responsibilities for determining who created the legacy and who should perform the restoration, rehabilitation or remediation required. Lastly, it explains the concepts of preventive and corrective environmental legacy management.

A. Origin, definitions and types of environmental legacies

There is no single definition of environmental legacies or environmental mining legacies in Latin America and the Caribbean. In recent decades, however, significant progress has been made with the development of concepts that are essential for drafting and improving regulatory frameworks and strengthening legacy management.

The term "contaminated site" is perhaps the broadest, as it includes both sites where activities are still taking place and those that have ceased to operate. The European Environment Agency defines a contaminated site as a specifically defined area where the presence of soil contamination posing a potential risk to humans, water, ecosystems or other receptors has been confirmed.[1]

[1] See https://www.eea.europa.eu/.

Nevertheless, definitions of environmental legacies are often associated with past activities, including those from many years ago; as a result, it is sometimes impossible to identify the party responsible for creating them. There are also names that identify the specific sector that caused the pollution, such as environmental mining legacies. Table I.1 shows the national regulations and definitions of environmental legacies and environmental mining legacies in force in selected Andean countries. Cabrera Leal and Ordóñez Potes (2022), based on Guerrero (2014), also compiled various nuances related to the term "environmental legacy" that have been used in reports, technical documents and legislative initiatives discussed in Colombia, such as: (i) environmental legacy, (ii) orphan environmental legacy, (iii) configured environmental legacy, (iv) contingent environmental legacy and (v) sociocultural environmental legacy.

Table I.1
Definitions used to classify environmental legacies and environmental mining legacies

Country	Definition	Regulations
Argentina	Environmental damage, in terms of water, soil, air pollution, deterioration of natural resources and ecosystems, produced by any type of public or private activity, during its ordinary operations or by unforeseen events throughout its history, which constitute a permanent and/or potential risk to the health of the population, the surrounding ecosystem and property, and which has been abandoned by the party responsible.	Act No. 14343 of 2011, on regulating environmental legacies (Province of Buenos Aires).
	Environmental damage that poses a current or potential risk to the health of the population, at a contaminated site abandoned by the party responsible.	Act No. 6117 of 2018, on contaminated sites environmental management (Legislature of the Autonomous City of Buenos Aires).
	Environmental legacies are understood as a series of negative and irreversible environmental impacts that entail the deterioration of natural resources and ecosystems, produced by any type of public or private activity, during its ordinary operations or by unforeseen events throughout its history, which pose a permanent or potential risk to human health, the ecosystem or property.	Act No. 10208 of 2014, on environmental policy of the Province of Córdoba.
Bolivia (Plurinational State of)	The series of negative impacts detrimental to health and/or the environment caused by certain works and activities existing in a certain period of time and the general environmental problems not resolved by certain works or activities.	Supreme Decree No. 24176 of 8 December 1995, corresponding to Act No. 1333 of 27 April 1992.
		Article 46 of the General Environmental Management Regulations.

Country	Definition	Regulations
Chile	An abandoned or idle mining operation, including its tailings, that poses a significant risk to human life or health or the environment.	2005 draft bill on the remediation of environmental mining legacies and Decree No. 2 of 2023.
	Site or land environmentally impacted by a past activity that has ended and over which no control is currently exercised.	National Policy for the Management of Sites with Contaminants.
Colombia	Environmental impacts caused by anthropic activities, directly or indirectly by human action, authorized or not, cumulative or not, that can be measured, located and geographically delimited, that generate an unacceptable level of risk to life, human health or the environment, as established by the Ministry of Environment and Sustainable Development and the Ministry of Health and Social Protection, and for the control of which there is no environmental or sectoral instrument.	Act No. 2327 of 2023.
Ecuador	Environmental damage and/or negative environmental impacts not respectively repaired or restored, or those that have been previously but inadequately or incompletely addressed and continue to be present in the environment, constituting a risk for any of its components, generated by a mining activity.	Mining Act (No. 45) of 2009, as amended in 2016, and Environmental Regulations for Mining Activities, Ministerial Agreement No. 37 of 2014, as amended in 2016.
Peru	Facilities, effluents, emissions, remains or waste deposits produced by mining operations that are currently abandoned or inactive and that pose a permanent and potential risk to the health of the population, the surrounding ecosystem and property.	Act No. 28271 to regulate the environmental legacies of mining activities, 2004.
	Facilities, effluents, emissions, contaminated sites and remains or waste deposits located in the national territory, including the sea shelf, marine sediments and groundwater, produced by abandoned productive, extractive or service activities, that currently, potentially or permanently affect human health, environmental quality and/or ecosystem functionality.	Supreme Decree No. 009-2023-MINAM, enacted in 2023, adopting the Regulations to Emergency Decree No. 022-2020, the emergency decree for strengthening the identification and management of environmental legacies.

Source: Prepared by the authors, on the basis of the countries' legislation.

Given the absence of a standardized definition, it is possible that, depending on the country, different concepts may be associated with the same problem. Each country has its own definitions, with different degrees of formalization: in national legislation, ministerial decrees or specific studies. For example, Colombia (Act No. 2327 of 2023) and Peru (Act No. 28271 of 2004 and Supreme Decree No. 009-2023-MINAM) have legally established definitions of environmental legacies: a general definition in Colombia and general and mining-specific definitions in Peru. In the Plurinational State of Bolivia, the definition refers to environmental legacies without specifying mining activities.

The differences between countries go beyond the legal status of the definitions, however: there are also distinctions in content and, accordingly, in restoration, remediation and rehabilitation obligations and approaches. This makes it difficult both for countries to apply consistent treatment methods and for them to collaborate and share experiences.

In general, the conceptualization of environmental legacies involves two elements: risk and damage. Both issues are contained in all the definitions and indicate the likelihood of legacies having a negative impact on health or the environment.

For the purposes of this book, environmental mining legacies are understood as the potential negative social and environmental impacts associated with abandoned mining operations (and the residues deposited therein), regardless of whether or not an owner or operator can be identified.

B. Risk and resilience in environmental mining legacies

As noted in the previous section, a environmental mining legacy represents a risk to the community and the environment. A risk is "the combination of the probability of an event occurring and its consequences" (Federal Institute for Geosciences and Natural Resources and National Geology and Mining Service [BGR and SERNAGEOMIN], 2008). Additionally, it can be defined as an "aggregate estimate of the probability and severity of an adverse event for life, health, property or the environment" (Association of Iberoamerican Geological and Mining Surveys [ASGMI], 2020, p. 19). The risks arising from environmental mining legacies generally relate to people's physical safety and to pollution, and they can have negative repercussions for economic activities.

A distinction must be drawn between the concepts of risk and damage. The Association of Iberoamerican Geological and Mining Surveys (ASGMI) defines environmental damage as a measurable adverse loss, change, deterioration, impairment, alteration or modification of habitats, ecosystems, natural elements and resources, their chemical, physical or biological conditions, the interactions and relationships between them, and the environmental services they provide (Presidency of the Republic of Mexico, 2013, as cited in ASGMI, 2020, p. 7).

In short, damage is a risk that has materialized. Although there are circumstances in which the concept of environmental damage could be equated to that of an environmental legacy (for example, when waste from industrial or mining activities seriously contaminates the environment), the

two should not be confused. From an analytical point of view, categorizing an environmental legacy is a necessary prior step in establishing environmental damage, since it implies its examination and analysis according to the type of risk. On the basis of that distinction, it can be said that environmental legacy has an ex ante connotation, since in time it could become environmental damage, while environmental damage has an ex post connotation, since the party responsible must assume the legal consequences of restoring and providing compensation for something that has already occurred. However, a legacy and environmental damage may coexist when, in the same place, an activity entails both risks of contamination and damage that has already materialized. In such cases, both preventive and corrective measures are required.

In particular, environmental damage —which could be due to unremediated environmental legacies— can arise from a range of factors: the collapse of a tailings dam, a spill of hazardous substances onto the ground or into watercourses, a concentrated release of pollutants into the atmosphere, the accumulation of contaminated waste at a specific site and so on. To be considered environmental damage, those factors must result in a significant modification or impairment of the pre-existing environmental conditions (ASGMI, 2020).

According to De Miguel and Pereira (2019), risk management is essential in analysing and assessing the potential impact of an environmental mining legacy on the surrounding communities and the environment. To achieve this objective, in addition to identifying abandoned mine sites and performing a cadastral registry of them, government authorities should assess the risks and link them to the existence of environmental mining legacies. It is therefore crucial that States have the resources needed to fund risk assessment processes.

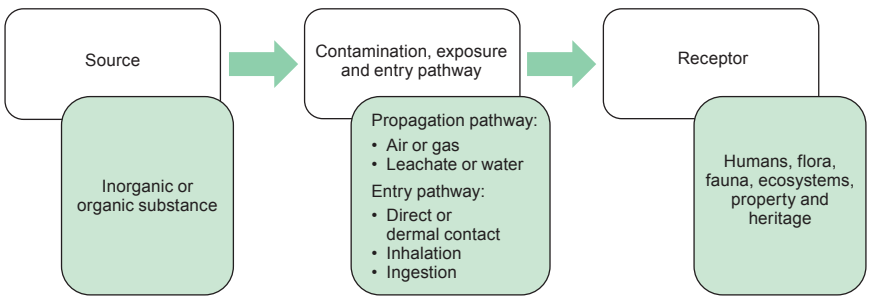
The impact is produced by physical and chemical transportation mechanisms. Depending on the source and its characteristics, it is possible to identify physical-mechanical processes, such as soil instability followed by collapse or erosion (tailings dam ruptures), or physical-chemical processes (propagation routes), such as the transport of substances and contaminants by suspension, in dissolved form (acid drainage or water contamination by metals in general), by air (particulate material) or by contact.

As for the receptors, contaminants can enter the organisms of humans and other living beings through direct ingestion of contaminated water or food, inhalation of vapours or particulate material and dermal contact with contaminated substances. Water sources, such as regional watersheds, can also be considered receptors (United States Environmental Protection Agency [EPA], 2024).

The risk resulting from chemical contamination processes and the source-pathway-receptor concept are addressed in depth in the different

laws and regulations governing contaminated sites and solid waste at the international level. Diagram I.1 depicts the source-pathway-receptor concept, which forms the basis for the risk assessment of contaminated sites.

Diagram I.1
Concept of chemical substance risk assessment



Source: Prepared by the authors.

By way of example, the main risks associated with an environmental mining legacy include massive tailings dam and waste dump ruptures and collapses, dust emissions and surface and groundwater contamination, all of which can cause health problems, damage the physical environment and endanger wildlife and biodiversity conservation (Aranibar et al., 2023).

Most national laws on environmental legacies and contaminated sites[2] require that technical interventions —such as remediation, securing, containment or removal of contaminants— be based on the concept of risk assessment. This encompasses the establishment of quantitative values in order to assess the generic risk posed by the concentration of a given substance, exposure pathway and receptor scenario, and which operate as reference values (for example, the *Estándar de Calidad Ambiental* in Peru, the Screening Value in the United States or the *Prüfwerte* in Germany).

These countries have also established site-specific risk calculation algorithms for determining contaminant status, pathways and receptors. They take account of local and site-specific characteristics, including human receptors. Once detected, the risk factors must be evaluated, the probability of occurrence and the severity of the consequences must be considered, and priority must be given to the treatment of the legacies that pose the greatest

[2] Such as those of the European countries (e.g. Act No. 7/2022 in Spain and the Federal Ordinance for the Protection of Contaminated Soils and Sites in Germany), those of Canada (where legislation in this area is adopted at the provincial level: e.g. Act No. 375/96 in British Columbia and Act No. 2002/171 in Yukon), those of the United States (Comprehensive Environmental Response, Compensation, and Liability Act of 1980) or those of Mexico (for example, the General Act for the Prevention and Integral Management of Waste).

risks to society and the environment (BGR and SERNAGEOMIN, 2008; De Miguel and Pereira, 2019).

Accordingly, the *Manual de Evaluación de Riesgos de Faenas Mineras Abandonadas o Paralizadas* (BGR and SERNAGEOMIN, 2008) presents two methodological approaches for estimating risk: one to measure contamination risks and another to measure safety risks. For the first, three factors must come together: the contaminant, the receptor and the exposure pathway. For the second, two concurrent factors are needed: a hazard scenario and a receptor of that scenario.

Table I.2 identifies the steps for estimating risks and prioritizing abandoned or idle mine sites (according to the nomenclature used in Chile).

Table I.2
Steps for assessing risks and prioritizing abandoned or idle mine sites

Steps	Description
Hazard scenario	Identify situations that pose a risk.
Potential receptors	Identify the potentially affected parties.
Probability of occurrence	Estimate the occurrence probability of each hazard scenario.
Severity of consequences	Estimate the severity of the consequences for the receptors.
Risk matrix	Apply a risk matrix to distinguish significant risks and, to that end, determine whether the sites are environmental mining legacies or not.
Detailed risk assessment	Apply a detailed risk assessment methodology in cases where there is a degree of uncertainty about the simple assessment carried out.
Cumulative risk assessment	Conduct a cumulative risk assessment, which consists of a review of the assessment carried out in cases where there is another abandoned or idle mine site nearby.
Prioritization	Classify the abandoned or idle mining sites in order of priority, according to the severity of the risks they pose.

Source: De Miguel, C. and Pereira, M. (2019). Pasivos ambientales mineros: retos para la sostenibilidad. In J. Sánchez (Ed.), *La bonanza de los recursos naturales para el desarrollo: dilemas de gobernanza*. ECLAC Books (157) (LC/PUB.2019/13-P). Economic Commission for Latin America and the Caribbean; Federal Institute for Geosciences and Natural Resources and National Geology and Mining Service. (2008). *Manual de Evaluación de Riesgos de Faenas Mineras Abandonadas o Paralizadas (FMA/P)*.

In summary, it is essential that a risk management plan be developed to manage environmental mining legacies' technical and socioeconomic conditions and to increase the degree of adaptation to their possible impacts. In addition, a community resilience analysis must be conducted to complement the risk-based approach, as outlined in methodologies such as those of Canada (National Orphaned/Abandoned Mines Initiative) and the United States (Superfund Community Involvement Handbook). Using those instructions, and based on information about the existing risks and the characteristics of the assessed environment, road maps can be created to increase the ability of communities to adapt to environmental mining legacies' potential negative impacts and to design community development programmes

(Organisation for Economic Co-operation and Development [OECD], 2014; United Nations Development Programme [UNDP], 2014, as cited in De Miguel and Pereira, 2019).

Broadly speaking, resilience is defined as an inherent and acquired condition achieved by managing risks over time at the individual, household, community and societal levels in ways that minimize costs, build capacity to manage and sustain development momentum, and maximize transformative potential (UNDP, 2013, as cited in De Miguel and Pereira, 2019). The aim of this approach is for stakeholders to have a common perspective of the risks they face, to understand the adaptation mechanisms and to strengthen them so they can design appropriate development strategies and policies (De Miguel and Pereira, 2019).

C. Allocation of responsibility

In managing an environmental mining legacy, the party who will be responsible for financing and executing the remediation actions necessary to avoid future social and environmental impacts must be determined. Normally, responsibility for remediating a legacy will fall on the party that created it: a public or private company, for example. However, many legacies have a historical origin going back decades or even centuries, so their identification, cadastral registration and risk analysis are not simple tasks.

There are cases in which it is not possible to clearly determine the party responsible for creating the legacy or in which the responsible party is not in a position (due to a lack of capacity or resources) to remediate the contaminated site. When the polluter cannot be held responsible, the responsibility lies with the land's current owner (or concession-holder) or with the State, depending on individual national laws (World Health Organization [WHO], 2021).[3]

In many cases, when the party who created the legacy cannot be identified or located, responsibility for management and remediation falls on the State. The new financial obligations make the environmental legacy a contingent liability under the State's quasi-fiscal policy (De Miguel and Pereira, 2019). Since environmental mining legacies are a situation inherited from the past and, therefore, predate the entry into force of the environmental regulations deliberately formulated to prevent them, States should increase the budgetary resources earmarked for remediation actions, which are generally limited. However, to avoid the creation of new mining environmental legacies, the State should include responsibility clauses in its contracts or concessions with third parties.

[3] In many of the region's countries, subsoil mineral resources are owned by the State, which grants concessions for their exploitation to private companies.

D. Approaches to the management of environmental mining legacies

A distinction must be drawn between preventive management, which aims to avoid the creation of new legacies, and corrective management, which covers the management of existing environmental mining legacies. Thus, corrective management, directed towards closed, abandoned or idle mines, seeks to mitigate damage by implementing a remediation plan, while preventive management, targeting active mines, seeks to prevent damage and the emergence of new legacies by implementing good practices and adequate closure plans (De Miguel and Pereira, 2019).

Managing environmental mining legacies entails a range of interventions that cover the process of controlling the risk posed by an environmental mining legacy to the health of people or the environment, and the actions needed to reincorporate an environmental legacy into the economic cycle, either through reprocessing or reuse of its surface, invariably with the use of risk control measures.

According to De Miguel and Pereira (2019), preventive and corrective management mechanisms include the application of various environmental principles set out in the 1992 Rio Declaration on Environment and Development, including principle 3 (intergenerational rights), principle 4 (incorporating the environmental variable as an integral part of the development process), principle 7 (the common but differentiated responsibility of States), principle 10 (on participation and access to information), principle 15 (the precautionary approach) and principle 16 (the "polluter pays" principle).

1. Preventive management

In Latin America and the Caribbean, preventive management is currently more institutionalized than corrective management (Morales, 2023; Morales and Hantke Domas, 2020). Most countries in the region have specific laws on the closure of mining activities, as well as more general environmental laws that cover project closures and the application of environmental impact assessments (see chapter III). Moreover, in many cases, governments have made efforts to incorporate into their mine closure laws the requirement for financial compliance guarantees to ensure that the State has sufficient resources to carry out mine closure plans when companies fail to comply with their obligations (Saade Hazin, 2014; Oblasser, 2016; De Miguel and Pereira, 2019).

Funding must be assured throughout the project life cycle, even after closure, as remediation actions may be required in the post-closure phase. Financial guarantees are therefore a crucial tool that must be taken into account from the very start of a mining project.

Closure plans are fundamental for the responsible management of mining activities, as they include measures to compensate, correct, mitigate and prevent the impacts derived from those activities throughout the project life cycle. At the same time, environmental impact assessments enable environmental factors to be addressed during the project, in order to prevent and mitigate negative effects on human health, the environment or ecosystems.

Preventive management can also include measures to encourage the processing of materials extracted by other nearby mining operations to reduce the environmental footprint and favour smaller companies. For example, the Mining Act in Mexico states that concessionaires who process minerals or substances subject to the terms of this law are obliged to process the ore of small and medium-sized miners and of the social sector under competitive conditions up to a minimum of 15% of the installed processing capacity, when this is greater than one hundred tons in 24 hours (Presidency of the Republic of Mexico, 1992, p. 24).

2. Corrective management

Adequate corrective management requires an inventory that identifies the environmental mining legacies existing in a country and assesses the risks they pose. Once identified, they are ranked by their risk level and, based on that classification, their remediation is prioritized (De Miguel and Pereira, 2019). Inventories also increase transparency and information access.

Corrective measures for environmental mining legacies are in line with principle 1 (the right of people to live in harmony with nature), principle 4 and principle 16 of the Rio Declaration. Likewise, corrective measures must include standards for regeneration and remediation that are based on objective criteria. In particular, for principle 16 to be effective, the applicable responsibilities must be assigned to determine who is to pay for and execute the remediation actions, as indicated in section C of this chapter.

When responsibility for remediation falls on the State, Oblasser (2016) lists five sources of funding: (i) funds from the budget, (ii) specific fines, charges or taxes related to polluting activities, (iii) environmental protection funds or other competitive funds for implementing remediation projects, (iv) public-private partnerships, and (v) international assistance.

This requires the existence of specific legislation that grants the institutions in charge of remediation actions powers of oversight and sanction and ensures efficient corrective management. The remediation of an environmental mining legacy, depending on its design, can encourage secondary mining or offer an alternative use of the site. Thus, remediation can become a source of investment that boosts the local economy, given that, in accordance with the principles of the circular economy, it would provide job opportunities and allow for the reuse of existing associated infrastructure.

Secondary mining is a practice that aims to promote and achieve sustainable mining by using new or different technologies to process lower ore grades. It involves recovering valuable elements from mining waste through metallurgical processes and identifying opportunities for reprocessing and reconverting environmental mining legacies (i.e. converting them into assets). With such reconversions, mining can generate social, environmental and economic value. Although the countries of the Andean region have made progress with secondary mining, many of them are still at the stage of producing studies and evaluations.

Finally, it should be noted that planning management actions is also part of the intervention and includes measures such as research, risk assessment and the actual technical measures for risk control or mitigation and the reuse of the legacy. Table I.3 identifies the elements associated with the management of environmental mining legacies.

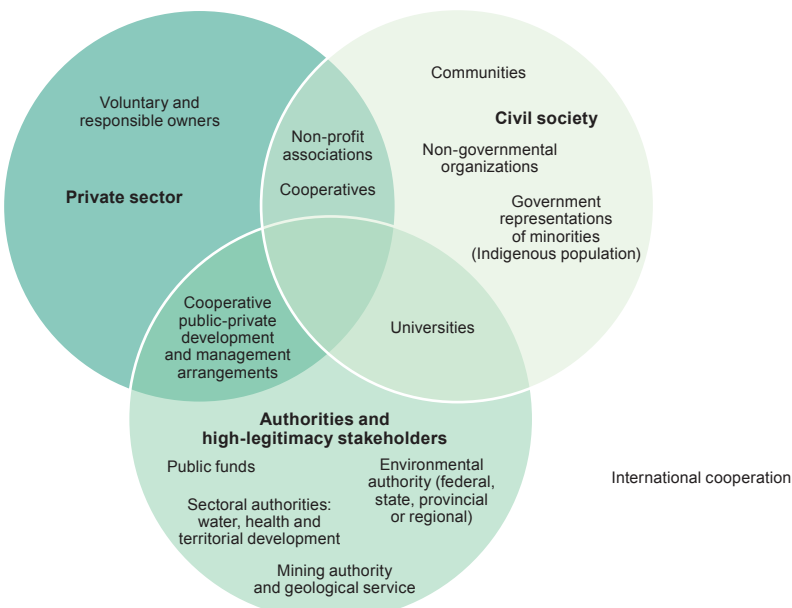
Table I.3
Essential elements in managing an environmental mining legacy

Measures or actions	Description
Corrective intervention	Measures to control and mitigate the risk posed by environmental mining legacies to health and the environment in a sustainable way through technical activities such as research, risk assessment, remediation projects and monitoring.
Repurposing and revaluation	Measures to reuse, recycle, repurpose, revitalize and restore some or all of the properties related to the environmental mining legacy, in order to increase its economic, urban, cultural or social value.
Institutional and cooperative agreements	Institutional and cooperative arrangements needed to ensure the governance, management and implementation of interventions, provide legal certainty and encourage private investment.
Financial and economic agreements and models	Financial and economic agreements and models to ensure the availability of resources in line with institutional and cooperative arrangements.
Social responsibility measures	Measures to ensure stakeholder buy-in and ownership, and to secure economic and social benefits.

Source: Prepared by the authors.

The actors and stakeholders involved in legacy management vary from country to country depending on the legislation in force and the institutional structures that exist. Diagram I.2 summarizes the main actors, divided into three interacting groups: government authorities and agencies, private sector actors and civil society.

Diagram I.2
Overview of major actors and stakeholders in the management of environmental mining legacies



Source: Prepared by the authors.

In short, ensuring efficiency in an environmental legacy's preventive or corrective management requires:

- Agreeing on common definitions.
- Clearly establishing responsibilities.
- Creating specific funding mechanisms.
- Collecting transparent, up-to-date information.
- Necessarily including all stakeholders and ensuring better coordination among them.

E. Conclusions

This chapter contains multiple definitions of the environmental legacies that mining activities and other industries can create. Although no standardized definition exists, environmental mining legacies are understood as the potential negative impact on the health and physical safety of people and the environment. Under the definition used in this study, references to the potential negative impact include the concept of risk. Likewise, environmental mining legacies are associated with abandoned mining operations (and the wastes deposited therein), with or without an identifiable owner or operator.

It also notes that quantifying an environmental legacy's potential impact requires assessing the risks. Risk analysis enables environmental legacies to be identified, evaluated, inventoried and prioritized. Implementing a risk management plan is key to increasing the community's level of adaptation and resilience to the possible impacts of environmental mining legacies. This enables the design of road maps that take account of the assessed environment, with a view to increasing people's adaptive capacities and developing community development programmes.

Another important element in managing environmental mining legacies is identifying the party responsible for their creation. In most instances, when dealing with historical environmental mining legacies —often without an identified owner— it is the State that is responsible for their management. If a responsible party is identified, however, the "polluter pays" principle can be applied to ensure the implementation and financing of remediation actions. According to the principles of the Rio Declaration, States must ensure their citizens a life in harmony with nature and the preservation of a healthy environment in order to achieve sustainable development. Controlling risks to people and to the environment is therefore essential.

The chapter also introduces the concepts of preventive and corrective management. Preventive management is intended to prevent the emergence of new legacies through instruments such as environmental impact assessments and closure plans for mining operations. Conducting an ex ante assessment of the financial viability —including closure and post-closure costs— of any new mining project is therefore essential. Corrective management, in contrast, focuses on remedying existing liabilities inherited from the past. The instruments that exist for carrying it out include, for example, the environmental liability laws in Colombia and Peru.

Finally, ensuring the proper management of an environmental legacy and reducing or eliminating the risk of it having a negative impact requires: (i) agreeing on standardized definitions to facilitate the production of specific and timely policy instruments, (ii) clearly determining the party responsible

for the remediation actions, (iii) ensuring funding for remediation and follow-up actions in the mining activity's post-closure phases, (iv) ensuring the availability of accurate and up-to-date information on registered environmental mining legacies and (v) involving all stakeholders in legacy management.

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Chapter II

The importance of mining and the origin of environmental mining legacies in selected countries of the Andean region

Historically, the Andean region has made extensive use of its rich mineral wealth, with which mining is one of the main sectors of its countries' economies. For example, the silver mines of Potosí in what is today the Plurinational State of Bolivia were deemed the richest in the world in the sixteenth and seventeenth centuries (Enríquez, 2002). This chapter examines the economic importance of the mining sector in Argentina, Chile, Colombia, Ecuador, Peru and the Plurinational State of Bolivia, as well as the relationship between mining activities and the creation of environmental legacies. The final section of the chapter presents the information available on the environmental mining legacy inventories that the sectoral authorities have officially identified.

A. Economic importance

Mining is a leading source of income for most of the Andean region countries. In Chile, Colombia, Peru and the Plurinational State of Bolivia, mineral and metal exports have accounted for between 35% and 55% of total exports in recent decades. In Argentina and Ecuador, the percentage was generally below 10% of the total export volume during that period.

When prices are favourable, mining is a powerful engine of economic growth that drives national economies. The mining boom at the start of the twenty-first century also benefited government revenues, which allowed for greater fiscal slack. In addition, the adoption of countercyclical policies

helped the countries to better cope with the global financial crisis of 2008 and 2009. In this regard, mining has enormous potential to generate financial and productive alternatives that can contribute to the long-term strengthening of other sectors.

The current context indicates that in light of international demand for minerals, mining will continue to command a privileged place in many of the region's economies, at least in the short and medium term. Given the economic boost provided by this sector, compliance with the principles of sustainable development must be ensured, taking due account of the activity's environmental and social impact. It is therefore important to ensure that mine closure plans are properly formulated and incorporated into the life cycle of mining projects, in order to eliminate —or at least reduce— the risk of creating new environmental mining legacies, in keeping with the preventive management approach.

Before analysing the regulatory frameworks, which are examined in chapter III, the importance of the mining sector in selected Andean region countries should be examined.

1. Argentina

Metal mining in Argentina is focused on the extraction of gold, silver, lead, aluminium and copper.[1] The country also has the third-largest lithium reserves in the world and is the world's fourth-largest lithium producer, behind Australia, Chile and China (Ministry of Productive Development of Argentina, 2020, 2022; Ministry of Economic Affairs of Argentina, 2022a, 2022b).

The country still has important geological resources to be tapped. As of February 2024, Argentina had 160 mining projects, of which 94 were at either advanced or early stages in the exploration phase.[2] As of the same date, other projects were at the economic evaluation and construction phases. A large proportion of those projects —28.57% of the total portfolio— involved lithium and gold. In 2023, there were 22 projects in operation, extracting mainly copper, lithium, gold, silver, coal and lead (Ministry of Economic Affairs of Argentina, 2024).

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1 Ministry of Economic Affairs of Argentina (2022a). For years, copper was the main export mineral; however, the main mine (Bajo de la Alumbrera, in Catamarca) ceased operations in 2018. Current investment projects promise increasing copper exports in the second half of the decade (from 2025 onward).

2 Ministry of Economic Affairs of Argentina (2024). These figures correspond to projects involving new discoveries. However, there are mines at the production stage that also invest in exploration. The data in the report were current as of June 2023; however, an official update from the Ministry of Economic Affairs dated May 2025 reports a portfolio of 187 mining projects. For additional information, see Sistema de Información Abierta a la Comunidad sobre la Actividad Minera en Argentina [SIACAM] (2024).

The increase in exploration activities is closely related with the increase in resources and reserves, as well as with the potential to increase mining exports. Exploratory budgets in Argentina rose by 94.87% between 2015 and 2021 (Ministry of Economic Affairs of Argentina, 2024).

According to 2022 data, gold production totalled 1.33 million ounces; silver production, 30.9 million ounces; and lithium production, 33,000 tons of lithium carbonate equivalent (Ministry of Economic Affairs of Argentina, 2023a, 2023b, 2023c). The Argentine National Institute of Statistics and Censuses (INDEC) estimates that the extraction of metalliferous minerals contributed approximately 1.2% of the country's gross value added in 2024 (National Institute of Statistics and Censuses [INDEC], 2024a, 2023).

Argentina's mining exports in 2022 totalled US$ 3.878 billion, while metalliferous and lithium exports, according to provisional INDEC data, accounted for more than 6% of the country's total exports. The most exported mining products were gold (56%), silver (20.8%) and lithium (18.1%, between lithium carbonate and lithium chloride) (Ministry of Economic Affairs of Argentina, 2022c; INDEC, 2024b).[3] In the latter case, exports totalled US$ 696 million in 2022, for a year-on-year growth of 234%, the highest figure in a decade (Ministry of Economic Affairs of Argentina, 2023a). It should be noted, however, that the size of that increase is unlikely to indicate a trend.

Lastly, the tax revenues contributed by the mining sector at the national and subnational levels must be differentiated. Nationally, companies pay export duties, income tax and taxes on bank account credits and debits. Mining's contribution to value added tax (VAT) is reduced by exemptions for international sales, since the Mining Investment Act allows for VAT refunds in exploration services. Public revenues at the provincial and municipal levels come from royalties, mining fees, gross income, and commercial and municipal taxes of different kinds. In addition, contributions are obtained from trust funds, which are usually set as a proportion of mining turnover or production and vary from province to province (Ministry of Productive Development of Argentina, 2022).

2. Plurinational State of Bolivia

Mining is a key source of income for Bolivia. In 2022, the sector reached a record level of mineral output value, surpassing the levels recorded before the COVID-19 pandemic and thus consolidating the recovery of the mining and metallurgical sector in Bolivia (see table II.1) (Ministry of Mining and Metallurgy of the Plurinational State of Bolivia, 2023). The minerals with the

[3] INDEC (2024b). Data for 2021 and 2022 are provisional. According to INDEC, metalliferous mining and lithium accounted for over 6% of exports in 2021.

highest levels of output value are gold, zinc, silver, tin and lead (accounting for 95.5% of the total) (Ministry of Mining and Metallurgy of the Plurinational State of Bolivia, 2022).

According to the Integrated Production Information System (SIIP), metal and non-metal mining in the Plurinational State of Bolivia (excluding the extraction of oil and natural gas) contributed 4.4% of the gross domestic product (GDP) in 2023 (Ministry of Productive Development and the Plural Economy of the Plurinational State of Bolivia, 2023). Over the past four decades (1980–2022), output volumes have varied widely and differently from one type of mineral to another; in general, however, the trend has been an upward one. In the case of gold, the refined volume has increased significantly compared with 1980. There were also increases, albeit smaller, in silver, lead and zinc. However, there were drops in the output of other products, such as antimony and tin (see table II.1).

Table II.1
Plurinational State of Bolivia: historical output of main minerals

Mineral	Unit	1980	1990	2000	2010	2019	2020	2021	2022
Zinc	Fine metric tons	50 260	103 849	149 134	414 492	527 521	358 411	499 257	517 523
Tin	Fine metric tons	27 480	17 249	12 464	20 058	17 147	14 709	19 628	17 613
Gold	Fine kilograms	1 620	5 198	12 001	6 394	42 040	23 207	45 662	53 374
Silver	Fine kilograms	190 176	310 543	433 592	1 262 483	1 152 628	929 909	1 289 456	1 214 301
Antimony	Fine metric tons	16 379	8 454	1 907	4 980	2 747	2 629	3 084	3 453
Lead	Fine metric tons	17 270	19 913	9 523	72 834	88 002	64 619	92 767	89 761
Wolfram	Fine metric tons	3 464	1 235	481	1 518	1 342	1 699	1 971	1 713

Source: Prepared by the authors, on the basis of Aranibar, A., Lafuente, D. and Pabón, E. (2023). Remediación y activación de pasivos ambientales mineros en el Estado Plurinacional de Bolivia. *Environment and Development series*. (174) (LC/TS.2023/66); Ministry of Mining and Metallurgy of the Plurinational State of Bolivia. (2022). *Dossier: Estadísticas del Sector Minero Metalúrgico 1980-2021*; Ministry of Mining and Metallurgy of the Plurinational State of Bolivia. (2023). *Anuario Estadístico y Situación de la Minería 2022*; Economic and Social Policy Analysis Unit. (2023). *Dossier de Estadísticas Sociales y Económicas*, *33*. https://www.udape.gob.bo/portales_html/dossierweb2023/htms/doss0109.html.

Mining cooperatives, which account for 57.5% of the output value, are the country's leading mineral producers. The private mining sector contributes 36.2%, with another 6.3% from State mining (Ministry of Mining and Metallurgy of the Plurinational State of Bolivia, 2023).

Mining is an important source of income for the public coffers of the Plurinational State of Bolivia. A 25% tax is levied on the income of companies in the sector, as is the case for all other sectors in the country. In addition, the mining sector contributes an additional tax rate of 12.5% —if the profits of foreign beneficiaries are taken into account— with which its total contribution rises to 37.5% (Altomonte and Sánchez, 2016; Aranibar et al., 2023). Another source of income is mining royalties, which are specific to the sector and are transferred directly to the regional governments. According to the Ministry of Productive Development and the Plural Economy of the Plurinational State of Bolivia (2023), total royalty revenues were US$ 238.1 million in 2022. Of that amount, 85% went to the autonomous departmental governments, with the remaining 15% allocated to the governments of the municipalities where the mining operations are located.

In contrast to the resources allocated to the national and departmental governments, the municipalities must use at least 85% of the royalty revenues they receive for public investment projects, and at least half of those projects are expected to be carried out in the area impacted by the mining operation. Therefore, part of the funds derived from mining royalties could be used for environmental management by the autonomous territorial entities (Aranibar et al., 2023).

Between 2016 and 2022, mining royalties amounted to some US$ 1.254 billion, of which US$ 1.066 billion went to the departmental autonomous governments and US$ 188 million to the municipalities (Aranibar et al., 2023; Ministry of Mining and Metallurgy of the Plurinational State of Bolivia, 2023). In addition, in 2022, the country's mineral exports earned foreign exchange worth US$ 6.689 billion, an increase of 13.3% over the previous year (Ministry of Mining and Metallurgy of the Plurinational State of Bolivia, 2023). By value, the main exports were gold (45%), zinc (27%) and silver (13%) (Aranibar et al., 2023; Ministry of Mining and Metallurgy of the Plurinational State of Bolivia, 2023).

Particularly notable is the upward trend of the country's gold production. As will also be seen in the cases of Colombia and Peru, the increase in gold production in the Plurinational State of Bolivia is often linked to informal and illegal mining operations in peripheral geographical areas of the nation's territory (Aranibar et al., 2023). Illegal mining, particularly of gold, relates strongly to environmental degradation. In addition, according to the United Nations Office on Drugs and Crime (UNODC), it has ties to human trafficking, child labour and trafficking in arms and drugs (United Nations Office on Drugs and Crime [UNODC], 2022a).

3. Chile

Mining in Chile dates back to pre-Columbian times. In the nineteenth and twentieth centuries, saltpetre was the country's main mineral, but it was later superseded by copper. In the late 1990s, the country became a world mining centre, with virtually all the world's major copper producing companies operating there (Lagos et al., 2002a).

Mining accounted for 6.3% of GDP in 1996 and 11.7% of GDP in 2024 (measured in current currency) and has averaged 10.4% over the last 26 years (Chilean Copper Commission [COCHILCO], 2022a). During 2022, mining remained one of the country's main economic pillars, commanding a 14.2% share of national GDP, with copper mining alone accounting for 10.9% (National Geology and Mining Service [SERNAGEOMIN], 2023). In turn, lithium accounted for 3.4% of mining GDP in 2022, and production capacity is expected to increase steadily (Griffith-Jones et al., 2023).

Mining activities account for the largest share of revenue from the country's export shipments. In 2022, mining-related exports were worth a total of US$ 58.152 billion (free on board value),[4] equal to 59.6% of the country's total exports that year (SERNAGEOMIN, 2023).

Copper has traditionally been the country's top mining product. According to the Chilean Copper Commission (COCHILCO), 2018 saw the highest level of output in history: a total of 5.83 million tons (COCHILCO, n.d.).[5] In 2022, Chile retained its first place in global production of copper (25.4%), its second place in molybdenum production (17.9%) and its fourth place in silver production (5.0%). It also remained the world's largest producer of iodine (66%) and ranked second in lithium production (29.6%) (SERNAGEOMIN, 2023).

In 2022, with the exception of copper mining, mining activity grew thanks to the production of non-metallic minerals, led in terms of incidence and momentum by lithium (Central Bank of Chile, 2023). Chile has one of the world's largest lithium reserves and, together with Australia, is one of the leading lithium producers (Government of Chile, 2023).[6]

Chile's foreign trade data for the period from 2010 to 2021 (up to October 2021) show the trend in lithium exports. Lithium carbonate was the main export product, in line with its production trend, and accounted for 87% of the total during the period. It was followed by lithium hydroxide (10%)

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4 FOB: an indicator of value used in foreign trade for maritime or river transport.

5 Chilean mine copper production (annual). According to COCHILCO data, this volume was produced only by large mining companies (medium- and small-scale mining operations are not included).

6 Government of Chile (2023). It is estimated that Chile's lithium reserves account for between 36% and 40% of the global total. The Salar de Atacama is the largest operating continental brine deposit in the world. Australia produces 46% of the world's total lithium, alongside Chile's 32%.

and, lastly, by lithium chloride and lithium brines (3%) (COCHILCO, 2021a). According to the Central Bank of Chile, lithium carbonate mining exports accounted for 8% of the country's total goods exports in 2022 and for 6% in 2023. They also accounted for 14% of mining exports in 2022 and for 10% in 2023, making lithium the second-largest mining export after copper (Central Bank of Chile, n.d.). It should nevertheless be noted that in 2022 there was an unprecedented increase in the price of lithium, which subsequently began to trend downward. Although the lithium industry is important to the Chilean economy, it still represents a minor percentage compared with the production and export of copper (Central Bank of Chile, n.d.; COCHILCO, 2021a).

4. Colombia

According to statistics from the Bank of the Republic of Colombia and the National Administrative Department of Statistics (DANE), the mining sector accounted for approximately 4% of GDP in 2022 (National Mining Agency [ANM], 2023; National Administrative Department of Statistics [DANE], 2024a). Coal production[7] has increased in recent decades and, between 2015 and 2022, exceeded 80,000 tons; there has, however, been a decrease over the past few years (DANE, 2024b). According to preliminary data, coal mining in the fourth quarter of 2022 accounted for 0.6% of Colombia's GDP and 15.5% of its mining GDP (DANE, 2024a).

In 2022, coal accounted for 74% of mining sector exports, gold for 18.9%, ferronickel for 5.5% and emeralds for 0.63%. Other minerals made up the remainder (ANM, 2023). In 2021, royalties and fees generated US$ 673.63 million in revenue (ANM, 2023). The royalties came mainly from coal (82%), nickel (6.6%) and precious metals (around 10%)[8] (Cabrera Leal and Ordóñez Potes, 2022).

It should be noted that informal and illegal mining still exists in the country. Illegal mineral extraction, by its very nature, entails little or no compliance with fiscal and environmental obligations, so it is likely that these operations will become mining legacies (Cabrera Leal and Ordóñez Potes, 2022).

According to UNODC, alluvial mining, particularly for gold, is practised in the departments of Chocó, Antioquia and Bolívar (UNODC, 2022b). These activities are problematic, as they can involve both formal and informal processes and methods (UNODC, 2022b).

Act No. 1892 of 2018, which came into force in July 2018 and was ratified on 26 August 2019 under the Minamata Convention on Mercury, contains regulations aimed at controlling and eliminating the use of mercury in mining

[7] Includes thermal coal and metallurgical coal.
[8] Precious metals include gold, silver and platinum.

activities. That milestone was essential in complying with environmental and mining obligations in formal activities; however, those obligations remain pending in the case of illicit practices (Cabrera Leal and Ordóñez Potes, 2022). Also noteworthy is Act No. 1930 of 2018, which declares that *páramos* are strategic ecosystems and prohibits mining exploration and extraction within their confines.

5. Ecuador

Historically, Ecuador has been characterized by artisanal and small-scale metal mining. In 2014, small-scale mining accounted for 22% of the country's gold production, while artisanal miners produced the remaining 78% (Organization of American States [OAS], 2021a). As a result of several reforms to the regulatory framework for mining, increased political and economic stability, and improved infrastructure and services, large-scale mining began in 2019 with the opening of the Fruta del Norte gold mine (Estupiñan et al., 2021; OAS, 2021a; Ministry of Energy and Mining of Ecuador, 2022). Currently, there are two large active mines, Fruta del Norte and Mirador, which began exporting minerals in 2019 and 2020, respectively, leading to a substantial increase in mining exports (Ministry of Energy and Mining of Ecuador, 2022; Central Bank of Ecuador [BCE], 2023a).

To date, 7.1% of the country's total land area has been concessioned and about 10% has been explored (Estupiñan et al., 2021; Ministry of Energy and Mining of Ecuador, 2022). Following a popular consultation with the inhabitants of the country's capital held in August 2023, however, it was decided to prohibit artisanal and small-, medium- and large-scale mining in the Chocó Andino, a natural reserve noted for its diversity of fauna and flora in the northwest of Quito. The consultation's outcome would not affect, at first, any of the mining concessions for the extraction of gold, copper and silver that were previously approved and are in the early stages of exploration (Conservation International, 2023).

As regards large-scale production, between September 2019 and June 2023 the Fruta del Norte mine processing plant produced 5.06 million tons of ore.[9] Similarly, between July 2019 and June 2023, the Mirador mine yielded 54.66 million tons of ore (BCE, 2023a).

The growth of the mining sector can also be seen in the figures for non-traditional exports, which are divided into oil and non-oil exports.[10] The non-traditional, non-oil group includes gold, lead and copper concentrates, and other mining products, which accounted for 26.5% and 30.8% of this

[9] BCE (2023a). Ore is the mineral from which a metal can be extracted, generally because it contains a sufficient amount for exploitation. Of the 5.06 million tons of ore mined, the plant processed 4.85 million tons.

[10] Ecuador's non-oil exports are led by traditional exports, including shrimp, bananas, cacao and fish.

group's total volume in 2021 and 2022, respectively (Ministry of Energy and Mining of Ecuador, 2022; Ministry of Production, Foreign Trade, Investments and Fisheries of Ecuador, 2023).[11] According to data from the Central Bank of Ecuador, mining (non-oil) products totalling US$ 2.092 billion were exported in 2021, which rose to US$ 2,775 billion in 2022. Thanks to that increase, mining products became the national economy's fourth-largest export, accounting for 7.8% of total exports in 2021 and 8.5% in 2022, after crude oil, shrimp and bananas (Ministry of Energy and Mining of Ecuador, 2022; Ministry of Production, Foreign Trade, Investments and Fisheries of Ecuador, 2023; BCE, 2023b).

Official Government of Ecuador sources indicate that the country's mining GDP is quantified through two national accounts: mining and quarrying, and manufacture of other non-metallic mineral products. Taking both accounts together, mining GDP would represent 1.64% of the national total in 2019 and approximately 2% in the 2020–2022 period (Ministry of Energy and Mining of Ecuador, 2020; BCE, 2023b).

The mining sector's tax obligations are collected through royalties, taxes and mining profits. The Mining Act regulates conservation patents (art. 34), royalties (arts. 92 and 93) and mining profits (art. 67) (National Assembly of Ecuador, 2009). The amounts payable vary from one mining regime to another. In addition, all companies are required to pay VAT, income tax, the Single and Temporary Contribution, the tax on foreign exchange outflows, along with other levies (Ministry of Energy and Mining of Ecuador, 2022).

By law, 60% of the royalties and profits collected are destined to social investment projects (Ministry of Energy and Mining of Ecuador, 2020, 2022). The mining sector contributed US$ 74 million in sector taxes in 2021 and approximately US$ 202 million in 2022 (Ministry of Energy and Mining of Ecuador, 2022, 2023).

6. Peru

Peru has a wide variety of metal deposits, including gold, silver and copper, which have been exploited since pre-Inca times. Mining is, at present, one of the most dynamic sectors of the country's economy (Glave and Kuramoto, 2002). Peru also has the world's largest reserves of silver, lead, zinc and molybdenum (National Institute of Statistics and Informatics [INEI], n.d.; United States Geological Survey, 2023), the world's second-largest copper reserves and its fourth- largest gold reserves (Schatan et al., 2022).

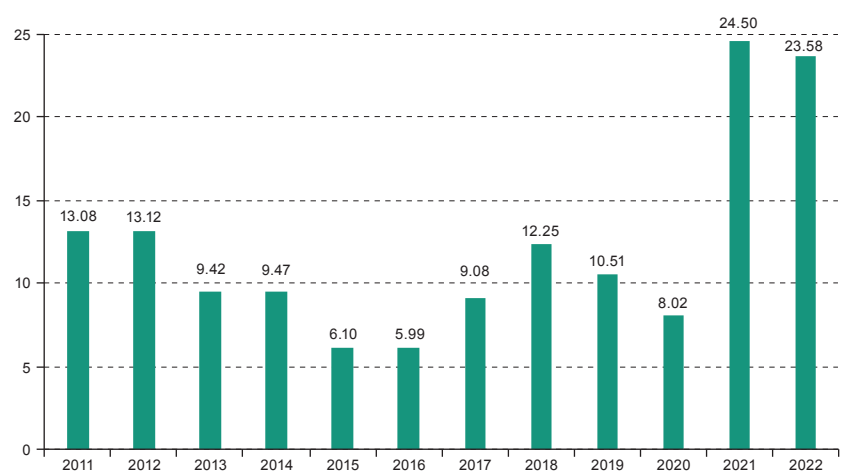
[11] As of October 2023, this figure equates to 36.8% of total non-traditional, non-oil exports.

Mining's contribution to the Peruvian economy is unquestionable. The country's vast mineralogical potential places it among the world's leading producers of numerous metals (Chappuis, 2019). In 2022, Peru ranked seventh in the world in gold production, second in copper and zinc, third in silver and fifth in lead (COCHILCO, 2023; The Silver Institute, 2023; United States Geological Survey, 2023; Venditti, 2022; World Gold Council, 2025). According to statistics from the Central Reserve Bank of Peru, the mining and hydrocarbons sector contributed 11.3% to national GDP in 2022, with metal mining contributing 8.3% (Central Reserve Bank of Peru [BCRP], 2024).

The mining sector makes the largest contribution to the country's trade balance and is an important source of foreign exchange (Glave and Kuramoto, 2002; Schatan et al., 2022). According to information from the Ministry of Energy and Mining (MINEM), mining exports (including metallic and non-metallic mining) totalled US$ 42.790 billion, an increase of 12% over the previous year. The main export metals were copper, gold and zinc. Metal mining exports represent 64% of the country's total exports, while non-metal mining exports account for only 1.9% (Ministry of Energy and Mining of Peru [MINEM], 2023; based on BCRP data).

In addition to general taxes and duties (profit tax, VAT, import duties and so on), there are other specific taxes and duties in the mining sector, such as mining royalties, the Special Mining Tax and the Special Mining Levy (Poveda Bonilla, 2022). Figure II.1 shows the trend in mining subsector tax revenues for the 2011–2022 period (MINEM, 2023).

Figure II.1
Peru: annual tax revenues from the mining subsector, 2011–2022
(In billions of soles)



Source: Prepared by the authors, on the basis of Ministry of Energy and Mining of Peru. (2023). *Boletín Estadístico Minero*. (10-2023).

B. The link between mining and environmental legacies

The importance and long tradition of mining in the Andean region's economies is undeniable. However, mining activities have also put pressure on the environment and created negative externalities —such as atmospheric emissions, discharges into watercourses and the disposal of waste— as well as other adverse effects on flora, fauna, biodiversity, landscape resources and cultural heritage. Environmental mining legacies have also fuelled a large number of social and environmental conflicts (Saade Hazin, 2014). Mining conducted over many years in a context of inadequate or non-existent legislation and a lack of good practices has resulted in hundreds of affected areas, thousands of tons of waste and unquantified damage to communities and the environment.

In addition, consideration must also be given to mining closure processes, the result of factors such as resource depletion, price fluctuations and social pressures. For example, the tin crisis of the 1980s forced the government of the Plurinational State of Bolivia to reprivatize or discontinue unprofitable operations (Enríquez, 2002). Similarly, coal mines and oil wells in southern Chile have been gradually closed owing to the depletion of economically exploitable reserves (Lagos et al., 2002b).[12]

Over hundreds of years of mining activity, numerous extractive close-downs have failed to follow adequate closure processes, and these have become sites with a high risk of contamination that affect the landscape, make other land uses unviable and endanger public health. For example, minerals such as iron sulfide, which may be in the form of pyrite or pyrrhotite, can be found at some of the mined deposits. When pyrite decomposes, it facilitates the generation of acidic water, which leaches heavy metals such as lead, copper, arsenic and cadmium. Acidic waters, enriched with heavy metals, reach the surface through mechanized activities or natural flow and can contaminate soils and other bodies of water (Aranibar et al., 2023).

Unregistered, irregular and illegal small-scale gold mining operations are found in Colombia, Ecuador, Peru and the Plurinational State of Bolivia, especially in the Amazon region (Aranibar et al., 2023; Cabrera Leal and Ordóñez Potes, 2022; Chappuis, 2019; Poveda Bonilla, 2022; UNODC, 2022b; UNODC and Ministry of Mining and Energy of Colombia, 2022).[13] This problem entails little or no fiscal or environmental compliance, which gives rise to environmental mining legacies. According to Cabrera Leal and Ordóñez Potes (2022), estimating the social and environmental damage and

[12] Metal mining in southern Chile is rare and its share of GDP is below the national average.
[13] Informal or illegal mining has also been detected in Amazonian areas of Brazil and Ecuador.

impact of, for example, the use of mercury[14] or cyanide in illegal gold mining is extremely complex. The use of those compounds can have disastrous consequences for the environment and negatively affect public health.

According to data from the mining census conducted in Colombia in 2011, 86% of metallic mineral mining production units (MPUs), 40% of coal PUs, 59% of non-metallic mineral MPUs and 16% of stone MPUs did not have a mining title or an environmental licence (Cabrera Leal and Ordóñez Potes, 2022).

In the Plurinational State of Bolivia, Aranibar et al. (2023) note that in the cooperative and small-scale mining sector, environmental management is very weak and constitutes a source of environmental mining legacies, mainly in gold mining, where there are a large number of informal operations. In addition, according to reports from the Comptroller General's Office, the management of environmental licences, protected areas and environmental legacies needs to be improved. There is a lack of regulation, oversight and sanctions for both formal, licensed activities and for unlicensed informal activities. There are also a high number of environmental mining legacies, many located in high-risk areas and without restoration measures (Comptroller General's Office, 2020, 2021a, 2021b).

In Ecuador, illegal gold mining and commercialization have increased significantly in recent years. This is the result of numerous factors, such as high levels of informality and poverty, the presence of mineral deposits in remote areas, the existence of illegal mining networks in neighbouring countries and the scant presence of supervisory authorities in mining areas (OAS, 2021a). Illegal mining in the country is concentrated mainly in the border regions, particularly along the northern border with Colombia and the southern border with Peru (OAS, 2021a).[15] When a gold deposit cannot be exploited or an operation's large-scale activities have to be suspended for technical or financial reasons or because of social conflicts, there is an increased risk of the emergence of illegal mining hotspots. In addition, the extraction techniques used by artisanal gold miners often include the use of mercury and cyanide. According to government sources, in 2018 the country produced approximately 23.6 tons of gold, which coincided with the 29.6 tons of mercury released into the environment (Ministry of Environment, Water and Ecological Transition of Ecuador, 2020).

In Peru, around 500,000 miners are estimated to be working informally and illegally (OAS, 2021b). Illegal mining remains a widespread practice in some parts of the country, especially in remote regions where there is little government presence, resulting in massive deforestation, environmental

[14] Rubiano-Galvis (2019). The use of mercury, especially in informal and illegal mining, also has a negative cross-border impact, as pollution is spread beyond national borders.

[15] Illegal gold mining is also present in the provinces of Azuay, El Oro and Zamora Chinchipe.

contamination and violence. In particular, unregulated activities are common in remote areas of the departments of Madre de Dios, Arequipa, Puno, Piura, Amazonas, La Libertad and Ayacucho (OAS, 2021b).

Mining generates waste, such as tailings, waste rock, effluents and emissions into the atmosphere,[16] which represents both a challenge and an opportunity. The challenge is knowing how to manage and dispose of them, and the opportunity lies in the economic revaluation of the materials present (COCHILCO, 2021b). The adoption of a circular economy model in mining depends on a combination of factors specific to the type of mining (small-, medium- or large-scale) and the waste it generates.

In general, it is estimated that for every ton of metal mined, between 2 and 12 tons of tailings and waste are discarded[17] (Mohanty et al., 2010; Julca Zuloeta, 2022). For example, Chilean mining is estimated to produce 800 million tons of tailings per year and 2.8 billion tons of waste rock per year (see table II.2) (Chilepolimetálico Project Team, 2021). In Peru, a copper mine processing 20,000 metric tons of 0.5% copper ore per day produces 19,600 metric tons of tailings a day (Villachica et al., 2021).

Table II.2
Chile and the world: estimated volumes of secondary mineral resources

Waste type	World tonnage	Tonnage in Chile	Potentially valuable contents
Tailings	7 billion tons per year	800 million tons per year	Iron, lead, zinc, copper, molybdenum, rhenium, cobalt, platinum group metals, rare earth elements, silicon dioxide and kaolinite
Copper smelter slag	35 to 40 million tons per year	40 million tons (cumulative)	Copper, molybdenum, rhenium, silicon dioxide, aluminium oxide and iron oxide
Copper smelting dust	660,000 tons per year (2019)	36,400 tons per year (2018)	Copper, zinc, germanium, lead and silver
Anode slimes	57,000 tons per year (2018)	n/d	Copper, silver, gold, platinum, palladium, selenium and telluride
Leach residues	n/d	63 million tons per year	Copper, aluminium, manganese, gallium, indium, indium and others
Waste rock	20.8 billion tons per year	2.8 billion tons per year	Copper and by-products

Source: Chilepolimetálico Project Team. (2021). *Chilepolimetálico: Diversificando la minería chilena*.

[16] According to Julca Zuloeta (2022), tailings are the material that, because of its economic characteristics at the time of extraction, does not contain enough ore to be processed and therefore falls beneath the cut-off grade. Waste rock is the material removed from the rock mass (with no economic value for the mining project) in order to access and extract the economically valuable materials (economically extractable deposit).

[17] Depending on the country, the terms *relave*, cola, jale and lodo minero all refer to tailings, defined as the fine residues and water resulting from leaching and mineral concentration processes (Association of Iberoamerican Geological and Mining Surveys [ASGMI], 2020, p. 6).

In Chile, the Production Development Corporation (CORFO) is conducting a research and development programme titled "Recovery of Elements of Value from Tailings Deposits". In the programme's first stage, it was determined that the tailings deposits contained minerals such as silicon oxide (SiO_2), aluminium oxide (Al_2O_3), titanium oxide (TiO_2), iron oxide (Fe_2O_3), calcium oxide (CaO), magnesium oxide (MgO), manganese oxide (MnO), sodium oxide (Na_2O), potassium oxide (K_2O) and phosphorus oxide (P_2O_5) (JRI Engineering and Ecometales, 2019). In June 2024, CORFO issued a call for proposals entitled "Technological programmes for the reconversion of environmental legacies". This initiative aims to address the competitiveness shortfalls both in solutions to the accumulation and resolution of environmental legacies in the identified priority sectors and in technological development for reconverting waste into new products or raw materials with economic value (secondary mining), which the industry could implement during the execution of the programme.[18]

By avoiding the creation of waste, promoting the recovery and revaluation of metals found in mining waste and extending the useful life of a mine, secondary mining and the circular economy could help reduce the socioenvironmental impact of environmental mining legacies and promote the development of local and national businesses (Julca Zuloeta, 2022; COCHILCO, 2021b). Kinnunen and Kaksonen (2019) note that the revaluation of mine tailings is still embryonic worldwide and that progress in that direction will require the development of suitable technologies to deal with the low metal content, heterogeneity and impurities of tailings (Julca Zuloeta, 2022). Some companies in Chile and Peru are already applying the principles of the circular economy to mining, particularly as regards the reuse of tailings. Notable in this regard are the operations of Minera Valle Central and Planta Magnetita in Chile, and the B2 project of the San Rafael mine in Peru (COCHILCO, 2022b; Julca Zuloeta, 2022).

C. Inventories of environmental mining legacies in selected Andean countries

Processes to identify, evaluate, monitor, control or remediate environmental mining legacies must be adequately managed in order to prevent or mitigate risks to human health and the environment (Organization of Latin American and Caribbean Supreme Audit Institutions [OLACEFS], 2021). Corrective management requires information systematization tools to create registers of the environmental mining legacies that exist in each territory. This section details the information available on registers, inventories, and maps of environmental mining legacies in the Andean region countries analysed.

[18] For further information, see Production Development Corporation [CORFO] (2024).

Inventories enable existing environmental mining legacies to be identified and their risk levels to be assessed. Identifying legacies enables them to be ranked according to their risk level, remediation actions to be prioritized and, consequently, resources to be allocated to those sites that require rapid interventions, such as environmental mining legacies with potentially more risky socioenvironmental impacts (De Miguel and Pereira, 2019; OLACEFS, 2021). However, difficulties still exist in identifying and determining the damage and current and future impact of environmental mining legacies in the Andean region, on account of the absence, in most cases, of specific regulations and the fact that the existing environmental mining legacy inventories are in many cases incomplete (Aranibar et al., 2023; Cabrera Leal and Ordóñez Potes, 2022; Chappuis, 2019; OLACEFS, 2021).

Inventories of environmental mining legacies and the availability of updated and accessible information about their impact and risks to people and the environment are central aspects in the Regional Agreement on Access to Information, Public Participation and Access to Justice in Environmental Matters in Latin America and the Caribbean, known as the Escazú Agreement (Economic Commission for Latin America and the Caribbean [ECLAC], 2022). Article 6.3.d of the Escazú Agreement provides: "Each Party shall have in place one or more up-to-date environmental information systems, which may include, inter alia: ... a list of polluted areas, by type of pollutant and location" (ECLAC, 2022, p. 20–21).

1. Argentina

Although Argentina does not have a national inventory of its environmental mining legacies, proposals to advance in that direction have been made, such as the National Atomic Energy Commission's Uranium Environmental mining Restitution Project (PRAMU), and the Secretariat of Mining's Environmental mining Management subprogramme (GEAMIN). The authority responsible for compiling the inventory is the Argentine Mining Geological Service (SEGEMAR), which, as of 2024, had developed partial cadastres and geoenvironmental studies in three areas of the country: in San Antonio de los Cobres (Salta and Jujuy), in the Farallón Negro volcanic complex (Catamarca) and in the mountains of Tierra del Fuego. Based on the geoenvironmental studies, SEGEMAR identified 21 areas with environmental mining legacies from abandoned mining operations in San Antonio de los Cobres (Salta and Jujuy) (General Audit Office, 2022; OLACEFS, 2021).

In that context, mention should be made of the Programme for the Environmental Management of Contaminated Sites (PROSICO), established in 2006 by resolution No. 515/2006 of the Secretariat of Environment and Sustainable Development, which aims to identify and remediate contaminated sites in Argentina in order to prevent harm to human health and the environment.

This programme was a co-founding member of the Latin American Network for the Prevention and Management of Contaminated Sites (ReLASC), which aims to encourage the production, dissemination and exchange of knowledge on the management and revitalization of contaminated areas in Latin America.

2. Plurinational State of Bolivia

Since 2005, the Geological Mining Service (SERGEOMIN) of the Plurinational State of Bolivia has been responsible for preparing the inventory of environmental mining legacies, to which end it carried out a project to draw up an Atlas of Environmental Mining Legacies. Through that project, in 2013 (the last year the inventory was carried out) SERGEOMIN registered 305 environmental mining legacies, which represents around 52% of the country's total. However, it is estimated that as of 2019 there were around 1,200 legacies, with large volume legacies accounting for 30% of the total, characterized by low levels of stability and little or no maintenance and which, owing to their location, posed a significant threats to surrounding populations (Aranibar et al., 2023).

The geographical distribution of the environmental mining legacies identified as of 2019 shows that most of them are located in the departments of Potosí and La Paz, followed by Oruro and Cochabamba, which account for approximately 97% of the nation's inventory (Ministry of Environment and Water of the Plurinational State of Bolivia and Ministry of Mining and Metallurgy of the Plurinational State of Bolivia, 2023).

3. Chile

In Chile, the National Geology and Mining Service (SERNAGEOMIN) registered 1,338 abandoned and idle mining operations between 2002 and 2019 (SERNAGEOMIN, 2019). According to SERNAGEOMIN (2023), mining operations currently generate tailings at a rate of 530 million tons per year, which cover extensive areas with an accumulated volume of some 24 billion tons across the nation's territory (SERNAGEOMIN, 2025).

Table II.3 shows the details of the registered tailings deposits published by SERNAGEOMIN as of 2023. Of the 764 tailings deposits surveyed, 84.5% were inactive or abandoned and could therefore be associated with the emergence of environmental mining legacies. The absence of regulations that define legacies and of policies covering them makes it difficult to allocate resources for inventorying and for the consequent prioritization of legacies according to the assessed risks.

Table II.3
Chile: tailings deposits, by status

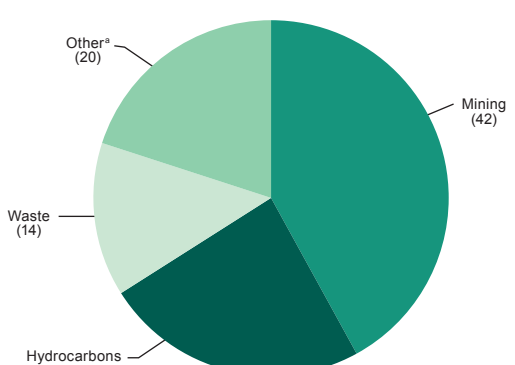
Status	Quantity
Active	110
Inactive	473
Abandoned	173
Under construction	7
Under review	1
Total	764

Source: Prepared by the authors, on the basis of National Geology and Mining Service. (2025). *Catastro de Depósitos de Relaves de Chile*.

4. Colombia

In Colombia, the Ministry of Environment and Sustainable Development estimates that there are 1,843 sites that could be considered environmental legacies, of which 673 have been georeferenced (Cabrera Leal and Ordóñez Potes, 2022). According to Innovación Ambiental and Ministry of Environment and Sustainable Development of Colombia (2015), 781 of the total number of environmental legacies are related to mining activities. Figure II.2 shows the percentage shares of the total represented by the different types of environmental legacies identified by the Ministry of Environment and Sustainable Development and the National Planning Department (DNP) in 2016. Note that a responsible party has been identified for 40% of those legacies and that 36% have been georeferenced, most of which are located in Cundinamarca and Chocó (National Planning Department [DNP], 2019).

Figure II.2
Colombia: environmental legacies, by type, 2016
(Percentages)



Source: Prepared by the authors, on the basis of National Planning Department. (2019). *Gestión de pasivos ambientales en Colombia*. https://www.cepal.org/sites/default/files/events/files/8._liceth_cantor_pasivosambientales_dnp.pdf.

[a] Includes environmental legacies generated by industry, agriculture and infrastructure.

5. Ecuador

According to statistics from the Ministry of Environment, Water and Ecological Transition's Environmental and Social Reparation Programme (PRAS), Ecuador has 3,710 environmental mining legacies. According to other classifications, however, that number could be higher, as some mining operations do not have records of their contamination or are classified as suspended (see table II.4).

According to the Mining Act (art. 9), the Agency for the Regulation and Control of Energy and Non-Renewable Natural Resources (ARCERNNR) is the entity in charge of keeping a registry of mining concessions and publishing it electronically (Poveda Bonilla, 2022; National Assembly of Ecuador, 2009). The mining cadastre available on the ARCERNNR Geoportal, updated in 2020, reports the existence of 7,030 mines under concession (either registered or in the process of registration) across the nation's territory (Agency for the Regulation and Control of Energy and Non-Renewable Natural Resources, 2020). Note that Executive Decree No. 256 of 8 May 2024 ordered the division of ARCERNNR into three new entities, one of which is the Mining Regulation and Control Agency (ARCOM), which is responsible for this sector.

Table II.4
Ecuador: sources of mining contamination, by type and status, 2009–2020
(Totals)

Source of contamination	Status of mining activity						
	Abandoned	Active	Inactive	Remediated	Not registered[a]	Suspended	Total
Alluvial	59	427	147	3	1	9	646
Stony alluvial	3	190	42		1	1	237
Pithead	84	367	294		9	25	779
Pithead mine water	47	425	106		3	35	616
Quarry	17	232	121	2	6	7	385
Landfill	72	764	292	12	10	35	1185
Abandoned infrastructure	116	10	18		2		146
Pool	2 049	796	140		16	22	3 023
Tailings dam	8	586	95		6	36	731
Total	2 455	3 737	1 255	17	54	170	7 748

Source: Ministry of Environment, Water and Ecological Transition of Ecuador. (n.d.). *Explotación minera*.
[a] No information available.

6. Peru

According to information provided by the Ministry of Energy and Mining (MINEM), Peru has 6,001 environmental mining legacies (Ministry of Energy and Mining of Peru [MINEM], 2025a). The Initial Inventory of Environmental Mining Legacies was approved by Ministerial Resolution

No. 290-2006-MEM/DM. Since then, the inventories have been updated annually, and those for 2007 to 2025 are available on the ministry's website (MINEM, 2025b).

The General Directorate of MINEM is responsible for the remediation of environmental mining legacies. Of the 6,001 legacies identified to date, 44% have undergone some kind of restorative intervention. Of the legacies that have not yet been dealt with, 238 are classified as posing a moderate or very high risk, requiring priority attention (MINEM, 2025a). One of the remediation methods considered is reuse, which involves extracting potentially valuable minerals from the legacies. As at 31 December 2024, 112 legacies have received reuse treatment, with environmental impact studies approved in 63 of them (MINEM, 2025a).

D. Conclusions

This chapter showcases the importance of the mining sector for the economies of the Andean countries under review. It also highlights the sector's economic contributions and describes a number of tax structures that enable the redistribution of some of the income generated by mining. It also analyses the relationship between the industry and the creation of environmental legacies, and it stresses the need to collect information and identify the environmental mining legacies that exist in each country.

The mining sector accounts for between 35% and 55% of total exports in Chile, Colombia, Peru and the Plurinational State of Bolivia, and almost 10% in Argentina and Ecuador. Over the last five years, the sector's contribution to GDP in the study countries ranged from 4% to 10%. In addition, tax revenues from royalties and specific taxes are an important source of income for the region's countries and, in some cases —such as Chile, Peru and the Plurinational State of Bolivia— account for more than 1% of GDP.

In addition to its economic contributions, this sector also generates waste, including tailings, waste rock, effluents and atmospheric emissions. The challenge posed by waste management is compounded by the historical absence or inadequacy of specific environmental regulations, which has led to the emergence of countless environmental mining legacies. Legacies are often related to socioenvironmental conflicts, which are exacerbated when informal and illegal mining in rural or remote areas is involved, and this problem affects several of the region's countries.

In view of the above, complete and updated cadastres are essential to assess the status of each legacy and the risk it poses to both the population and the environment so that the most appropriate management actions for each case can be carried out. However, the analysis of the selected Andean countries shows that in most of them, the inventories are incomplete,

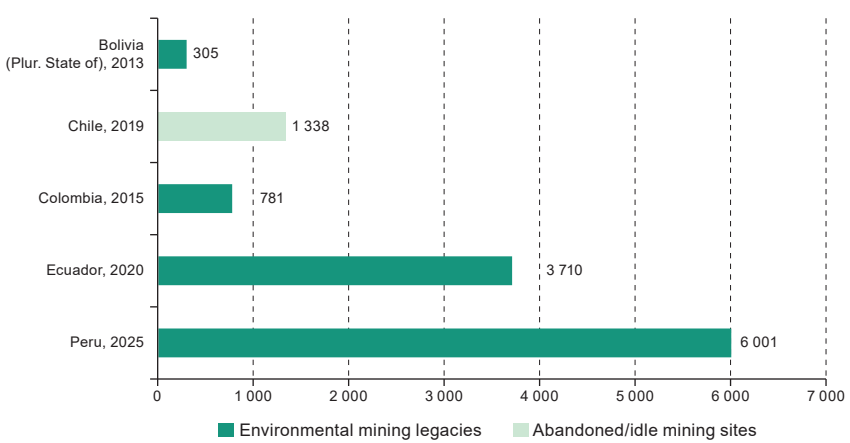
non-existent or out of date. That is a cause for concern, since inventories are an essential tool for the adoption of measures to guarantee access to information and basic rights relating to the health of people and ecosystems.

The Escazú Agreement, in force since 2021, seeks to promote the generation and dissemination of environmental information, including reports on the state of the environment, lists of contaminated areas, pollutant releases, transfer registers and so on. It has been signed by 24 of the region's countries and ratified by 19. Of the study countries, Argentina, Chile, Colombia, Ecuador and the Plurinational State of Bolivia have already ratified the agreement, while Peru has signed but not yet ratified.

Despite the difficulties identified above, around 12,000 environmental mining legacies have been inventoried in the region: 6,001 environmental mining legacies in Peru, 3,710 in Ecuador, 781 in Colombia, 305 in the Plurinational State of Bolivia and 1,338 abandoned or idle mining operations in Chile.

Figure II.3 shows the number of environmental mining legacies and idle or abandoned mining operations (with specific reference to the case of Chile) identified to date. The actual number of legacies may be higher, since the official figures may not include data from artisanal, small-scale or informal mining.

Figure II.3
Latin America (selected countries): inventory of environmental mining legacies and abandoned or idle mining operations
(Totals)



Source: Prepared by the authors, on the basis of Aranibar, A., Lafuente, D. and Pabón, E. (2023). Remediación y activación de pasivos ambientales mineros en el Estado Plurinacional de Bolivia. *Environment and Development series*. (174) (LC/TS.2023/66); Ministry of Environment, Water and Ecological Transition of Ecuador. (n.d.). *Explotación minera*; Innovación Ambiental and Ministry of Environment and Sustainable Development of Colombia. (2015). *Diseño de una Estrategia Integral para la Gestión de los Pasivos Ambientales en Colombia: diseño de instrumentos específicos de la estrategia*; Ministry of Energy and Mining of Peru. (2025a). *Anuario Minero 2024*; National Geology and Mining Service. (2019). *Catastro de Faenas Abandonadas: Actualizado a 2019*.

Note: No information available for Argentina. The Geological Mining Service (SERGEOMIN) estimated that in 2014, the inventory of environmental mining legacies covered 40% of the total number existing in the Plurinational State of Bolivia.

Environmental mining legacy management policies should include measures to support national geological services, in order to provide them with the tools and resources needed to ensure that those sources of information —which are essential for formulating recommendations on the prioritization of remediation actions— are kept up to date.

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Chapter III

Regulatory and institutional framework for mining in the Andean region

This chapter describes the regulations and institutional frameworks in place for mining and, in particular, with regard to environmental mining legacies. It also highlights the desirability of improving the regulations —which are currently separated between mining and environmental issues— to establish a coordinated framework for legacy management.

In many of the Andean region's countries, the mining authority is generally in charge of managing environmental mining legacies. In this area, the enforcement of sectoral legislation must be complemented by laws governing environmental, health and water issues, especially as regards determining risks and setting remediation goals for legacy sites. At the same time, the environmental authority is responsible for managing issues related to sectoral impacts on water resources and ecosystems.

The start of a mining project normally requires environmental impact assessments (EIAs) and specific environmental licences, usually granted by the environmental authority and required by the mining authority prior to the granting of a mining licence. Regulatory and institutional frameworks should therefore focus on managing existing legacies, preventing the creation of new legacies, and ensuring the long-term sustainability of remediation actions. Those actions must be taken throughout the life cycle of the mining activity, including the post-closure phase (De Miguel and Pereira, 2019). The following sections describe the regulatory frameworks for mining and other associated rules currently in force in the Andean countries under study.

A. Regulatory framework for mining activities

In most of the countries where mining takes place, laws and codes have been enacted to regulate mining activities and the closure of mining operations. In particular, when a law governing closures of mining operations exists, it requires the closure plans to include corporate rules and standards, regulatory guidelines and an adequate basis for estimating the actual costs of closing the operation. Closure plans should therefore be dynamic documents, developed and detailed during the mine's life cycle and, most particularly, during the decommissioning and closure stages (Morales and Hantke Domas, 2020). Such plans provide a preventive management mechanism and help mitigate potential negative impacts on people and the environment.

In recent decades, the Andean region has made significant progress with the development of legal and administrative frameworks to protect the environment and regulate mining activities. However, those advances are still insufficient to resolve the problems generated by the sector. As long as countries do not have specific legislation governing environmental mining legacies, their management —and especially their corrective management— will remain a very difficult proposition. It is essential for the institutions in charge of management to have the necessary powers and legal tools to supervise or sanction the parties responsible for legacies.

Of the countries examined, only Peru has a specific law for the treatment and remediation of environmental mining legacies. In September 2023, Colombia passed Act No. 2327 of 2023 establishing the definition of environmental legacies, guidelines for their management and other provisions (Congress of Colombia, 2023). While the law is not specific to the mining sector, it unquestionably represents a crucial step forward in its conceptualization and management.

At the same time, although Argentina, Chile, Ecuador and the Plurinational State of Bolivia do not have specific laws for environmental mining legacies, they have made progress with their legal structures for regulating mining and environmental protection. Those countries began to develop their regulations during the final decades of the last century, and the regulations were later refined and integrated into their structure and jurisprudence. In all instances, new administrative, environmental and mining structures have been created, licensing, monitoring and oversight systems have been improved, and significant efforts have been made to identify and quantify the problem.

The similarities between the levels of regulatory and institutional development in the different Andean countries reveal the existence of common challenges and problems. For example, they still need to address certain shortcomings, especially as regards coordination and management capacities between authorities and levels of government, which could be remedied with a definition of environmental mining legacies and its incorporation into a single legislative text that regulates the issue in a comprehensive, cross-cutting and integrated manner.

The following sections describe how the regulations governing instruments for managing environmental mining legacies have evolved in Argentina, Chile, Colombia, Ecuador, Peru and the Plurinational State of Bolivia. Preventive management tools include environmental impact assessments, the correct close-down of mining activities and guarantees of social and environmental compliance. Corrective management tools include registries, inventories and specific laws governing environmental mining legacies. Although preventive management mechanisms are more common in the Andean countries, several countries have corrective instruments.

1. Argentina

Argentina does not have specific laws governing environmental mining legacies; it does, however, have a regulatory framework that establishes guidelines for sustainable environmental management and provides tools that can also be used for environmental legacies. The main regulations are found in the Constitution of the Argentine Nation, the General Environment Act (No. 25675 of 2002) and the Mining Code (Act No. 24585 of 1995) (Ministry of Economic Affairs of Argentina, 2022a; Organization of Latin American and Caribbean Supreme Audit Institutions [OLACEFS], 2021).

(a) National Constitution[1]

Article 41 of the Constitution recognizes the right of people to live in a healthy environment. It also grants the State the authority to enact rules setting minimum standards for the protection of natural resources, which the provinces are granted the authority to expand. Thus, article 124 provides that the stewardship of natural resources is the responsibility of the provinces (see table III.1).

[1] The first version of the Argentine Constitution dates back to 1853. This chapter refers to the text as amended in 1994.

Table III.1
Argentina: provisions on environmental mining legacies enshrined in the Constitution

Article	Contents
Part one, chapter two, article 41	All inhabitants enjoy the right to a healthy and balanced environment fit for human development and for productive activities to meet present needs without compromising those of future generations, and they have the duty to preserve it. Damage to the environmental shall trigger the obligation of repairing it in accordance with the law. The authorities shall provide for the protection of this right, the rational use of natural resources, the preservation of the natural and cultural heritage and of biological diversity, and environmental information and education. The nation shall enact minimum protection standards, and the provinces those necessary to reinforce them, without altering their local jurisdictions. The entry into the national territory of current or potentially dangerous wastes, and of radioactive ones, is forbidden.
Part two, title two, article 124	The provinces may create regions for economic and social development and establish entities with powers for the fulfilment of their purposes, and they may also, with the knowledge of Congress, enter into international agreements provided they are consistent with national foreign policy and do not affect the powers delegated to the federal government or the public credit of the nation. The city of Buenos Aires shall have the regime established for that purpose. The provinces shall have original dominion over the natural resources existing in their territories.

Source: Prepared by the authors, on the basis of National Congress of Argentina. (1995, 3 January). *Constitución de la Nación Argentina*.

At the national level, the National Mining Secretariat has taken steps to identify and evaluate inactive mines that are not subject to oversight or management. Its strategic planning for the 2020–2023 period, approved by Resolution No. 47/2020, proposed the establishment of the National Mining Sustainability Programme, the National Community Development Programme and the Mining Environmental Assets and Legacies Diagnosis Programme (General Audit Office, 2022; OLACEFS, 2021). Based on those plans, Resolutions No. 161/2021 and 181/2021 were enacted in 2021, approving the General Guidelines for the Closure of Mines with Financial Guarantees in the Argentine Republic and the General Guidelines for the Rational Management of Mining Waste, respectively.

In compliance with the constitutional mandate, and in line with article 41, the Preventive Mining Environmental System was established, comprising two interrelated frameworks: (i) the mining environmental legal framework, composed of the second section of the Mining Code, the complementary regulations and the minimum standards, and (ii) the institutional framework, which is composed of the competent authorities under the provisions of Act No. 24585 of 1995 (supplementary title on environmental protections for mining activity) and receives technical assistance from the Provincial Mining Environmental Management Units and the Department of Mines (Ministry of Federal Planning, Public Investment and Services of Argentina, 2008).

(b) Mining Code[2]

The Mining Code regulates mining operations and establishes rights, obligations and procedures related to the acquisition, exploitation and use of minerals. Act No. 24585 of 1995 incorporated into the Code a series of environmental regulations that mining operators must observe. Specifically, the chapter on environmental protection in mining activities was added, which contains rules to preserve the environment and natural and cultural heritage assets that may be affected by mining. Article 233 provides that miners may exploit their properties freely, subject to no rules other than those of safety, policing and environmental conservation (Ministry of Economic Affairs of Argentina, 2022a; Ministry of Federal Planning, Public Investment and Services of Argentina, 2008; OLACEFS, 2021).

(c) General Environmental Act

In line with the provisions of article 41 of the Constitution, the General Environmental Act (ActNo. 25675), passed in 2002, includes the minimum steps to be followed to ensure the sustainable and appropriate management of the environment at the national and provincial levels (OLACEFS, 2021; Ministry of Economic Affairs of Argentina, 2022a). This law establishes the fundamental principles of environmental policy, including the principle of responsibility (art. 4), and it provides for environmental management instruments, such as environmental insurance (art. 22) and the Federal Environmental System (art. 23), together with the concept of environmental damage and the assignment of liability for that damage (arts. 27 and 28) (see table III.2).

Table III.2
Argentina: instruments for the preventive management of environmental mining legacies established in national law

Law	Instrument	Contents
Rules for the generation, handling, transport and treatment of hazardous wastes – Act No. 24051 of 1992[a]	Registration of hazardous waste generators and operators Sworn statement by generator Environmental certificate Hazardous waste manifest Closure plan Annual environmental fee	Defines hazardous waste and regulates the obligations of hazardous waste generators and operators by defining their responsibilities.

[2] The Mining Code was introduced by Act No. 1919 of 1886 and amended by Act No. 24585 of 1995 and Act No. 27111 of 2015.

Law	Instrument	Contents
Mining Investment Act – Act No. 24196 of 1993	Annual fee for environmental conservation	In order to prevent and remedy any alterations to the environment that mining activity may cause, companies must establish a special provision to that end. The determination of the annual amount of that provision shall be at the company's discretion, but it shall be considered as a deductible charge in the determination of income tax, up to an amount equal to five percent (5%) of the operating costs of extraction and processing. Amounts not used by the provision established in the preceding paragraph must be restored to the income tax balance at the end of the production cycle (ch. VII, art. 23).
Act No. 24585 of 1995, supplementary title on environmental protection in mining activities (Amends the Mining Code, Act No. 1919 of 1886)	Environmental impact report Environmental impact statement	Replaces article 282 of the Mining Code (Act No. 1919 of 1886) and incorporates the complementary title "on environmental protection in mining activities". The first section introduces the concept of "environmental damage" in mining activities and determines the obligations of those responsible for its management. The persons included in the activities indicated in article 4 shall be liable for any environmental damage caused by non-compliance with the provisions of this title, whether caused directly or by persons under their authority or by contractors or subcontractors, or caused by the inherent risk or defect of the property concerned. The holder of the mining right shall be jointly and severally liable, in the same cases, for the damage caused by the persons authorized by him to exercise that right (art. 3). The second section incorporates two environmental management instruments: (i) environmental impact report (art. 6) and (ii) environmental impact statement (art. 7). The third section includes environmental protection and conservation regulations. The fourth section establishes liabilities for environmental damage: whoever causes current or residual damage to the environmental heritage shall be obliged to mitigate, rehabilitate, restore, or remedy it, as appropriate (art. 18). The fifth section establishes the system of infractions and penalties.
Document of San Carlos de Bariloche (1996)	Environmental impact report Environmental impact statement Monitoring plan	Complementary regulations that set minimum standards. Complements Act No. 24585 of 1995 and incorporates annexes I, II, III and IV. The first three annexes describe the contents of environmental impact reports for each stage in mining activities (annex I: environmental impact report for the prospecting phase; annex II: environmental impact report for the exploration phase; and annex III: environmental impact report for the exploitation phase). Annex IV establishes baselines for water, soil and air quality. The environmental impact report is defined as the document that describes a mining project, the setting where it takes place, the environmental impact it will produce and the environmental protection measures proposed for adoption. Annex III also includes the Environmental Management Plan, which covers actions related to the closure and abandonment of operations, as well as post-closure monitoring.
Decree No. 1663 of 1996	Monitoring and oversight plans	Approves the organizational structure of the Argentine Mining Geological Service. Its duties include the monitoring and technological oversight of the environmental standards and parameters in the planning and development of mining activities at the request of the mining environmental authorities or the productive sector, in order to verify compliance with environmental protection legislation applicable to mining activities.

Law	Instrument	Contents
Decree No. 968 of 1997	Environmental impact report	Complements the contents of Act No. 24585 of 1995 through its provisions and annexes, and enforces them in the Province of Buenos Aires.
Act for the Comprehensive Management of Waste from Industrial and Service Activities, Act No. 25612 of 2002	Environmental impact study Waste manifest Registration and integrated information system	Introduces the concept of integrated industrial waste management. It defines industrial waste as any element, substance or object in solid, semisolid, liquid or gaseous form, obtained as a result of an industrial process, through the performance of a service activity, or by being directly or indirectly related to the activity, including any emergencies or accidents, which its possessor, producer or generator cannot use, discards, or has the legal obligation to do so (ch. I, art. 2). It also defines integrated management as the set of interdependent and complementary activities that include the stages of generation, handling, storage, transport, treatment or final disposal of the same, and that reduce or eliminate the levels of risk in terms of their danger, toxicity or harmfulness, as established by the regulations, to ensure environmental preservation and the population's quality of life (ch. I, art. 3).
General Environmental Act – Act No. 25675 of 2002	Environmental impact assessment Environmental Compensation Fund	Establishes minimum standards for achieving a sustainable and adequate management of the environment, the preservation and protection of biological diversity and the implementation of sustainable development (art. 1). The principles of environmental policy (art. 4) include the principle of responsibility: the generator of current or future degrading effects on the environment is liable for the costs of preventive and corrective rehabilitation actions, without prejudice to the validity of the applicable environmental legacy systems. It establishes the following environmental policy and management instruments: (i) the environmental impact assessment (art. 11), (ii) the environmental impact study (art. 12), and (iii) environmental insurance (art. 22). In addition, the Federal Environmental System is established in order to conduct the coordination of environmental policy towards the achievement of sustainable development, between the national government, the provincial governments and the government of the City of Buenos Aires. It will be implemented by the Federal Environmental Council (art. 23). It defines environmental damage as any significant alteration that negatively modifies the environment, its resources, the balance of ecosystems, or collective goods or values. It also regulates the actions that cause it (art. 27) and determines the applicable liabilities (art. 28). Creates the Environmental Compensation Fund (art. 34).
Act on the National System for Integral Risk Management and Civil Protection, Act No. 27287 of 2016	Early-warning system National fund for integral risk management National emergency fund Risk reduction, crisis management and recovery plans	Establishes the National System for Integral Risk Management and Civil Protection, with the purpose of providing people, communities and the environment with comprehensive protection in the face of risks.
New Federal Mining Agreement (2017)	Coordination of environmental oversight and inspection functions Environmental oversight measures Environmental funds and guarantees	Agreement signed between the central government and the 23 provincial governments to coordinate their actions in environmental and mining matters (part III, art. 10) within the Federal Mining Council and to act in conjunction with the Federal Environmental Council to increase the effectiveness of the State's environmental oversight and supervision duties.

Law	Instrument	Contents
Good Practice Resource Guide for Mine Closures (2019)	Mine closure plan	The aim of the Guide is to provide a map of key issues, best practices and available resources related to mine closures and their planning.
Resolution No. 161/2021	Mine closure plan	Approves the General Guidelines for the Closure of Mines with Financial Guarantees in the Argentine Republic.
Resolution No. 181/2021	Mining waste management guidelines	Approves the General Guidelines for the Rational Management of Mining Waste.

Source: Prepared by the authors, on the basis of Organization of Latin American and Caribbean Supreme Audit Institutions. (2021). *Auditoría coordinada sobre estructuras de gobernanza para el manejo integral de los pasivos ambientales mineros;* Marin, A., Stubrin, L., Murguía, D., Carreras, E. and Palacin, R. (2021). Innovation and competitiveness in mining value chains: the case of Argentina. *Discussion Paper.* (892). http://dx.doi.org/10.18235/0003720; General Audit Office. (2022). *Informe de Auditoría de Gestión Ambiental: Manejo Integral de Pasivos Ambientales Mineros.* https://www.agn.gob.ar/sites/default/files/informes/2022-087-Informe.pdf; Ministry of Federal Planning, Public Investment and Services of Argentina. (2008). *Sistema Ambiental Minero Preventivo.* http://www.infoleg.gob.ar/basehome/actos_gobierno/actosdegobierno1-12-2008-2.htm; National Congress of Argentina. (1993, 24 May). *Ley 24.196;* National Congress of Argentina. (1995, 24 November). *Código de Minería: Ley 24.585;* National Congress of Argentina. (2002, 29 July). *Gestión Integral de Residuos Industriales y de Actividades de Servicios: Ley 25.612;* National Congress of Argentina. (2002, 28 November). *Política Ambiental Nacional: Ley 25.675.*

[a] Law amended by Resolution No. 897/2002, "Obligations of hazardous waste generators, transporters and operators".

The country has adopted the preventive mining environmental regime as a policy strategy (Ministry of Economic Affairs of Argentina, 2022a; OLACEFS, 2021). Although a national law on mine closures has yet to be drafted, progress in that direction has been made in recent years; for example, the National Mining Secretariat published the *Good Practice Resource Guide for Mine Closures* in 2019 (Ministry of Production and Labour of Argentina, 2019)[3] and, as noted above, Resolution No. 161/2021 in 2021. According to the Constitution, however, the federal government does not have direct jurisdiction over the territory where the environmental legacies are located, but it is authorized to collaborate with the provinces in the application of the optimal management methodologies (General Audit Office, 2022; OLACEFS, 2021).

Provincial authorities grant exploration and extraction rights, collect royalties and ensure environmental stewardship through their own regulatory frameworks (Marin et al., 2021).[4] As regards preventive management, the provincial regulatory frameworks include: (i) decrees determining the enforcement authority with provincial jurisdiction for title XIII, section two, of the Mining Code, (ii) decrees implementing the complementary regulations, and (iii) institutional resolutions and internal administrative

[3] This guide is fundamental, as it served as the basis for the development of the mine closure law in the Province of Santa Cruz.

[4] The independence of each province's mining jurisdiction poses challenges for the coordination of policies and regulations applicable to mining companies, on account of the regulatory decentralization and institutional diversity among the provinces.

procedural resolutions that complete the environmental management of mining operations[5] (OLACEFS, 2021), such as the Act for the Regulation of Environmental Legacies of the Province of Buenos Aires.

Tables III.2 and III.3 summarize the instruments for preventive and corrective environmental legacy management in force in the country.

Table III.3
Argentina: instruments for the corrective management of environmental mining legacies established in national law

Law	Instrument	Contents
Act Regulating Environmental Legacies – Act No. 14343 of 2011 (Law of the Province of Buenos Aires)	Registration of environmental legacies Mechanisms for filing complaints, penalties, and measures for prevention and redress Provincial Environmental Fund	Regulates the identification of environmental legacies and requires the remediation of contaminated sites or areas that pose a risk to public health, in order to mitigate negative impacts on the environment such as water, soil or air pollution.

Source: Prepared by the authors.

2. Plurinational State of Bolivia

The Plurinational State of Bolivia has neither a legal definition of environmental mining legacies nor a specific regulatory framework for them. The country's environmental laws do, however, include precepts applicable to any harm inflicted on the environment. According to Aranibar et al. (2023), since early 2000 the Plurinational State of Bolivia has promoted a vision of development that is more respectful of the environment, reflected in the National Development Plan: A Dignified, Sovereign, Productive and Democratic Bolivia for Living Well, which proposes respect for the rights of Mother Earth and Indigenous communities. Great efforts have also been made in the management of environmental mining legacies, including the enforcement of the Environmental Act (Act No. 1333 of 1992).

(a) National Constitution

The Constitution of the State, adopted in 2009, meant a change in the vision of the State, notably the incorporation of the rights of Mother Earth and Indigenous Peoples as a prevailing right in different fields of citizen action.

It recognizes the strategic nature of natural heritage and the obligation of public and private entities to prevent, mitigate, repair and provide compensation for environmental damage. The aim is to neutralize the

[5] Among the decrees regulating mining environmental management is Decree No. 968 of 1997, which regulates environmental impact assessments for the mining sector in the Province of Buenos Aires.

harmful impact on the environment of economic activities. In particular, the concepts of environmental legacies and mining environmental damage are explicitly mentioned in the country's legislative framework (see tables III.4 and III.5).

Table III.4
Plurinational State of Bolivia: provisions on environmental mining legacies enshrined in the 2009 Constitution

Article	Contents
Article 346	Introduces the concept of natural heritage and states that it is of public interest and of a strategic nature for the country's sustainable development. Establishes that its conservation and use for the benefit of the population is the exclusive responsibility and authority of the State, and does not compromise sovereignty over natural resources. The principles and provisions relating to its management are left to primary legislation.
Article 347, paragraphs I and II	I. The State and society shall promote the mitigation of harmful effects on the environment and of environmental legacies that affect the country. Legacy for historical environmental damage is established, and statutory limitations shall not apply to environmental crimes. II. Those who carry out activities that have an impact on the environment must, at all stages of production, avoid, minimize, mitigate, remedy, repair and provide compensation for the damage caused to the environment and public health, and they must establish the necessary safety measures to neutralize the possible effects of environmental legacies.
Article 33	People have the right to a healthy, protected and balanced environment. The exercise of this right must allow individuals and collectives of present and future generations, as well as other living beings, to develop in a normal and permanent manner.
Article 34	Any person, individually or on behalf of a collective, is entitled to bring legal action in defence of the right to the environment, without prejudice to the obligation of public institutions to take *ex officio* action in violations against the environment.
Article 345, paragraphs 1, 2 and 3	Environmental management policies shall be based on: (1) Participatory planning and management, with social oversight. (2) The use of environmental impact assessment systems and environmental quality control, without exception and in a cross-cutting manner to all activities that produce goods and services and that use, transform or affect natural resources and the environment. (3) Liability for the pursuit of any activity that causes environmental damage and its civil, criminal and administrative sanction for non-compliance with environmental protection regulations.

Source: Aranibar, A., Lafuente, D. and Pabón, E. (2023). Remediación y activación de pasivos ambientales mineros en el Estado Plurinacional de Bolivia. *Environment and Development Series.* (174) (LC/TS.2023/66). Economic Commission for Latin America and the Caribbean; Constituent Assembly of the Plurinational State of Bolivia. (2009). *Constitución Política del Estado*.

(b) Framework Act on Mother Earth and Integral Development for Living Well

The Framework Act on Mother Earth and Integral Development for Living Well (Act No. 300 of 2012), enacted in 2012, is a general protection law that promotes respect for the environment, life and community heritage. The law recognizes the rights of Mother Earth as a collective subject of public interest, as well as the collective and individual rights of Indigenous Nations and Peoples, intercultural and Afro-Bolivian communities, and the rest of the urban and rural population, in order to achieve the objective of "living

well", understood as the achievement of integral development in harmony with nature. It also includes two articles related to environmental mining legacies (see table III.5).

Table III.5
Plurinational State of Bolivia: provisions on environmental mining legacies enshrined in the Framework Act on Mother Earth and Integral Development for Living Well

Article	Contents
Article 11, No. 5	Persons directly responsible for damage caused to the components or life zones of Mother Earth shall be obliged to restore them, in such a way that they approximate the conditions that existed prior to the damage, either directly or through the State, when appropriate. The Plurinational State of Bolivia shall in turn demand the reimbursement amounts paid from the directly responsible party, in accordance with the specific legislation.
Article 26, No. 4	Establish measures so that public and private, national and foreign companies or cooperatives engaged in mining and hydrocarbon activities, works or projects carry out procedures to restore life zones and mitigate damage. Small mining producers and mining cooperatives shall carry out those procedures jointly with the competent entities of the Plurinational State of Bolivia.

Source: Aranibar, A., Lafuente, D. and Pabón, E. (2023). Remediación y activación de pasivos ambientales mineros en el Estado Plurinacional de Bolivia. *Environment and Development Series*. (174) (LC/TS.2023/66). Economic Commission for Latin America and the Caribbean; Plurinational Legislative Assembly. (2012, 15 October). Ley Marco de la Madre Tierra y Desarrollo Integral para Vivir Bien. *Gaceta Oficial del Estado Plurinacional de Bolivia.* (0431).

As table III.5 shows, the act provides that the person directly responsible for the environmental damage is obliged to restore the contaminated site to its previous state. This can be done with or without the intervention of the State, with due compensation and in accordance with the "polluter pays" principle.

Lastly, the act provides for the adoption of additional regulations to determine the way and conditions under which public and private companies are to carry out restoration processes. However, that legislation has not yet been drafted (Aranibar et al., 2023). The adoption of more explicit regulations that determine the allocation of responsibility for environmental mining legacies is therefore needed.

(c) Mining and Metallurgy Act

Under the Mining and Metallurgy Act (Act No. 535 of 2014), title to mining rights in a given area is granted by means of an administrative mining contract signed between the interested party and, on behalf of the State, the Mining Administrative Jurisdictional Authority. In order to obtain such titles, a mining investment and development plan must be submitted. Once the contract is signed, the law obliges mining operators, regardless of the tenure type, to rehabilitate the exploited areas and it allows them exemption from liability for past environmental damage by conducting a baseline environmental audit. If they fail to do so, they assume liability for mitigation. However, the rule does not address liability for existing environmental mining legacies or how to manage them (Aranibar et al., 2023).

(d) Proposed law on environmental mining legacies

In early 2020, the Ministry of Mining and Metallurgy presented a first draft of the proposed environmental mining legacies act. The draft was submitted to the Ministry of Environment and Water, the General Directorate of Legal Affairs, the General Directorate of Mining Policy and Oversight of the Ministry of Mining and Metallurgy, the Geological Mining Service and the Bolivian Mining Corporation for their analysis (Aranibar et al., 2023).

The bill defines environmental mining legacies and the reuse and repurposing of environmental mining legacies. It also provides for the creation of the National Environmental Mining Legacies Programme, as an operational technical body attached to the Ministry of Environment and Water and the Ministry of Mining and Metallurgy, to coordinate and guide legacy management and remediation.

As of December 2020, the bill was being adjusted based on feedback from the participating entities. Aranibar et al. (2023) emphasize the need for integrated mining-specific environmental and mining management.

Historical environmental mining legacies are a topic of particular interest. In this regard, one common problem is drawing a distinction between the most recent legacies and those created in the past. In the Plurinational State of Bolivia, most efforts have focused on containing, as far as possible, new damage and ensuring that current mining operations comply with the environmental regulations. Efforts to manage past damage have, however, been significantly weaker and more disperse. This places a not insignificant burden on the treasury and on the government apparatus in terms of surveying and assigning responsibilities, as can be seen in the identification of sites and the quantification of damages. Although the country has taken specific and important steps to identify and subsequently treat environmental mining legacies, those efforts are still insufficient.

Also noteworthy are the baseline environmental audits established by the Mining and Metallurgy Act, which allow a new actors to start mining operations and carry out an audit to define their responsibility for the pre-existing environmental mining legacies in the area, without being obliged to consider compensation measures. Audits of this kind have been implemented in the Bolivian Mining Corporation's partnership contracts with the private sector so that new works are started without the burden of the previous legacies and without the new responsible parties having to address them.[6]

Table III.6 shows the evolution of the regulatory framework for preventive management in the Plurinational State of Bolivia.

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[6] Baseline environmental audits focus on subjective responsibility, which means that the person responsible for damage is the one who generated it by acting with fault or malice. However, consideration should also be given to the role of strict liability, which establishes the obligation to repair any (future) damage or risk occurring in the pursuit of a certain activity.

Table III.6
Plurinational State of Bolivia: instruments for the preventive management of environmental mining legacies established in national law

Law	Instrument	Contents
Act No. 1333 of 1992 – Environmental Act	Environmental impact assessment	This law creates the National Environmental Secretariat[a] as the agency in charge of environmental management. Its functions include the power to approve, reject and supervise environmental impact assessment studies, which are deemed one of the basic instruments of environmental planning (arts. 7 and 12). Chapter IV of the act is devoted entirely to environmental impact assessments (arts. 24 to 28).
General Environmental Management Regulations (1995) Article 54	Environmental impact assessment	These are the basic regulations that establish environmental procedures for all activities, works and projects either under execution or to be executed in the nation's territory. The Environmental Impact Assessment Study (EIAS) is intended to identify and evaluate the potential positive and negative impacts that may be caused by the implementation, operation, induced future, maintenance and abandonment of a project, work or activity, in order to establish the measures needed to avoid, mitigate or control those that are negative and encourage those that are positive.
Environmental Prevention and Control Regulations (1992)	Environmental impact assessment	Related to the management of environmental mining legacies on account of its connection with prevention, mitigation and environmental restoration measures.
Environmental Regulations for Mining Activities (1997) Article 65	Mining closure plan[b]	The mining concession-holder or operator must close and rehabilitate the area of the mining activities inside and outside the perimeter of its concession when: (1) the mining activities are partially or totally closed in accordance with the provisions of the corresponding environmental licence, and (2) the mining operations or activities are abandoned for more than three years.
Act No. 535 – Mining and Metallurgy Act (2014) Article 221	Mining closure plan[b]	Holders of mining rights under any of the mechanisms provided for in this act, operators in mining contracts, and holders of operating licences that are in the production phase shall establish an accounting provision to cover the cost of closing their operations.
Supreme Decree No. 3549 (2018) (amending the Environmental Prevention and Control Regulations)	Environmental impact assessment	Amends the Environmental Prevention and Control Regulations and includes criteria for updating and defining the procedure for approving decommissioning, closure and rehabilitation plans.
Supreme Decree No. 3856 (2019) (amending the Environmental Prevention and Control Regulations)	Environmental impact assessment	(i) Sets environmental category levels for activities, works and projects by sectors, and (ii) amends the conditions and procedure for updating environmental licences, which includes the Prevention and Mitigation Programme and the Environmental Enforcement and Monitoring Plan.

Source: Prepared by the authors, on the basis of Presidency of the Plurinational State of Bolivia. (1995, 8 December). Reglamento General de Gestión Ambiental. *Decreto Supremo*. (24176); Presidency of the Plurinational State of Bolivia. (1997, 31 July). Reglamento Ambiental para Actividades Mineras. *Decreto Supremo*. (24782); Ministry of Mining and Metallurgy of the Plurinational State of Bolivia. (2023). *Ley N° 535. Ley de Minería y Metalurgia (texto compilado). Ley de 28 de mayo de 2014*.

[a] The ministry currently responsible for environmental management is the Ministry of Environment and Water.

[b] The Plurinational State of Bolivia has no specific legislation covering mine closures.

3. Chile

Chile has no specific legislation on environmental mining legacies. However, the country's regulatory framework has evolved to incorporate issues related to the environment and its preventive management, including instruments such as environmental impact assessments and a mine closure law.

(a) Constitution of the Republic of Chile

Article 19.8 of the Constitution of the Republic of Chile (1980) recognizes in the right of all people to live in a pollution-free environment. It also establishes that it is the duty of the State to ensure that this right is not affected and to protect the preservation of nature and the power to impose specific restrictions on the exercise of certain rights or freedoms to protect the environment. Lastly, article 20 provides for the possibility of filing a protection remedy in the following situations when the right to live in a pollution-free environment is affected by an unlawful act or omission attributable to a particular authority or person (Office of the Minister and Secretary General of the Presidency of Chile, 2005).

(b) Mining Code and Mining Safety Regulations

There are no environmental provisions in the Mining Code (Act No. 18248 of 1983). However, Supreme Decree No. 132, enacted in 2002 to adopt the Mining Safety Regulations,[7] addresses the responsibility of mining companies to ensure the integrity of the environment and to minimize the risk of its deterioration (arts. 25, 51 and 68). This is a regulatory instrument that explicitly obliges them to take care of the lives and health of all people who may be affected by mining activities, such as workers, residents of neighbouring areas and service providers.

(c) General Environmental Bases Act

In 1994, with the enactment of the General Environmental Bases Act (Act No. 19300), these issues began to be included in Chilean law. The act established the right to live in a pollution-free environment, as well as the issue of nature preservation (art. 1). Although environmental legacies are not explicitly addressed, title III deals with environmental damage, liability for damage and remediation. In addition, Act No. 20417 of 2010 amended Act No. 19300 and created the Environmental Assessment Service, a functionally decentralized public agency with its own legal personality and assets. The Environmental Assessment Service, through the National Environmental Impact Assessment System, contributes to sustainable development, the preservation and conservation of natural resources and the improvement of the population's quality of life.

[7] The decree was amended in 2022 by Decree No. 30, which replaced title XV of the original regulation with a new regulatory text.

(d) National Geology and Mining Service

In 1980, by means of Decree Law No. 3525, the National Geology and Mining Service was created under the authority of the Ministry of Mining. This is a State service with jurisdiction over the environment and with powers directly related to the country's natural and mining resources; it therefore actively participates in the environmental impact assessment of mining and non-mining projects admitted to the National Environmental Impact Assessment System, which is an environmental management instrument that ensures a transparent, technical and efficient environmental qualification, coordinates the relevant actors of the State and encourages citizen participation in the evaluation processes (see table III.7).

Table III.7
Chile: instruments for the preventive management of environmental mining legacies established in national law

Law	Instrument	Contents
Act No. 19300 on General Environmental Bases (1994)	Environmental impact assessment	Establishes the National Environmental Impact Assessment System (arts. 8 to 25). Lists the projects and activities that may have an environmental impact and must therefore be submitted to the National Environmental Impact Assessment System (art. 10). Determines the effects, characteristics or circumstances of a project or activity that require the preparation of an environmental impact study. These include: (i) risks to public health, (ii) significant adverse effects on the quantity and quality of renewable natural resources, (iii) the resettlement of human communities, and (iv) alterations to landscapes (art. 11). Title III of the law covers liability for environmental damage (arts. 51 to 59).
Decree No. 132 – Mining Safety Regulations (2002)	Preventive environmental and risk-management instruments Mine closure rules Management plans for waste and for tailings dams and deposits	Establishes preventive measures: Mining companies must draft, develop and maintain specific internal regulations for critical operations that guarantee the physical integrity of workers, the care of installations, equipment, machinery and the environment (art. 25). Mining site administrators shall have the means, plans and programmes for the maintenance of all facilities, equipment and machinery used in a mine, whether underground or open pit, to ensure its proper operation and minimize the risk to the integrity of workers, equipment and facilities and of environmental degradation (art. 51). Mining site administrators shall be responsible for maintaining under permanent control the emissions of pollutants of any type into the environment, the indexes of which must remain below the maximum concentrations indicated by the COREMA resolution, based on the environmental commitments assumed. They shall also have approved means and procedures for the disposal of industrial wastes and residues (art. 68).

Law	Instrument	Contents
Decree No. 100 – Establishing the consolidated, coordinated and systematized text of the Political Constitution of the Republic of Chile (2005)	Constitutional environmental framework	Includes provisions on the care of the environment and public health (art. 19, nos. 8 and 9). The law may impose specific restrictions on the exercise of certain rights or freedoms in order to protect the environment (art. 19, no. 8).
Decree No. 248 – Regulations for the Approval of Design, Construction, Operation and Closure Projects for Tailings Deposits (2006)[a]	Mining activity closure plan	Grants the National Geology and Mining Service the authority to apply and oversee the regulations. Requires the preparation and presentation of a mine closure project (title V). The closure project shall include, inter alia, a plan for conditioning the reservoir to withstand conditions in the long term, considering reinforcement and rehabilitation measures, such that it protects the health and safety of people and restores the land to acceptable condition, as promised and accepted in its Closure Plan (art. 46).
Act No. 20417 (2010) (amending Act No. 19300)	Environmental impact assessment	Amends the 1994 General Environmental Bases Act and creates the Ministry of the Environment, the Environmental Evaluation Service and the Environmental Superintendency.
Act No. 20551 – Regulating the Closure of Mining Sites and Facilities (2011)	Mining activity closure plan Compliance guarantee	Regarding the purpose of the closure plan, the act provides as follows: The purpose of the mine closure plan is the integration and execution of the measures and actions intended to mitigate the effects derived from the pursuit of extractive mining, in the places where it is carried out, in order to ensure the physical and chemical stability thereof, in keeping with the applicable environmental regulations. The execution of the measures and actions in the manner indicated above shall provide due protection for the life, health and safety of people and the environment, in accordance with the law. The closure plan for extractive mining activities is part of their life cycle. Mine closures shall be planned and implemented progressively, during the various operation stages of the mine site, throughout its useful life. The mining site closure plan shall be executed by the mining company before the end of its operations, so that at the end thereof the conditions of physical and chemical stability are implemented and created in the place where the site operated (art. 2). The performance guarantee is covered by title XIII, articles 49 to 54: Every mining company or mining entrepreneur that carries out mining operations subject to the generally applicable procedure must provide a guarantee that assures the State of full and timely compliance with the closure obligation established in this act. Its purpose is to guarantee the mining company's execution of the closure obligation, in the terms indicated in the preceding section. Filing with the Service the set of instruments constituting the guarantee will imply the imposition, by the sole authority of the law, of the Service's legal and irrevocable mandate to liquidate and collect it from the company, for the purpose of applying it to full compliance with the closure plan. For all legal purposes, this mandate shall be free of charge (art. 49).

Law	Instrument	Contents
Decree No. 41 (2012)	Mining activity closure plan	Approves the Regulations to the Mining Site and Facilities Closure Act.
	Compliance guarantee	The compliance guarantee is addressed in title X, articles 94 to 97.
Decree No. 40 (2012)	Environmental impact assessment	Approves the Regulations of the National Environmental Impact Assessment System. The environmental impact study shall include a description of the project or activity, containing: The description of the closure phase, if any, indicating the parts, works and actions associated with that phase. If applicable, it shall describe the activities, works and actions for: - Dismantling or ensuring the stability of the infrastructure used by the project or activity; - Restoring the geoform or morphology, vegetation and any other environmental component that has been affected during the execution of the project or activity; - Preventing future emissions from the location of the project or activity, to avoid affecting the ecosystem, including air, soil and water, and - The necessary maintenance, upkeep and supervision (art. 19, sect. 7).
Act No. 20819 (2015) (amending Act No. 20551)	Mining activity closure plan	Adopts amendments to Act No. 20551 in order to improve the way in which the useful life of mining projects is calculated, to determine the best time to establish the financial guarantee for hydrocarbon projects and to adjust the procedure for evaluating closure projects. Also amends Decree Law No. 3525 (1980), which created the National Geology and Mining Service.

Source: Prepared by the authors, on the basis of Office of the Minister and Secretary General of the Presidency of Chile. (1994, 1 March). *Ley 19.300. Aprueba Ley sobre Bases Generales del Medio Ambiente;* Office of the Minister and Secretary General of the Presidency of Chile. (2005, 17 September). *Decreto 100. Fija el texto refundido, coordinado y sistematizado de la Constitución Política de la República de Chile;* Ministry of Mining of Chile. (2002, 30 December). *Decreto 132. Aprueba Reglamento de Seguridad Minera;* Ministry of Mining of Chile. (2006, 29 December). *Decreto 248. Aprueba Reglamento para la Aprobación de Proyectos de Diseño, Construcción, Operación y Cierre de los Depósitos de Relaves;* Ministry of Mining of Chile. (2011, 28 October). *Ley 20.551. Regula el Cierre de Faenas e Instalaciones Mineras;* Ministry of the Environment of Chile. (2012, 30 October). *Decreto 40. Aprueba Reglamento del Sistema de Evaluación de Impacto Ambiental.*

[a] This Decree was amended in 2021 by Exempt Resolution No. 1295.

As shown on table III.7, the Chilean regulatory framework establishes specific and appropriate prevention tools. For mine closures, the existing instruments allow for the impacts of mining to be mitigated in order to ensure physical and chemical stability in the closure and post-closure phases (National Geology and Mining Service [SERNAGEOMIN], 2019).

However, the country lacks specific regulations for corrective actions. The absence of rules for the remediation or reclamation of areas affected by legacies is related to the absence of a soil quality standard that determines the contaminant concentrations applicable to soil treatment and reclamation. In addition, the lack of a specific law on environmental legacies hampers the determination of liability for contaminated sites and the standardization of methodologies for identifying, evaluating and prioritizing remediation or treatment actions (OLACEFS, 2021). Currently, the National Geology and Mining Service is the agency responsible for collecting information on contaminated sites and monitoring them.

(e) National Mining Policy

Lastly, Chile has the 2050 National Mining Policy, approved by Decree No. 2 of the Ministry of Mining in 2022 and subjected to a strategic environmental assessment[8] in order for environmental and sustainability considerations to be incorporated into its design. The decree makes explicit reference to environmental mining legacies, defining them as abandoned sites that pose a significant risk to public health and safety and to the environment. It also recognizes the potential for revaluing mining residues and wastes —such as tailings, slag, metallurgical gases and refining solutions— by means of circular economy processes (Ministry of Mining of Chile, 2022b).

4. Colombia

Since the twentieth century, Colombia has significantly developed its regulations governing mining and environmental issues and, in recent decades, those advances have accelerated. The evolution of the regulatory framework since the 1970s is briefly summarized below.

(a) Constitution

The 1991 Constitution consolidated the legal protection of nature and the basic right of all persons to a healthy environment; it also promoted the creation of new environmental regulations that more clearly identified the responsibility of productive actors.

The Constitution promoted the formulation of Act No. 99 of 1993, which restructured the National Environmental System, created the Ministry of the Environment (currently the Ministry of Environment and Sustainable Development) and strengthened the management instruments. The new legislation states that the beneficiaries of mining titles for open-pit mining are responsible for the restoration or morphological and environmental substitution of the soil, and it extended the requirement for an environmental licence to any project that could lead to a deterioration of its surroundings. Based on that law, the regulatory framework for environmental licences was established by Decree No. 1753 of 1994.[9]

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[8] The strategic environmental assessment of the 2050 National Mining Policy was intended to incorporate sustainability criteria, impact prevention and citizen participation from the start of the policy formulation process.

[9] According to Cabrera Leal and Ordóñez Potes (2022), that decree detailed procedures for preventing, mitigating, correcting and providing compensation for the impact of works, projects or activities subject to the formality. Mining projects were required to have a licence for management and oversight, regardless of their scale. Large-scale mining projects would be under the jurisdiction of the Ministry of Environment and Sustainable Development, while the remainder would be the responsibility of the Regional Autonomous Corporations.

(b) National Code of Renewable Natural Resources and Environmental Protection

The 1974 National Code of Renewable Natural Resources and Environmental Protection establishes that an environmental licence is required prior to the start of mining activities. This requirement is based on the recognition that those activities may affect the environment. Since then, environmental issues have become increasingly important and were included in the 1991 Constitution.

(c) Mining Code (Act No. 685 of 2001)

The Mining Code addresses various issues related to the regulation of environmental impacts, including: (i) plans for closing operations and decommissioning facilities and infrastructure (art. 84), (ii) the programme of works on the nature of the project (art. 95), and (iii) the environmental impact assessment (art. 204), which allows for the incorporation of measures for the decommissioning and closure of works and their management plan. In addition, article 209 specifies the environmental obligations that must be fulfilled in closures following the termination of contracts.

This is a legal and administrative framework that regulates operating mining activities. Thus, Cabrera Leal and Ordóñez Potes (2022) emphasize the country's efforts to organize the mining sector as regards both large-scale mining and small-scale operations.

In 2024, the Ministry of Mining and Energy, the National Mining Agency, the Mining and Energy Planning Unit and the Colombian Geological Survey submitted to Congress the draft Mining Act for the Just Energy Transition, National Reindustrialization and Mining for Life. This initiative seeks to amend the Mining Code and includes several provisions related to the prevention of unsafe conditions and the creation of environmental legacies. For example, article 117 refers to guarantees for mine closure and rehabilitation, and article 172 addresses the environmental recovery of territories affected by the use of mercury in gold mining (Ministry of Mining and Energy of Colombia et al., 2024).

(d) 2011–2012 restructuring of the mining sector

Between 2011 and 2012, Colombia carried out a major restructuring of its mining sector, which included the creation of the National Mining Agency (Decree No. 4134 of 2011) and the establishment of the National Authority of Environmental Licences (Decree No. 3573 of 2011). It also modified the legal status of the National Institute of Geological and Mining Research and created the Colombian Geological Survey for geosciences research (Decree No. 4131 of 2011).

In 2011, the Congress of the Republic passed a constitutional amendment that created the General Royalties System (Poveda Bonilla, 2022).

In compliance with the constitutional amendment, Act No. 1530, on the General Royalties System, was enacted in 2012, which assigned the Ministry of Mining and Energy responsibility for the oversight of non-renewable resources. Subsequently, by means of Resolution No. 180876 of 2012, the Ministry of Mining and Energy delegated that function to the National Mining Agency.[10] The same year, through Decree No. 381, the Vice Ministry of Mines was created within the Ministry of Mining and Energy.

Mention should also be made of the Mining and Energy Planning Unit, which was created in the 1990s and is part of Colombia's mining institutions, together with the other actors described in the preceding paragraphs. Table III.8 lists the preventive management instruments implemented in Colombia in recent decades.

Table III.8
Colombia: instruments for the preventive management of environmental mining legacies established in national law

Law	Instrument	Contents
Decree No. 2811 of 1974 – National Code of Renewable Natural Resources and Environmental Protection	Environmental impact studies Environmental licence	Provides that the State and individuals must participate in the preservation and management of the environment, understood as common heritage, and of natural resources, which are of public utility and social interest (art. 1).
Act No. 99 of 1993 – General Environmental Act	Environmental licence	Establishes the National Environmental System, defined as the set of orientations, rules, activities, resources, programmes and institutions that allow the implementation of the general environmental principles contained in this act (art. 4). Indicates that the Ministry of the Environment is responsible for evaluating environmental impact studies and deciding whether to issue, deny or suspend environmental licences (art. 5, paragraph 15). Title VIII – Environmental licences (including environmental impact studies) (arts. 49 to 62).
Decree No. 1753 of 1994	Environmental licence	Partially regulates titles VIII and XII of Act No. 99 of 1993 on environmental licences.
Act No. 685 of 2001 – Mining Code[a]	Closure and restoration plan	The beneficiary shall be obliged to carry out the works and implement all the environmental measures necessary for the closure or abandonment of the operations and works (art. 209).
Decree No. 1728 of 2002	Environmental licence	Regulates title VIII of Act No. 99 of 1993 on environmental licences.
Environmental Policy for the Integral Management of Hazardous Wastes (2005)[b]	Waste inventories and management plans	Seeks to prevent the creation of hazardous waste and ensure the proper management of those that already exist, in order to minimize negative impacts on the environment and public health.

[10] Poveda Bonilla (2022). In 2020, Act No. 2056 established a new legal framework to regulate the organization and operation of the General Royalties System and Act No. 1530 of 2012 was repealed.

Law	Instrument	Contents
Decree No. 4134 of 2011 (amended by Decree No. 1681 of 2020)	Environmental oversight and coordination instruments	Creates the National Mining Agency and defines its objectives and organizational structure. The purpose of the National Mining Agency is to comprehensively manage the mineral resources owned by the State, promote the optimal and sustainable use of mining resources in accordance with the relevant regulations and in coordination with the environmental authorities in the matters that so require (art. 3).
Decree No. 2041 of 2014	Environmental licence	Regulates title VIII of Act No. 99 of 1993 on environmental licences. Dismantling and abandonment phases. When a project, work or activity requires or must initiate its dismantling and abandonment phase, the owner shall submit to the competent environmental authority, at least three months in advance, a study containing at a minimum: (a) an identification of the environmental impacts present at the beginning of this phase, (b) the dismantling and abandonment plan, which shall include management measures for the area, final restoration activities and other pending actions, (c) plans and maps showing the location of the infrastructure to be dismantled and abandoned, (d) the obligations derived from the administrative formalities, identifying those pending and those completed, attaching the relevant documentation for that purpose, (e) the costs of the activities for the implementation of the dismantling and abandonment phase and other pending obligations to be met. The environmental authority shall, in a maximum term of one month, verify the project's status and shall declare said phase initiated by means of an administrative act, in which it will consider the executed obligations as fulfilled and will impose the dismantling and abandonment plan that also includes the fulfilment of the pending obligations and the final restoration activities (art. 41).
Sole Regulatory Decree of the Mines and Energy Administrative Sector – Decree No. 1073 of 2015 (amended by Decree No. 2504 of 2015)	Instruments for socioenvironmental impact monitoring and prevention	Decree No. 1073 compiles the national government's regulations in force for the entities of the mining and energy sector. Decree No. 2504 amends the Sole Regulatory Decree of the Mines and Energy Administrative Sector —in particular, its technical, technological, operational and administrative aspects related to the oversight of mining— in order to regulate the oversight of mining titles and mining formalization subcontracts.
Sole Regulatory Decree of the Environment and Sustainable Development Sector – Decree No. 1076 of 2015	Permits, concessions and authorizations for the use and exploitation of natural resources Environmental licences Environmental plans, programmes and policies National Environmental Fund	Compiles the regulatory provisions of Decree No. 2811 of 1974.

Law	Instrument	Contents
Policy for Sustainable Soil Management (2016)	Soil conservation and risk management programmes Soil quality monitoring and follow-up	Seeks to promote sustainable soil management in the country. Uses a territorial approach with different levels of intervention: national, regional, local and international.
National Development Plans	Risk management Management and remediation plans Financial instruments for remediation	With a four-year implementation period, since 2014 they include objectives linked to environmental mining legacies.

Source: Prepared by the authors, on the basis of Presidency of the Republic of Colombia. (1974, 18 December). *Decreto 2811 de 1974. Por el cual se dicta el Código Nacional de Recursos Naturales Renovables y de Protección al Medio Ambiente;* Presidency of the Republic of Colombia. (2011, 3 November). *Decreto 4134 de 2011. Por el cual se crea la Agencia Nacional de Minería, ANM, se determina su objetivo y estructura orgánica;* Presidency of the Republic of Colombia. (2014, 15 October). *Decreto 2041 de 2014 por el cual se reglamenta el Título VIII de la Ley 99 de 1993 sobre licencias ambientales;* Congress of Colombia. (1993, 22 December). *Ley 99 de 1993 por la cual se crea el Ministerio del Medio Ambiente, se reordena el Sector Público encargado de la gestión y conservación del medio ambiente y los recursos naturales renovables, se organiza el Sistema Nacional Ambiental, SINA, y se dictan otras disposiciones;* Congress of Colombia. (2001, 15 August). *Ley 685 de 2001 por la cual se expide el Código de Minas y se dictan otras disposiciones.*

[a] A bill to reform the Mining Code was presented in 2023.

[b] This policy was updated in 2022 and published as the Environmental Policy for Integrated Hazardous Waste Management and 2022–2030 Action Plan.

For preventive management, other national-level instruments have been designed, including programmes for works and projects, mining-environmental guidelines for exploration and exploitation, and formalization processes for small-scale and artisanal mining, led by the national and regional governments (see table III.9).

Table III.9
Colombia: other preventive management instruments

Instrument	Regulation or entity in charge
Terms of reference for work programmes and projects (legalization requests)	Decree No. 480 of 2014, Resolution No. 417 of 2014/ Ministry of Mining and Energy
Terms of reference for work programmes and projects (subcontracts for mining formulation)	Resolution No. 414 of 2014/National Mining Agency
Mining-environmental guidelines for exploration	Resolution No. 143 of 2017
Mining formalization subcontracts	Decree No. 480 of 2014/National Mining Agency
Study and regulations to implement closure plans for mines and their associated infrastructure	Mining and Energy Planning Unit
Terms of reference for project closures	
Methodological guide for implementing mining project closure plans	
“Mining Project Closure Plan” bill	
Proposed guidelines for the formulation of public policies for mining project closures	

Instrument	Regulation or entity in charge
Methodology for determining interventions and the evaluation and selection of intervention alternatives in areas of abandoned mining activity, according to technical mining, legal, environmental and socioeconomic criteria	Ministry of Mining and Energy
Methodological guide for producing risk, vulnerability and prioritization maps for risk analyses in abandoned mining areas	
Methodology for flood hazard analyses in abandoned mining areas	
Methodology for analyses of mass movement hazards in abandoned mining areas	
Methodology for environmental vulnerability analyses in abandoned mining areas	
Methodology for physical vulnerability analyses in abandoned mining areas	
Methodology for social vulnerability analyses in abandoned mining areas	

Source: Cabrera Leal, M. and Ordóñez Potes, M. (2022). Avances institucionales y normativos para la gestión integral de pasivos ambientales mineros en Colombia. *Environment and Development Series*. (172) (LC/TS.2022/12). Economic Commission for Latin America and the Caribbean.

In accordance with current legislation, business owners must adopt a risk management plan to anticipate and resolve potential situations of this kind. Guidelines are also established for municipalities and districts to provide data for the national registry of settlements in high-risk areas and for the incorporation of risk management into urban development plans (OLACEFS, 2021).

(e) Act No. 2327 of 2023

Over the past ten years, the National Planning Department, the Ministry of Environment and Sustainable Development and the Ministry of Mining and Energy have made progress with the development of a conceptual and methodological framework for defining environmental legacies.

In September 2023, Act No. 2327 was enacted, establishing the definition of environmental legacies, guidelines for their management and other provisions (Congress of Colombia, 2023). Measures for the creation of the National Committee for the Management of Environmental Legacies are also being taken, which represents an important step forward in the management of legacies, including mining legacies (see table III.10).

Table III.10
Colombia: instruments for the corrective management of environmental legacies established in national legislation

Law	Instrument	Contents
Act No. 2327 of 2023	Instruments for the management of environmental legacies	Defines environmental legacies and establishes guidelines for their participatory, appropriate and timely management (arts. 1 to 3). Creates the National Committee for the Management of Environmental Legacies and a technical support panel made up of technical teams from the ministries on the National Environmental Council (art. 4).

Source: Prepared by the authors, on the basis of Congress of Colombia. (2023, 13 September). *Ley 2327 de 2023*.

Key elements of this law include: (i) the establishment of definitions, for both environmental legacies and risk levels (art. 2), (ii) strengthening of the institutional framework for environmental legacies by determining the powers and resources of the competent authorities (at the local, regional and national levels), (iii) mechanisms for intersectoral coordination and financing, such as the creation of the Environmental Legacy Management Strategy and the National Environmental Legacy Management Committee and the establishment of responsibilities (arts. 4 and 5, and 7 to 11), and (iv) emphasis on access to information and public participation through the establishment of the Environmental Legacy Information System as the sole instrument for information on the strategy for managing and registering environmental legacies (arts. 3, 5 and 6; Congress of Colombia, 2023).

5. Ecuador

The right of people to live in a healthy and ecologically balanced environment is recognized in the 2008 Constitution of the Republic of Ecuador (art. 14). The Constitution establishes the National System of Protected Areas (art. 405) to guarantee the conservation of biodiversity and the maintenance of ecological functions. It also prohibits the extraction of non-renewable resources, both in protected areas and in areas declared as untouchable (art. 407), although it leaves the possibility of doing so open subject to a declaration of national interest (National Assembly of Ecuador, 2008; Barragán, 2017).

Historically, the country's laws have focused on small-scale and artisanal mining, owing to their relevance and impact on the gold trade. In recent years, however, various steps have been taken to reform the regulatory framework for mining, promote large-scale mining and attract foreign investment, such as the elimination of the tax on extraordinary profits in the mining sector (Organization of American States [OAS], 2021).

The following are the main legal provisions governing mining activities and their potential impact.

(a) Constitution of the Republic

The Constitution stipulates that non-renewable natural resources —mineral and hydrocarbon deposits in particular— are the property of the State (art. 408). It also states that subsoil products can be exploited only if they comply with the environmental principles established in the Constitution, and it further provides that the State shall share in the profits from the exploitation of those resources, in an amount that shall not be less than that of the company that exploits them (National Assembly of Ecuador, 2008; OAS, 2021).

(b) Mining Act[11]

The Mining Act regulates the exercise of the sovereign rights of the Ecuadorian State to administer, regulate, control and manage the strategic mining sector (art. 1) (National Assembly of Ecuador, 2009).[12] It also clarifies the sector's institutional structure (art. 5) and categorizes mining activities into four groups: (i) artisanal or subsistence mining, (ii) small-scale mining, (iii) medium-scale mining, and (iv) large-scale mining (Central Bank of Ecuador, n.d.).[13]

It establishes environmental protection requirements, including those related to mine closures (art. 85) and a ban on the use of mercury in mining activities. In accordance with the Constitution's provisions, mines and deposits are the property of the State (art. 16), although, in exceptional cases, the State may delegate its participation in the mining sector to third parties by means of concessions (art. 30; National Assembly of Ecuador, 2009).

Article 16 of the Mining Act also states that mining operations must comply with guidelines including the principles of environmental protection and conservation and must respect the natural and cultural heritage of the exploited areas (Central Bank of Ecuador, n.d.). As for administrative issues, article 26 of the act establishes that, prior to carrying out any mining activity, certain administrative prerequisites must be met, such as obtaining environmental permits (environmental licensing). Table III.11 presents the main regulations relating to the preventive management of environmental legacies.

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[11] The Mining Act was enacted in 2009 and amended in 2013 by the Organic Act Reforming the Mining Act.

[12] The act excludes oil and other hydrocarbons.

[13] The procedures and requirements for obtaining mining permits depend on the scale of operations and the category of activity (OAS, 2021).

Table III.11
Ecuador: instruments for the preventive management of environmental mining legacies established in national law

Law	Instrument	Contents
Act No. 45 of 2009 – Mining Act[a] (amended by the Organic Act Reforming the Mining Act (2013))	Environmental licence Environmental and social impact study Mine closure plan and financial guarantees	Prohibits the extraction of non-renewable resources in protected areas (art. 25). Environmental licences are among the administrative formalities required before mining operations can be carried out (art. 26). The preparation and presentation of environmental and social impact studies or documents is required to prevent, mitigate, control and repair the environmental and social impact derived from their activities (art. 78). Regarding the cessation of activities, it establishes that the holders of mining concessions and operators of processing, smelting and refining plants shall include, in their Environmental Impact Studies for mining exploitation, processing, smelting or refining activities, plans for the close-down of their activities, incorporated into the Environmental Management Plan and with the corresponding guarantee. That planning must begin at the project's infeasibility stage and continue throughout the life of the project, until closure and final decommissioning (art. 85).
Executive Decree No. 119 of 2009 – General Regulations to the Mining Act	Socioenvironmental impact prevention instruments	Establishes the regulations needed for enforcement of the Mining Act. Creates the Mining Regulation and Control Agency and defines its objectives, jurisdiction and competence; determines the objectives and content of the mining registry and cadastre; defines the powers of the National Geological, Mining and Metallurgical Research Institute; and regulates the scope of mining concessions and the payment of patents, royalties and other tax obligations.
Executive Decree No. 120 of 2009 – Regulations of the Special Regime for Small-scale Mining	Environmental impact studies Environmental management, closure and restoration plans Environmental monitoring and follow-up Managing environmental legacies	Defines small-scale mining as mining that, on account of the area, characteristics of the deposit, amount of investments and installed capacity for exploitation and smelting or processing, is categorized as such and differentiated from artisanal or subsistence mining and other categories of mining activity, in accordance with the regulations applicable to the special regime for small-scale mining and artisanal mining (art. 4). Defines artisanal mining as mining that is carried out through individual, family or associative work by those who carry out mining work in free areas, solely and exclusively as a means of subsistence, as established in article 134 of the Mining Act (art. 18). It also provides that artisanal mining activities, on account of their special subsistence nature and different from small-scale and large-scale mining activities, are not subject to the payment of royalties or patents (art. 19).
Executive Decree No. 203 of 2010	Environmental impact studies Environmental management plans Mine closure plans	Creates the National Mining Company, the purpose of which is the management of the strategic non-renewable natural resource sector in mining activities for their sustainable use, in accordance with the Mining Act, to intervene in all phases of the activity in pursuit of environmental preservation and respect for peoples' rights (art. 2).

Law	Instrument	Contents
Ministerial Agreement No. 37 of 2014 – Environmental Regulations for Mining Activities (amended by Ministerial Agreement No. 69 of 2016)	Environmental licence Environmental impact study Management plans Plans for closing operations Compliance guarantees	Determines the liability of mining title holders and their contractors, including responsibilities for mine closure and decommissioning (art. 5). Stipulates that mining projects, according to their scale and current stage, require an environmental registration or an environmental licence (art. 7). Regulates processes for conducting environmental impact studies and issuing environmental licences and registrations. Guarantees of compliance with management plans for mining operations are regulated by articles 34 to 42.
Executive Decree No. 399 of 2018	Socioenvironmental impact prevention instruments	Establishes the merger by absorption of the following institutions into the Ministry of Hydrocarbons (renamed the Ministry of Energy and Non-Renewable Natural Resources): the Ministry of Electricity and Renewable Energy, the Ministry of Mining and the Secretariat of Hydrocarbons (arts. 1 and 2). Creates the Geological and Energy Research Institute, attached to the Ministry of Energy and Non-Renewable Natural Resources as a result of the merger between the National Institute of Energy Efficiency and Renewable Energies and the National Geological, Mining and Metallurgical Research Institute (art. 4).
Executive Decree No. 752 of 2019 – Regulations to the Organic Environmental Code	Strategic and project environmental assessments Biodiversity management, quality and environmental information instruments	Regulates the Organic Environmental Code. Establishes national environmental committees (chapter II, title I of book I).
Executive Decree No. 1036 of 2020	Socioenvironmental impact prevention instruments	Creates the Energy and Non-Renewable Natural Resources Regulation and Control Agency through the merger of the electricity, hydrocarbons and mining regulation and oversight agencies.

Source: Prepared by the authors, on the basis of National Assembly of Ecuador. (2009, 29 January). Ley de Minería. *Registro Oficial*. (517); Presidency of the Republic of Ecuador. (2009, 16 November). Reglamento del Régimen Especial de Pequeña Minería. *Registro Oficial*. (67); Presidency of the Republic of Ecuador. (2010, 14 January). Crea la Empresa Nacional Minera, ENAMI EP. *Registro Oficial*. (108).

[a] The last amendment was made on 20 December 2023 through Official Gazette supplement No. 461.

Despite the amendments to the Mining Act, in practice more mechanisms are needed to facilitate the management of the mining project life cycle, since there is no information on technical aspects or on financial and legal guarantees in cases of early closure of mining operations (Estupiñan et al., 2021).

Table III.12 sets out the rules governing the corrective management of environmental legacies. Note that Ministerial Agreement No. 37 of 2014 and the Organic Environmental Code are repeated in tables III.11 and III.12, as they include both preventive and corrective instruments.

Table III.12
Ecuador: instruments for the corrective management of environmental mining legacies established in national law

Law	Instrument	Contents
Ministerial Agreement No. 37 of 2014 – Environmental Regulations for Mining Activities Amended by Ministerial Agreement No. 69 of 2016	Environmental regularization Environmental oversight, follow-up and monitoring Remediation or rehabilitation programmes Environmental licences	Follow-up of remediation or rehabilitation programmes. The Ministry of the Environment shall require the holders of mining rights to deliver environmental remediation or rehabilitation programmes and projects that must be approved prior to their execution, without prejudice to the actions to be taken immediately after each incident (art. 50).
Ministerial Agreement No. 61 of 2015 – Amending book VI of the Unified Text of the Ministry of the Environment's Secondary Legislation	Quality, emission and discharge standards Environmental monitoring, management and remediation plans	According to these rules, the environmental authority is responsible for verifying and evaluating environmental damage and legacies and participating, on a subsidiary basis, in their remediation; and collecting from the party that caused the damage in the cases identified in the applicable regulations. For that purpose, it shall establish national information systems and indicators for the assessment, evaluation and determination of environmental damage and legacies, together with mechanisms for the remediation, monitoring, follow-up and evaluation of environmental damage and legacies, without prejudice to the powers that the legal system confers to other entities in the social field (art. 5.p).
Executive Decree No. 752 of 2019 – Regulations to the Organic Environmental Code	Instruments for the remediation of environmental damage and legacies	The National Environmental Quality Committee, among other functions, is to coordinate the intersectoral enforcement of national environmental policy regarding the prevention and control of environmental pollution, and the comprehensive remediation of environmental damage and legacies (art. 19.a). Chapter III, title I of book 7 covers the issue of comprehensive rehabilitation. It explicitly establishes the obligation for mining operators to present the competent environmental authority with a corrective action plan that must include a remediation and environmental restoration plan in the event of non-compliance with current environmental regulations or the environmental management plan (art. 813).

Source: Prepared by the authors, on the basis of Organization of Latin American and Caribbean Supreme Audit Institutions. (2021). *Auditoría coordinada sobre estructuras de gobernanza para el manejo integral de los pasivos ambientales mineros;* Ministry of the Environment of Ecuador. (2014, 27 March). Acuerdo 37: Refórmase el Reglamento Ambiental de Actividades Mineras. *Registro Oficial*. (213); Ministry of the Environment of Ecuador. (2015, 4 May). Acuerdo No. 061. Reforma del Libro VI del Texto Unificado de Legislación Secundaria. *Registro Oficial*. (316); Presidency of the Republic of Ecuador. (2019, 12 June). Reglamento al Código Orgánico del Ambiente. *Registro Oficial*. (507).

As shown on tables III.11 and III.12, the management instruments that exist in Ecuadorian law cover environmental legacies in general. Notable among the preventive regulations are those specifically aimed at the closure phase of mining activities, such as the Mining Act, the Environmental Regulations for Mining Activities and the Organic Environmental Code.

The Ecuadorian regulations include definitions of the concepts of environmental damage and environmental legacies and specify the obligations and powers of all competent actors and responsible entities, which assists the division of competencies into the realms of prevention and restoration or remediation. In accordance with the principle of subsidiarity, when an operator does not carry out a comprehensive remediation of the socioenvironmental damage caused by its activity, or when the responsible party does not exist or cannot be identified, the obligation of intervention and remediation falls on the State. In any case, as a general rule, actors that carry out potentially polluting activities must include all the measures necessary to prevent, avoid or reduce socioenvironmental damage in their production costs (OLACEFS, 2021).

Lastly, the Ministry of Environment, Water and Ecological Transition is the authority in charge of the environmental oversight of mining activities. As such, it oversees the correct implementation of and compliance with the activities established in the environmental management plans and in the restoration or remediation plans of each mining project.

6. Peru

The regulatory framework for mining in Peru was consolidated by the General Mining Act and the Act for the Promotion of Investments in the Mining Sector, complemented by the Revenue Sharing Act and the Mining Royalty Act. In addition, environmental and mining regulations are consolidated with the Act Regulating the Environmental Legacies of Mining Activities and the Act Regulating Mine Closures. That legislation covers the identification, inventorying, and remediation of environmental legacies, responsibility for them, and the obligation to submit closure plans for extractive activities.

(a) Constitution of Peru

The Constitution of Peru stipulates that renewable and non-renewable natural resources are the patrimony of the nation and that the State is sovereign in their use (art. 66). It also provides that the State is to determine national environmental policy and promote the sustainable use of its natural resources (art. 67). At the same time, it emphasizes that the State is obliged to promote the conservation of biological diversity and natural protected areas (art. 68) (Congress of the Republic of Peru, 1993).

(b) General Mining Act and laws governing the mining sector

Peru's regulatory framework for mining was established in the early 1990s. Among the regulations enacted during this period were the General Mining Act (Legislative Decree No. 109 of 1981) and the Act for the Promotion of Investments in the Mining Sector (Legislative Decree No. 708 of 1991).

The Revenue Sharing Act (Act No. 27506), adopted in 2001, orders the distribution of 50% of all income tax revenues from mining activities to the subnational governments. Subsequently, the Mining Royalty Act (Act No. 28258) was enacted in 2004, and an amendment to it was adopted in 2011 (Act No. 29788), which, as noted in chapter II, introduced the Special Mining Levy and the Special Mining Tax (Poveda Bonilla, 2022).

(c) Environmental laws related to mining

In early 2000, Peru began to develop specific regulations for environmental matters. The country has legislation on the treatment and remediation of environmental mining legacies. Initially, this was Act No. 28271, enacted on 2 July 2004, but in 2005 it was replaced by Act No. 28526, which has undergone several amendments (see box III.1). This act and its regulations (Supreme Decree No. 059-2005-EM)[14] specifically address environmental mining legacies, include remediation concepts and assign responsibility to the State when the party responsible for creating legacies cannot be identified. The law also obliges the Ministry of Energy and Mining to identify the parties responsible for abandoning tailings dumps, mine workings or mining facilities and requires the restoration of the affected land to a satisfactory state (see box III.1).

Box III.1
Relevant articles in the Act Regulating the Environmental Legacies of Mining Activities

The purpose of this act is to regulate the identification of the environmental legacies of mining activities, the responsibility for and financing of the remediation of the areas affected by them, for their reduction and/or elimination, in order to mitigate their negative impact on the health of the population, the surrounding ecosystem and property (art. 1).

Identification and inventory of environmental legacies:

The identification, preparation and updating of the inventory of environmental mining legacies shall be carried out by the competent technical body of the Ministry of Energy and Mines. Mining title holders with current concessions shall provide the access and information requested (art. 3).

Allocation of responsibilities:

The parties responsible for environmental legacies shall submit the Environmental Legacy Closure Plan, unless they proceed in accordance with the provisions of articles 10 or 11 of this act. The State shall only assume remediation duties for those legacies in which responsible parties cannot be identified. Should the holder of a current concession lose it owing to any of the causes of extinction set forth in the General Mining Act, it shall maintain responsibility for the environmental legacies (art. 5).

[14] Amended by Supreme Decree No. 003-2009-EM (2009).

Presentation of the environmental legacy closure plan:

Those responsible for the remediation of environmental legacies referred to in the preceding article shall carry out the corresponding studies, actions and works to control, mitigate and eliminate, to the extent that is possible, the polluting and harmful risks and effects on the population and the ecosystem in general. The reference for these studies shall be the maximum permissible limits or quality standards established by the competent environmental authorities, as appropriate, for which Environmental Legacy Closure Plans shall be submitted, in accordance with the Guidelines on Environmental Legacy Closure approved by the General Directorate of Mining Environmental Affairs of the Ministry of Energy and Mines, with the opinion of the Ministries of Agriculture and Health (art. 6).

Sources of financing:

The National Environmental Fund (FONAM) is the entity in charge of obtaining international financial cooperation, donations, debt swaps and other resources intended to finance the remediation of environmental legacies assumed by the State under article 5 of this act.

Additionally, the remediation of environmental legacies may be financed through agreements entered into between mining owners and the Ministry of Energy and Mines, as well as through other mechanisms established in the regulations to this act (art. 9).[a]

Source: Prepared by the authors, on the basis of Congress of the Republic of Peru. (2004, 2 July). *Ley que regula los pasivos ambientales de la actividad minera. Ley N° 28.271.*

[a] In 2020 the National Environmental Fund was merged with the Fund for the Promotion of Natural Protected Areas, a private non-profit entity specialized in raising and managing financial resources for the implementation of programmes and projects contributing to biodiversity conservation and climate change mitigation and adaptation.

In addition, the Act Regulating Mine Closures (Act No. 28090), enacted in 2003, contributes to the prevention of environmental mining legacies and regulates such issues as the establishment of environmental guarantees to be furnished by the mining industry that ensure compliance with the included investments, subject to the principles of protection, preservation and recovery of the environment and with the aim of mitigating negative impacts on the health of the population, the surrounding ecosystem and property (Congress of the Republic of Peru, 2003).

In 2017, Supreme Decree No. 012-2017-MINAM was issued, adopting criteria for the management of contaminated sites. This decree, which is of a general nature, includes in its complementary provisions a section dedicated to environmental mining legacies and hydrocarbons.

In 2023, Supreme Decree No. 009-2023-MINAM was issued, approving the regulations of Emergency Decree No. 022-2020 on strengthening the identification and management of environmental legacies. The regulations specifically address environmental legacies located in the continental area and the maritime basin of the nation's territory, created by productive, extractive

or service activities, excluding the activities of the mining and hydrocarbon subsectors (Ministry of the Environment of Peru [MINAM], 2023). The regulations introduce the Environmental Legacies Management Plan as a complementary management tool to the National Environmental Impact Assessment System. They also determine the role and responsibilities of the National Fund for Natural Areas Protected by the State, especially as regards financing.[15]

Table III.13 shows the preventive management tools for environmental mining legacies provided for in the mining regulatory framework:

Table III.13
Peru: instruments for the preventive management of environmental mining legacies established in national law

Law	Instrument	Contents
Act No. 26821 – Organic Act for the Sustainable Use of Natural Resources (1997)	Environmental impact assessment	Covers compliance by holders of mining rights with environmental impact assessment procedures and management plans (art. 29.c).
Act No. 27446 – National Environmental Impact Assessment System Act (2001)	Environmental impact assessment	Creates the National Environmental Impact Assessment System as a single and coordinated system for the identification, prevention, monitoring, oversight and early correction of negative environmental impacts arising from human actions conducted through the investment project (art. 1). Establishes mechanisms to ensure citizen participation in the environmental impact assessment process.
Act No. 27651 – Act for the Formalization and Promotion of Small-scale and Artisanal Mining (2002)	Environmental impact statement or study	Regulates the activities of small-scale and artisanal miners. The regional governments are in charge of oversight and penalties in this subsector (art. 14). For the launch or relaunch of activities, small-scale and artisanal mining producers shall be required to submit an environmental impact statement or semi-detailed environmental impact study (art. 15). Those producers who, as of the date of this act's publication, have not complied with the requirements set forth herein must submit, within a maximum period of one year, an Environmental Adjustment and Management Programme detailing their remediation, adjustment and investment commitments, as well as the schedule of works (art. 18).
Act No. 28090 – Act Regulating Mine Closures (2003)[a]	Mining activity closure plan Compliance guarantee	Defines the Mine Closure Plan and its objectives (art. 3). Establishes the obligation for miners to provide guarantees to cover the costs of rehabilitation measures (art. 11).

[15] The National Fund for Natural Areas Protected by the State is administered by the Fund for the Promotion of Natural Protected Areas, established by Decree Law No. 26154 of 1992 as an untouchable trust fund for the conservation, protection and management of natural areas protected by the State.

Law	Instrument	Contents
Supreme Decree No. 033-2005-EM – Mine Closure Regulations (2005)	Mining activity closure plan Compliance guarantee	Regulations to Act No. 28090.
Act No. 28611 – General Environmental Act (2005)	Environmental impact assessment	Regulates the National Environmental Impact Assessment System (art. 24), environmental impact studies (art. 25) and closure plans (art. 27). Includes the principle of environmental responsibility, whereby the party responsible for damage to the environment and its components is obliged to take the steps necessary for their restoration, rehabilitation or remediation, as appropriate.
Supreme Decree No. 019-2009-MINAM – Regulations to the National Environmental Impact Assessment System Act (2009)	Environmental impact assessment Mining activity closure plan	Adopts the regulations to Act No. 27446 (National Environmental Impact Assessment System Act). The competent authorities are obliged to regulate the closure or abandonment of an investment project's operations and to require the adoption of environmental management measures. Those measures must avoid socioenvironmental impacts and consider rehabilitation actions (art. 31).
Supreme Decree No. 012-2009-MINAM – National Environmental Policy (2009)	Instruments to prevent socioenvironmental impacts	Adopts the National Environmental Policy, intended to guarantee the existence of healthy ecosystems through the prevention, protection and sustainable use (integrated management) of natural resources.
Act No. 29968 – Act for the Creation of the National Environmental Certification Service for Sustainable Investments (2012)	Environmental impact assessment (detailed)	The National Environmental Certification Service for Sustainable Investments reviews and approves the detailed environmental impact studies governed by Act No. 27446 and its regulations, which include public, private or mixed-capital investment projects of national or multi-regional scope involving activities that could cause significant environmental impact (art. 1.3).
Legislative Decree No. 1100 (2012)	Instruments to prevent socioenvironmental impacts	Regulates the control of illegal mining in the country.
Supreme Decree No. 040-2014-EM – Environmental Protection and Management Regulations for Exploitation, Processing, General Labour, Transportation and Storage Activities in Mining (2014)	Environmental impact studies and assessment Mining activity closure plan	Refers to the competencies of the actors involved in mining environmental management, general environmental obligations, the environmental studies required for the pursuit of mining operations and the environmental management and mine closure plans.
Ministerial Resolution No. 251-2016-MEM/DM – Regulations Governing the Constitution of the Real Estate Guarantee Trust to Guarantee Mine Closure Plans (2016)	Compliance guarantee	Regulates the provisions that apply to the guarantee extended by holders of mining titles as regards the guarantee trust on real estate other than mining activity concessions and the facilities subject to the Mine Closure Plan (art. 1).
Supreme Decree No. 013-2019-EM – amendment of the Mine Closure Regulations (2019)	Mining activity closure plan Compliance guarantee	Amends Supreme Decree No. 033-2005-EM.

Law	Instrument	Contents
Board Resolution No. 006-2019-OEFA/CD – Supervision Regulations (2019)	Instruments for the preventive management of environmental legacies	Establishes rules and criteria that regulate supervisory functions within the framework of the National Environmental Assessment and Control System and other regulations that assign that responsibility to the Environmental Assessment and Control Agency.

Source: Prepared by the authors, on the basis of Congress of the Republic of Peru. (2001, 20 April). *Ley del Sistema Nacional de Evaluación de Impacto Ambiental. Ley Nº 27446;* Congress of the Republic of Peru. (2002, 21 January). *Ley de Formalización y Promoción de la Pequeña Minería y la Minería Artesanal. Ley Nº 27651.*

[a] Amended by Act No. 31,347 of 2021.

Table III.14 deals with the Environmental Assessment and Oversight Agency, particularly as regards the remediation instruments used by waste generators and voluntary remediators. The agency has oversight and sanctioning powers, in that it supervises compliance with the obligations arising from the corrective management mechanisms. Reference is also made to National Environmental Certification Service for Sustainable Investments, which reviews and approves the environmental certifications of detailed environmental impact studies and, when appropriate, of semi-detailed environmental impact studies. In 2015, the Ministry of Energy and Mines transferred the responsibility for reviewing detailed mining sector environmental impact studies to the National Environmental Certification Service for Sustainable Investments (Pereira et al., 2022). Artisanal and small-scale mining (ASM) are not subject to the supervision of the Environmental Assessment and Oversight Agency or the National Environmental Certification Service for Sustainable Investments. The main regulations related to the corrective management of environmental mining legacies are presented below.

Table III.14
Peru: instruments for the corrective management of environmental mining legacies established in national law

Law	Instrument	Contents
Act No. 28526 – Act Regulating the Environmental Legacies of Mining Activities (2005) (replaces the similarly named Act No. 28271 of 2004)	Instruments for the management of environmental mining legacies	Regulates the identification of environmental legacies generated by mining activities, and the responsibility for and financing of the remediation of affected areas. Includes definitions; the identification and inventory of environmental mining legacies; the determination and allocation of responsibilities for environmental mining legacies; the presentation of closure plans; control, oversight and sanctions; and sources of financing.
Supreme Decree No. 059-2005-EM – Regulations on Mining Activity Environmental Legacies (2005)	Instruments for the management of environmental legacies	Regulations to Act No. 28526. Establishes responsibilities for the environmental remediation of environmental mining legacies and provides for penalties in case of non-compliance (art. 3).

Law	Instrument	Contents
Ministerial Resolution No. 290-2006-MEM/DM (2006)[a]	Instruments for environmental mining legacy management and cadastre	Approves the initial inventory of environmental mining legacies.
Supreme Decree No. 003-2009-EM – amendments to the Regulations on Mining Activity Environmental Legacies (2009)	Instruments for the management of environmental mining legacies	Amends Supreme Decree No. 059-2005-EM. Describes four methods for the voluntary remediation of a legacy: (i) the closure plan for environmental mining legacies, (ii) the inclusion of environmental mining legacies in the Mine Closure Plan, (iii) reuse and (iv) repurposing (art. 12).
Supreme Decree No. 009-2023-MINAM (2023)	Environmental Legacy Management Plan	Adopts the Regulations to Emergency Decree No. 022-2020. Defines processes for managing environmental legacies. Establishes that the Environmental Legacy Management Plan must be submitted to the competent sectoral environmental authority, unless there a closure plan or similar environmental management instrument has already been approved and implemented. In such a case, the closure plan must be modified to include the environmental legacy management measures deemed appropriate (art. 33.1).

Source: Prepared by the authors, on the basis of national legislation.
[a] Updated yearly. The versions available at the date of writing cover the 2007–2023 period.

Act No. 28526 provides that the parties responsible for remediating environmental mining legacies must conduct the corresponding studies and carry out the actions required to monitor, mitigate and eliminate —to the extent possible— the risks and negative impact of mining operations on people and the environment. These studies make it possible to prepare and present the closure plan for environmental legacies, including the monitoring programme, which must be carried out until the physical and chemical stability of the mining components covered by the closure plan can be verified (Ministry of Energy and Mining of Peru [MINEM], 2005; OLACEFS, 2021).

As shown in table III.14 and in accordance with the Act Regulating the Environmental Legacies of Mining Activities and its regulations, with their respective amendments, the Ministry of Energy and Mines, through the General Directorate of Mining, evaluates and approves applications for the reuse of environmental mining legacies, which can be accessed by the public through its website (Ministry of Energy and Mines of Peru, n.d.).

Lastly, mention should be made of the international initiatives that have been implemented in the countries analysed. These initiatives, in alignment with the United Nations Sustainable Development Goals (SDGs), offer tools for the promotion and dissemination of best practices, as well as for the promotion of transparency in the mining sector. Around

160 voluntary certification systems for mining currently exist, including: (i) the assurance and validation mechanism for the performance expectations of the International Council on Mining and Metals (ICMM), (ii) the Copper Mark, (iii) the Standard for Responsible Mining of the Initiative for Responsible Mining Assurance (IRMA), (iv) Towards Sustainable Mining (TSM) of the Mining Association of Canada, (v) the LMEpassport of the London Metal Exchange (Dufey and Zamorano, 2023), and (vi) the international standard for the management of environmental mining legacies developed by the International Organization for Standardization (ISO). The adoption of these standards would be of great help to countries that have no strong regulatory framework governing the mining sector —and environmental legacies in particular— or where enforcement mechanisms are lacking, as it would contribute to resolving those shortfalls and making progress towards the SDGs (Dufey and Zamorano, 2023).

In conclusion, this first part of the chapter has analysed the regulations for the preventive and corrective approach to environmental legacies in force in the Andean countries studied. The following section provides an analysis of the public institutional framework.

B. Public institutional framework related to the management of environmental mining legacies

The correct application of environmental mining legacy management instruments depends on the existence of a sectoral institutional framework with sufficient powers and resources to monitor and control them within a procedural framework (De Miguel and Pereira, 2019).

This section examines the environmental institutional framework for mining activities in the countries under review. Understanding the regulations and the institutions in charge of their application is crucial in identifying the tools available for designing and implementing public policies. These policies should ensure the efficient, transparent and democratic use of the natural resources that exist in each country (Poveda Bonilla, 2022), as well as the adequate supervision of mining operations in order to avoid —to the extent that is possible— risks to and negative impacts on people and ecosystems.

The environmental institutional framework for mining in the Andean countries analysed is presented below.

1. Argentina

Argentina's institutional framework for mining has evolved over time. Between 2015 and 2019, the mining sector held ministerial status through what was then the Ministry of Energy and Mining. From 2019 to 2023,

the sector's administration was the responsibility of the National Mining Secretariat, under the Ministry of Productive Development. At present, the Mining Secretariat is attached to the Ministry of Economic Affairs (Decree No. 8 of 2023).

Given Argentina's federal structure, each province has its own mining and environmental enforcement authority and institutions in its jurisdiction (General Audit Office, 2022).

Table III.15 indicates the national and provincial public institutions with responsibilities for environmental mining legacies.

Table III.15
Argentina: national and provincial public institutions with responsibilities for environmental mining legacies

Mining institutions	Environmental institutions
National	
Mining Secretariat (Ministry of Economic Affairs)	Environment Undersecretariat (Ministry of the Interior)
Argentine Mining Geological Service	Federal Environmental Council
Federal Mining Council	
Provincial	
Ministry of Mining of Catamarca	Ministry of the Environment of the Province of Buenos Aires[a]
Ministry of Mining of Jujuy	Ministry of Water, Energy and the Environment of Catamarca
Secretariat of Mining and Hydrocarbons of Mendoza	Secretariat of Environment and Climate Change of Córdoba
Secretariat of State for Mining of Neuquén	Institute of Water and the Environment of Corrientes
Mining and Energy Secretariat of Río Negro	Ministry of Environment and Sustainable Territorial Development of Chaco
Ministry of Energy and Natural Resources of Salta	Ministry of Environment and Sustainable Development Oversight of Chubut
Ministry of Mining of San Juan	Environment Secretariat – Ministry of Production, Tourism and Economic Development of Entre Ríos
Energy and Mining Undersecretariat of Santa Cruz	Ministry of Production and the Environment of Formosa
	Ministry of the Environment of Jujuy
	Environment Undersecretariat – Ministry of the Treasury and Finance of La Pampa
	Environment Secretariat – Ministry of Production and the Environment of La Rioja
	Environment and Territorial Ordering Secretariat of Mendoza
	Ministry of Ecology and Renewable Natural Resources of Misiones
	Environment Undersecretariat – Territorial Development and Environment Secretariat of Neuquén
	Environment and Climate Change Secretariat of Río Negro
	Ministry of Production and Sustainable Development of Salta
	Environment and Sustainable Development Secretariat of San Juan

Mining institutions	Environmental institutions
	Secretariat of State for the Environment and Sustainable Development of San Luis
	Secretariat of State for the Environment – Ministry of Health and the Environment of Santa Cruz
	Ministry of the Environment of Santa Fe
	Ministry of Production, Natural Resources, Forestry, Land and the Environment of Santiago del Estero
	Ministry of Production and the Environment of Tierra del Fuego, Antarctica and the South Atlantic Islands
	Secretariat of State for the Environment of Tucumán

Source: Prepared by the authors, on the basis of official information.
[a] The Autonomous City of Buenos Aires has its own institutional structure for environmental issues: the Environment Secretariat of the Government of the Autonomous City of Buenos Aires.

According to Decree No. 480 of 2022, the National Mining Secretariat is responsible for managing, overseeing, designing and implementing public policies related to the mining sector at the national level; it also formulates the strategic planning of the mining sector with short-, medium- and long-term objectives and promotes the rational and sustainable use of geological and mining resources. In addition, the Secretariat adopts initiatives for the identification and evaluation of environmental mining legacies at inactive mines that are not subject to oversight or management (National Mining Secretariat, n.d.). Together with the provinces, the Secretariat coordinates the implementation of national mining policy at the central and local levels through the Federal Organization of Mining States and the Federal Mining Council. The Secretariat's structure is formed by the Mining Development Undersecretariat and Mining Policy Undersecretariat, the functions of which are explained in the decree.

Within the Mining Policy Undersecretariat, the National Directorate of Sustainable Mining Production proposes initiatives related to mine closures to ensure the correct decommissioning of operations and minimize socioenvironmental risks.

The Federal Organization of Mining States is an interstate body for coordinating mining activities in the country. It was formed in 2012 by 10 mining provinces to align sectoral policies across the country and coordinate relations between the provinces and the private sector and with the State at the national level.[16] The Federal Mining Council is a State advisory body of the Mining Secretariat. Composed of the national government and the provinces, it works to actively participate in and contribute to the design, implementation and monitoring of the country's mining policy.

[16] The 10 provinces that make up the Federal Organization of Mining States are Río Negro, Chubut, Santa Cruz, Salta, Catamarca, La Rioja, San Juan, Mendoza, Neuquén and Jujuy.

In 1996, the organizational structure of the Argentine Geological and Mining Service was created and approved, as the successor of the Division of Mines, Geology and Hydrology, established in 1904. The Argentine Geological and Mining Service is a national scientific and technological agency, responsible for the production of geological, technological, mining and geo-environmental knowledge and information about the country. It is currently attached to the Ministry of Economic Affairs and is overseen by the Mining Secretariat.

As regards the environmental institutions, the Environment Undersecretariat is the successor institution to the Ministry of Environment and Sustainable Development (dissolved in December 2023) and is currently attached to the Ministry of the Interior.[17] Its function is to assist the President and the Chief of the Cabinet of Ministers, within the scope of their competencies, in all matters related to environmental policy and its sustainable development, as well as to the rational use of natural resources. In addition, the undersecretariat is responsible for control, oversight and prevention of pollution and for the conservation of natural assets to ensure the population's quality of life.

According to the most recent information, to date there are two agencies that report to this undersecretariat:

(i) National Parks Administration: responsible for designing, leading and overseeing the execution of the policies necessary to conserve and manage the country's national parks, natural monuments and national reserves.

(ii) Federal Environmental Council: comprising the signatory provinces, the national government and the current Autonomous City of Buenos Aires.[18] Its main purpose is to contribute to the development of an environmental policy that is integrated between the provinces and the federal government.

2. Plurinational State of Bolivia

The Plurinational State of Bolivia has three levels of government: national, departmental and municipal. The environmental authority has a presence at those three levels and in technical bodies (see table III.16) (Aranibar et al., 2023).

[17] The Ministry of the Environment and Sustainable Development was created in 2015.

[18] At present, the Federal Environmental Council comprises all of Argentina's provinces: Buenos Aires, Catamarca, Córdoba, Corrientes, Chaco, Chubut, Entre Ríos, Formosa, Jujuy, La Pampa, La Rioja, Mendoza, Misiones, Neuquén, Río Negro, Salta, San Juan, San Luis, Santa Cruz, Santa Fe, Santiago del Estero, Tierra del Fuego, Antártida e Islas del Atlántico Sur and Tucumán.

The Ministry of Environment and Water has the strategic objective of promoting the management of environmental quality and the management of the components of Mother Earth for integral territorial development in harmony with Mother Earth (Ministry of Environment and Water of the Plurinational State of Bolivia [MMAyA], n.d.). This ministry comprises the Vice-Ministry of Drinking Water and Basic Sanitation, the Vice-Ministry of Water Resources and Irrigation and the Vice-Ministry of Environment, Biodiversity and Climate Change.

Extractive activities are overseen by the Mining and Hydrocarbons Environmental Prevention and Oversight Unit, which reports to the Vice-Ministry of Environment, Biodiversity and Climate Change.

Table III.16
Plurinational State of Bolivia: structure of the environmental authority

Environmental authority	Description
Competent national environmental authority	Regulatory framework: Supreme Decree No. 29894 of 2009, complemented by Supreme Decrees No. 429 and 3549, establishes that the Vice-Ministry of Environment, Biodiversity and Climate Change and the Vice-Ministry of Forestry Management and Development are to serve as the competent national environmental authority through the environmental agency to which they are attached. Powers: To regulate and supervise the activities within its competence in coordination with sectoral and departmental public agencies. To approve or reject and supervise environmental impact assessment studies at the national level, in coordination with sectoral ministries and departmental environmental secretariats. As regards the mining sector, it is responsible for granting environmental licences for mining activities, works and projects.
Competent departmental environmental authority	Regulatory framework: Act No. 1333 of 1992, article 8 of the General Environmental Management Regulations and article 2 of Supreme Decree No. 3549. Powers: Departmental governors, through their administrations' environmental agencies, have the power to define the category of the Environmental Impact Assessment Study, to grant the exemption certificate, and to approve, reject or suspend the environmental impact statement or the environmental adequacy statement.
Competent sectoral agency	Regulatory framework: Article 12 of the General Environmental Management Regulations. Powers: To establish permissible limits, proposing sectoral environmental policies and preparing technical reports on the Environmental Impact Assessment Study for granting environmental licences.
Autonomous municipal governments	Regulatory framework: Territorial jurisdiction. Powers: To perform oversight and monitoring of activities that actually or potentially affect the environment and natural resources at the local level.

Environmental authority	Description
National Protected Areas Service	Regulatory framework: Supreme Decree No. 3549, amending the Environmental Prevention and Control Regulations. Powers: In addition to the powers and functions established in Supreme Decree No. 24781 of 1997, on environmental prevention and oversight, the National Protected Areas Service has the power to review the Regulatory Instruments of Specific Scope. It also submits technical opinions to the competent sectoral agency, recommends the issuing or rejection of environmental licences and participates in environmental monitoring and oversight processes within its area of competence.

Source: Prepared by the authors, on the basis of Aranibar, A., Lafuente, D. and Pabón, E. (2023). Remediación y activación de pasivos ambientales mineros en el Estado Plurinacional de Bolivia. *Environment and Development Series.* (174) (LC/TS.2023/66). Economic Commission for Latin America and the Caribbean.

State mining is managed by the Bolivian Mining Corporation, which closed almost all of its mining operations between 1986 and 1990. Those closures were carried out during a deep economic and financial crisis and, since there were no specific regulations for the proper decommissioning of mining activities, the result was led to the creation of several environmental mining legacies.

Once the crisis was over, and with the support of international assistance, the Corporation implemented several mitigation projects and actions. In addition, in light of the rising prices for minerals on the international market, the Corporation has been conducting mineralogy studies at environmental mining legacies in several areas to determine the feasibility of metallurgical retreatment processes (secondary mining) (Aranibar et al., 2023). Table III.17 summarizes the institutional framework for environmental mining legacies.

Table III.17
Plurinational State of Bolivia: public institutions with responsibilities for environmental mining legacies

Mining institutions	Environmental institutions
Ministry of Mining and Metallurgy	Ministry of Environment and Water
Mining Administrative Jurisdictional Authority	
Geological Mining Service	
Mining and Metallurgical Research Centre	
National Service for the Registration and Oversight of Mineral and Metal Marketing	
Bolivian Mining Corporation	
Bolivian Lithium Deposits	

Source: Prepared by the authors, on the basis of Aranibar, A., Lafuente, D. and Pabón, E. (2023). Remediación y activación de pasivos ambientales mineros en el Estado Plurinacional de Bolivia. *Environment and Development Series.* (174) (LC/TS.2023/66). Economic Commission for Latin America and the Caribbean; Poveda Bonilla, R. (2022). La institucionalidad y la regulación minera en los países andinos: Bolivia (Estado Plurinacional de), Chile, Colombia, Ecuador y Perú. *Natural Resources and Development Series.* (212) (LC/TS.2022/190). Economic Commission for Latin America and the Caribbean.

3. Chile

In Chile, several challenges exist in the implementation of measures, programmes and policies for the management of environmental mining legacies. These include the absence of a specific law on environmental legacies or environmental mining legacies, the lack of strategic definitions by the sectoral public institutions with responsibilities for legacies and a limited budget for implementing management mechanisms.

However, there are public agencies —with jurisdiction over both mining and environmental matters— that are responsible for abandoned and idle mining operations. For mining, these include the Ministry of Mining, the Chilean Copper Commission and the National Geology and Mining Service,[19] while the agencies responsible for environmental issues include the Ministry of the Environment, the Environmental Evaluation Service, the Environmental Superintendency and the Environmental Courts (see table III.18).

Table III.18
Chile: public institutions with responsibilities for environmental mining legacies

Mining institutions	Environmental institutions
Ministry of Mining	Ministry of the Environment
Chilean Copper Commission	Environmental Evaluation Service
National Geology and Mining Service	Environmental Superintendency
	Environmental Courts

Source: Prepared by the authors, on the basis of Poveda Bonilla, R. (2022). La institucionalidad y la regulación minera en los países andinos: Bolivia (Estado Plurinacional de), Chile, Colombia, Ecuador y Perú. *Natural Resources and Development Series.* (212) (LC/TS.2022/190). Economic Commission for Latin America and the Caribbean.

For the mining sector, the Undersecretariat of Mining, within the Ministry of Mining, is the agency charged with developing public policies for promoting and strengthening the mining sector through the sustainable development of mining, in keeping with environmental, social, inclusion and citizen participation standards (Ministry of Mining of Chile, 2022a).

The Chilean Copper Commission is the specialized technical agency for the production of copper and its by-products and, with the exception of coal and hydrocarbons, other metallic and non-metallic mineral substances. It also oversees and evaluates the investments and management of state-owned mining companies.[20]

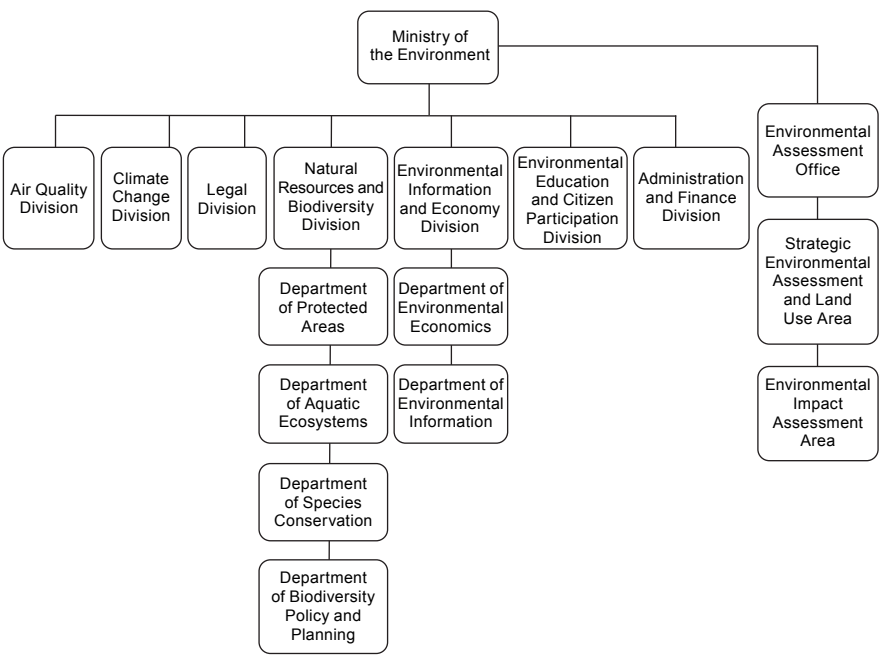
[19] The Chilean Copper Commission and the National Geology and Mining Service are attached to the Ministry of Mining.

[20] https://www.cochilco.cl/web/descripcion-general/

The National Geology and Mining Service is the technical agency responsible for generating, maintaining and publishing information on basic geology and geological resources and hazards in the nation's territory. It also regulates and oversees compliance with mining regulations regarding safety, ownership and closure plans, in order to contribute to the development of the national mining industry.[21] At the same time, it has direct responsibilities in evaluating mining projects that enter the Environmental Impact Assessment System.

Regarding the environmental institutions, the aim of the Ministry of the Environment is to establish a development model that guarantees environmental protection and public well-being by applying a cross-cutting ecological approach in the State's public policies. Diagram III.1 shows a simplified organizational chart of the ministry's structure, indicating the offices and divisions with responsibilities for environmental legacies.

Diagram III.1
Chile: simplified organizational chart of the Ministry of the Environment



Source: Prepared by the authors, based on Ministry of the Environment. (n.d.). *Organizational structure.* https://mma.gob.cl/estructura-organizacional/.

[21] https://www.sernageomin.cl/mision-y-vision-institucional/

Within the Ministry of the Environment, the Natural Resources and Biodiversity Division is the body that provides advice to the minister and sets priorities for environmental policies and standards for the conservation and protection of biodiversity and the environmental heritage.

The Environmental Information and Economy Division is responsible for advising the ministry on the environmental evaluation of public policies, proposing economic instruments for environmental management and sustainability, coordinating the preparation and publication of reports on the state of the environment, administering the National Environmental Information System, and managing information from air, water, and soil quality monitoring programmes.

The Environmental Evaluation Office advises the ministry on matters related to strategic environmental assessments and their use in land use policies, plans and instruments.

At the same time, the Environmental Evaluation Service, created in 2010 by Act No. 20417, contributes to sustainable development, the preservation and conservation of natural resources and the population's quality of life through environmental impact assessments of projects, citizen participation and consultations with the Indigenous population in the evaluation of projects, and relevance consultations.[22] The Environmental Evaluation Service administers the National Environmental Impact Assessment System, a preventive environmental management tool that determines whether the environmental impact of an activity or project complies with current regulations.[23]

The Environmental Superintendency, also established in 2010, is responsible for monitoring, oversight and sanctions in relation to the country's environmental management instruments, such as environmental qualification resolutions, environmental prevention or decontamination plans, environmental quality standards and emission standards, and management plans.

Lastly, the Environmental Courts, established by Act No. 20600 of 2012, are special jurisdictional bodies subject to the oversight of the Supreme Court with the function of resolving environmental disputes under their jurisdiction.

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[22] See https://www.sea.gob.cl/.

[23] In February 2024, the amendment to the Regulations of the National Environmental Impact Assessment System was published in the Official Gazette of the Republic of Chile (Ministry of the Environment of Chile [MMA], 2024).

4. Colombia

The institutional framework for the mining sector in Colombia is provided by the Ministry of Mining and Energy, which prepares mining and energy sector policies and sets the guidelines to be followed by the entities attached or linked to it, such as the National Mining Agency, the Mining and Energy Planning Unit, the Colombian Geological Survey and, at the territorial level, the governors' and mayors' offices (see table III.19) (Cabrera Leal and Ordóñez Potes, 2022).

Table III.19
Colombia: public institutions with responsibilities for environmental mining legacies

Mining institutions	Environmental institutions
Ministry of Mining and Energy	Ministry of Environment and Sustainable Development
National Mining Agency	National Environmental Licensing Authority
Mining and Energy Planning Unit	Regional Autonomous Corporations, Sustainable Development Corporations and Urban Environmental Authorities
Colombian Geological Survey	

Source: Prepared by the authors, on the basis of Cabrera Leal, M. and Ordóñez Potes, M. (2022). Avances institucionales y normativos para la gestión integral de pasivos ambientales mineros en Colombia. *Environment and Development Series.* (172) (LC/TS.2022/12). Economic Commission for Latin America and the Caribbean; Poveda Bonilla, R. (2022). La institucionalidad y la regulación minera en los países andinos: Bolivia (Estado Plurinacional de), Chile, Colombia, Ecuador y Perú. *Natural Resources and Development Series.* (212) (LC/TS.2022/190). Economic Commission for Latin America and the Caribbean.

The mining sector reforms carried out between 2011 and 2012 resulted in the creation, within the Ministry of Mining and Energy, of the Vice-Ministry of Mines, the Office of Environmental and Social Affairs (under the Minister of Mining and Energy) and the Mining Formalization Directorate (under the Vice-Ministry). These offices are of particular importance, as they are all directly or indirectly related to environmental legacies. For example, the creation of the vice-ministry allowed for mining management actions to be oriented in a structured and specific way.

In turn, the Office of Environmental and Social Affairs has led investigations into environmental mining legacies and has been responsible for structuring different actions to improve the sector's management in its area of competence, as well as for coordinating the inter-ministerial agencies and providing venues for dialogue. Lastly, the Mining Formalization Directorate formulates and designs policies and guidelines to promote the development of formal mining. It focuses primarily on small-scale mining, particularly informal mining, which has historically been responsible for the largest number of environmental mining legacies in the country (Cabrera Leal and Ordóñez Potes, 2022).

Among the mining institutions, the National Mining Agency is the agency with competence for granting mining titles. It is also responsible for the monitoring and oversight of mining operations as regards the obligations derived from works programmes, which provide the technical, economic, commercial, safety and hygiene bases for conducting the mining project.

In contrast, the Mining and Energy Planning Unit is in charge of mining and energy planning. It has a Mining Subdirectorate, which is responsible for such tasks as preparing the National Mining Development Plan, updating the National Mining Management Plan and conducting studies and research on mining and its socioenvironmental impact.

The Colombian Geological Survey is responsible for research and data and information management tasks on geology, subsoil resources and geological hazards. At the local level, it is the responsibility of mayors' offices to register the artisanal miners in the jurisdiction of each municipality.

Regarding the management of environmental mining legacies, a distinction must be drawn between mining activities with environmental licences and informal mining, since, in principle, mining operations with environmental or sectoral permits should not generate legacies (Act No. 2327 of 2023).

The Ministry of Environment and Sustainable Development is the body in charge of the policy governing Colombia's institutional framework for environmental matters. The entities attached or linked to it are the environmental research institutes and the National Natural Parks Unit. Likewise, the operational entities in charge of verifying compliance with environmental regulations and environmental licensing for environmental mining legacies in the nation's territory are the National Environmental Licensing Authority, which deals with the largest projects of national scope, and the regional environmental authorities —such as the Regional Autonomous Corporations, the Sustainable Development Corporations and the Urban Environmental Authorities— which deal with medium- and small-scale projects (see table III.19).

Locally, the departments and municipalities, together with the regional environmental authorities and support from law enforcement, carry out environmental and renewable natural resources oversight and surveillance tasks. The role of the local authorities is essential and efforts must be made to continue strengthening their work, as those areas are where informal mining is carried out.

The following are the key characteristics of the main actors involved with environmental management and environmental mining legacies:

- The Ministry of Environment and Sustainable Development, as the lead agency for environmental issues, has a great influence on defining and characterizing environmental mining legacies, as well as on their management.
- The Regional Autonomous Corporations, the Sustainable Development Corporations and the Urban Environmental Authorities play a very important role in the management of degraded areas, given their responsibility in the implementation of prevention, management and restoration measures in the territories under their jurisdiction.
- Governors and mayors are responsible for protecting the ecological heritage, regulating land use and promoting basic sanitation.

5. Ecuador

At present, the country's institutional framework for mining and environmental issues related to the management of environmental mining legacies comprises the Ministry of Energy and Mines, the Geological and Energy Research Institute, the Mining Regulation and Control Agency, the National Mining Company and the Ministry of Environment, Water and Ecological Transition (see table III.20). These five agencies have different but complementary responsibilities in relation to the sustainability of extractive activities.

Table III.20
Ecuador: public institutions with responsibilities for environmental mining legacies

Mining institutions	Environmental institutions
Ministry of Energy and Mines	Ministry of Environment, Water and Ecological Transition
Geological and Energy Research Institute	
Mining Regulation and Control Agency	
National Mining Company	

Source: Prepared by the authors, on the basis of Poveda Bonilla, R. (2022). La institucionalidad y la regulación minera en los países andinos: Bolivia (Estado Plurinacional de), Chile, Colombia, Ecuador y Perú. *Natural Resources and Development Series.* (212) (LC/TS.2022/190). Economic Commission for Latin America and the Caribbean.

Executive Decree No. 400 of 2022 changed the name of the Ministry of Energy and Non-Renewable Natural Resources to the Ministry of Energy and Mines. This ministry includes the Vice-Ministry of Hydrocarbons, the

Vice-Ministry of Electricity and Renewable Energy, the Vice-Ministry of Mines and the Undersecretariat of Territory and Environmental Monitoring. In turn, the Vice-Ministry of Mines comprises the Undersecretariat of Artisanal and Small-scale Mining and the Undersecretariat of Industrial Mining.

The Ministry of Energy and Mines is the authority that regulates, manages and oversees the mining sector in Ecuador. It is responsible for formulating national mining policy and for developing, implementing and monitoring public policies in this area. It also promotes the development and use of the mining resources existing in the nation's territory in a socially and environmentally responsible manner. The ministry is also responsible for granting and administering mining concessions and rights (Ministry of Energy and Non-Renewable Natural Resources of Ecuador, 2021).

The Geological and Energy Research Institute was created in 2018 by Executive Decree No. 399. Its purpose is to generate and promote knowledge in the field of geology and energy through scientific research, technical assistance and specialized services aimed at ensuring the responsible use of the country's natural resources.[24]

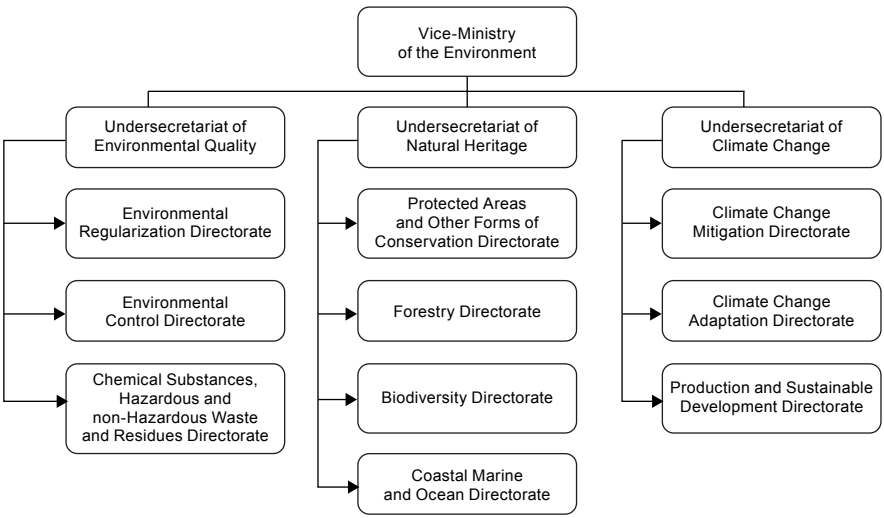
The Mining Regulation and Control Agency was created by Executive Decree No. 256 of 2024. The agency is a technical and administrative body responsible for the monitoring, auditing, intervention and oversight of all phases of mining activities in the country. It also oversees the rational and technical use of mineral resources, guarantees the fair collection of state benefits and ensures that mine owners comply with their social and environmental obligations.

In addition, Executive Decree No. 59 of 2021 approved the change of the name from the Ministry of Environment and Water to the Ministry of Environment, Water and Ecological Transition. It includes the Vice-Ministry of the Environment, the Vice-Ministry of Water and the Directorate of Environmental and Water Education and Information for Ecological Transition. Diagram III.2 shows the detailed structure of the Vice-Ministry of the Environment.

The ministry formulates environmental policies and coordinates strategies, projects and programmes aimed at promoting correct environmental stewardship and the sustainable use of natural resources. It is also responsible for issuing operating permits based on its environmental studies (OAS, 2021).

[24] See https://www.geoenergia.gob.ec/.

Diagram III.2
Ecuador: organizational chart of the Vice-Ministry of the Environment



Source: Prepared by the authors, based on Ministry of Environment, Water and Ecological Transition. (n.d.). *Organigrama del Ministerio del Ambiente.* https://www.ambiente.gob.ec/organigrama-del-ministerio-del-ambiente/.

6. Peru

The regulation and oversight of the mining sector in Peru depends on different areas, such as the environment, agriculture, health, labour and culture. Under Act No. 28271 of 2004, the management of environmental mining legacies is the responsibility of the mining operators or —if no other responsible parties can be identified— of the State. When the responsibility falls on the State, management actions are channelled through the General Directorate of Mining Environmental Affairs, attached to the Ministry of Energy and Mines (Chappuis, 2019).

In addition, under Act No. 27783 on the Bases of Decentralization (2002), medium and large-scale mining operations are the responsibility of the central government, while the regional governments are responsible for small-scale and artisanal mining. Since 2006, remediation actions have been carried out by the State-owned company Activos Mineros S.A.C., which, as of 2023, had intervened in 1,194 environmental mining legacies in 11 of the country's regions (El Gas Noticias, 2023).

Table III.21 summarizes the main institutions involved in the public management of mining activities, particularly with regard to authorizations, oversight and monitoring.

Table III.21
Peru: public institutions with responsibilities for environmental mining legacies

Mining institutions	Environmental institutions
Ministry of Energy and Mines	Ministry of the Environment
Vice-Ministry of Mines: • General Directorate of Mining Environmental Affairs • General Directorate of Mining	
Geological, Mining and Metallurgical Institute	Environmental Assessment and Oversight Agency
Energy and Mining Investment Supervisory Agency	National Environmental Certification Service for Sustainable Investments

Source: Prepared by the authors, on the basis of Chappuis, M. (2019). Remediación y activación de pasivos ambientales mineros (PAM) en el Perú. *Environment and Development Series.* (168) (LC/TS.2019/126). Economic Commission for Latin America and the Caribbean; Poveda Bonilla, R. (2022). La institucionalidad y la regulación minera en los países andinos: Bolivia (Estado Plurinacional de), Chile, Colombia, Ecuador y Perú. *Natural Resources and Development Series.* (212) (LC/TS.2022/190). Economic Commission for Latin America and the Caribbean; Ramírez, T. and Valle-Riestra, E. (2022). Capacidad estatal en la gestión de los cierres de minas y pasivos ambientales mineros en el Perú. *Documento de Trabajo.* (2). Centro de Estudios sobre Minería y Sostenibilidad.

Note: The Geological, Mining and Metallurgical Institute is a public agency attached to the Ministry of Energy and Mines. The Environmental Assessment and Oversight Agency and the National Environmental Certification Service for Sustainable Investments are attached to the Ministry of the Environment. The Environmental Assessment and Oversight Agency is a specialized technical entity and is the governing body of the country's National Environmental Assessment and Oversight System. The National Environmental Certification Service for Sustainable Investments is a specialized public agency in charge of approving environmental impact studies for projects with a national scope.

Table III.22 details the specific competencies of the authorities responsible for the management of environmental mining legacies.

Table III.22
Peru: competencies of the authorities responsible for managing environmental mining legacies

Administrative level	Sector	Institution	Management type
Central government	Mining	Ministry of Energy and Mines – General Directorate of Mining Environmental Affairs	Reviews and approves the semi-detailed studies required for non-metallic mining, exploration, general labour and transport concessions, and concentrate storage. Evaluates the remediation instruments (Environmental Mining Legacy Closure Plan) submitted by waste generators and voluntary remediators.
Central government	Mining	Ministry of Energy and Mines – General Directorate of Mining	Authorizes the start of operations or expansions of medium- and large-scale mining operations once binding opinions have been received from the competent agencies. Focuses on field research and prepares the inventory of the country's environmental mining legacies. Identifies and sanctions the parties responsible for remediation actions. Develops mechanisms for financing those actions. The General Directorate of Mining can assign responsibility for the management of environmental mining legacies to the State when the risk is high and the party responsible for the remediation has not remediated the affected area or after repeated non-compliance with the Environmental Mining Legacy Closure Plan.

Administrative level	Sector	Institution	Management type
Central government	Environment	Ministry of the Environment	Sets maximum permissible limits of pollutants and environmental quality standards that must be met in Environmental Mining Legacy Closure Plans.
Central government	Mining	Geological, Mining and Metallurgical Institute	Grants concessions for exploration and exploitation activities.
Central government	Environment	National Environmental Certification Service for Sustainable Investments	Approves detailed environmental instruments.
Central government	Agricultural development and irrigation	National Water Authority	Grants authorizations for the study and use of water resources.
Central government	Agricultural development and irrigation	National Forestry and Wildlife Service	Safeguards forestry resources, even before a concession is granted.
Central government	Health	General Directorate of Environmental Health and Food Safety of the Ministry of Health	Authorizes discharge volumes and evaluates their characteristics.
Central government	Culture	Ministry of Culture	Responsible for managing untouchable archaeological remains and conducting prior consultations in Indigenous Peoples' territories.
Central government	Labour and employment promotion	National Superintendency of Labour Inspection	Oversees compliance with the occupational safety obligations of mine owners.
Regional government	Mining	Regional Directorate of Energy and Mines	Evaluates the remediation instruments of the Environmental Mining Legacy Closure Plan submitted by waste generators and voluntary remediators in small-scale and artisanal mining. Grants authorizations and is responsible for monitoring and overseeing the obligations of small-scale and artisanal mining operators.
Regulatory agencies	Environment	Environmental Assessment and Oversight Agency	Oversees the Environmental Mining Legacy Closure Plans of waste generators and voluntary remediators in medium and large scale mining.
Regulatory agencies	Mining	Energy and Mining Investment Supervisory Agency	Oversees the security of infrastructure.

Source: Prepared by the authors, on the basis of Chappuis, M. (2019). Remediación y activación de pasivos ambientales mineros (PAM) en el Perú. *Environment and Development Series.* (168) (LC/TS.2019/126). Economic Commission for Latin America and the Caribbean.

C. Conclusions

This chapter has explored the regulations governing the management of environmental mining legacies and the roles of the different actors involved in the Andean countries under study. The analysis carried out

reveals the current situation in each country and outlines their progress with the recognition, conceptualization and comprehensive management of environmental legacies.

A comparative analysis of the regulations reveals various laws, regulations and instruments that address the management of environmental legacies, particularly preventive management. For example, prior to carrying out extractive activities in the countries studied, environmental impact assessments or studies are required to evaluate the risk posed by the project to the public and to the environment, in addition to the preparation of closure plans. The Chilean and Peruvian legislation governing mine closures also provide for compliance guarantees, which ensure the financing of timely and suitable decommissioning procedures. In addition, most countries regulate mine closures in their domestic laws.

Notable in the area of corrective management are the experiences of Colombia (Act No. 2327 of 2023) and Peru (Act No. 28271 of 2004), which have specific laws on, respectively, environmental legacies and environmental mining legacies. Emphasis is also placed on the importance of updated, complete and accessible inventories of environmental legacies and of strong institutions with clearly defined areas of authority to avoid gaps or overlaps.

The key concepts and practices for further progress in the management of environmental legacies must be kept in mind. Thus, in order to ensure the correct implementation of the management mechanisms, avoid policy overlaps and gaps and a lack of institutional articulation and functionality, a regulatory framework must be established and reinforced that includes concepts and specific regulations on environmental legacies that promote the structuring and direction of the institutions responsible for the management of environmental mining legacies (Yupari, 2004; Saade Hazin, 2014).

Regulatory frameworks must determine the parties responsible for management and remediation actions, financing and possible penalties for non-compliance, as well as their obligations. Clarity is also needed regarding responsibilities and resources so that the institution in charge of preparing the cadastre and the inventory of environmental mining legacies can do so with up-to-date, science-based data. Ensuring that the regulations establish regeneration standards for environmental components, taking into account the opinion of the public, is also crucial. A sound regulatory framework enables the design and implementation of integrated and coordinated policies and actions among the authorities responsible for monitoring, mitigating and, ideally, eliminating the risks posed by mining activities (OLACEFS, 2021).

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Chapter IV

International approaches to environmental legacies

Few regulations on the remediation of environmental legacies exist at the international level,[1] primarily because priorities in the use of generally limited funds from State budgets lead to the postponement of investments in remediating situations inherited from the past. Efforts to revert that trend have been made, however, after it was found that environmental legacies pose a risk to public health and the environment.

A series of challenges exist in drafting laws for the remediation of environmental legacies. These are related to defining legacies, identifying the parties responsible for the remediation and establishing funding mechanisms in the event that the responsible party cannot pay or cannot be identified.

Accordingly, the laws define what environmental legacies are or describe the conditions from which they arise. Likewise, they offer alternatives for assigning responsibility based on the system of fault- or negligence-based liability (subjective) or on the system of strict or risk-based liability (objective), depending on whether the creation of the environmental legacy was intentional or not.[2] To finance remediations, special funds, budget allocations, tax incentives and asset auctions between the title holder (if any) and local, regional and national authorities are created.

In general, in order to counter adverse effects on human life and health and the environment, countries have been developing laws that require environmental impact assessments of investment projects before they are

[1] For a detailed discussion of the definitions, see chapter I of this book.

[2] In some cases, joint and several liability may exist, in which more than one responsible party or non-responsible third parties request the management of the legacy in order to repurpose it.

undertaken. This means that project owners have to take responsibility for the potential impact during construction as well as during operations and the closure or decommissioning phases. They must also take steps to control any unforeseen impact on the environment that may arise from project execution or from changes in the environmental variables evaluated. These advances help prevent the creation of legacies.

Countries also report the existence of environmental legacies created by decommissioned industrial facilities and mining installations, which can damage or endanger the health and safety of the public and the environment. The presence of abandoned sites arises from the historical lack of environmentally adequate management and decommissioning regulations, poor environmental practices, the inability to locate their owners, the transfer of rights over the properties on which the legacies are located, or legal actions or exceptions that exempt their owners from liability.

This situation is a cause for concern in the countries and, as already noted, has led them to undertake the remediation of environmental legacies that were created before the entry into force of the environmental regulations intended to prevent them. Those regulations are based on the principle of prevention and are contained in a range of different types of legislation, including environmental laws and specific statutes.

This chapter contains a comparative analysis of the definitions of environmental legacies and the systems for assigning liability and responsibility for remediation established in various national laws. It also proposes a series of basic elements that any environmental legacy management system should include.

A. Context of environmental legacy management

1. Origin and types of environmental legacy

Industrial development has yielded numerous benefits for society, but it has also had a negative effect on the environment, through the contamination, to different degrees, of its components (water, air and soils). In addition, the presence of closed or abandoned industrial sites, mines and fuel storage depots poses risks to human health and the environment, with an unequal impact on different socioeconomic groups.

Addressing the impact of environmental legacies on human health can directly or indirectly contribute to the achievement of several Sustainable Development Goals (SDGs). In that context, the Industrially Contaminated Sites and Health Network (ICSHNet) identifies those related to health (SDG 3), clean water and sanitation (SDG 6), affordable and clean

energy (SDG 7), inequality (SDG 10), sustainable cities and communities (SDG 11) and responsible production and consumption (SDG 12) (Iavarone and Martuzzi, 2019). According to Iavarone and Martuzzi (2019, p. 13), taking a proactive approach to the environmental and human health impacts of environmental legacies is a key entry point for intersectoral public health action and in ensuring that the necessary and urgent transition from a linear economy to a regenerative, sustainable and equitable circular one also helps build sustainable communities that enjoy both health and well-being.

Environmental legacies are the result of deficient regulations and poor environmental management practices in industrialization processes.[3] Past activities can cause local and diffuse accumulations of environmental stressors, which can endanger public health and the environment by altering air quality, affecting soil functions and contaminating groundwater and surface water.

The ways in which environmental legacies are dealt with in regulations and laws vary from country to country. In some cases, legacies are addressed in broad terms, regardless of the economic activity that created them, the primary pollutant or the time at which the pollution occurred. In other cases, countries establish specific regulations for certain predominant economic activities, such as the mining and hydrocarbons sectors, or regulations that address environmental legacies that were generated in the past or before the entry into force of the applicable environmental standards.

In the laws compared in this chapter, the terminology used is "environmental legacies" or "contaminated sites".

The comparison shows that the procedures for managing environmental legacies and the basic elements that the regulations should contain are universal and can be applied to legacies of all kinds.[4] If sector-specific regulations are adopted, efforts must be made to ensure consistency between them.

Although there is no single way to meet the challenge, the existence of a single, common set of regulations can contribute greatly to understanding the powers of the competent bodies and the system used to determine responsibilities in the execution of remediation tasks, as well as the methods used for those tasks. It can assist with the joint and synergistic management of more than one environmental legacy within a given territory, with the financing alternatives available for the purpose and with the conditions under which the legacy is released once the remediation tasks have been completed. This prevents overlaps and omissions and makes more efficient use of human, technical and financial resources.

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[3] In the past, the best available technologies were not as advanced as they are today, as best practices and knowledge about negative effects evolve over time.

[4] These include definitions and concepts, risk assessment systems, powers of the authorities, responsibility and liability regimes, regulation of procedures, funding mechanisms and so on.

2. Managing environmental legacies

The management of environmental legacies has many potential benefits, and one of the most important is the reduction of damage to the environment and risks to the population's health and safety. Remediating environmental legacies can reduce direct and indirect exposure to contamination in nearby populations, land, ecosystems and surface and groundwater.

In particular, the management of environmental legacies in urban settings offers an opportunity not only to improve environmental health conditions in those areas, but also to achieve urban renewal and restructuring on a larger scale.

According to the World Health Organization (WHO, 2021, p. 2), the redevelopment of formerly contaminated sites helps generate the urban land resources required to establish more open public spaces, provide local services and reduce mobility needs, and increases resilience for future events. Addressing these key challenges to "build forward better" requires an investment in sustainable and green recovery, and the establishment of new urban infrastructure. Repurposing contaminated sites for urban redevelopment may therefore address the environmental legacies of the past and foster opportunities for healthy and sustainable cities.

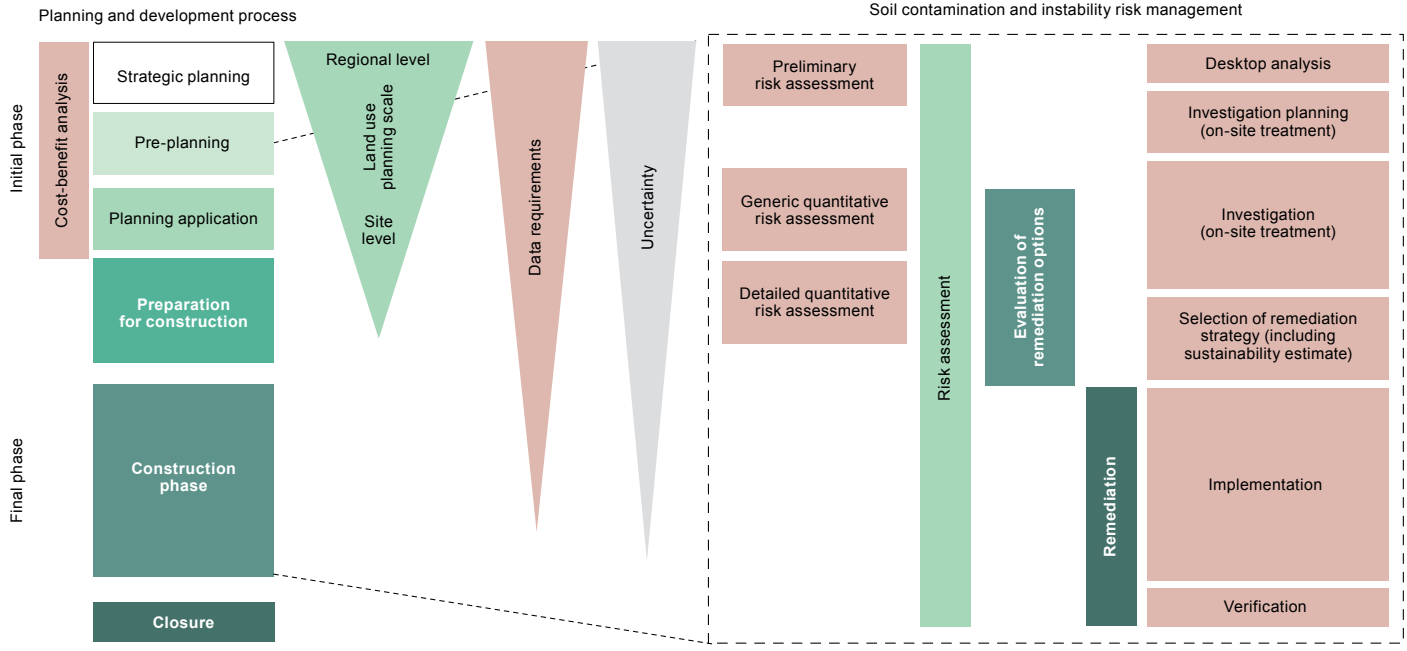
Moreover, since legacy sites are often located in or around disadvantaged neighbourhoods, redevelopment helps reduce local inequalities and increase social cohesion.

There are two main tools for the systematization and corrective management of environmental legacies: (i) inventorying all a country's legacies, the identification and evaluation of which enables prioritization strategies to be set according to the level of risk and resources available, and (ii) the management of legacies, either individually or jointly.

Generally speaking, broad international consensus exists regarding these processes, which require specialized expertise —often from several disciplines— for implementation. Diagram IV.1 portrays a typical environmental legacy management process, including planning, assessment, remediation and verification. The diagram shows a generic legacy management process: specific remediation techniques will depend on the type of contaminant and the conditions at each site. A wide range of remediation technologies exist, and these are often categorized according to their operational characteristics or purpose by means of the following criteria: (i) the objective of the remediation, (ii) the site where the remediation process is to be applied, and (iii) the type of treatment used.

Diagram IV.1

Typical remediation management process for environmental legacies and contaminated sites



Source: Prepared by the authors, on the basis of Hammond, E. B., Coulon, F., Hallett, S. H., Thomas, R., Hardy, D., Kingdon, A. y Beriro, D. J. (2021). A critical review of decision support systems for brownfield redevelopment. *Science of the Total Environment, 785*(147132). https://doi.org/10.1016/j.scitotenv.2021.147132 (figure 1).

Depending on the remediation objective, a distinction can be drawn between containment techniques, which isolate the pollutant without acting on it; confinement techniques, which act by altering the physical and chemical conditions of the medium, thus reducing the mobility of the pollutant; and decontamination techniques, which reduce or eliminate the concentration of the pollutants present.

According to where the remediation is to take place, treatment can take place on site (when the remediation tasks are carried out directly on the contaminated site) or off site (when the contaminated medium must be extracted for subsequent treatment, either on site or in external facilities).

Distinctions can be drawn by the type of treatment used: biological treatments involve the degradation, transformation or removal of pollutants through the natural metabolic activity of certain organisms; physical and chemical treatments destroy, separate or contain contaminants by taking advantage of their physical or chemical properties or those of the medium; while thermal treatments entail the application of high temperatures to volatilize, decompose or melt the contaminants.

New remediation technologies are constantly being developed worldwide; regulations should therefore include definitions based on remediation objectives and not on specific remediation techniques.

One of the most difficult issues for countries to resolve is the responsibility for financing the management and, especially, the remediation of environmental legacies. According to WHO, owing to the significant cost of site remediation, economic considerations have a huge impact on the probability of contaminated sites being remediated and redeveloped. Legal frameworks should assign the responsibility for contamination (and its associated impacts) on the entity responsible for the pollution, and include rules for managing possible legal conflicts. Although this is the case in most legal frameworks, practice shows that with each passing year after site closure it becomes increasingly unlikely that the polluters will be made legally accountable for the contamination and the related remediation costs (WHO, 2021, p. 19).

When responsibility for remediation cannot be assigned to the polluter, it may fall on the current landowner or the State, although the specific rules governing that responsibility vary from country to country. Such cases give rise to a redistributive problem involving the privatization of the benefits of mining and the socialization of environmental costs.

Another challenge related to funding involves contaminated sites located in areas of low economic value, as neither public or private stakeholders stand to obtain financial benefits from their remediation. As a result, such sites generally remain abandoned and unused and become areas of environmental

and social degradation, affecting urban planning and development. According to WHO (2021, p. 20), publicly funded environmental remediation is often the only way to make the site usable for new functions.

3. Systems for assigning responsibility and their use with environmental legacies

One of the most complex issues that countries face in regulating environmental legacies and finding adequate solutions to the problem is choosing a regime for allocating responsibility in order to identify the party required to perform the remediation tasks.

Identifying the creator of a given environmental legacy is not always possible. In some cases, this is on account of the legacy's age, which exceeds the lifetime of the possible responsible parties —be they individuals or corporations— or because even though they have been identified, they have been able to elude liability for the environmental legacy owing to the passage of time, through the expiry of the statute of limitations.[5] In other cases, it is because several actions and intervening parties produced the environmental legacy, such as cases involving several responsible parties and cumulative harmful effects. It may also be due to the coexistence of different regimes governing the use of the property where the environmental legacy is located, such as ownership, lease or easement.

Historically, the mechanism of non-contractual civil liability —understood as the obligation to account in court for damage caused and to repair its consequences by compensating the victim— has been used to determine who should respond for the damage caused. Non-contractual civil liability enables balance to be restored between the assets of the party who caused the damage and those of the injured party; it also contains a preventive element, as it encourages citizens to act prudently in order to avoid triggering liability. Additionally, it enables the burden of a given instance of harm to be distributed when it would be inequitable for it to be borne solely by the person who caused it, especially when insurance is involved. In some cases, civil liability may even have a punitive function, such as when compensation is awarded for moral damages, even though the harm is not measurable in monetary terms (Le Tourneau, 2004).

[5] Such cases involve long-standing environmental legacies and, according to general rules of civil law, the time limit established for determining liability —for example, five years— has been exceeded. If the State files suit with the courts against those responsible for creating the environmental legacy after that deadline, the defendantsmay file a statute of limitations exception and be released from responsibility. For that reason, environmental law has set deadlines —albeit equally limited— that begin to run from the moment the damage becomes evident, which may occur several years after the legacy was created.

Given that identifying the responsible parties is essential for the success of environmental legacy remediation tasks, the following section analyses how States resolve this challenge through the mechanism of non-contractual civil liability.

(a) Extracontractual civil responsibility systems

Two models for assigning responsibility have traditionally coexisted in all legal systems: that based on fault or negligence (subjective liability), which holds the third party who caused the damage responsible, whether they acted with fault or malice; and that of strict or risk-based liability (objective liability), which requires the repair of all the damage caused in the exercise of the activity, regardless of the diligence applied (Barros Bourie, 2010) or the care that may have been exercised by the person carrying out the activity, since liability arises from the mere fact of exercising that activity.

The origins of fault-based liability date back to Roman law, which established the first rules requiring civil reparations for harm inflicted on third parties. Two types of unlawful harm were distinguished: those directed against the State, which were punished with incarceration and fines, and those judged only at the request of the offended party, such as theft, personal injury and damage to property, which gave rise to monetary indemnification (*lex aquilia*), a concept that is still used under the name of aquilian liability. However, the jurisprudence of the courts, in relation to the interpretation of the term *iniuria* (unjust), established the obligation of responding for negligent acts that caused damage, for which the term "fault" was used, and it was established that any fault that caused damage was punishable (Corral Talciani, 2011).

Under the moral conceptualization of fault in medieval doctrine and jurisprudence, the obligation of redress arises from the reproachable action of the party that caused the harm. In the nineteenth century, however, the first European civil codes, influenced by liberal and economic philosophy, established the general principle that "there should be no liability without fault". Thus, the French Civil Code of 1804 introduced the principle of fault for the imputation of liability, which was followed by other civil codes adopted in the nineteenth century, including those of Italy (1865) and Spain (1889) and, in Latin America, those of Peru (1852), Chile (1855) and Argentina (1869) (Vidal Ramírez, 2001).

With regard to non-contractual liability, at the end of that century, French jurisprudence took a notable turn by introducing, as a variant of subjective or fault-based liability, liability arising from the risk of using dangerous items, which establishes the obligation of paying compensation based on the objective fact of the damage caused. Similarly, the German Civil

Code reduced its emphasis on the criterion of fault and instead emphasized the damage caused by adopting a set of general provisions for redress, which led to the development of the objective criterion of liability, based on the damage from the existence of a causal link (Vidal Ramírez, 2001).

Objective, strict or risk-based liability is technically different from subjective or fault-based liability in that the former does not require negligence on the part of the responsible party. This new version of liability is triggered by the mere causal relationship between the defendant's action and the damage suffered by the plaintiff, and is based on the risk created by the person carrying out a certain activity and not on the omission of duties of care. Assigning liability does not therefore require a value judgment regarding the actions of the responsible party, since it is sufficient for the damage to occur as a result of an activity with a risk that is covered by a statute of non-negligent liability (Barros Bourie, 2010).

The basic premise of this variant of civil liability is that any activity that involves a risk for a third party makes the person performing it responsible for any damage that it may cause, without the need to establish fault as the origin of the harm. As an expression of an elementary notion of justice, this theory seeks to ensure that all persons who can obtain a benefit for themselves must, in return, repair the damage they cause (Le Tourneau, 2004). This idea is fundamental in terms of distributive justice, especially when it is applied to environmental mining legacies and considers the risk approach to people and the environment (see section (c) below).

Unlike fault-based liability, which can be formulated as a general principle, strict or objective liability is applied restrictively to those cases in which the law expressly authorizes it, which invariably entail a situation of abnormality or exposure to great risks or dangers.

Strict liability does not imply an absolute and definitive objectification of the liability of any right, but is triggered solely by certain types of damage. Industrial and manufacturing activities constitute one of those types: industrial accidents, for example, which must be subject to objective rules, and damage inflicted on third parties through the operation of a company's means of production (explosions, electric shocks and so on). In addition, companies' products themselves are a source of strict liability when harm is caused by product defects. Another realm of damage in which this type of liability applies is that of activities involving particularly or typically dangerous objects, such as firearms or automobiles (Cavanillas Mújica, 1996).

In keeping with the restrictive nature of strict liability, it should be noted that Roman law records cases in which this type of liability was already applied, based on the dangerousness of the conduct, such as the fall of objects from upper floors of buildings and damage caused by dangerous animals.

In modern times, cases mainly deal with risks created by technology, such as railways and, later, with those related to aeronautics, nuclear energy and genetic engineering (Barros Bourie, 2010).

In any event, although strict liability has been applied in different fields —mainly thanks to jurisprudential creation relating to facts of things— the general liability regime is still based on negligence. Negligence-based liability remains the general and supplementary liability regime in most legal systems (Barros Bourie, 2010).

Countries where civil law favours the fault-based liability regime, owing to the difficulties it presents in relation to identifying responsible parties, have used the resource of establishing presumptions of liability for those who carry out risky activities. This reverses the burden of proof, since parties performing such activities have the obligation of proving in court that the damage was not the result of their actions or activity. As in the case of strict or risk-based liability, it should be statute and not case law that decides on the application of this remedy.

(b) Responsibility for environmental damage

At the United Nations Conference on the Human Environment, held in Stockholm in 1972, the countries of the United Nations for the first time discussed the causes of environmental degradation and the need to adopt concrete measures for environmental protection.

The negative effects of economic activity, or negative environmental externalities, can lead to environmental damage, understood as a lack or deprivation, a loss or impairment, a slight or partial destruction or a decrease or deterioration of the environment. This harm may arise from the responsible party's failure to comply with environmental protection mechanisms —such as quality, emission or discharge standards, waste management and disposal, and forestry management plans— or from negligent or careless conduct that affects the environment or surrounding communities.

In that context, it may be difficult for the legislature to delegate the determination of environmental damage to the parties and the judge on account of the diversity of potential cases, since a reduction, destruction or deterioration of the environment or of one or several of its components may exist, without, in general, any gradation or level thereof. Accordingly, a broad or generous interpretation of the legal definition of environmental damage by the courts could give rise, in practice, to considerable excesses in the assignation of liability, especially when commercial or productive activities are involved (Lavín Valdés, 1996).

Regarding the delimitation of the judge's task, two approaches have been developed for the determination of environmental damage. The first focuses

responsibility on the human being, so that no environmental damage exists if the harmful result does not come from human action. Likewise, no environmental damage exists as a source of liability if the presence of real damage to one or more human beings is not established (Corral Talciani, 2011). As already noted, this approach raises the problem of the impossibility of repairing the harm caused in certain cases, owing to difficulties in identifying the party responsible: for example, in cases of cumulative contamination, or when there are multiple sources of contamination, which complicates the establishment of the causal link (Sánchez-Friera González, 1994).

The second approach holds that compensation to redress harm suffered is an authentic social imperative and it does not assign fault. This model seeks to repair all damage in which it cannot be justified that the victim alone bears the burden; accordingly, it determines, reasonably and equitably, who should bear the burden, in accordance with the principles of social solidarity, which require focusing on the injured party and on ensuring their redress (Sánchez-Friera González, 1994). In the absence of a general principle of strict liability, the proposal is to shift the burden of proof to the party responsible. When the damage occurs as a consequence of the normal or abnormal exercise of an activity that generates economic benefits for the responsible party, the burden of proof is inverted: the injured party does not have to establish the fault of the party responsible, but the latter must prove that it took all possible precautionary measures to prevent harm. Thus, there is a shift from requiring the plaintiff to prove fault to requiring the defendant to prove diligence (Díez-Picazo, 1966).

This change in jurisprudence is based on the theory of risk, which states that persons who, within social life, create a situation of risk or danger for their own benefit must assume the consequences arising therefrom. Thus, the idea of risk implies that whoever pursues an activity that may inevitably cause harm to others must be liable for the damage caused, regardless of whether or not he or she is at fault, since distributive justice is the foundation of this type of activity (Sánchez-Friera González, 1994).

Lastly, it should be noted that among European statutes, the German Environmental Legacy Act of 10 December 1990 expressly regulates liability for risk. Under that act, if an environmental impact caused by an installation specified in annex 1 causes a person's death, injury to his or her body or damage to his or her health, or damage to property, the operator of the installation has an obligation to compensate the injured person for the resulting damage, except in cases of force majeure. The German law also recognizes a certain limitation of liability when the installation is operated in accordance with current rules or when the material damage is insignificant or tolerable, depending on site conditions (Cabanillas Sánchez, 1996).

(c) System of responsibility for the remediation of environmental legacies

As in the case of responsibility for environmental damage, the existence of unwanted environmental legacies is the result of the pursuit of industrial or productive activities that, despite having concluded, generate —or could generate— residual effects that may compromise or affect people's health or cause harm to the environment.

Examples of environmental legacies include facilities that have not been dismantled, abandoned mine sites, pollutants and waste products that have been improperly disposed of, soil disturbances caused by the extraction of minerals and the presence of hydrocarbons in soils or water. These legacies are created when the owner does not follow environmentally appropriate closure procedures, either because at the time of the decommissioning there were no such legal requirements or because the duty of care to avoid the consequences of damage or risk was not observed.

Because of legislative, jurisprudential and doctrinal advances in environmental matters, industrial or productive activities currently underway are not expected to generate new environmental legacies, since their owners must comply with closure and decommissioning requirements. The environmental legacies that exist are therefore connected to residual situations that were not managed in the past, and they must undergo environmental treatment or remediation because they may cause damage or risk of damage to the health of the public or the environment.

Determining who should assume those obligations is a matter for extracontractual civil liability, in the form of either subjective liability (due to fault or negligence) —which is the general mechanism and most common in current legislation— or objective liability (strict or risk-based), taking into account the considerations analysed above.

The difficulties presented by fault-based liability —such as identifying the possible owner; proving the damage inflicted, the causal link and the responsible party's faulty or negligent conduct; and the triggering of statutory limitations due to the passage of time elapsed— favour the establishment of a risk-based liability system whereby the person or persons who carried out the activity and obtained the benefits are held responsible, or a system of presumption of liability, which allows the burden of proof to be inverted.

However, although legislation favours the system of strict liability or presumption of liability, other alternatives must be considered. These include those provided for in the special rules of civil law, which oblige the owner of a property that poses a risk —a ruined building, for example— to assume liability and to take appropriate measures to avoid harm; this does not apply in cases when property owners can excuse themselves through

the exercise of real-property rights, such as the lease of a part of the property or easement contracts, in which case the beneficiaries of those rights will be held liable.

In any case, and without prejudice to the above, States must promote the creation of remediation funds or economic incentives to fund remediation tasks when responsibility cannot be assigned to the owners or when they do not have the financial wherewithal.

B. Basic components of an environmental legacy management system

The pursuit of economic activities in the absence of laws governing how the environmental impacts they may produce are to be treated has given rise to the emergence of environmental legacies. This situation should continue to change as systems for the preventive evaluation of environmental impacts demand more requirements at the different stages of new project development (construction, execution and closure or decommissioning). The exception is those particular situations arising from force majeure or the financial inability of the responsible parties to undertake remediation tasks with their own funds.

Environmental legacies should be understood as the legacy of a way of executing projects that belongs to the past, and the challenge is being able to remedy them. Responsibility for remediation lies with those who undertook the projects; or responsibility can fall on the State when the responsible party cannot be determined or, if they are identified, they do not have the wherewithal to cover the remediation costs. Technical and legal instruments are therefore needed for the intervention or remediation of environmental legacies.

Based on the knowledge acquired from the management of environmental legacies and the experiences revealed by comparing the laws specifically dealing with this issue, any regulations on the management and remediation of environmental legacies should include the following aspects and components.

1. Definitions and concepts

A precise definition is the starting point for determining the existence of an environmental legacy and developing a management and remediation plan. For this book's purposes, an environmental mining legacy is a potential negative social and environmental impact associated with abandoned mining operations (and the associated waste), with or without an identifiable owner or operator.

Under this definition, for example, the environmental mining legacies of metallic mining could include abandoned mine sites of any kind, mine shafts, open pits, tailings dams, leach pads, concentrators, tailings pipelines, shipping docks, processing plants and any disused facilities that could pose risks to the health or safety of people or the environment.

2. Risk assessment system

Instruments for assessing land quality, such as environmental quality standards, cannot always determine the existence of an environmental legacy and the actions needed for its remediation. This is because environmental quality objectives are intended for general purposes and not for evaluating specific situations; therefore, the exposure to risk is generic. In contrast, exposure at contaminated sites is usually specific and limited to the people who come into physical contact with them; accordingly, the use of these tools is not effective, as it could overestimate or underestimate the risk.

In view of the above, there is a need for management tools, such as risk assessments, that are different from or complementary to quality or emission standards. A risk assessment would identify the potentially adverse health or environmental effects caused by exposure to hazardous or risk factors. It would also help determine whether the presence of contaminants at a site poses a risk to the environment or human health and establish site-specific levels of remediation based on the acceptable risk.

3. Prioritized list of environmental legacies

Risk assessments also enable environmental legacies to be prioritized for remediation according to the danger they pose.

In this way, countries can detect their most at-risk situations at an early stage and assign them a remediation order based on that.

4. Powers of the authorities

The different national, regional, provincial, district or community authorities must have the power to declare the existence of environmental legacies, establish the order of priority, assign responsibilities, regulate procedures (including mechanisms for challenging decisions regarding environmental legacy declarations), require and approve remediation plans, carry out oversight and sanctioning tasks in the remediation process, issue remediation compliance certificates and ensure the right of public participation.

5. Responsibility regime

Environmental legacy regulations must establish a regime to identify the parties responsible for creating the legacy and for carrying out remediation. For that purpose, a choice can be made between fault- or negligence-based

liability, strict or risk-based liability —which is the approach most commonly used in current laws— or a combination of both through presumptions of guilt that reverse the burden of proof.

6. Regulation of procedures

Legislation on the management and remediation of environmental legacies must provide, at a minimum, for the following administrative procedures.

(a) Declaration of environmental legacy

The procedure must include the participation of the competent authority, which, after evaluating the risks and other relevant background information, must officially declare the existence of an environmental legacy. In addition, it must recognize the right of those potentially affected —either because the legacy is located on their property or because they have been identified as potentially responsible— to challenge that declaration, provided that it is contestable. They must also be given the possibility of appealing the declaration to a higher authority.

(b) Remediation plan

This procedure addresses the obligation imposed on the party responsible for remediating the environmental legacy to present, within a specified deadline, a remediation plan as required by the competent authority, which must also include venues for challenges. Remediation plans must take account of risk control and the process of rehabilitating the site for new productive activities, and can also provide for the maximization of social, environmental and economic dynamics.

(c) Conformity certificate

A procedure is also needed for obtaining the conformity certificate for the remediation carried out. This will include the presentation to the competent authority of the work performed and the necessary supporting documents —cleaning, inertization, removal, coverage and so on— that demonstrate that the environmental legacy's risks have been eliminated, together with the mechanism for releasing the party that has carried out the remediation from responsibility.

(d) Venues for public participation

The legislation must establish and guarantee a regime of public access to information on environmental legacies and a venue for public participation regarding their determination, the remediation plans adopted, the adequacy of their implementation and the certification of remediation compliance.

(e) Funding mechanisms

To address the difficulties posed by the lack of funds for undertaking remediation tasks when the responsible party has not been identified or, if identified, lacks the solvency necessary to assume those tasks, or when dealing with abandoned environmental legacies, funding mechanisms for remediation, to be covered by the State, must be established. Such mechanisms include tax incentives for the individuals or companies that assume the remediation tasks, annual allocations in the corresponding national budget, the creation of funds at the national, regional, provincial or local level, or a combination thereof so that the remediation objective can be met. Chapter V describes various sources of financing, including public financing from tax revenues (either general revenue or specifically from the mining industry and other pollution generators), public-private partnerships, international assistance and cooperation and financing from private voluntary contributions.

C. Analysis of selected countries

An analysis of how environmental legacies are regulated must cover a range of issues: the hierarchy of applicable rules (laws or regulations); the definition of environmental legacies and of the protected legal goods that justify remediation tasks; procedures for declaring their existence; the authorities empowered to make such declarations and lead remediation processes; the responsibility allocation regime for identifying the parties who must contribute to remediation work; remediation measures, instruments and tools; certifying the adequacy of remediation; and funding mechanisms.

Australia, Canada, Germany, Peru and the United States have been selected as examples of how States have dealt with these issues which, taken together, constitute a comprehensive regulation of environmental legacies. A table summarizing the main elements contained in the laws regulating the management of environmental legacies in those countries is included at the end of the section.

1. Germany

(a) Applicable legislation

Since Germany is a federal State, federal and State regulations exist alongside each other. In matters of environmental legacy, a system exists in which several laws can be applied depending on the specific case and the potentially affected legal goods.

The Federal Mining Act (1980) regulates mining operations from the planning stage to decommissioning. However, once the mine closure process is completed, in the case of abandoned sites, the Federal Soil Protection

Act (1998) applies. This occurs when other specific regulations cannot be enforced, such as the Water Resources Management Act of 2009, the Federal Immission Control Act of 1974 and State laws protecting against emissions, the Federal Radiation Protection Act of 1986, the Federal Nature Conservation Act of 2009, the Public Order Authorities Acts, the Environmental Legacy Act of 1990 and the German Civil Code.

(b) Concepts and protected legal goods

The Federal Mining Act is intended to avoid risks to life, human health and the property of third parties (sect. 1.3). One of its objectives is to remediate sites during and after mining operations. It also enforces the principle of operator liability and, as such, requires compensation for damage caused by mining activities.

The Federal Soil Protection Act protects the soil and its natural functions (art. 1) and identifies the life and health of the population and the environment as protected legal goods (art. 2.2). As regards remediation, it draws a distinction between remediation measures and protective and restrictive measures (art. 2.7).

In German law there is no fixed concept of damage or risk. Its meaning depends on the rule under analysis. In general, the relationship between damage and risk is parallel to the relationship between private law, which protects individual legal property, and public law, which protects common legal goods, such as the environment or public health.

(c) Allocation of responsibility

Public law rules are generally of a preventive nature; thus, for the authority to take a decision requires solely the existence of a risk to the goods that those rules protect. In these cases, the system of objective liability is chosen, as in the Federal Mining Act and the Federal Water Resources Management Act.

In contrast, the rules of private law enshrine the system of subjective civil liability for fault or negligence based on the existence of actual damage.

Under the Federal Mining Act, site remediation is the responsibility of the mine operator, who must cooperate with the authorities to prevent contamination or adverse effects to third parties and restore land use (sects. 58, 114 and 170).

Under the Soil Protection Act (art. 4.3), it falls to the authority to determine the party responsible for remediation, which may be the perpetrator of a soil disturbance or site contamination (and their universal successors) or the owner of the property.

(d) Determination of the existence of an environmental mining legacy

The purposes of the Federal Mining Act include preventing environmental legacies. To that end, operators are requested to submit a closure plan (sect. 53). The authority may require a guarantee (sect. 56) to ensure compliance with the obligation of restoring the land for use. Oversight is carried out by local entities with competence for mining matters (sect. 69) or in conjunction with community authorities responsible for land use planning.

According to the Federal Soil Protection Act, if indications of a possible soil disturbance exist, the competent authority must investigate the situation (art. 9). To that end, the act contains a list of hazardous substances and pollutants, together with their permissible concentrations (art. 8).

In this regard, two types of concentration must be distinguished. The first type are those concentrations that require a quantitative assessment of the site, taking into account land use, to determine if a soil disturbance has occurred or if the site is contaminated. The second type of concentrations indicate the presence of soil disturbance or site contamination, and the need for intervention measures.

The competent authority may order the parties responsible for a site to carry out risk assessments or submit a remediation plan (arts. 9 and 13).

(e) Activation of the remediation system

Under the Federal Mining Act, remediation begins with the closure plans that must be submitted by mine operators.

Under the Federal Soil Protection Act, the competent authority requires site remediation following the detection of levels of hazardous substances or pollutants in excess of the permitted levels identified in the act (art. 13).

(f) Scope of remediation

The Federal Mining Act provides that all necessary measures must be taken to avoid risks to third parties outside the site or operating mine. In addition, the surface must be restored for use, as determined by the competent authority in each case (sect. 55.2).

Under the Federal Soil Protection Act, measures must be taken to prevent risks of soil disturbance on a property (arts. 1, 4 and 7), and water must be permanently restored to prevent substantial risk, damage or nuisance to the population. To that end, the implementation of the remediation measures established in article 2.7 may be ordered. These include decontamination measures, to eliminate or reduce pollutants; containment measures, to prevent or reduce spreading of pollutants in a lasting way, without eliminating the

pollutants themselves; and protection and restriction measures, particularly restrictions on land use, intended to eliminate or reduce risks and adverse effects on the population.

(g) Competent authority and powers

The Federal Mining Act establishes an oversight system (sects. 69 and 142) that includes entities at three levels: lower-ranking authorities, intermediate-ranking authorities and a federal ministry. The authorities must safeguard mineral resources, prevent risks to third parties and treat soils in a cost-effective and careful manner. They have broad powers to grant permits, approve operating plans and oversee soil conservation and restoration.

Under the Federal Soil Protection Act, the local authority can order the actions needed to determine the existence of soil alterations or an environmental legacy (art. 9). If an environmental legacy is found to exist, the authority may request the responsible party to take the appropriate steps for its remediation and to submit a remediation plan. The authority itself may also develop a remediation plan and require such remediation measures as it deems appropriate (art. 14).

(h) Limitations on individual rights in conducting remediation

According to the Federal Mining Act, operating plans produce effects on property rights, such as restrictions on construction or land use (sect. 107).

Under the Federal Soil Protection Act, the competent authority may order the responsible party to monitor the existence of hazards, carry out water and soil measurements and install monitoring stations (art. 15). The authority may also take such measures as it deems appropriate to prevent risks through restrictions on access and land use (art. 4).

As noted below, the law establishes public usufructs to ensure payment or reimbursement to the State of funds used for remediation.

(i) Funding

In general, the responsible parties are to cover remediation costs. Under the Federal Mining Act, remediation is carried out by complying with operating and closure plans and, if necessary, with the guarantees required from operators by the authority (sects. 53 and 56).

Under article 25 of the Land Protection Act, if the market value of a property increases significantly when pollution is managed with public resources, the owner must reimburse the State for the difference between the property's current and previous values.

However, there are special cases, such as the Wismut Act, which regulates the remediation of former uranium mining sites, which is paid for by the State as the owner of the land, or the remediation of land under the responsibility of municipalities, which do not receive remediation funding.

2. Australia

(a) Applicable legislation

Australia has a federal system of government and several States have laws applicable to contaminated sites. This chapter offers a detailed examination of the State of Western Australia's Contaminated Sites Act ("CS Act") of 2003 and the State of New South Wales's Contaminated Land Management Act ("CLM Act") of 1997. Other relevant legislation includes the 1986 Environmental Protection Act, the 1911 Health (Miscellaneous Provisions) Act, the 1996 Planning Legislation Amendment Act, the Mining Industry Good Practice Regulations and related government guidelines.

(b) Concepts and protected legal goods

Part 1, section 4 of the Contaminated Sites Act defines a contaminated site as an area of land, including groundwater and surface water, that has concentrations of contaminants in excess of permitted levels and that presents —or has the potential to present— a risk of harm to human health, the environment or any environmental value. The Contaminated Land Management Act defines a contaminated site as one that presents a significant risk of harm to human health or any other aspect of the environment and is in need of remediation.

The CS Act (part 3, division 1, section 32) also provides a definition of orphan sites: all or part of a site for which the State is responsible for remediation because the person responsible for remediation cannot be identified or found, is insolvent or has been granted an exemption certificate for the site in question.

(c) Allocation of responsibility

Under part 3, division 1 of the CS Act, the person responsible for remediation is the person who has caused or contributed to the contamination of the site, the owner or occupier of the site who changed the land use (or proposes to change it) or the owner of the site.

When the contamination is the result of a regulatory breach, the person shall be responsible even if the contamination occurred before the entry into force of the law (criterion of retroactivity). At orphan sites, responsibility for remediation lies with the State.

The CLM Act (part 1, division 6) establishes an order of priority for the attribution of responsibility: first, the person mainly responsible for the contamination of the land; second, the owner of the site; and third, the notional owner or interested party (i.e. any person who is in possession of the site or has a legal interest in the land).

Under the provisions of the CS Act, when determining liability, interested parties may request environmental audits to detect and obtain information on contamination existing prior to the law's entry into force or to avoid liability when acquiring contaminated property (part 6, division 3).

Likewise, if no disclosure statement was filed, the owner or occupier of the site may also be liable for remediation, even if the contamination occurred before the law came into force (part 6, division 3). In addition, that person must assume the cleanup activities deemed necessary as a consequence of the changed land use, in order to reduce the possible risks to human health that the change of land use entails. Responsibility for remediation may be transferred by means of an agreement between private parties, subject to the written approval of the competent authority.

(d) Determination of the existence of an environmental mining legacy

Under the CS Act, the Health Department must assess the site to determine its status according to certain criteria (part 2, division 2). If the site is deemed "contaminated – remediation required", it must undergo a remediation process. Among the evaluation criteria, mining is included in the list of potentially contaminating industries, activities and land uses.

Under the CLM Act (part 3, division 1), an environmental assessment process is conducted, and the Environmental Protection Authority determines whether a site poses a significant risk to human health, the environment or both, in which case regulatory action is required. The Environmental Protection Authority must abide by the criteria defined in the assessment.

(e) Activation of the remediation system

Under the CS Act (part 3), if the site is classified as "contaminated – remediation required", cleanup activities must be performed. The Contaminated Sites Committee is responsible for arranging the remediation of the site and issuing an order specifying the party responsible and the scope of the remediation.

According to the CLM Act (part 3, division 2), the Environmental Protection Authority declares the existence of the contaminated site. The responsible party must submit a remediation plan for approval by the competent authority. In the plan is not submitted, the Environmental Protection Authority issues a remediation order.

Under both acts, non-compliance may result in fines. The authority may also order the remediation to be carried out by third parties at the expense of the responsible party.

(f) Scope of remediation

According to the CS Act (part 1, division 3), remediation activities mean the adoption of measures necessary to protect human health, the environment and environmental values. Those measures include the restoration of the site to its state before the contamination occurred; the restriction or prohibition of access to or use of the site; the removal, destruction, reduction, containment or dispersal of the substance causing the contamination; and the protection of human health, the environment or environmental values.

Under the CLM Act, the aim is to ensure the elimination or reduction of the risk so that the site can continue to be used as before or be put to another use approved by the Environmental Protection Authority. Remediation involves preparing a long-term management plan for the site; removing, dispersing, destroying, reducing, mitigating or containing the site's contamination; and eliminating or reducing any hazard arising from that contamination (including entry by persons or animals) (part 1).

(g) Competent authority and powers

Under the CS Act (part 3, division 2), the Contaminated Sites Committee, under the Minister of the Environment, decides who is responsible for remediation, as well as its scope. It may also order the investigation or cleanup of the site if the responsible party has not done so.

Private parties have a number of obligations, such as reporting the existence of contaminated sites and submitting disclosure statements if contamination is detected on the date of entry into force of the law, in order to avoid future legacies.

The Contaminated Sites Committee must evaluate those statements and, if appropriate, grant an exemption certificate. Under the CLM Act (part 1), the Environmental Protection Authority is responsible for the remediation process and may investigate the site, verify its condition, declare it as an area under investigation or remediation, as necessary, and issue cleanup orders to individuals or public entities in the event of non-compliance.

(h) Limitations on individual rights in conducting remediation

The CS Act (part 9) provides that representatives of the State may access any site where remediation actions are to be carried out, either to conduct an investigation or to perform cleanup. Sites may also be expropriated for reasons of public interest. If the remediation is to be financed with public funds, the State may secure payment or reimbursement through a right of first refusal that will be recorded on the property title.

In the event that the person responsible for the remediation has to access land belonging to third parties to perform the cleanup, permission must be obtained from the owner or occupier, who cannot refuse without just cause. In the event of a refusal, the competent authority may grant permission to enter and, in the event of non-compliance by the private party, may impose fines (part 5, division 1).

If a person performs cleanup or remediation activities, he or she may recover costs from the party ultimately responsible, for which a right of action and preference is granted (part 5, division 2).

The CLM Act (part 3, division 2) establishes similar powers to facilitate site investigation and cleanup, focusing on the liability of those who enter private property in the event of damage.

(i) Funding

The CS Act creates a Contaminated Sites Management Account (part 5, division 4), with resources for financing the management and remediation of orphan sites. It is made up of revenues received by the State from different sources, such as the payment of fines, fees paid for the granting of exemption certificates or other services of the regulatory entity, money received from the sale of sites over which the State has a right of first refusal in the payment or reimbursement of remediation expenses, and funds from the State's budget.

The CLM Act (part 3, division 6) provides for the creation of a Consolidated Fund specifically for the investigation and remediation of contaminated soils.

In accordance with the regulations, the authority may require a person to pay all or part of the costs incurred by the Environmental Protection Authority in preparing and issuing an investigation or remediation order, or in carrying out monitoring and follow-up actions. When private parties carry out the investigation or remediation of a site for which they are not responsible, they may recover the costs through legal action against the responsible party and are entitled to a preference in payment.

3. Canada

(a) Applicable legislation

In general, mining activity is regulated by provincial laws, but federal legislation applies to all three northern territories (Nunavut, Northwest Territories and Yukon). The mining laws provide for the existence of mine closure plans and require operators to provide financial guarantees to ensure compliance with their obligations at the end of the mines' useful life.

There is no specific federal legislation covering abandoned mines or environmental mining legacies. Those issues are, however, included in some provincial laws, which establish obligations for owners of surface soils, along with certain remediation actions. Some provinces, such as British Columbia, Ontario, Quebec and Saskatchewan, have established specific regulatory regimes for the assessment and remediation of contaminated land.

(b) Concepts and protected legal goods

Contaminated sites are defined as areas where the land or water contains sediment, vapor or substances in quantities or concentrations that exceed hazardous criteria, standards or conditions.

The environmental protection provisions of federal and provincial laws are intended to ensure care for human health and the environment. The purpose of the provincial laws on abandoned sites and environmental mining legacies is to reduce safety risks to people.

(c) Allocation of responsibility

Under the provincial environmental laws, responsibility for the cleanup of contaminated land generally rests with current and former owners and occupants.

In some cases, responsibility is assigned to the producers of the substances that generate pollution, so that, under the rules of common law, the party responsible is the causer of the pollution. On some occasions, however, responsibility is attributed to innocent owners or occupants who have not taken steps to control the migration of contamination outside their property.

(d) Determination of the existence of an environmental mining legacy

Provincial law establishes the circumstances under which the authority may require the investigation and remediation of contaminated sites. In British Columbia, for example, there is an obligation to register contaminated sites that have been identified. In Ontario, meanwhile, when a contaminated site that was previously used for industrial or commercial purposes is turned over to residential or recreational use, it is subject to investigation and remediation requirements.

Under these provincial laws, the simple detection of exceeded standards at a site is not usually decisive, so there is an obligation to investigate the contaminated site. Generally, the provincial authorities request data that determine the off-site impact before ordering the evaluation or remediation of the contaminated site.

(e) Activation of the remediation system

The provincial governments are responsible for approving plans for rehabilitation, restoration or closure of mining activities, in keeping with provincial mining laws and regulations. After the operations are closed down, the approved plans must be implemented and, if contaminated sites are found to exist, they must be remediated.

(f) Competent authority and powers

In British Columbia, Ontario and the Yukon, the competent authority is the Minister of Environment and Climate Change, who may delegate his powers to the director. In Manitoba, the authority is the director of the Environmental Approvals Branch. In addition, within their jurisdictions, municipalities have authority over environmental matters.

In 2006, the Canadian Council of Ministers of the Environment drew up a set of guiding principles for the remediation of contaminated sites: the "polluter pays" principle, equity, sustainability and emergency response. Canada's programmes for abandoned mines are evaluated according to those guiding principles.

(g) Limitations on individual rights in conducting remediation

Environmental regulators have very broad statutory site access powers. In addition, allowing access is a common condition in environmental approvals in Canada. In general, an environmental inspector or investigator may enter the property, make excavations, take samples, conduct tests, examine records and make copies of them, take photographs or video recordings, require the production of documents or data, and make reasonable inquiries, without a warrant or court order and at any reasonable time.

If the purpose of access is to investigate non-compliance with a view to prosecuting those responsible, the Canadian courts restrict the power of entry, so investigators may need to obtain a search warrant.

(h) Funding

Various sources of funding are available for the remediation of contaminated sites, including funds from the general government budget at the provincial or federal levels; cost-sharing agreements between the provincial and federal governments; taxes on mining industry output; partnerships between the mining industry and the provincial or federal governments; reduction of incentives to the mining industry or reallocation of current tax revenues to be used for the remediation of abandoned mines; fines imposed on the mining industry; and donations from individuals and other minor funding sources.

In British Columbia and Ontario, bond amounts are required to be calculated using a third-party cost analysis. In British Columbia, the administrative costs associated with the government's responsibility for land reclamation are taken into account. In Yukon, bond amounts are calculated by Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) based on third-party cost analyses and a contingency rate of between 10% and 20%.

In Manitoba, the Mining Rehabilitation Reserve Fund, consisting of funds received as collateral or under securities or letters of credit provided as security, is earmarked for rehabilitation work under closure plans, and authorized disbursements are charged to it.

Abandoned mine programmes, inventories, site assessment, reclamation and rehabilitation of abandoned mines have been funded primarily through general government revenues at the provincial or federal level, with a small contribution from seized property. Abandoned mine programmes are at different stages of implementation and development in the various provinces.

In the case of Ontario, in 2003 the Ontario Mining Association and the Ministry of Energy and Mines signed a memorandum of understanding to regulate the participation of both parties in the financing of projects for the rehabilitation of land threatened by abandoned mine sites located on government-owned land. Under that memorandum, remediation activities are being carried out in projects of mutual interest.

4. United States

(a) Applicable legislation

State and federal laws exist, notably the 1980 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), which applies to contaminated sites or sites at risk of contamination by hazardous substances. At the federal level, the 1977 Surface Mining, Control and Reclamation Act (SMCRA) covers coal mining and contains provisions for the remediation of abandoned coal mines.

Other laws also apply by reference, such as the Clean Water Act of 1972, the Resource Conservation and Recovery Act of 1976 and the Oil Pollution Act of 1990.

(b) Concepts and protected legal goods

CERCLA allows action to be taken in the event of the occurrence —or significant threat of occurrence— of a discharge of a hazardous substance or any pollutant into the environment that may pose an imminent and substantial danger to public health or well-being.

Under SMCRA, lands eligible for rehabilitation are those on which coal mining activities were conducted and abandoned or left in an inadequate state of repair prior to the entry into force of the act. In addition, there must be no obligation to remediate those lands under other State or federal laws. Their rehabilitation protects the health, safety and well-being of the population, property, the environment and, in particular, soil and water components.

According to CERCLA, the objective of remediation is to achieve a cleanup of hazardous or polluting wastes that, at a minimum, ensures the protection of the health of the population and of the environment. Remedial actions are to be relevant and appropriate to the circumstances resulting from the release or threatened release of the substance, waste or pollutant in question.

According to SMCRA, rehabilitation and restoration include all activities intended to remediate land on which activities related to coal mining have taken place.

(c) Allocation of responsibility

CERCLA identifies four categories of responsible parties: current and former owners and operators (if the issue occurred during their possession of the site); persons in general who ordered the disposal or treatment of the substances that caused the contamination; transporters of those substances who selected the disposal or treatment site; and other responsible parties, such as legal successors, parent entities, directors, shareholders or officers.

Liability under CERCLA is strict (objective) and, despite an ongoing constitutional debate, applies retroactively.

Possible limitations of liability are recognized for owners whose land has been contaminated by acts occurring on neighbouring or nearby land, as well as for those who can establish that the contamination occurred prior to the site's acquisition date.

Under SMCRA, mining companies must provide a financial guarantee at the start of their activities. If the operator does not carry out remediation once the activity has ended, the guarantee will be used to finance it and, if it is not sufficient, the difference will be paid from the Abandoned Mines Reclamation Fund, which receives contributions from a wide range of companies nationwide.

(d) Determination of the existence of an environmental mining legacy

If pollutants or hazardous substances are found to have been released into the environment, any person having control or responsibility for the facility or conveyance emitting significant quantities of them is required to

notify the Environmental Protection Agency (EPA). Also, if EPA determines that additional studies are needed at the site, it must include them in a risk assessment system, in accordance with the pre-established requirements of a national contingency plan. In the event that the risk assessment so warrants and in certain circumstances, EPA may serve a remediation order on the title holder. When a site presents a certain level of risk, it is added to a National Priority List (NPL), which means that it is eligible for cleanup with public funding.

Under SMCRA, the Secretary of the Interior or the State in question have broad powers to investigate whether an environmental mining legacy exists and to assess the site. Depending on the results of that evaluation, public funds may be made available.

(e) Activation of the remediation system

EPA may, under the terms of CERCLA, issue administrative orders to compel responsible parties to carry out remediation actions. In the event of non-compliance, the agency may take steps to enforce the order or may directly undertake remediation at the expense of the responsible party. The agency may also take action to recover funds spent on remediation.

EPA also has the power to reach agreements with potentially responsible parties for the execution or funding of private remedial actions, and it may establish their liability. Individuals can initiate citizen suits, which are intended to force responsible parties to undertake remediation or to demand that government authorities comply with their legal obligations.

Under SMCRA, operators are the primary responsible parties for remediation. If remediation is not carried out, the guarantee deposited at the beginning of the operation may be enforced. In addition, if the guarantee amount is not sufficient, public funds can be used. Under this law, citizen suits may be brought against the United States, any government agency or any person who violates its terms.

(f) Scope of remediation

CERCLA states that the responsible party must adopt all measures in accordance with the National Contingency Plan, an instrument that contains the Environmental Protection Agency's regulations for responding in the event of an actual or potential release of hazardous substances. Cleanup actions include the removal of those substances, through short-term measures aimed at containing, stabilizing or mitigating risks and damage, and remediation, which is aimed at the permanent rehabilitation of the site and includes long-term cleanup activities. Before remediation actions can begin, a preliminary assessment —ordered by EPA on its own initiative or requested by private parties— must be carried out.

The selection of the remedial action to be implemented is based on the site evaluation, the investigation process and the feasibility study, according to previously established requirements. The cost of remediation is an important factor when several alternatives are available for the cleanup needed. If environmental protection levels can only be achieved through a given action, its cost is not a reason to opt for other actions. Once the remediation action has been selected, the proposed remediation plan is formally presented and comments are received from the public.

Under SMCRA, restoration actions are broad and cover surface land, processing facilities, tailings deposits, sealing or backfilling of pits or cavities, planting of vegetation to prevent erosion, treatment of water contaminated by acid drainage and construction of facilities or works to prevent or control hazards.

(g) Competent authority and powers

CERCLA assigns responsibility for the process to the Environmental Protection Agency. The authorities are empowered to require information to determine the presence of hazardous substances, the existence and nature of contamination, the ability of a person to finance or carry out remediation, and access to any documents or records deemed necessary for those purposes; and to enter any site where contamination has occurred, and inspect and obtain samples. Failure to comply with any of these orders may result in legal action and fines. In addition, the EPA Administrator is granted broad powers to carry out all relevant remediation actions.

Under SMCRA, the responsible entity is the Office of Surface Mining Reclamation and Enforcement (OSMRE), an agency of the Department of the Interior. It is responsible for administering and enforcing the provisions of the act and, if local authorities fail to do so adequately, those of State laws.

(h) Limitations on individual rights in conducting remediation

Under CERCLA, the authorities have broad powers to take action and limit the right of private property when necessary to investigate, assess and remediate contaminated sites.

With respect to the sites it covers, SMCRA provides that the State and its agents have broad powers to enter private property, impose limitations on access or use, and acquire land, whether by purchase, donation or expropriation. The act also stipulates that when the State undertakes remediation, a lien may be imposed on the solvent legal owner, in an amount not greater than the difference between the value of the site before and after remediation.

(i) Funding

CERCLA provides that the primary sources of remediation funding include specific taxes levied on the various potentially polluting activities or industries and appropriations from the annual budget law.

As already noted, SMCRA created the Abandoned Mine Reclamation Fund, which contains public funds and resources from mining sector companies (recovery fees). It is used when the financial guarantees provided by companies at the start of operations are insufficient.

5. Peru

(a) Applicable legislation

Act No. 28271, regulating the environmental legacies of mining activities, as amended by Act No. 28526, establishes provisions regarding the identification of environmental legacies generated by mining, the responsibility for the remediation of the areas affected by them and the funding thereof, in order to reduce or eliminate them and mitigate their negative impact on the health of the population, the surrounding ecosystem and property (art. 1).

Similarly, Act No. 29134, regulating the environmental legacies of the hydrocarbons subsector, establishes mechanisms to ensure the identification of environmental legacies, the determination of the parties responsible, the updating of the inventory of the hydrocarbons subsector's environmental legacies, and the presentation, evaluation and execution of area abandonment plans, accompanied by the corresponding technical grounding, with the same goal of reducing or eliminating their negative impacts on the health of the population, the ecosystem and property.

Both laws are equipped with the corresponding sets of regulations.

(b) Concepts and protected legal goods

Act No. 28271 defines an environmental mining legacy as those facilities, effluents, emissions, tailings or waste deposits produced by mining operations that are currently abandoned or inactive and that pose a permanent and potential risk to the health of the population, the surrounding ecosystem and property (art. 2).

Hydrocarbon legacies are poorly abandoned wells and facilities, contaminated soils, effluents, emissions, remains or waste deposits located anywhere in the nation's territory, including the marine shelf, produced as a consequence of operations in the hydrocarbons subsector carried out by companies that have ceased their activities in the area where those impacts occurred (Act No. 29134, art. 2).

Several particular features of the two definitions should be noted. For example, the definition of hydrocarbon legacies explicitly refers to contaminated soils, but not to the risk thereof.

(c) Allocation of responsibility

Under Act No. 28271, the parties responsible for the creation of environmental mining legacies are those mining operators who abandon tailings deposits, workings or mining facilities, thus generating various forms of environmental legacies. The holders of inactive mining concessions who maintain the concession or mining permit up to the present time and carry environmental legacies are also considered responsible parties (art. 4).

In the hydrocarbons legislation (Act No. 29134), responsibility is assigned in the following terms: (i) companies operating in hydrocarbon subsector activities assume responsibility for the environmental legacies they create, as well as those created by third parties covered by applicable transfer or assignment contracts, or in any other way; (ii) companies that create environmental legacies that are not operating and whose owners have been identified as generators of environmental legacies are responsible for those legacies; (iii) in all cases in which those responsible for environmental legacies cannot be identified, the State will progressively assume their remediation; and (iv) a clause must be included in new licence or service contracts entered into by Perupetro S.A. with contractors, specifying the responsibilities for environmental legacies that may be found in the area, with the possibility of remediation being assumed by the new contractor or by the previous one, according to the agreement entered into with Perupetro S.A. In the latter case, the new contractor of the State-owned oil company, who must avoid the creation of environmental legacies as a requirement for signing the corresponding contract, is invited to take charge of the remediation of the environmental legacies that may exist in the area covered by the contract.

The law on hydrocarbon legacies also provides for actions to challenge the allocation of responsibility as determined by the authorities when the responsible party believes that it is not responsible for responding because other natural or legal persons played a part in generating the environmental legacy; because remediation work, approved by the Energy and Mining Investment Supervisory Agency, was performed prior to decommissioning; because remediation works, approved by that agency, were carried out after decommissioning by the party filing the challenge; because agreements exist between the company, the State and third parties, without prejudice to the corresponding joint and several liability; or because of other technical or legal reasons, evaluated by the competent authority, that so justify (art. 8).

(d) Determination of the existence of an environmental mining legacy

The General Directorate of Environmental Affairs of the Ministry of Energy and Mines is responsible for ruling on the existence of environmental mining legacies. For that purpose, owners must provide access to the sites and the information requested of them (Act No. 28271, art. 3).

Under the legislation on hydrocarbon legacies, the same determination is the responsibility of the Energy and Mining Investment Supervisory Agency (Act No. 29134, art. 3).

(e) Activation of the remediation system

Once the environmental mining legacy and the party responsible for creating it have been identified, the competent authority must notify them of their obligation to submit an environmental legacy closure plan, in accordance with the guidelines on mine closure, and to sign the corresponding environmental remediation contract (art. 6). The same provision establishes that the State will progressively respond for the abandoned environmental legacies of unidentified owners or of those that cancel their right to the mining concession.

Parties responsible for hydrocarbon environmental legacies are also required to submit an area abandonment plan (art. 6).

(f) Scope of remediation

Under the legislation governing the remediation of environmental mining legacies, the parties responsible for those legacies are to carry out the relevant studies, actions and works for controlling, mitigating and, as far as possible, eliminating pollution risks and effects that harm the population and the ecosystem in general, in accordance with the environmental legacies remediation contract. Those studies are to use the maximum permissible limits or quality standards established by the competent environmental authorities as their point of reference. Subsequently, the responsible parties must present their environmental legacy closure plan, in accordance with the guidelines on mine closure approved by the General Directorate of Environmental Affairs, with the opinion of the Ministry of Agriculture and the Ministry of Health, if applicable (art. 6).

Under the law on hydrocarbon environmental legacies, the area abandonment plan must include the actions proposed for decontamination, restoration, reforestation, removal of installations and so on that are necessary for remediation, taking into account the original conditions of the ecosystem, the current geographical conditions and the future use of the area (art. 6).

The corresponding closure plan is to be approved by the Ministry of Energy and Mines, through the General Directorate of Environmental Affairs (Act No. 28271) and the General Directorate of Environmental Energy Affairs (Act No. 29134).

(g) Competent authority and powers

Through its competent technical agency, the Ministry of Energy and Mines is to identify the parties responsible for mining operations that led to abandoned waste deposits, workings or mining facilities and created environmental legacies in their various forms. It is also to identify the holders of inactive mining concessions who maintain the concession or mining permit up to the present time and carry environmental legacies (art. 4).

(h) Limitations on individual rights in conducting remediation

The holder of a current mining concession must provide the competent authority with access to the site and information related to the determination of environmental mining legacies (art. 3).

(i) Funding

Parties responsible for environmental mining legacies assume the costs of remediation through the remediation contract (art. 6). When the State assumes the costs of remediation, either wholly or in part, they are to be financed by the National Environmental Fund, which will be in charge of organizing international financial cooperation, donations, debt swaps and other resources so as not to affect the public treasury (art. 9). That article was amended by Legislative Decree No. 1042 to include additionally, the remediation of environmental legacies may be financed through agreements entered into between mine owners and the Ministry of Energy and Mines, as well as through other mechanisms established in the regulations to this law.

Act No. 29134 on hydrocarbon environmental legacies entrusts the National Environmental Fund with raising funds from international financial cooperation, donations, debt swaps and other resources to cover the remediation of environmental legacies to be assumed by the State (art. 10).

6. Summary of the selected countries' laws

Table IV.1 presents a summarized comparison of three selected countries' laws and highlights how they deal with the general aspects involved in regulating environmental legacies.

Table IV.1
Germany, Australia and Canada: comparative institutional frameworks

Country	Protected goods	Responsible party	Legacy declaration	Authority	Funding
Germany	Human life, human health, the environment, the soil and the property or real estate of third parties.	The mine operator, the producer of the contamination, the universal successor to the relinquished contaminated land and the owner of the property.	The authority may order the responsible party to conduct risk assessments and submit a remediation plan.	Under the Federal Mining Act, oversight for soil conservation and restoration is carried out at three levels: ministries, intermediate level authorities and lower level authorities. Under the Federal Soil Protection Act, the local authority is responsible for oversight and enforcement.	The responsible parties are liable to pay for remediation by complying with the operation and closure plans. The management of contamination can also be paid for with public funds, but the owner must reimburse the State for the difference between the current and previous values of the property.
Australia	Human health, the environment or the environmental value.	Under the Contaminated Sites Act, the responsible party is the person who caused or contributed to the contamination, the owner or occupier of the site who changed or proposes to change the use made of the land, or the owner of the site. The owner or occupier of the contaminated site, even if the contamination occurred prior to the entry into force of the law, may also be a responsible party if no disclosure statement was filed. Likewise, the owner or occupant must assume the cleanup activities deemed necessary as a result of the changed land use in order to reduce the possible risks to human health posed by that change. The State is responsible for remediating orphan sites. According to the Contaminated Soil Management Act, responsibility falls, first, on the party with primary responsibility for the soil contamination; second, on the site owner; and, third, on the notional owner or interested party (i.e. any person in possession of the site or having a legal interest in the land).	The Contaminated Sites Act stipulates that the authority must evaluate the site to determine its status according to certain criteria. If the site is classified as “contaminated: remediation required”, it must undergo a remediation process. Under the Contaminated Land Management Act, an environmental assessment process is conducted and the authority determines whether a site poses a significant risk to human health, the environment or both; if so, regulatory action is required.	The Department of Health, according to both laws.	The Contaminated Sites Act creates the Contaminated Sites Management Fund to finance the remediation of orphan sites. In addition, the Contaminated Land Management Act provides for the creation of the Consolidated Fund, to be used for the investigation and remediation of contaminated land. The authority may require a person to pay all or part of the costs incurred by the Environmental Protection Authority in preparing and issuing an investigation or remediation order, or in carrying out monitoring and follow-up actions. If a private party has carried out site investigation or remediation actions at a site for which it is not responsible, it may recover costs from the party responsible through legal action.

Country	Protected goods	Responsible party	Legacy declaration	Authority	Funding
Canada	Human health and the environment. In the provincial laws governing abandoned sites and environmental mining legacies, the reduction of risks to human safety.	Under the provincial environmental laws, the responsible party is the current or previous owner or occupant. In some cases, responsibility is assigned to the producers of substances that create pollution, so responsibility lies with the party that causes the pollution. Responsibility is also assigned to innocent owners or occupants who have not taken steps to control the migration of contamination outside their property.	Under the provincial laws, the authority may require the investigation and remediation of contaminated sites. British Columbia requires the registration of contaminated sites that have been identified. In Ontario, when land is converted from industrial use to residential or recreational use, the site must be investigated and remediated. The provincial authority requires data demonstrating off-site impact before ordering the assessment or remediation of contaminated sites.	In British Columbia, Ontario and Yukon, the minister, who may delegate his powers to the director. In Manitoba, the director of the Environmental Approvals Branch. Municipalities also have competence over environment matters within their jurisdiction.	A combination of funding sources exists: funds from the general government budget at the provincial or federal level; cost-sharing agreements between the provincial and federal governments; taxes on mining industry output; partnerships between the mining industry and the provincial or federal governments; reduction of incentives to the mining industry or reallocation of current tax revenues to be used for the remediation of abandoned mines; fines imposed on the mining industry; and donations from individuals and other minor funding sources. Manitoba has a Mine Rehabilitation Fund. Programmes to inventory abandoned mines have also been funded through general government revenues at the federal and provincial levels, with small contributions from seized assets. An agreement has been signed to establish a public-private partnership to carry out remediation projects of mutual interest.

Source: Prepared by the authors.

D. Conclusions

In many cases, the emergence of environmental legacies is due to the lack of regulations to ensure their environmentally correct management, to poor environmental practices, to the impossibility of locating site owners, to transfers of rights over the properties where the legacies are located, or to legal actions or exceptions that exempt the owners from liability.

Upholding the right of citizens to live in a healthy and pollution-free environment requires the State not only to prevent the environmental impacts of industrial and mining activities, but also to eliminate threats to the health and safety of the population and the environment, such as historic sites that constitute environmental legacies.

Determining who should assume responsibility for remediating environmental legacies is a challenge for legislators. One commonly used option is extracontractual civil liability, applying the system of fault- or negligence-based liability (subjective liability). A more effective and modern alternative for determining the responsible parties exists in the form of strict or risk-based liability (objective liability). This system does not require the guilt or wilful action of the environmental legacy's creator to be established, but only his or her ownership of the activity that caused the risk and damage.

Additional alternatives also exist, such as those contained in special provisions of civil codes, which oblige the owner of the property that generates the risk to assume responsibility and take the steps necessary to avoid it, unless they can be excused by virtue of the exercise of real-property rights, such as the lease of part of the property or easement contracts, in which case the beneficiaries of those rights will be held responsible.

The comparison of the selected regulations shows how countries, particularly industrialized ones, have opted for risk-based liability to assign responsibility for the remediation of environmental legacies. To that end, they have set up remediation assistance funds at the various national or local levels and have provided interesting examples of legislation drafted for the management and remediation of contaminated sites and environmental mining legacies.

Lastly, the chapter identifies the issues that States should address in drafting environmental legacy legislation: (i) a definition of environmental legacies, (ii) a risk assessment system, (iii) the prioritization of environmental legacies, (iv) the attribution of powers to the authorities that are to lead environmental legacy remediation processes, (v) the applicable regime of responsibility, (vi) the regulation of administrative procedures, (vii) the recognition of venues for public participation, and (viii) funding mechanisms for the remediation of environmental legacies.

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Chapter V

Funding the remediation of environmental mining legacies

As explained in previous chapters, there is no single all-purpose approach to funding the remediation of environmental legacies. Each action depends on the specific legacy to be remediated, and its financing may come from one or more synergistically combined mechanisms (Norwegian Institute for Water Research [NIVA], 2018).

Neither is there a specific financial mechanism for environmental legacies. Multilateral agencies do offer credits, however, and financial instruments for the greening of the economy and sustainable financing have recently been introduced.

Through an analysis of several countries, this chapter provides an overview of the funding mechanisms and instruments that exist for environmental legacies and contaminated sites. Although all the study countries apply the "polluter pays" principle, the State is generally responsible for carrying out and paying for remediation actions at those environmental legacies where the responsible party cannot be identified.

The remediation of environmental legacies inherited from the past is a problem shared by all the world's mining countries. However, no single solution has yet been found to remedy their impact or to pay for remediation. Several financing mechanisms for managing them currently exist, and these can be grouped into four categories: public funding from tax revenues, public-private partnerships, international assistance and cooperation, and financing from private voluntary contributions (see table V.1) (NIVA, 2018; Oblasser, 2016).

Table V.1
Funding mechanisms for the management of environmental mining legacies

Type		Description
Public funding from tax revenues	General tax revenue	General tax revenue, not specific to the mining sector
	Tax revenue linked to the mining industry or other sources of pollution	Tax revenue from mineral production, new mining operations, metal market trading or other activities
Public-private partnerships		Collaboration between State and private entities for the reclamation of specific environmental mining legacies
International assistance and cooperation		Funds from international cooperation or loans from multilateral development banks
Funding from private voluntary contributions		Voluntary financing of remediation projects (e.g. through "Good Samaritan" actions or crowdfunding), mainly by mining companies

Source: Prepared by the authors, on the basis of Norwegian Institute for Water Research. (2018). *Green Finance Approaches to Soil Remediation: International Examples*. Financing Models for Soil Remediation. International Institute for Sustainable Development. https://www.iisd.org/publications/report/green-finance-approaches-soil-remediation-international-examples and; Oblasser, Á. (2016). Estudio sobre lineamientos, incentivos y regulación para el manejo de los Pasivos Ambientales Mineros (PAM), incluyendo cierre de faenas mineras: Bolivia (Estado Plurinacional de), Chile, Colombia y el Perú. *Environment and Development Series* (163) (LC/L.4208). Economic Commission for Latin America and the Caribbean.

Depending on the financing mechanism selected, money may come from different sources: allocations from national budgets, fines imposed for violations, use of competitive funds for implementing remediation projects, specific taxes on polluting activities or contributions from the private sector (Oblasser, 2016).

The following sections describe these mechanisms and identify those used in selected countries.

A. Public funding from tax revenues

In many mining countries, the State has assumed a central role in the financing of environmental mining legacies, particularly orphaned or abandoned ones.

Depending on the political structure of the country in question, the use of funds may be managed at the federal, State or regional level. Resource management is generally associated with the creation of government funds or programmes, which do not always focus exclusively on mining legacies but cover contaminated sites in general or those with certain characteristics, depending on the country's goals.

At the national level, major financing programmes exist for the remediation of environmental legacies, including those produced by mining activities. They include the Comprehensive Environmental Response,

Compensation, and Liability Act (CERCLA, also known as the Superfund Act) in the United States, the Federal Contaminated Sites Action Plan of Canada and Activos Mineros S.A.C. of Peru. Notable at the subnational level are the programmes and funds in Australia (the States of Western Australia and Queensland and the Northern Territory) and the territorial programmes in Canada (Yukon, Northwest Territories and Nunavut, and the Provinces of British Columbia, Manitoba, Ontario, Quebec and Newfoundland and Labrador). These countries also have federal, State or provincial statutes that support the implementation of measures.

Two sources of funding can be distinguished within public financing from tax revenue: general tax revenue, and tax revenue from the mining industry or other sources of pollution.

1. General tax revenue

The argument for this funding mechanism is that the government determined the operating and taxation rules, provided access to minerals and collected various forms of taxes[1] but did not require proper rehabilitation during the sites' operating life when there was still someone available to answer for the resulting financial obligations. Consequently, the burden of remediating their environmental mining legacies is borne by all taxpayers (Castrilli, 2010). It should be noted that in many of the region's countries, the State is the owner of mineral resources and therefore charges for their use (Pereira et al., 2009). However, as the owner, it is also responsible for remediation.

Resources from general tax revenues not associated with mining activities are usually allocated to funds or programmes. There are two advantages to using that mechanism. First, the funds are independent of mining activities and market conditions, which guarantees their availability over time, at least when minimum regular allocations are provided for. Second, the mechanism allows for long-term planning and systematic implementation, which is important for remediation projects that may take more than a year to implement or that entail subsequent follow-up activities (Oblasser, 2016).

The mechanism's disadvantages include the fact that the financial burden falls on society and its taxpayers. In addition, funding is subject to political priorities and must compete for tax revenue allocations with other social needs. Examples of this funding mechanism include the Hazardous Substance Superfund Trust Fund (Superfund Program) in the United States and the Federal Contaminated Sites Action Plan of Canada.[2]

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1 Income tax, mining taxes, royalties, payroll taxes, personal income taxes and so on.

2 These funds are intended for contaminated sites in general, which may include, in certain circumstances, environmental mining legacies.

2. Tax revenue linked to the mining industry or other sources of pollution

This mechanism is based on the "polluter pays" principle, understood as meaning that the contaminating industry assumes responsibility for environmental damage and the associated costs. Mining industry tax revenues may come from a range of sources, including levies on mine output, financial guarantees required from ongoing mining operations, fines and penalties imposed for violations, cost recovery from responsible parties and interest earned on investments.

This type of mechanism offers three advantages. First, the financial burden of remediating environmental mining legacies falls on the mining industry itself. Second, it can fund the measures needed by existing legacies (historical or abandoned) and provide long-term financial security (for legacies that may arise from the inadequate closure of ongoing operations). Third, as with the previous mechanism, it allows for long-term planning and systematic execution (Oblasser, 2016).

However, there are also three disadvantages. First, revenue amounts depend directly on mining activity and market conditions, which may give rise to uncertainty in the availability of annual cash flows and, additionally, exacerbate or deepen perceptions of dependence on the mining industry. Second, if there are no regulations requiring financial guarantees for the closure of mining operations, collecting taxes could generate a perverse incentive for not meeting the closure objectives of operating sites, which could lead to the creation of new environmental mining legacies. Third, with regard to levies on mining output, the effectiveness of this financing mechanism requires that the levies imposed are commensurate with remediation needs and with the availability of funds earmarked for the remediation of those legacies. Accordingly, the generation of funds would be expected to be aligned with a clear schedule for the investments needed, project returns and the allocation of funds for remediation works. That may not be the case in all countries, however, which would lead to a failure to raise the funds needed for remediation (Castrilli, 2010; Oblasser, 2016; Pepper et al., 2014).

It should be noted that internationally, tax revenue from a given industry's output has not always been used to rehabilitate sites associated with that same industry.[3]

[3] Until 1995, for example, the Superfund programme in the United States was largely funded by levies and taxes on the petroleum and chemical industries, as well as by revenue that went into a general fund for the cleanup of sites contaminated with hazardous substances.

Financial guarantees can also be used, meaning a contractual document or financial instrument used to confirm that an operator will perform cleanup as required in the country's specific regulations (Sassoon, 2008, cited in Shen, 2016).

The purpose of a financial guarantee is to ensure that industrial users of land and resources pay for closure and a successful post-mining transition. If a mine operator fails to adequately close operations and restore the site, the financial guarantee allows a third party to carry out those activities on behalf of the State (Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development [IGF], 2021). These guarantees would therefore be used to pay for the remediation of environmental mining legacies created by the inadequate closure of ongoing mining operations. They should not be used to raise funds for other instances of non-compliance or for abandoned mines, which should be addressed separately (World Bank, 2021).

In Chile, Act No. 20551 of 2011 requires all mining companies to submit a closure plan approved by the National Geology and Mining Service at the time that notice of commencement of mining operations is given, along with a financial guarantee to ensure compliance.

In Ecuador, the Environmental Regulations for Mining Activities require financial guarantees for the closure of mining operations, ensuring compliance with the environmental management plan. In addition, rehabilitation and decommissioning activities must be taken into account when estimating closure costs (art. 129). Those costs must be reviewed regularly to adapt to changes over the project's life. The Organic Environmental Code[4] requires a bond or guarantee for environmental legacies associated with economic activities, in particular the closure of mining operations (Mining Act, art. 85).[5] Operations closure plans are to be reviewed and updated periodically in annual environmental programmes and budgets and in environmental compliance audits. Two years before the end of the mining, processing, smelting or refining project, the holder of the concession must submit a final closure plan for the national environmental authority's approval (Morales and Hantke Domas, 2020).

Numerous financial assurance instruments are found across the world. The Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development has categorized them as follows (IGF, 2021):

- Letter of credit (bank guarantee): An irrevocable agreement between a bank or financial institution and the company, whereby the bank agrees to provide funds to a third-party beneficiary

[4] Regulations to the Organic Environmental Code (Executive Decree No. 752 of 2019).

[5] Article 85 of Act No. 45 of 2009 refers to the closure of mining operations and is linked to environmental impact studies.

(the government) according to the terms and conditions of the agreement, which reference the approved closure plan and associated costs. Letters of credit normally have a one-year term and are renewable. Any changes to the terms of the credit must be agreed to by all parties (company, government and bank). If the bank does not agree to renew the agreement and the company does not provide a suitable alternative form of assurance, then the letter of credit is in default and the government can request payment in full.

- Surety bond (performance bond or insurance bond): An agreement between a mining company and an insurance company, with the government as the beneficiary of the bond. The bond guarantees that the company will fulfil its closure obligations as required by the government; otherwise, the government can draw from the bond to recover any financial losses. As with letters of credit, they are issued for a set period of time and are renewable, and any changes must be agreed upon by all the parties. The terms and conditions must reference the approved closure plan and associated costs. Upon renewal, the value of the bond may be adjusted to reflect current closure liabilities. If the bond is not renewed and the company does not provide a suitable alternative form of assurance, then the government can request payment in full.
- Cash (deposit, bank draft or certified cheque): Used to cover closure costs. The funds are deposited in a government account that can only be accessed by the government, and they are intended to cover any default in closure completion by the mining company.
- Company guarantee (corporate guarantee or self-test): When an evaluation of the assets, liabilities and financial strength of a mining company is used to assess its ability to meet closure costs. A range of measures may be considered in the evaluation, such as the company's current bond rating, its ratio of assets to liabilities, its financial history and the net worth of its liquid assets. A company guarantee can be used to cover the full financial liability for closure but, more often, it is combined with other forms of financial assurance to make up only a portion of the total guarantee required by the government. Many jurisdictions have stopped accepting company guarantees owing to the risks they pose and the public perception that a company is contradictorily guaranteeing itself against its own liabilities.
- Trust fund (cash trust, qualifying environmental trust or mining reclamation trust): An agreement between a mining company and a trust company whereby a specific amount of money is set aside for the sole purpose of funding the closure of a site. There must be an agreement between the mining company and the

government that is administered by the trust and that specifies the amount of funds required in the trust, the acceptable forms of those funds (cash, bonds or securities), how the funds can be used and the schedule of payments into the trust. The funds must be designated for closure liabilities only and ringfenced from the general budget. Additionally, each mining operation must have its own separate fund, not combined with other funds belonging to the same company. The mining company's payments are typically made over a number of years and can be structured to reflect increasing closure liabilities as a mine develops. While this is a secure form of financial assurance, it may not be fully funded in the early years of a mine's operations and thus entails a level of risk.

Table V.2 summarizes the financial assurance instruments identified by the Forum.

Table V.2
Financial assurance instruments

Instrument type	Advantages	Disadvantages
Letter of credit (bank guarantee)	• Inexpensive to set up, with low administrative requirements. • Secure (subject to the soundness of the financial institution). • Does not tie up company capital. • Irrevocable and non-transferable. Any changes must be agreed to by all the parties, including the government. • If the bank does not renew the credit and the company does not offer an acceptable alternative, the government may request full payment of the outstanding amount. • The government may reserve the right to approve which banks may issue guarantees, to reduce the risk of failure of weak institutions.	• Reviewed annually by the bank, with a decision on whether or not to renew it. • Availability is subject to the company's credit rating. Some companies may be required to deposit the full value of the loan with the bank, which may reduce their borrowing power. • The annual cost to the company ranges from 0.5% to over 3.0% of the guaranteed amount. • Funds are non-interest bearing. • The government may specify the acceptable banks; that could be a disadvantage in some countries, since if a local bank is needed, it may have limited financial resources. • The bank or financial institution may default or become unable to cover the liability.
Surety bond (performance bond or insurance bond)	• Inexpensive for the company (although often more expensive than a letter of credit) with low administrative requirements. • Does not tie up company capital. • Any changes must be agreed to by all the parties, including the government. • If not renewed by the insurance company, the government can collect the full amount (unless the operator provides another form of assurance).	• The bond issuer may default. • Availability is subject to the company's credit rating. Some companies without a proven track record may be required to deposit up the full value of the bond with the insurance company, which may reduce their borrowing power.

Instrument type	Advantages	Disadvantages
Cash (deposit, bank draft or certified cheque)	• Cash is secure and easily accessible to cover closing costs. • High level of public acceptance on account of its visibility. • Suitable for small-scale or junior miners, who may not meet the banks' strict criteria for a letter of credit. • Deposited funds can earn interest.	• A significant portion of the company's capital is tied up. • Some governments may be tempted to use the deposited cash for other purposes. • The financial institution may be under government control. In such cases, mining companies may be reluctant to use those institutions owing to the risk of theft, fraud or diversion of funds.
Company guarantee (corporate guarantee or self-test)	• Does not tie up company capital. • Less costly for companies. • Easy to administer. • The annual reports and financial statements of publicly listed companies are available to the public. • Many jurisdictions that accept company guarantees require that they be converted into other types of financial guarantee (such as bonds or letters of credit) well before the end of the mine's useful life.	• Limited public acceptance. • Requires a long history of financial stability, a credit rating from a specialized service and, at least, one annual financial statement prepared by a chartered accounting firm. • Even large companies can fail, regardless of their financial history. • Governments must have the capacity and expertise to periodically review the company's financial health.
Trust fund (cash trust, qualifying environmental trust or mining reclamation trust)	• High level of public acceptance on account of its visibility and transparency. • Fund value can appreciate. • The company and the government must decide on the types of investment available and specify them in the agreement. • If the company fails to make the payments and no acceptable alternative is provided, the government can withdraw the full amount of the fund. • The trust fund's management and performance are subject to periodic review. • Can be used to finance post-closure maintenance and operating capital costs (as opposed to financing costs during the actual close-down period).	• Relatively costly to manage and administer. • Company funds are increasingly tied up. • Risk of poor long-term fund investment and management. • May not accumulate enough value if the mine closes prematurely. • A secondary financial assurance instrument (bond or letter of credit) may be required until the full amount of the fund is reached.

Source: Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. (2021). *Global review: financial assurance governance for the post-mining transition.* International Institute for Sustainable Development.

Insurance policies —financial tools used to guarantee compliance with mining obligations— are also available in the Andean region, according to the legislation of each country. In Chile, for example, they have been regulated since 2020 (Decree No. 6 of 2020 of the Ministry of Mining), in Colombia since 2014 (Resolution No. 338 of 2014) and in Peru since 2005 (Supreme Decree No. 033-2005-EM).

The gradual release of financial guarantees when mine closure work is partially advanced can be an effective incentive for mining companies to carry out closure activities progressively over the life cycle of the mine, which also reduces the financial risk to the government.

In the Andean countries, with the exception of Peru, financing initiatives generally do not include abandoned or orphaned environmental mining legacies; instead, they focus on the closure and post-closure activities of active operations. Normally, the management of those legacies is financed with public resources from initiatives or funds created on an ad hoc basis to conduct remediation actions.

In Ecuador, for example, until 2008, environmental legacy remediation actions were paid for with funds from oil sales surpluses, whereas today, State and private funds are used (Benítez et al., 2018). In addition, the Special Account for Production and Social Recovery, Scientific and Technological Development and Fiscal Stabilization, created in 2005, allocates 5% of its resources to the environmental and social remediation of impacts from hydrocarbon and mining activities carried out by the State that created legally enforceable environmental legacies (Ministry of the Environment, 2017).

In April 2008, the Constituent Assembly eliminated all the oil funds and many of the pre-appropriations of oil revenues through the Organic Act for the Recovery of the Use of Oil Resources of the State and Administrative Rationalization of Indebtedness. That statute allowed the transfer of all current and future moneys from the oil funds to the general budget (Cuevas and Ortiz, 2013). As a result, the funds used for environmental remediation were withdrawn, forcing the government to use its own resources to pay for the Environmental and Social Repair Programme. Subsequently, in 2010, the following strategic lines of work were defined: the development of a socioenvironmental information system, the characterization and assessment of environmental legacies and their impact on the social matrix, and the design and implementation of comprehensive remediation plans. According to the Ministry of the Environment (2017), the crosscutting axes that guide these strategic lines are:

- Enforcement of the "polluter pays" principle.
- The State will act on a subsidiary basis in restoring ecosystems affected by economic agents.
- The actions and outcomes of integrated environmental legacy management are to be framed by the strategic lines set out in the Constitution of the Republic, in the National Plan for a Good Life and in the strategic framework of the Ministry of the Environment, which the Environmental and Social Reparation Programme should strengthen and complement.

In practice, the Environmental and Social Remediation Programme does not implement remediation plans; instead, it designs comprehensive remediation plans for environmental and social legacies, follows up on, monitors and evaluates those plans, and carries out prior or complementary actions.

B. Public-private partnerships

Numerous examples of public-private partnership initiatives exist across the world. While public funds have been created from voluntary or mandatory private sector contributions (such as Activos Mineros S.A.C. in Peru or, until 1995, the Superfund Act in the United States), public-private partnerships seem more promising and actively motivate the private sector to co-finance and manage environmental mining legacies. Examples include Canada's Restor-Action-Nunavik Fund for the cleanup of contaminated sites and the National Orphaned/Abandoned Mine Management Initiative (NOAMI),[6] and Germany's Association for Land Recycling and Contaminated Site Remediation.

This financing mechanism has two advantages: first, the financial burden can be shared between the State and the private sector and, second, win-win situations for both parties can be created (Oblasser, 2016). For the private sector in particular, the benefits include efficient processing of processes, more direct participation in public policies and favourable conditions in individual projects.

The mechanism does have some disadvantages, however, such as the tendency to finance specific projects or projects located in a certain territorial area according to the interests of the private sector; the failure to secure stable long-term sources of financing; the existence of barriers that limit the private sector's interest in environmental mining legacy remediation initiatives, related to the responsibility private agents assume with respect to the site and the necessary permits, and the requirement for a framework of rules and incentives that facilitates private participation.

Public-private partnerships are not restricted to financing: they can also include investigation or remediation activities, the provision of in-kind contributions (services, labour, equipment, housing, transportation and so on) and the implementation of social projects in affected communities.

[6] NOAMI was formed in 2002 as an advisory committee with representatives from federal, provincial and territorial governments, the Canadian mining industry, environmental non-governmental organizations and Indigenous communities. The committee presented Mining Canada with proposed actions to remediate contaminated sites, prevent future environmental mining legacies and promote sustainable development. It also drew up an inventory of contaminated sites, which provided information on the location of sites and their classification by risk. NOAMI did not provide funding for the remediation of contaminated or abandoned sites.

Moreover, depending on the country's political structure, public-private partnerships can be managed at the federal, State or regional level and include citizen participation.

In addition to including remediation actions, this mechanism includes preventive measures that are prioritized according to the polluting industry's needs.

One example of the mechanism's use is to transfer land requiring remediation from the public sector to a private entity. Such sales are accompanied by an agreement between the parties covering the management and funding of actions for the environmental legacy's remediation. The case of Keno Hill in Canada, which will be analysed in detail below, shows how the country's government and the company Alexco Resources agreed that upon acquiring the land where the environmental mining legacy was located, the company would assume responsibility for it, voluntarily and in conjunction with other actors, even though it was not responsible for its creation.

C. International assistance

Although cases of international assistance for the remediation of environmental mining legacies are not common, the mechanism is an alternative in certain countries. One of its advantages is that in addition to providing funds, it can provide knowledge transfers and capacity-building in the recipient countries. One example of this mechanism is the Zambian Copper Belt Environmental Project, which was funded with World Bank support and included strengthening the environmental regulatory framework through capacity-building in conjunction with the Environmental Council of Zambia and the licensing agencies. The World Bank's commitment consisted of a loan of US$ 19 million and a grant of US $21 million for a project with an estimated total of cost US$ 39.5 million (World Bank Group, 2012).[7]

It should be noted that depending on the institution and the type of financial support provided, funding through this mechanism may not be available for certain countries. For example, the World Bank's funds granted through the International Development Association depend on the country's poverty level, determined on the basis of gross national income per capita. Accordingly, the Association has determined that 75 countries, including Zambia, are currently eligible for funding (International Development Association [IDA], 2024).

[7] For various reasons explained in World Bank Group (2012), the project's final cost rose to US$ 53.1 million. The Nordic Development Fund also committed a US$ 13 million loan for the project's parallel financing, and the beneficiary contributed US$ 3.8 million. As a result, only US$ 15.5 million of the World Bank loan was used.

The Andean countries that have historically received international assistance for mining activities are the Plurinational State of Bolivia and Peru. In Argentina, Colombia and Ecuador, international assistance has not focused on the mining sector, and since Chile is classified as a high-income country, it does not qualify for international cooperation funding.

In the Plurinational State of Bolivia, the Bolivian Mining Corporation has received technical and financial support from the Danish International Development Agency since 2002, most notably through the project to prioritize mining sites for environmental remediation, which enabled environmental mitigation works to be carried out at some of the company's former operating sites (Aranibar et al., 2023).

Between 2006 and 2010, the Plurinational State of Bolivia received resources from the Danish International Development Agency as part of the programme to support sustainable development, natural resource management and the environment in the country. One component of that programme focused on prevention, monitoring and mitigation of pollution from the mining sector. In particular, it sought to improve the socioenvironmental conditions at sites belonging to the Bolivian Mining Corporation, including the remediation of at least 10 environmental legacies and the adoption of environmental prevention and control measures. The total budget for that component was US$ 9.5 million, of which some US$ 7 million came from Danish cooperation and US$ 2.5 million from the Bolivian Mining Corporation (Bolivian Mining Corporation [COMIBOL], 2005). In 2017 and 2018, total transfers from international donors totalled US$ 276 million, including funds from the European Union, the Government of Denmark, the Inter-American Development Bank, the International Bank for Reconstruction and Development (IBRD), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) of Germany, and the Government of Sweden (National Union of Institutions for Social Action Work, 2019).

Notable among the funding sources for issues related to environmental mining legacies in the Andean region is the Regional Cooperation for a more Sustainable Management of Mineral Resources in the Andean Countries project (MinSus), implemented by GIZ and the German Federal Institute for Geosciences and Natural Resources. The aim of the project was to exchange international experiences, build technical capacities in the Andean countries and provide guidelines for managing environmental mining legacies in pursuit of a more sustainable mining model.

D. Funding from private voluntary contributions

Numerous examples of remediation projects undertaken by the private sector on a voluntary basis can be found across the world. Within this financing mechanism, the concept of the "Good Samaritan" has been developed:

individuals or entities wishing to participate voluntarily in the remediation of abandoned or orphaned environmental legacies, despite not being responsible for creating the site's historical impact and, therefore, exempt from legal responsibility for remediation.

While this mechanism represents an opportunity for governments to save tax revenues, there are also barriers to its implementation. Those include the requirements that must be met by parties wishing to carry out voluntary remediation projects, the strict enforcement of the existing rules and regulations, the extension of responsibility for the environmental mining legacy for a lengthy period after remediation, the lack of clear and adequate incentives to make voluntary remediation efficient and attractive to the private sector, the tax treatment of income from remediation and the requirement that certain permits be obtained (Oblasser, 2016).

To reduce the barriers to voluntary collaboration, the following points should be taken into account (NOAMI, 2002, cited in Oblasser, 2016):

- Include, in the regulatory framework, instruments to facilitate and encourage the private sector's voluntary participation in the remediation of environmental mining legacies.
- Establish the volunteer's exemption from liability if, prior to the remediation, it can be shown that the volunteer was not the party responsible for the site in question, and determine if the competent public agencies (ministries, services and so on) have approved the proposed remediation work. Exemptions should not apply if the negligent execution of the remediation work causes adverse effects.
- Establish programmes for remediating environmental mining legacies that have no identifiable responsible party using the Good Samaritan mechanism. The programmes should define the approval processes for voluntary remediation projects, set minimum standards and ensure both participation by the public and oversight of the work by the competent public entities.
- Facilitate authorizations and permits for the remediation of environmental mining legacies for private, governmental and other entities.

There are a number of instruments available to facilitate and encourage the private sector's voluntary participation: (i) tax exemptions, which increase a project's cash flow by allowing revenues to be used for contaminated land remediation rather than tax amounts due and, in some cases, also improve the financial institutions' assessment of the project for loan purposes (Bartsch and Wells, 2003), (ii) the creation of environmental offset programmes, to produce or generate an alternative positive effect equivalent to a detected

adverse effect that cannot be mitigated or repaired, (iii) the establishment of programmes that allow, facilitate and encourage operating sites to voluntarily receive abandoned tailings, and (iv) the granting of exploitation concessions and transfers of mining concessions located in areas containing abandoned tailings deposits, allowing their relocation. One example of an offset programme is the Adopt a Tailings campaign under way in Chile since 2018, through which mining companies with active operations assume responsibility for and eliminate environmental legacies created by past mining operations (Chile Sustentable, 2018).

In Chile there are also cases of abandoned tailings that have been relocated with private funds, with the removal activities implemented to comply with decontamination plans or the requirements for ongoing mining projects to obtain the Environmental Qualification Resolution (RCA): for example, at Andacollo, La Higuera and Copiapó (Godfrid et al., 2024; Ministry of Mining, 2019).

In the United States, attempts to provide voluntary remediators with legal protection have been ongoing for several years. The Good Samaritan Cleanup of Abandoned Hardrock Mines Act of 2013 and other statutes on the subject cover such crucial aspects as the limitation of liability with respect to current legislation governing water resources (covered by the Clean Water Act) and contaminated sites (covered by the Comprehensive Environmental Response, Compensation and Liability Act).

The remediation of environmental mining legacies can generate economic benefits for some parties —such as local governments, private industries and conservation groups— that have shown interest in contributing to this effort (Wood, 2020).

For mining companies, the motivation to participate in remediation projects is mainly on account of the possible recovery of valuable minerals left in the tailings of abandoned mines. The potential profit opportunity comes from two sources: first, today's technology is more advanced than in the past, allowing mineral recoveries that were not previously feasible (Parbhakar-Fox, 2016), and, second, tailings from older mines may contain high-value minerals that were unknown or valued at lower prices decades ago (Wood, 2020). If a mining company obtains the right to process those tailings and keep any valuable minerals extracted from them, remediation can be cost-effective.

Public utilities, such as water or electricity companies, may also have an economic interest in participating in remediation projects. For example, when water utilities incur substantial treatment costs (which may increase owing to upstream sources of contamination), remediation of an abandoned mine could cost less or generate savings compared to ongoing treatment (Wood, 2020). Similarly, electric company projects can also generate economic

benefits: in the United States, for example, Dominion Energy evaluated the use of abandoned coal mines as hydroelectric pump storage facilities for power generation by moving water between reservoirs (Forman, 2017).

Finally, conservation groups and sports practitioners also have an incentive to contribute to remediation efforts. For the former, they can restore the conditions of fauna and flora that existed prior to the contamination and address environmental mining legacies that pose a risk of acid drainage that may affect streams and, therefore, the habitats of fish, waterfowl and other species (Wood, 2020). Similarly, practitioners of sports can contribute to remediation in order to reclaim areas and take advantage of the environment for their recreational activities.

While no stakeholder is likely to be able to assume the full financial burden of a remediation project, jointly they may be able to provide the resources needed to resolve the problem.

E. Financial instruments used in selected countries

This section describes some of the mechanisms used to fund environmental legacy remediation actions in Australia, Canada, Germany, Peru and the United States.

1. Germany

In Germany, responsibility for contaminated sites and their remediation lies with the current site owner. Therefore, if the State owns the contaminated property and no previous owner can be held liable, sites are remediated with funds from general tax revenue.

Accordingly, to manage environmental mining legacies, Germany primarily uses public funds from general tax revenues, which are assigned through remediation programmes, such as the administrative agreement between the federal government and the new federal States for financing lignite remediation.

One of Germany's funding methods is the subsidiarity model, used in particular with municipalities and companies for the treatment of plots or industrial sites with contaminated soils or accumulated waste (Minería Chilena, 2013).

(a) Association for Land Recycling and Contaminated Site Remediation

In 2002, the Association for Land Recycling and Contaminated Site Remediation, a public law organization of the State of North Rhine-Westphalia, was established for the remediation and recovery of contaminated land

and environmental legacies without a responsible party. The association's objective is to fund and promote the remediation of environmental legacies by means of an annual contribution from the State of North Rhine-Westphalia.

It consists of representatives of the State of North Rhine-Westphalia (Ministry of the Environment, Ministry of Mining and Ministry of Urban Development), local authorities (municipalities) and voluntary private-sector members. Its public-private partnership model is notable,[8] and it has managed to establish itself as an efficient instrument for managing environmental legacies, including those created by mining activities, since 2013 (Association for Land Recycling and Contaminated Site Remediation, 2020).

It is largely financed by fixed contributions from the budgets of the State of North Rhine-Westphalia and its municipalities. It also assumes about 80% of project costs and, although the contributions of the voluntary members (private sector) are significant, they fluctuate over time.

(b) Coal Financing Act

Since the 1960s, coal mining in Germany was largely subsidized by the State. Mining operations had an impact on the environment that persists to this day. In 2007, the federal government decided to end this type of mining and the subsidies in 2018. Against that backdrop, the Coal Financing Act came into force in 2017 (Federal Ministry of Justice, 2007).

This statute is intended to ensure the replacement of coal in the production of goods and services, closure costs, funding for environmental legacies and social and workforce adaptation processes. Specifically, it aims to fund sales of German hard coal for use in power plants and for blast-furnace steel production during 2018, mining companies' expenses resulting from permanent stoppages, the outstanding obligations of mining companies after the termination of subsidies for hard coal mining, and obligations arising from the socially acceptable adjustment process for older workers in the German coal industry.

To cover the expenses incurred by mining companies (e.g. those arising from permanent closures), the Federal Office for Economic Affairs and Export Control grants them maximum funds for the specified purposes from the federal budget. According to the latest year for which data have been published, a total of 794.4 million euros was made available in 2019 (Federal Ministry of Justice, 2007).

Moreover, after the deadline for the closure of subsidized hard coal mining, up to 1.658 billion euros from federal budget funds will be made

[8] The association is independent in its management, administration and actions.

available to the mining companies for liabilities that continue to exist after the cessation of mining and that are not payable by the RAG-Stiftung.[9]

One third of the RAG-Stiftung's liabilities may be met from federal budget funds if the assets of the RAG-Stiftung are not sufficient to cover them in full (Federal Ministry of Justice, 2007).

2. Australia

At the national level, Australia has adopted several strategies for managing mine closures. Notable examples include the Strategic Framework for Mine Closure, prepared by the Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia (2000) and the manual *Mine Closure and Completion* (Department of Industry, Science and Resources, 2006).

Australia has also recognized the importance of remediating the environmental legacies created by the mining industry. Accordingly, it has adopted the Strategic Framework for Managing Abandoned Mines in the Minerals Industry (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2010), which seeks to achieve convergence in the management of abandoned site data, provide a better understanding of the liabilities and risks associated with abandoned mines, improve reporting, standardize processes and methods for risk assessment and share knowledge and skills across Australia's jurisdictions. The framework was established as a reference point for the remediation of abandoned mines and to avoid the emergence of new environmental mining legacies in the future (Saade, 2014).

In addition, each of the country's States and territories has its own environmental laws, which generally require the granting of an environmental authorization for mining activities. Environmental authorizations regulate all project phases, including exploration, development, construction, operation, closure and rehabilitation. The environmental licensing process involves identifying environmental impacts and deciding how to manage them (Office of the Auditor General for Western Australia, 2022).

Although environmental authorizations vary among the States and territories, they share some common characteristics: the initial proposal and the environmental management plan; the government's assessment, which includes consultations with potentially affected parties; government

[9] The RAG-Stiftung is a private foundation established in 2007 which, since the beginning of 2019, is responsible for managing and financing perpetual obligations of the German hard coal mining industry along the Ruhr and Saar rivers and in Ibbenbüren (during the liquidation of subsidized mining). It also performs tasks in mine water management, polder management and groundwater purification and carries out educational, scientific and cultural projects. For more information, see: https://www.rag-stiftung.de/en/.

approvals, which require transparent oversight; and progressive rehabilitation requirements during mining operations. The States and territories have also developed their own standards for inventorying mining sites and managing the related data (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2010).

The country's different jurisdictions have adopted a range of financing mechanisms to raise resources for remediating abandoned mines in their territories: government funds, taxes on mine output, public-private financing, trusts, bonds and so on.

Government funds have been limited because budgets have been subject to the programmes and priorities of successive administrations. In contrast, fundraising through taxes on output has been effective, with significant amounts collected. Possible disincentives for companies in the sector should be analysed, however.

Public-private financing has become increasingly important in recent years as a way to improve the mining industry's reputation vis-à-vis its socioenvironmental impact. Several mining companies have therefore funded the remediation of abandoned mines in an attempt to project a good image through concrete and beneficial actions, especially within the affected communities.

While different options exist, the mining regulations in most States and territories require companies to provide the Department of Mines, Petroleum and Exploration with a reclamation bond as a guarantee to cover such costs as may be incurred.[10] Those guarantees are returned once the land is completely rehabilitated. Table V.3 shows the different types of financial assurance used in selected Australian States and territories.

Table V.3
Australia: types of financial assurance, by State and territory

State or territory	Cash or similar	Letter of credit	Bond	Company guarantee	Trust fund
South Australia	✓	✓	✓		
Western Australia					
New South Wales	✓	✓	✓		
Queensland	✓	✓	✓		
Northern Territory	✓	✓			
Victoria		✓			

Source: Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. (2021). *Global review: financial assurance governance for the post-mining transition.* International Institute for Sustainable Development.

[10] It should be borne in mind that establishing and maintaining a guarantee also represents a cost for the company. Therefore, the conditions for the execution of the assurance and its coverage must be analysed.

Several interesting cases are presented below.

(a) Western Australia Mining Rehabilitation Fund (MRF)

Under Western Australian mining law, companies were required to set up bonds as collateral to assure compliance with their obligations vis-à-vis any environmental impacts generated by their mining operations. However, the unconditional performance bond system was not sufficient to cover all the costs of rehabilitating abandoned mines (Saade, 2014).

In response, in 2012 the Western Australian Government enacted the Mining Rehabilitation Fund Act, establishing the Mining Rehabilitation Fund, the declaration of abandoned mine sites[11] and a fee payable in respect of mining authorizations. During its first year, contributions to the Fund were voluntary but became mandatory in July 2014.

The fund's main objective is to provide a source of financing for the rehabilitation of abandoned mine sites and other land affected by mining operations. The fund is expected to provide the government with sufficient resources to rehabilitate priority sites when the property's owner or operator fails to meet their rehabilitation obligations and the land is taken over by the State, or when efforts to recover funds from the owner or operator are unsuccessful. As of June 2023, the fund's balance totalled 291 million Australian dollars ($A). Between 2022 and 2023, more than 7,000 tons of waste were collected, of which 55% was recycled (Western Australian Government, 2023). In addition, 43,511 hectares of land were rehabilitated between 2023 and 2024 (Western Australian Government, 2024).

This government-managed fund is financed with resources from owners and operators, which include any amounts paid or recovered in connection with liability for rehabilitation costs (for further details, see section 9A of the Act), any lien amount paid or recovered, any fine amount paid or recovered and investment income. It also requires that all owners provide the Department of Energy, Mines, Industry Regulation and Safety with accurate information[12] on the areas and types of soil disturbed during their operations, which is used to calculate the annual remediation fee.[13] In addition, the interest generated by the contributions is used to pay for the fund's administration and to carry out rehabilitation work at abandoned mine sites (Office of Surface Mining Reclamation and Enforcement, n.d.-a).

Additionally, thanks to the fund's resources, in 2016 the Abandoned Mines Program was created. It is guided by the Abandoned Mine Policy,

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11 Abandoned mine sites are lands where mining operations, now ceased, were conducted in, on, above or below ground.

12 Presenting erroneous information can be sanctioned with fines.

13 Owners whose estimated rehabilitation legacies are below the threshold of US$ 50,000 are only required to submit the information, but are not required to pay into the fund.

published the same year, and provides a framework for the prioritization and subsequent rehabilitation or management of abandoned mine sites. This policy requires that sites be prioritized according to the risk they pose to the community and the environment, and that the potential value associated with a site be identified and protected (Office of Surface Mining Reclamation and Enforcement, n.d.-b). As of February 2024, seven projects were under way under this programme.[14]

(b) Queensland Abandoned Mine Lands Program

In the State of Queensland, the Mineral and Energy Resources (Financial Provisioning) Act came into force in April 2019, rectifying the Environmental Protection Act of 1994. The latter required financial guarantees for rehabilitation activities, which were replaced by the Financial Provisioning Scheme (Queensland Treasury, 2019). These reforms help encourage progressive rehabilitation rather leaving it to be carried out at the end of a mine's useful life.

The purpose of the programme is to improve State management and reduce financial risk in the event that holders of environmental authorities or small scale mining tenure holders fail to meet their environmental management and remediation obligations. The programme will also provide funds to support the rehabilitation of abandoned mines and expand research on the subject.

The programme's manager is responsible for managing small mining tenure holders and the financial provisioning of holders on behalf of the State of Queensland. Accordingly, the programme will continue to collect financial assurance (cash, bank guarantees or insurance bonds) through the Financial Provisioning Scheme. Thus, as established in that scheme:

- Small mining tenure holders and other holders with estimated rehabilitation costs of less than $A 100,000 will continue to provide surety and will not be part of the annual risk category assessment process.
- Holders with estimated rehabilitation costs of at least $A 100,000 will go through the scheme manager's risk category assessment process for a period of three years. The assessment process will determine whether the holder is required to contribute to the scheme's Financial Provisioning Fund and/or to provide the scheme's manager with assurance (Queensland Treasury, 2019).

In 2012, the Queensland Audit Office estimated that the 15,000 abandoned mines represented a State liability of $A 1 billion. The Government of Queensland's Abandoned Mine Lands Program is responsible for assessing

[14] For more information, see https://www.dmp.wa.gov.au/Geological-Survey/Program-projects-29315.aspx.

abandoned mine sites and reducing risks to public health and safety (Government of Queensland, 2021). Sites are classified as abandoned once the mining tenure has expired.

(c) Northern Territory Mining Remediation Fund

In 2001, the Northern Territory's Department of Industry, Tourism and Trade drafted the Mining Management Act, which regulates the licensing of mining activities, the management of mining sites, the protection of the environment at those sites and the provision of economic and social benefits to communities affected by mining activities (Northern Territory Government, 2001). It also introduced a levy on mining operations to fund the treatment of legacy mining sites. This is a non-refundable annual levy of 1% of the total calculated rehabilitation cost, applied to each mining operation authorized by the Mining Management Act. To offset the impact on the industry, a 10% discount is applied to the total amount of the surety to be paid by the operators (if deposited in cash). The Department of Industry, Tourism and Trade still maintains a minimum assurance of 100% for each site, as the 10% discount extended to operators is taken from a calculated surety amount that includes a 15% contingency component.

The Mining Management Act establishes a Mining Remediation Fund to provide the Northern Territory Government with the necessary resources, which are placed in a trust and used to minimize or rectify environmental damage caused by unsecured mining activities. The fund's income will represent at least 33% of the amount of each levy paid by operators.[15] It may be used to identify environmental damage caused by unsecured mining activities, assess the risk posed by that damage, conduct scientific research and studies, prepare the remediation plans needed to address the damage, carry out the required short- and long-term remediation work and hire experts to carry out other activities related to the damage.

3. Canada

The Government of Canada follows the "polluter pays" principle, which means that private companies usually bear the cleanup (or remediation) costs of contaminated areas (Government of Canada, 2019b). In addition, all the country's provinces, plus the Northwest Territories and Yukon, have legislation that requires financial assurance for the reclamation of abandoned mines in the event that the mine operator is unable to perform the task (Mackasey, 2000). Table V.4 shows the types of financial assurance used in selected Canadian provinces and territories.

[15] The minimum percentage payable to the fund may be increased by regulations.

Table V.4
Canada: types of financial assurance, by province and territory

Province or territory	Cash or similar	Letter of credit	Bond	Company guarantee	Trust fund
British Columbia	✓	✓		✓	✓
Ontario	✓	✓	✓	✓	✓
Quebec	✓	✓			✓
Northwest Territories	✓	✓			

Source: Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. (2021). *Global review: financial assurance governance for the post-mining transition.* International Institute for Sustainable Development.

For many years, mining activity has been a fundamental part of Canada's economic development, resulting in a legacy of orphaned and abandoned mines and generating negative impacts on community and environment health. In August 2024, the Government of Canada reported 24,231 contaminated sites in the custody of federal departments, agencies and consolidated Crown corporations[16] (see table V.5).

Table V.5
Sites listed in the Federal Contaminated Sites Inventory, by classification

Classification	Suspected	Active	Closed[a]	Total
High priority	0	659	1 101	1 760
Medium priority	1	1 580	1 911	3 492
Low priority	1	943	1 631	2 575
Insufficient information	0	158	431	589
Not a priority	0	321	2 729	3 050
Not yet classified	1 363	797	10 605	12 765
Total	1 365	4 458	18 408	24 231

Source: Treasury Board of Canada Secretariat. (n.d.). *Find sites by classification*. Retrieved in February 2024 https://www.tbs-sct.gc.ca/fcsi-rscf/classification-eng.aspx.
[a] Sites where closure has been completed or where no action is required.

The existence of these contaminated sites led to the creation of the Federal Contaminated Sites Action Plan, which is funded by the Government of Canada in collaboration with partners in charge of federal contaminated sites. In addition, four programmes exist at the territorial and provincial levels, which will be described in detail later in this section: the Northern Contaminated Sites Program (for the Northern Territories); the Northern Abandoned Mine Reclamation Program (for Yukon and Northwest Territories, managed in conjunction with Indigenous communities); the Crown Contaminated Sites Program (for the Province of British Columbia), and the Orphaned and Abandoned Mine (OAM) Site Rehabilitation Program (for the Province of Manitoba). The final example is the Restor-Action-Nunavik Fund, a public-private initiative.

[16] Last revision date: 28 August 2024. These sites are located on land owned or leased by the federal government or for which it has accepted responsibility for contamination.

(a) Federal Contaminated Sites Action Plan

As noted above, in response to the growing number of federal contaminated sites in the country, the Federal Contaminated Sites Action Plan was created in 2005. This cost-sharing plan helps partners (federal departments, agencies and consolidated Crown corporations[17]) take ownership of contaminated sites that fall under their purview and to deal with those that pose the greatest risks to human health and the environment. In addition to providing financial support for site assessment, remediation and risk management, it also engages in skills development, training and job generation, including in Indigenous communities and rural and Northern areas (Government of Canada, 2019a).

The plan is limited to those sites that meet, among other things, the definition of a contaminated site established by the Treasury Board, understood as one that contains substances at concentrations above background levels and pose —or are likely to pose— an immediate or long-term hazard to human health or the environment, or one where the levels specified in policies and regulations are exceeded (Treasury Board of Canada Secretariat, n.d.). These sites may also include federal contaminated land if they meet the conditions established for funding under the plan (Government of Canada, 2023a).

Since the plan has limited resources, the federal sites to be funded are selected by means of a process of determination, ranking and prioritization carried out by the partners. This is done using the National Classification System for Contaminated Sites, a tool that helps to assess and classify sites into five categories, depending on the need for action: high priority, medium priority, low priority, not a priority and insufficient information (Canadian Council of Ministers of the Environment, 2008). Once site assessment and ranking has been completed, the partners may request a review of the documents to determine if their sites are eligible for funding from the plan. Depending on the risks and site-specific characteristics, funding may be assigned for remediation procedures[18] or risk management actions[19] (Government of Canada, 2016).

The plan is funded by periodic allocations made by the Treasury Board, based on the assessment and remediation activities planned by the federal partners (Government of Canada, 2018). The plan was initially established as a 15-year programme with funding of 4.54 billion Canadian dollars (Can$) for the 2005–2019 period. The allocations were spread across three phases: phase I (2005–2010), phase II (2011–2015) and phase III (2016–2019). In 2019, the programme was renewed for an additional 15 years (2020 to 2034), with an allocation of Can$ 1.16 billion for the first five years (phase IV, 2020–2024),

[17] The list of Partners of the Federal Contaminated Sites Action Plan identifies the agencies responsible.
[18] For example, active remediation, which includes removal of contaminants and their disposal at appropriate disposal sites, groundwater pump-and-treat systems and bioremediation.
[19] Include restrictions on site access, land use change and the isolation of contaminants.

distributed as follows: Can$ 1.05 billion to remediate 1,316 of the highest priority contaminated sites,[20] 24.3 million to assess 242 sites and 83.4 million to administer the plan (Government of Canada, 2023b).

(b) Territorial programmes for contaminated sites

Some of Canada's provinces and territories have contaminated site or abandoned mine programmes that are specific to their jurisdictions. These programmes are associated with funds that come from direct financing from the provincial governments (supplemented, in some cases, by taxes on mining output and by private contributions) or from contributions from the Federal Action Plan for Contaminated Sites. Four programmes that focus exclusively on the remediation of contaminated sites or abandoned mines have been identified (see table V.6).

Table V.6
Canada: territorial programmes

State programmes	Description
Northern Contaminated Sites Program	This programme was created in the early 1990s to address environmental legacies generated by mining, oil and gas activities in Yukon, Northwest Territories and Nunavut. This programme manages 156 contaminated sites in the North that are the responsibility of Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC). Since April 2020, the programme has received funding from the Federal Action Plan for Contaminated Sites and the Northern Abandoned Mine Reclamation Program of CIRNAC. It has an estimated five-year budget of Can$ 188 million. In addition to contributing to the assessment and remediation of contaminated sites, the programme supports employment, training and the development of economic opportunities for the population of the North, particularly its Indigenous Peoples.
Northern Abandoned Mine Reclamation Program	This programme was created in early 2019 solely to manage the largest and highest-risk abandoned mines in Yukon and the Northwest Territories. The programme has a 15-year term and aims, in particular, to manage the remediation of eight abandoned mines that were inherited by Crown-Indigenous Relations and Northern Affairs Canada under the Northwest Territories and Yukon devolution agreements. While funding for the programme comes from the Federal Action Plan for Contaminated Sites, the remediation and management of contaminated sites is carried out in collaboration with territorial and Indigenous governments and other partners. As with the Northern Contaminated Sites Program, the programme supports the access of Indigenous communities and people in the North to job and business opportunities linked to cleanup or remediation actions. The budget allocated by the federal government for cleanup and remediation actions under this programme is Can$ 2.2 billion over a 15-year period starting in 2020.

[20] Federal contaminated sites are classified and prioritized according to the National Contaminated Site Classification System of the Canadian Council of Ministers of the Environment and the Aquatic Site Classification System developed as part of the Federal Action Plan for Contaminated Sites.

State programmes	Description
Crown Contaminated Sites Program	This programme is led since 2003 by the Ministry of Forests, Lands, Natural Resource Operations and Rural Development of the Province of British Columbia. It exclusively manages contaminated sites in the province that do not have a responsible party answering for them. Its funds come directly from the provincial government, although in previous years direct allocations from the federal government's general revenues were also received. It has investigated a total of 87 priority sites, of which 36 have been classified as high priority and 29 as low priority, and 19 have been remediated.
Orphaned/ Abandoned Mine Site Rehabilitation Program	The Province of Manitoba created this programme in 2000, which led to the identification of 149 orphaned or abandoned mine sites. The programme currently includes 153 sites. In 2006, the province also established an environmental legacy account with a specific budget earmarked for the rehabilitation of orphaned or abandoned mine sites. According to 2016 data, the province had invested Can$ 214.8 million in the rehabilitation of orphaned or abandoned sites.

Source: Prepared by the authors, on the basis of Government of Canada. (2019c). *Northern Contaminated Sites Program*. https://www.rcaanc-cirnac.gc.ca/eng/1100100035301/1537371472183; Government of Canada. (2019d). *Northern Abandoned Mine Reclamation Program*. https://www.rcaanc-cirnac.gc.ca/eng/1565968579558/1565968604553; Government of Canada. (2021, 1 April). *Marking a year of progress in cleaning up Canada's Northern contaminated sites*. https://www.canada.ca/en/crown-indigenous-relations-northern-affairs/news/2021/04/marking-a-year-of-progress-in-cleaning-up-canadas-northern-contaminated-sites.html; Government of British Columbia. (2020). *British Columbia Crown Contaminated Sites Program: 2020 Biennal Report*. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/reports-and-presentations/ccsp_biennielreport2020.pdf; National Orphaned/Abandoned Mines Initiative. (2015). *NOAMI Performance Update 2009-2015*; 2017; Government of Manitoba. (n.d.-a). *Orphaned and abandoned mines*. https://www.gov.mb.ca/sd/environment_and_biodiversity/mines/index.html#accordion-1; Government of Manitoba. (n.d.-b). *A History of Mine Site Rehabilitation in Manitoba*. https://gov.mb.ca/sd/environment_and_biodiversity/mines/oa_rehab_history.html; Runnells, J. (2019, 4-5 December). *BC's Crown Contaminated Sites Program (CCSP): experiences remediating small, old mines* [Presentation] 26th Annual MEND Metal Leaching/Acid Rock Drainage, Government of British Columbia, Vancouver]. http://bc-mlard.ca/files/presentations/2019-5-RUNNELLS-bcs-crown-contaminated-sites.pdf and Stewart, G. G. y Johnstone, H. (2007). *British Columbia Crown Contaminated Sites Program Overview*. http://dx.doi.org/10.14288/1.0042528.

(c) Restor-Action-Nunavik Fund

During the 2001–2002 period, the Province of Quebec identified 90 abandoned mining exploration sites requiring remediation actions in the Nunavik region[21] (Quebec Mining Association [QMA], n.d.). In response, 30 mining companies operating in the province created the Restor-Action-Nunavik Fund in 2007 in order to participate in remediation actions. According to Virginia Mines (2014, cited in Saade, 2014), these companies represent a new generation of mining companies seeking to demonstrate their commitment to environmental management practices and social

[21] The detection and location of abandoned mine sites enabled the preparation of an inventory and the identification of 90 orphaned or abandoned sites in need of remediation actions; of that total, 18 were classified as high remediation priorities, 27 needed intermediate remediation actions and 45 required minimal work.

responsibility. Particularly notable is their capacity to carry out concrete actions in the remediation of priority contaminated sites and to ensure compliance with environmental standards.

The fund, in conjunction with the Kativik Regional Government, the Makivik Corporation[22] and the Quebec Ministry of Energy and Natural Resources (since renamed the Ministry of Natural Resources and Forests), signed an agreement in 2007 to conduct the rehabilitation of the 18 priority sites. This fund received Can$ 4.1 million from the Government of Quebec and 1.5 million from the mining companies for the implementation of remediation actions over the 2007–2017 period (QMA, n.d.). In turn, the Kativik Regional Government assumed responsibility for the management and coordination of cleanup activities[23] and for the preparation of annual schedules and budgets. Finally, the Makivik Corporation supported the project with an in-kind contribution in the form of water-borne and air transport services for materials and workers (KRG, 2022). The partners provided other in-kind contributions, such as services, equipment and accommodation.

The original agreement (which only included phase 1, 2007 to 2012) was extended to 2017 (phase 2) and then to March 2022 (the third and final phase). This enabled cleanup activities to be conducted at a larger number of sites than the 18 initially detected. In the 2019–2022 period, a General Response Plan was established to reflect the reality of this updated schedule of work, which included the more recently detected mine sites (KRG, 2022). In the Government of Quebec's 2022–2023 Work Plan, a budget of Can$ 10.6 million was earmarked for the rehabilitation work planned for that period (Government of Quebec, 2023).

4. United States

Two funds are notable for the public financing of environmental mining legacies in the United States: the Abandoned Mine Reclamation Fund, which receives tax revenues from the coal mining industry, and the Hazardous Substances Management Superfund Trust Fund, which receives funds from general tax revenue. The country also has laws that encourage the participation of private entities through Good Samaritan initiatives, together with a Contaminated Land Revitalization Program that offers a series of financial instruments and technical support.

[22] Legal representative of the Inuit community of Quebec.

[23] One of the tasks of the Kativik Regional Government is to ensure that communities receive adequate information about the ongoing cleanup efforts.

(a) Abandoned Mine Reclamation Fund

This fund was created in 1977 under the Surface Mining Control and Reclamation Act (SMCRA)[24] to reclaim and restore sites —including soil and water resources— adversely affected by coal mining, abandoned prior to August 1977 and for which there are no responsible parties under federal or State law (Office of Surface Mining Reclamation and Enforcement [OSMRE], 1977).

This fund is managed by the Department of the Interior and is financed through reclamation fees charged to coal mine operators, fees charged on reclaimed land, interest on arrears, donations, reclaimed moneys and interest earned from the investment of the fund's principal (OSMRE, 1977).

Reclamation fees are fees imposed by SMCRA on mine operators based on the coal produced[25] and the type of mining performed,[26] to be paid to the Secretary of the Interior for deposit into the fund. As shown on table V.7, the rates have decreased over the years, in line with the 2006 amendments to SMCRA and its extension in 2021.

Table V.7
United States: Abandoned Mine Reclamation Fund rates, 1978–2034
(Dollars per ton of coal produced)

Type of mining	1978–2007	2008–2012	2013–2021	2022–2034
Surface	0.35	0.315	0.28	0.224
Underground	0.15	0.135	0.12	0.096
Lignite	0.10	0.09	0.08	0.064

Source: Prepared by the authors, on the basis of Office of Surface Mining Reclamation and Enforcement. (n.d.-a). *Reclaiming Abandoned Mine Lands: Title IV of the Surface Mining Control and Reclamation Act*. https://www.osmre.gov/programs/reclaiming-abandoned-mine-lands; and (n.d.-b). *Chronology of Major SMCRA-Related Events*. https://www.osmre.gov/laws-and-regulations/chronology-of-major-smrca-related-events.

Under SMCRA, along with the payment of the reclamation fee, all coal mine operators must submit a sworn and notarized statement specifying, among other things, the amount of coal produced during the calendar quarter, the extraction method used and the type of coal. If the operator fails to submit it within the deadline or includes false information, a fine of up

[24] The main federal law regulating the environmental effects of coal mining in the United States. While this act is federal in its scope, the country's States may define and regulate their own reclamation laws, provided they are comparable with the federal act and approved by the Office of Surface Mining Reclamation and Enforcement. Once passed, the State law takes precedence over SMCRA, but the federal office retains an oversight role (see CCSG Associates and MiningWatch Canada, 2001).

[25] Volume or tons produced, whichever is less.

[26] Surface or underground mining.

to US$ 10,000 and/or imprisonment for up to one year may be imposed. In addition, according to the terms of the law, if the recovery fee is not paid in a correct and timely manner, the payment of legal interest will be required.

Under the act, resources from the fund are also available to States and Indian tribes. The resources are distributed by means of a legal formula that calculates their respective shares in the annual receipts of coal recovery fee, based on current and historical coal production (Congressional Research Service, 2022). Disbursement of funds is subject to the Office of Surface Mining Reclamation and Enforcement's approval of the remediation programmes proposed by States and tribes, which may include participation by federal contaminated site management agencies, mine owners and operators and community stakeholders (Environmental Protection Agency, 2023b).

In addition to creating the Abandoned Mine Reclamation Fund, SMCRA provides that coal mine operators are responsible for providing financial assurances for complete site reclamation to either the federal government or the appropriate State, as required by the applicable federal or State law (Congressional Research Service, 2022).

(b) Hazardous Substance Superfund

The Hazardous Substance Superfund, created in 1986 by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), is intended for the cleanup of sites contaminated by hazardous substances. It funds a broad range of short- and long-term actions.[27] For long-term projects, access to the fund involves a complex multi-stage process, including the financing of abandoned mines and other contaminated sites.[28] The fund is restricted to sites included on the National Priorities List prepared by the Environmental Protection Agency (EPA). Despite their large cumulative effect, few abandoned mines can reach the top of this list on account of their individual impact[29] (Wood, 2020).

The fund's available resources have fallen in recent years. Initially, CERCLA imposed a special tax on the oil and chemical industries, which allowed for the creation of a trust fund to pay for cleanup efforts. That tax expired in 1995 and, as a result, the fund subsequently began to depend on appropriations from general tax revenue granted annually by Congress. However, Congress did not increase the appropriations to compensate for

[27] Its short-term actions are mainly to address emergencies.

[28] The process encompasses investigations and studies, the selection and design of solutions, and the implementation of corrective actions. For more information, see https://www.epa.gov/superfund/superfund-cleanup-process.

[29] As of February 2024, there were 1,335 contaminated sites on the National Priorities List, with a further 41 proposed for inclusion. In addition, 457 sites had been removed from the list (Environmental Protection Agency, 2023c).

the loss of the special tax, resulting in a gradual depletion of the trust fund (Wood, 2020). Thus, between 1999 and 2021, the annual allocations fell by more than US$ 1 billion, from approximately US$ 2.5 billion to US$ 1.2 billion (in constant dollars at 2021 prices). The effects of this reduction can be seen in a general backlog of projects, as the average number of projects concluded per year fell by approximately half per decade from 1999 to 2020. As EPA prioritizes the continuity of cleanup activities over the start of new work, the number of sites where cleanup work has begun has also fallen (Gordner, 2021).

Although the fund has other sources of income —such as interest earned on the fund balance, fines, penalties and cost recovery from responsible parties[30]— the amounts contributed by those sources vary from year to year, most markedly following the expiration of the special tax in 1995.

CERCLA provided the Environmental Protection Agency with several mechanisms to compel identified parties to assume responsibility for cleaning up contaminated sites.[31] Thus, EPA may require recovery of costs incurred when cleanup activities have been performed or it may ask the courts to order the responsible parties to perform the work directly[32] (Government Accountability Office [GAO], 2008). If they fail to comply, they can face cumulative fines for each day of non-compliance and be held liable for the damage caused, which can be as much as three times the amount spent by EPA as a result of the non-compliance, in addition to cleanup costs (GAO, 2008).

The fund also establishes financial assurance mechanisms for potentially responsible parties, enabling them to be assigned the financial burden of completing the cleanup of contaminated sites. The financial guarantee mechanisms allowed include trust funds, letters of credit, surety bonds, insurance policies, corporate financial tests and corporate guarantees (Environmental Protection Agency, 2024b).

(c) Good Samaritan initiatives

CERCLA, through its system of strict, joint and several, retroactive liability,[33] did not provide strong incentives for voluntary remediation cleanup actions at contaminated sites, particularly environmental mining legacies.

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30 Under the Comprehensive Environmental Response, Compensation and Liability Act or the Clean Water Act.

31 When a viable responsible party cannot be identified or does not exist, the fund transfers the resources and authority to clean up contaminated sites to the Environmental Protection Agency. For more information, see https://www.epa.gov/superfund/what-superfund.

32 Since 1990, the Environmental Protection Agency and the Department of Justice have followed a "compliance first" policy, whereby responsible parties must clean up sites identified by the fund whenever possible.

33 GAO (2008) explains the different types of liability in greater detail.

That situation was somewhat mitigated by the enactment of the Superfund Amendments and Reauthorization Act in 1986[34] and the launch of the Good Samaritan Initiative[35] in 2007.

According to Wood (2020), voluntary remediation raises some difficulties under CERCLA:

- The informal nature of the assurances provided through the Good Samaritan initiative, and the possibility of those assurances being revoked by the Environmental Protection Agency.
- The investigation into potentially responsible parties at sites prior to cleanup activities, which can be costly to identify.
- The requirement to disclose the identity of project donors, which can hinder fundraising efforts.
- The possibility of the Environmental Protection Agency requiring remediators to pay the costs of supervising the agreements.
- The possibility of some parties to the agreement losing protection from the Environmental Protection Agency in the event of unsatisfactory performance.
- The possibility of determining responsibilities for water resources under the Clean Water Act.

Bills H. R. 963 and H. R. 3843, debated during the 114th United States Congress, state that Good Samaritan permits can only authorize activities related to the remediation of historic mining waste at or from the site. However, H. R. 3843 also provides that permits may not authorize new mining activities, other than those directly related to the on-site remediation of inactive and abandoned mines. H. R. 3843 also states, *inter alia*, that permit applications must describe the proposed remediation and include any proposed recycling or incidental reprocessing of historical mine waste at the site and how it relates to the remediation. In the past, it was suggested that this provision could be interpreted as possibly restricting the ability of Good Samaritans to reprocess mine waste, which raised concerns among some stakeholders (Congressional Research Service, 2016).

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[34] That law allowed voluntary remediators to take charge solely of damage caused by their own negligence.

[35] Under this initiative, the Environmental Protection Agency offers two administrative tools for Good Samaritans: (i) a letter accepting the Good Samaritan's proposed cleanup plan and acknowledging the agency's willingness to provide support in the event of third-party claims, and (ii) a settlement agreement that provides further official protection by facilitating a federal agreement that prevents Good Samaritans from being sued or facing administrative action in exchange for a full and satisfactory cleanup of the site (Environmental Protection Agency, 2007).

(d) Programmes for the remediation of brownfield contaminated sites

A variety of instruments for remediating brownfield sites exist in the United States: specific State programmes for contaminated land, State programmes focused on other issues (housing and urban development, economic development or transport) that can be used to fund contaminated land remediation, federal tax programmes and local programmes (see table V.8).

Table V.8
United States: instruments available for the remediation of contaminated sites

Instrument type	Agency	Programme
Specific brownfield programmes	Environmental Protection Agency	• Brownfields Program - Brownfield Assessment Grants - Brownfields Revolving Loan Fund - Job Training Grants - Brownfield Cleanup Grants - Brownfields Multipurpose Grants - State and Tribal Brownfields Response Program Grants
Brownfield related programmes	Environmental Protection Agency	• Clean Water State Revolving Fund
	Department of Housing and Urban Development	• Community Development Block Grants • Section 108 Loan Guarantees • HOME Investment Partnerships Program
	Economic Development Administration	• Public Works and Economic Development Program • Economic Adjustment Program • Planning Program
	United States Army Corps of Engineers	• Continuing Authorities Program • Support for Others • Planning Assistance to States • General Investigations Studies and Projects
	Department of Transportation	• Sundry funds from the Department of Transportation
Federal tax programmes	n./a.	• Brownfield Tax Expensing • Low-Income Housing Tax Credits
Local programmes	Local governments	• Tax Increment Financing • Tax Abatements • Local Revolving Loan Funds • General Obligation Bonds

Source: Bartsch, C. and Wells, B. (2003). *Financing Strategies for Brownfield Cleanup and Redevelopment.* Northeast-Midwest Institute and Environmental Protection Agency. (2024a). *Brownfields*. https://www.epa.gov/brownfields/about.

Only two of the instruments listed on table V.8 focus exclusively on remediation of brownfield sites: the Environmental Protection Agency's Brownfields Program and the Brownfield Tax Expensing programme. While programmes with connections to brownfields can be used, the remediation objectives must be aligned with the programmes' requirements.

(i) Brownfields Program

Since 1995[36], the Environmental Protection Agency's Brownfields Program provides grants and technical assistance to communities, States, tribes, and others to prevent, inventory, assess, clean up, and reuse brownfield sites.[37] The programme is intended for the remediation of sites contaminated with hazardous substances or petroleum, but it focuses on lower risk sites not included in the Superfund Program or in the Underground Storage Tank Program[38] (Congressional Research Service, 2016).

At the onset, the Environmental Protection Agency provided small amounts of capital to local governments and, subsequently, through the Small Business Liability Relief and Brownfields Revitalization Act of 2002, equipped the public and private sectors with new tools for promoting the cleanup and sustainable reuse of brownfield sites (Environmental Protection Agency, 2024a). The programme currently provides funding for assessment and cleanup activities, as well as revolving loans, environmental job training, technical assistance, training and research on matters relating to abandoned industrial sites (Environmental Protection Agency, 2024c). Table V.9 summarizes the Brownfields Program's funding mechanisms.

Table V.9
United States: funding instruments of the Brownfields Program

Grant type	Description
Brownfield Assessment Grants	Provide funds for the recipient to conduct inventories and determine, assess and conduct a variety of planning activities, and for the development of site-specific cleanup plans and community involvement in brownfields areas. Three types of assessment grant exist depending on the number of sites to be remediated and their geographical location: (i) Community-wide assessment grants of up to US$ 500,000. (ii) Site-specific assessment grants of up to US$ 1 million. (iii) Community-wide assessment grants for States and eligible Alaskan tribes for up to US$ 2 million.
Brownfield cleanup grants	Provide funds for cleanup activities on brownfields, with the condition that the applicant must be the site owner. The grant amount can be up to US$ 500,000 (which can be increased to US$ 5 million).

[36] The Environmental Protection Agency covers 10 federal regions. In each, part of the federal brownfields restoration money is transferred to State railroad commissions and, in this way, local grant funds are made available to assist with contaminated land projects.

[37] These sites include land, associated waters and surrounding watersheds where rock and mineral extraction or processing —including coal— has occurred (Environmental Protection Agency, 2021a).

[38] The Underground Storage Tank Program focuses on the remediation of petroleum leaks from underground tanks and is charged with the detection and prevention of leaks from tanks that store oil products or hazardous substances. Since sites contaminated with petroleum products did not qualify for traditional brownfield funding, a provision was included in the Small Business Liability Relief and Brownfields Revitalization Act of 2002 that allocated 25% of annual brownfield funding to the assessment and cleanup of low-risk petroleum contaminated sites and their preparation for reuse (Environmental Protection Agency, 2021b).

Grant type	Description
Brownfields Multipurpose Grants	Provide funds for assessment and cleanup activities in a target area (neighbourhood, neighbouring cities, district, corridor, shared planning area or census tract). The grant amount can be up to US$ 1 million.
Brownfields Revolving Loan Fund	Provides funds for the recipient to capitalize a revolving loan fund and provide loans and subgrants for cleanup activities at brownfield sites. Once the loans are repaid, the loan amount is returned to the fund and on-lent to other borrowers, creating a continuous source of capital within a community. The maximum loan amount is US$ 1 million.
Job Training Grants	Provide environmental training for residents affected by brownfield sites in their communities, and enable non-profit organizations, local governments and other organizations to recruit, train and deploy unemployed and underemployed residents of areas affected by the presence of contaminated land. The programme aims to develop competencies in training activities that support the assessment and cleanup of brownfield sites and their preparation for reuse. The maximum grant amount is US$ 500,000.
State and Tribal Brownfields Response Program Grants	Provide funds to create new environmental response programmes or improve existing programmes related to brownfield sites. Seek to empower States, tribes, communities and other economic development stakeholders to work in a timely manner in order to prevent, assess, safely clean up and sustainably reuse brownfields. The grant amount is up to US$50 million per year.

Source: Prepared by the authors, on the basis of Environmental Protection Agency. (2024c). *Types of funding*. https://www.epa.gov/brownfields/types-funding.

The programme's target groups are diverse and include municipal, regional and State administrations, Indigenous organizations, non-profit organizations and project developers, research and teaching institutions and corporations with limited liability under specific conditions. As with the Superfund Program, resources come from general tax revenue appropriations granted annually by Congress. Those funds are administered by the Environmental Protection Agency in separate accounts exclusively for the assessment and cleanup of brownfield sites.

(ii) Brownfield Tax Expensing programme

This benefit enables taxpayers who own brownfield sites to deduct environmental cleanup costs from their federal income tax return in the year when they are incurred, rather than having to capitalize them over time. Access to the benefit requires the fulfilment of two conditions related to the ownership and contamination of the site: first, it is restricted to taxpayers owning brownfield sites who incur certain cleanup costs (site assessment and cleanup expenses, monitoring, operation and maintenance, and State programme oversight fees); and second, hazardous substances or petroleum products must be present or potentially present on the property. Sites listed or proposed for inclusion on the Environmental Protection Agency's National Priorities List do not qualify for this tax incentive (Environmental Protection Agency, 2011).

The operation of the benefit is simple: volunteer landowners investigate and clean up their sites, obtain a letter from their State environmental agency confirming the contamination and can then deduct the cost of the cleanup from their tax returns.

From the point of view of the landowners and the Treasury, the Brownfield Tax Expensing programme is an investment. First, the remediation of contaminated sites generates increased tax revenues for local, State and federal governments, as those properties were previously idle and did not produce income. Second, the deduction encourages developers and site owners to address severely contaminated land by reducing the effective cost of cleanup and, at the same time, stimulates economic gains from new capital investments in communities across the country. New development generates construction-related and permanent jobs, as well as housing, community facilities, stores and offices, which revitalize communities (The National Brownfields Coalition, 2021).

Deductions under the Brownfield Tax Expensing programme have been used over 600 times in more than 40 States (The National Brownfields Coalition, 2021).

5. Peru

Peru has several specific laws and decrees to regulate its environmental mining legacies. In financing for the management of environmental legacies, the participation of voluntary remediators —understood as a "Good Samaritan" initiative— has been promoted through decrees and resolutions.

Legislative Decree No. 1042 of 2008 allowed for the use of a wider range of mechanisms for third party participation in the remediation of environmental mining legacies and introduced incentives for detecting and remediating them and for enabling their reuse and repurposing for alternative uses, such as tourism (Oblasser, 2016). Other specific rules regulating voluntary remediation agreements have since been implemented and the use of the Works for Taxes mechanism has been discussed (Chappuis, 2019). Legislative Decree No. 1361, published in 2018, encourages the financing and execution of projects under the Works for Taxes mechanism. Through it, environmental legacy remediation projects were incorporated into the legislation (Ramírez and Valle-Riestra, 2022).

As noted above, and in relation to the closure of future and ongoing mining operations, Act No. 28090 (2003) defines closure plans and their contents, which are to include the rehabilitation measures and their cost, timing, methods for oversight and verification, and the amount and mechanism to be used to set up the necessary environmental guarantees. Supreme Decree No. 033-2005-EM, amended in 2019 by Supreme Decree No. 013-2019-EM, states that the following guarantee methods may be used (art. 55):

- Letters of guarantee or other equivalent financial mechanisms.
- Surety and other insurance policies.

- Security trust over the following: (i) cash, (ii) cash flow, (iii) movable and immovable property other than mining concessions and facilities subject to the Mine Closure Plan, and (iv) negotiable securities, except those issued by the mining activity operator.
- Joint and several third-party assurance based on the methods indicated in the preceding paragraphs, without benefit of discussion.

In the particular case of small-scale and artisanal mining, the corresponding authority defines the necessary forms of assurance and may establish collective guarantees based on the geographical location or the particular conditions of the owners required to present and execute Mine Closure Plans.

Once the rehabilitation measures have been completed, the competent authority may proceed to release the guarantees. In the event of partial compliance, the guarantees are released in accordance with the closure measures performed and only the amount needed for the completion of the closure and post-closure work is retained (Supreme Decree No. 033-2005-EM, art. 62).

For non-compliance in the management of environmental mining legacies, the legislation lists the types of violation and the corresponding maximum fines (see table V.10). Under Supreme Decree No. 059-2005-EM (art. 26), fines may be transferred by means of an agreement to the National Environmental Fund so that it may constitute a trust fund with the sole purpose of remediating areas with environmental mining legacies assumed or executed by the State or serving as a counterpart for obtaining funds from financial cooperation or other sources.

Table V.10
Peru: violations and fines for non-compliance related to environmental mining legacies

Article	Violation	Fine[a]
52.1	Failure to declare environmental mining legacies located in the area of the concession within the established deadline. Imposition of the fine does not release the owner from the obligation of presenting the Environmental Mining Legacy Closure Plan.	Up to 100 tax units (UIT)
52.2	Failure to present the Environmental Mining Legacy Closure Plan within the deadline. Imposition of the fine does not release the owner from the obligation of presenting the corresponding Environmental Mining Legacy Closure Plan. The immediate adoption of environmental mitigation or remediation measures may also be required.	Up to 250 tax units
52.3	Failure to comply with the timetable of the approved remediation instrument or the execution of the measures ordered by the authority.	Up to 75 tax units
52.4	Failure to immediately adopt the environmental mitigation or remediation measures or to implement the complementary measures ordered.	Up to 75 tax units

Article	Violation	Fine[a]
52.5	Failure to comply with maintenance and monitoring.	Up to 20 tax units
52.6	Failure to comply with the submission of semi-annual reports.	Up to 5 tax units
52.7	Creators of a environmental mining legacy who fail to obtain approval for the submitted Environmental Mining Legacy Closure Plan for causes attributable to them will be subject to the same penalties, considerations and requirements indicated for article 52.2. In such cases, the General Directorate of Environmental Affairs may hire a consultant —at the creator's expense— to take charge of the preparation and execution of the Closure Plan.	Up to 250 tax units
52.8	Failure of the party interested in the repurposing of an environmental legacy to present the Environmental Impact Study or the corresponding amendment within the indicated deadline.	Up to 10 tax units
52.9	Failure of the party interested in repurposing to comply with the obligation of informing the oversight body of progress with the repurposing of the environmental legacy and compliance with the related environmental obligations.	Up to 5 tax units

Source: Deutsche Gesellschaft für Internationale Zusammenarbeit and Federal Institute for Geosciences and Natural Resources. (2018). *Estudio de caso de pasivos ambientales mineros en la Región La Libertad/Perú. Las relaveras de la Ciénaga/Pataz: gestión del Estado Peruano y análisis específico de responsabilidad histórica y legal*.

[a] Under articles 52.1 to 52.9, a maximum fine of up to 20% of the amounts indicated may be imposed on voluntary remediators, or of between 1 and 2 tax units on artisanal mining producers or small mining producers, respectively.

State participation in environmental mining legacy remediation activities is limited to those sites for which responsible parties have not been identified. The State can intervene at such sites in three ways (Deutsche Gesellschaft für Internationale Zusammenarbeit and Federal Institute for Geosciences and Natural Resources, 2018):

(i) When a company owned by the State is responsible for at least two thirds of the corresponding remediation amount.

(ii) When the party responsible for the environmental mining legacy cannot be identified or when there is no voluntary remediator.

(iii) When an identified responsible party does not comply with the presentation or execution of the corresponding closure plan, provided that the authority establishes the existence of a high risk if the remediation measures are not adopted and the public interest is invoked.

Peru provides several financing mechanisms for the management of environmental mining legacies (Oblasser, 2016; Ramírez and Valle-Riestra, 2022):

- Public funding from the government, through the allocation of resources for environmental mining legacy remediation by the Ministry of Energy and Mines.

- Public funding from tax revenues from the mining industry, through Activos Mineros S.A.C., a State-owned company under private law.
- Public-private partnerships, under the responsibility of the National Environmental Fund, which —in coordination with the Ministry of Economy and Finance— is responsible for attracting international financial cooperation, donations, debt swaps and other resources so as not to affect the State treasury (Act No. 28271, art. 9). Noteworthy in this regard is the creation of a trust fund under an agreement between the National Environmental Fund and the Yanacocha mining company, the Compañía de Minas Buenaventura S.A.A. and the Gold Fields mining company, for the remediation of environmental mining legacies in the Province of Hualgayoc.[39] Also notable is the Private Investment Promotion Agency (PROINVERSIÓN), which enters into agreements to encourage private investment in environmental mining legacy remediation projects.
- International assistance, specifically through the projects Strengthening management for the remediation of environmental mining legacies in Peru, conducted by the Ministry of Energy and Mines and the Korea International Cooperation Agency in 2015–2017 and extended in 2018 for a period of five years,[40] and Improving mine closure and environmental mining legacy remediation processes for the fulfilment of the Sustainable Development Goals, signed in 2021 between the Peruvian Agency for International Cooperation, the Korea International Cooperation Agency and the Ministry of Energy and Mines and in force until 2025.
- Funding by private voluntary contributions, which although provided for in law, is still scarce in the country.

(a) Activos Mineros S.A.C.

Since 2005, the Ministry of Energy and Mines has received financial support from private mining companies and some international organizations. However, most of the budget comes from allocations intended for the remediation of environmental mining legacies by Activos Mineros S.A.C., a State-owned company under private law.

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[39] In 2020, the competencies of the National Environmental Fund were absorbed by the Fund for the Promotion of Natural Protected Areas of Peru.

[40] See the press release available on the website of the Government of Peru: https://www.gob.pe/institucion/minem/noticias/22886-peru-y-corea-firmaron-ampliacion-de-acuerdo-de-cooperacion-para-la-remediacion-de-pasivos-ambientales.

The company was created in July 2006 to promote responsible mining activity through the remediation of environmental mining legacies inherited by the State, the negotiation of new mining projects and the management of special assignments (AMSAC, 2016). Its responsibilities also include the maintenance of remediated legacies (post-closure and monitoring).

Activos Mineros S.A.C., which operates in 11 of the country's regions, is responsible for the remediation of environmental mining legacies assumed by the State (particularly by the Ministry of Energy and Mines) that have been declared high or very high risk in the national inventory. In 2012 and 2013, through two ministerial resolutions,[41] it was entrusted with the remediation of 475 environmental mining legacies located in Cajamarca, Lima, Junín, Pasco, Puno, Huancavelica, Ica and Ancash. For that work, it was allocated a sum of 45 million soles by the Geological, Mining and Metallurgical Institute and the Ministry of Energy and Mines (AMSAC, 2022).

According to article 23 of Supreme Decree No. 059-2005-EM, environmental mining legacies for which the State is responsible are to be remediated through trusts created for the purpose by the National Environmental Fund. The Ministry of Energy and Mines may transfer to this fund an annual budget amount for the remediation of areas with environmental mining legacies by setting up a trust, from the resources allocated to the environmental legacy assessment project or other sources. As of 2019, Activos Mineros S.A.C. had conducted the remediation or post-closure maintenance of 1,022 environmental mining legacies assigned to it since October 2006. The company's 2022 portfolio included 65 remediation projects and, during that year, 1,194 environmental mining legacies were remediated (AMSAC, 2023).

(b) Voluntary remediation agreements

Peruvian law contains detailed provisions to encourage remediation by private parties. According to articles 12 and 14 of Supreme Decree No. 059-2005-EM (as amended by Supreme Decree No. 003-2009-EM), the remediation of environmental mining legacies is not restricted solely to the parties responsible. Private entities that undertake the remediation of environmental mining legacies for which they are not responsible are exempt from any legal liability of an administrative or judicial nature for infractions, offences or redress arising in connection with those liabilities. That notwithstanding, all remediation projects must have an Environmental Mining Legacy Closure Plan.

The mechanisms through which the voluntary remediation of a environmental mining legacy can be undertaken, in accordance with Supreme Decree No. 003-2009-EM, are the following:

[41] Ministerial Resolutions Nos. 482-2012-EM and 094-2013-EM.

- Responsibility limited to the assessment of the environmental legacy and/or preparation of a specific environmental remediation study.
- Responsibility limited to the execution of certain actions or works for the environmental remediation of one or more environmental legacies or their environmental impact.
- Responsibility limited to the investment of a maximum amount of money foreseen as the budget for the closure plan's actions.
- Responsibility limited to the duration of the post-closure stage.
- Presentation of a closure plan for environmental mining legacies.
- Inclusion of mining legacies in a mine closure plan.
- Reuse.[42]
- Repurposing.[43]

Both reuse and repurposing involve the use of a mining component for the benefit of the creator, the mine owner or a third party and they are, in return, obliged to perform the closure work. Despite these benefits, to date there has not been much interest in projects of this kind. This could be due to several factors: the lack of incentives for voluntary remediation, legal issues related to the determination of responsibility or the lack of preliminary mineralogical studies with information on the content of tailings or waste rock (Deutsche Gesellschaft für Internationale Zusammenarbeit and Federal Institute for Geosciences and Natural Resources, 2018).

(c) Works for Taxes Act

Peru has a law that incentivizes private investment. The Works for Taxes Act (Act No. 29230 of 2008, amended in 2025 by Act No. 32460) allows private entities to invest in certain public projects and then to recover the total investment through a certificate that can be credited against their income tax payments. These projects include the signing of agreements with regional or local governments and are focused on the implementation of work programmes that have been prioritized by regional and local governments, regional and municipal communities, public universities or agencies of the national government.

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[42] Refers to the use that the holder of a mining concession may make of the environmental legacies found within the concession, such as exploration platforms, workings, clearings or tailings, which may be incorporated as part of current or future mining activities, provided that the obligation to remediate is determined.

[43] Understood as the extraction of minerals from environmental legacies such as waste dumps, tailings or others that could represent economic value, determining the obligation of their environmental remediation (Supreme Decree No. 003-2009-EM, art. 2).

Article VI of the law's regulations (enacted in 2022 and amended in 2024) provides that the Works for Taxes mechanism must go through the following phases:

- Prioritization: the projects to be carried out through the Works for Taxes mechanism are selected.
- Preliminary actions: actions necessary for the next phase's selection process are carried out.
- Selection process: the private company and the supervising private entity are selected.
- Execution: the private company's agreement and the supervising private entity's contract are executed, and the Regional and Local Public Investment Certificates (State Treasury) and the National Government Public Investment Certificates (State Treasury) are issued.

Since the enactment of this law, basic infrastructure projects have been built, including health centres, roads, bridges, public squares, water networks, treatment plants and so on. The use of this mechanism to remediate environmental mining legacies is still at an early stage.

F. Conclusions

The information provided in this chapter indicates that, in a scenario of limited resources, financing mechanisms that include both public and private funds should be considered. For example, a combination of financial instruments could be used, involving general tax revenues, territorial governments, levies on mining industry output, public-private partnerships, tax incentives and other sources of income (such as fines, penalties, interest earned and donations from individuals or third parties).

Regardless of the financing system and instruments used, they should be designed to eliminate the accumulation of environmental mining legacies within a reasonable time frame. This first requires a prioritized inventory of the environmental mining legacies to be remediated and an estimate of the resources needed for the various remediation and risk management actions to be implemented. When public agencies, whether at the national or subnational level, are responsible for their management, efforts to gather the necessary funds should be aligned with a clear investment schedule.

Some remediation projects are long-term propositions and can involve post-monitoring activities. Financing mechanisms must therefore include a permanent approach to funding —if possible, by means of a dedicated fund

for orphaned or abandoned mines— in order to ensure project continuity. If general government revenue is used as the main source of financing, minimum periodic allocations (annual or otherwise) should be established to guarantee the availability of funds for the different stages of projects.

When public-private partnerships and Good Samaritan initiatives are used, there are several instruments that can facilitate and encourage the private sector's voluntary participation. From the economic point of view, participation by private entities can be encouraged through tax exemptions that facilitate investment in site remediation activities and the granting of exploitation rights as part of remediation projects. Non-economic incentives include the exemption or limitation of liability at the sites that are to be remediated, the creation of environmental compensation programmes or incentives to receive abandoned tailings deposits at operating sites, allowing transfers of mining concessions located in areas containing abandoned tailings deposits and the streamlining of processes.

The use of financial guarantees is a common practice at the national and subnational levels in the countries reviewed. The purpose of this mechanism is to ensure the proper closure of active mines and prevent the creation of new legacies. Accordingly, the design of financial guarantees must be geared towards those objectives and not to their use in historical environmental mining legacies. However, funds from financial guarantees can be used for priority environmental mining legacies at the national level. The use of models or tools to estimate mine closure costs and the associated guarantee amounts is important to regulate existing mines. In addition, the partial release of financial guarantees when mine closure work is partially advanced can be an effective incentive for mining companies to implement closure activities progressively over the course of the mine's life cycle.

Finally, tables V.11 and V.12 present a compilation of the advantages, disadvantages and requirements of each of the financing mechanisms for environmental mining legacy remediation used in the countries and programmes discussed in the chapter.

Table V.11
Financing mechanisms for existing and historical environmental mining legacies

Financing mechanism	Instrument type	Examples	Requirements	Advantages	Disadvantages
Public financing from general tax revenues	Funds and programmes financed with general levies	United States: Superfund Program Brownfields Program Canada: Federal Contaminated Sites Action Plan and territorial contaminated site programmes	• Existence of a prioritized inventory of sites to be remediated, allowing for efficient resource use. • Determination of the minimum annual amounts and of the timing with which the allocations will be made. • Existence of laws or plans that support the creation of funds and programmes.	• Mechanism that is independent of the mining industry and market conditions. • Allows systematic and long-term planning and execution, and includes post-closing maintenance and operating capital costs. • High public acceptance because of visibility and transparency. • Fund value can appreciate.	• Annual cash flows are subject to political priorities. • Responsibility falls on taxpayers. • Resources availability is restricted to certain institutions.
Public financing using tax revenues from the mining industry or other sources of pollution	Funds and programmes financed with levies on mining output	United States: Abandoned Mines Reclamation Fund	• Establishment of funds for the remediation of environmental mining legacies. • Existence of a prioritized inventory of sites to be remediated, allowing for efficient resource use. • Design of levies in accordance with remediation needs. • Existence of laws or plans to support fund collection from the mining industry.	• Responsibility falls on the mining industry. • Allows systematic and long-term planning and execution.	• Annual cash flows are volatile because of mining activity and market conditions. • May create disincentives for the industry.
International assistance and cooperation	Grants and loans	Zambia: World Bank (International Development Association) Peru: Korea International Cooperation Agency	• Compliance with the criteria set for countries to receive resources.	• Support is not solely financial and may include knowledge transfer and capacity building. • Funding comes from international sources.	• Few institutions offer financing. • Restricted to certain countries (subject to the country's poverty level). • The amounts are relatively small compared to the needs.

Financing mechanism	Instrument type	Examples	Requirements	Advantages	Disadvantages
Public-private partnerships	Agreements between the public and private sectors	Canada: Restor-Action-Nunavik Fund Germany: Association for Land Recycling and Remediation of Contaminated Sites (State of North Rhine-Westphalia) Peru: Trust fund under an agreement between the National Environmental Fund and the Yanacocha mining company, the Compañía de Minas Buenaventura S.A.A. and the Gold Fields mining company	• Existence of guarantees limiting the legal liability of private entities in projects and in relation to damage caused by third parties in the past. • Existence of incentives to facilitate private participation, such as exploitation rights, environmental compensation programmes or tax exemptions. • Coordination among government agencies to facilitate processing and ensure efficiency.	• Distributes the financial burden between the State and private entities. • Creates win-win situations for all parties. • Support is not limited to money and may include in-kind contributions.	• Specific projects or projects for specific territorial areas are usually financed. • Does not offer a stable and secure source of long-term financing.
Private voluntary contribution	Tax incentives	United States: Brownfield Tax Expensing programme Peru: Works for Taxes Act	• Existence of a State agency to validate the remediation project and determine whether the private entity meets the conditions set to obtain the benefit. • Existence of guarantees limiting the legal liability of the private sector in the projects and in relation to damage caused by third parties in the past. • Existence of laws defining site ownership requirements and determining whether the sites and spending qualify.	• Simple to implement. • Reduces the effective cost of site cleanup for the private sector. • In some cases, improves lenders' evaluation of projects. • Creates win-win situations when contaminated land is reused and put to residential or commercial use.	• Limited by the interest of private parties. In general, does not cover sites requiring complex remediation.

Financing mechanism	Instrument type	Examples	Requirements	Advantages	Disadvantages
Tax incentives	Environmental compensation programmes	Chile: Adopt a Tailings campaign	• Existence of a prioritized inventory of sites needing remediation to identify opportunities for private entities. • Existence of laws or programmes that support the mechanism. • Existence of exploitation rights as an economic incentive. • Coordination among government agencies to facilitate processing and ensure efficiency.	• Creates win-win situations for all parties. • Allows the use of operating sites' capacities.	• Limited by the interest of private parties. In general, does not cover sites requiring complex remediation.
	Low-cost loans and grants	United States: Brownfields Revolving Loan Fund	• Existence of laws or programmes that support the instrument and set the requirements for borrowers and sites.	• Allows resources to be returned to the fund to finance new projects.	• Requirements may restrict access by the private sector.

Source: Prepared by the authors.

Table V.12
Financing mechanisms for newly created environmental mining legacies

Instrument type	Examples	Requirements	Advantages	Disadvantages
Letter of credit (bank guarantee)	Australia: Queensland, New South Wales, Victoria, South Australia, Northern Territory Canada: British Columbia, Ontario, Quebec, Northwest Territories	• Existence of regulations for the proper closure of mining sites to prevent the creation of new environmental mining legacies. • Technical information and calculation tools to estimate the guarantee amounts required. • Guarantee amounts should reflect the actual costs that the government would incur in implementing the closure plans and other subsequent related activities. • Institutional and governmental capacities to manage guarantee funds. • Establishment of funds for the remediation of environmental mining legacies. • Robust, government-approved financial institutions.	• Responsibility falls on the mining industry. • Provides long-term financial security. • Cheap to set up with few administrative requirements. • Does not tie up company capital. • Irrevocable and non-transferable. Any changes require the consent of all parties, including the government. • From the government's point of view, the instrument guarantees full payment of closing costs (subject to the health of the financial institution).	• From the mining company's point of view, there is no certainty that the bank will renew the instrument. • The instrument's availability is subject to the company's credit rating. • Funds are non-interest bearing.
Bonds (performance bond or insurance bond)	Australia: Queensland, New South Wales, South Australia Canada: Ontario	• Existence of regulations for the proper closure of mining sites to prevent the creation of new environmental mining legacies. • Technical information and calculation tools to estimate the guarantee amounts required. • Guarantee amounts should reflect the actual costs that the government would incur in implementing the closure plans and other subsequent related activities. • Institutional and governmental capacities to manage guarantee funds. • Establishment of funds for the remediation of environmental mining legacies. • Robust, government-approved financial institutions.	• Responsibility falls on the mining industry. • Provides long-term financial security. • Cheap to set up for the company, with few administrative requirements. • Does not tie up company capital. • Any changes require the consent of all parties, including the government. • From the government's point of view, the instrument guarantees full payment of closing costs (subject to the health of the financial institution).	• From the mining company's point of view, there is no certainty that the bank will renew the instrument. • The instrument's availability is subject to the company's credit rating.

Instrument type	Examples	Requirements	Advantages	Disadvantages
Cash (bank draft or certified cheque)	Australia: Queensland, New South Wales, South Australia, Northern Territory Canada: British Columbia, Ontario, Quebec, Northwest Territories	• Existence of regulations for the proper closure of mining sites to prevent the creation of new environmental mining legacies. • Technical information and calculation tools to estimate the guarantee amounts required. • Guarantee amounts should reflect the actual costs that the government would incur in implementing the closure plans and other subsequent related activities. • Institutional and governmental capacities to manage guarantee funds.	• Responsibility falls on the mining industry. • Provides long-term financial security. • Cash is secure and can be easily accessed to cover closing costs. • High level of public acceptance on account of its visibility. • Suitable for mining companies that cannot meet the banks' requirements for other guarantee instruments. • Deposited funds can earn interest.	• A significant portion of the company's capital is tied up. • The financial institution may be under government control. In this case, mining companies may be reluctant to use those banks owing to the risk of theft, fraud or diversion of funds.
Company guarantee (self-test or balance sheet)	Canada: British Columbia, Ontario	• Existence of regulations for the proper closure of mining sites to prevent the creation of new environmental mining legacies. • Technical information and calculation tools to estimate the guarantee amounts required. • Guarantee amounts should reflect the actual costs that the government would incur in implementing the closure plans and other subsequent related activities. • Institutional and governmental capacities to manage guarantee funds. • Establishment of funds for the remediation of environmental mining legacies. • Institutional and governmental capabilities and experience to periodically review the company's financial health.	• Responsibility falls on the mining industry. • Provides long-term financial security. • Does not tie up company capital. • The least expensive instrument for companies. • Easy to administer. • Companies' financial information is publicly available (in the case of publicly listed companies). • Many jurisdictions that accept company guarantees require that they be converted into other types of financial guarantee, such as bonds or letters of credit, well before the end of the mine's useful life.	• Limited public acceptance. • Requires a long history of financial stability, a credit rating from a specialized service and, at least, one annual financial statement prepared by a chartered accounting firm. • Even large companies can fail, regardless of their financial history.

Instrument type	Examples	Requirements	Advantages	Disadvantages
Trust fund	Canada: British Columbia, Ontario, Quebec	• Existence of regulations for the proper closure of mining sites to prevent the creation of new environmental mining legacies. • Technical information and calculation tools to estimate the amounts of funds required. • The amounts required must reflect the actual costs that the government would incur to implement the closure plans and other subsequent related activities. • Institutional and governmental capacities to manage the fund's resources in the event of non-compliance with the closure of operations.	• High level of public acceptance on account of its visibility and transparency. • Fund value can appreciate. • Decisions on the types of investment available can or must be made by the operator and the government, and they must be specified in the agreement. • The full amount of the fund can be withdrawn if the operator fails to make the payments and no acceptable alternative is offered. • The trust fund's management and performance are subject to periodic review. • Can be used to finance post-closing maintenance and operating capital costs.	• Relatively costly to manage and administer. • Company funds are increasingly tied up. • Risk of poor investments, and fund management is a long-term proposition. • May not accumulate enough value if the mine closes prematurely. • A secondary financial guarantee instrument may be required until the total fund amount is reached.

Source: Prepared by the authors, on the basis of Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. (2021). *Global review: financial assurance governance for the post-mining transition.* International Institute for Sustainable Development.

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Chapter VI

Notable cases of environmental mining legacy remediation and secondary mining

This chapter provides examples of environmental mining legacy remediation and repurposing taken from both within and outside the Andean region (Canada, Chile, Germany, Mexico and Peru). Both the successes and critical points are described and the factors and conditions essential for successful legacy management are identified. The examples' applicability and replicability in the rest of the Andean region is also examined.

The examples analysed include polymetallic mining legacies where remediation has been completed or is at an advanced stage. The cases were selected because they involve the repurposing of the sites, either by reprocessing the environmental mining legacy's waste and extracting valuable substances or by reusing the land it occupied.

The search for notable cases was based on a review of the specialized literature at the international and regional levels, as well as on information gathered through interviews, consultations and exchanges of documents with regional experts (for further details, see annex A1). Box VI.1 indicates the criteria used to select the cases chosen.

Notable among the international experiences are the policies and State programmes of Germany and Canada where, through a decentralized environmental authority, clear remediation rules are established based on environmental management, risk assessments and the determination of responsibilities. These countries have implemented cooperative public-private models to promote and finance cooperative, multi-stakeholder, proactive and voluntary legacy remediation. The replicability of those experiences in the Andean region should be considered in the medium and long terms.

Box VI.1
Criteria used to select notable cases of environmental mining legacy management

Macro criteria:

- Legacies preferably related to polymetallic deposits (copper, lead, zinc, gold, tin, etc.).
- Legacies produced by medium- to large-scale formal industrial mining.
- Remediation actions completed or at an advanced stage of implementation.
- Notable cases with potential for multiplication or replicability in the Andean region.

Technical criteria:

- Risk considerations: existence of data on controlling the risk to human health or ecosystems, where those efforts are assured, established and sustainable (long-term risk management and mitigation).
- Management considerations: existence of data on the funding of the measures, the mechanisms used, the parties responsible for them and their economic feasibility.
- Social acceptance considerations: existence of data on governance and social responsibility relating to the measures.
- Innovation and sustainability considerations: particular interest in obtaining information on innovative technologies and concepts, such as those related to ecological footprints or green remediation.

Operational criteria:

- Availability of and access to sufficient documentation, information and data to understand, analyse, explore and present background details of interest to the study.

Source: Prepared by the authors.

The international experiences also reveal important effects on employment, encouraged by the economic revaluation of environmental mining legacies (e.g. in Mexico) and highlight the benefits of community participation in decision-making related to remediation actions (e.g. in Canada).

In turn, the examples from the Andean region focus on voluntary remediation actions. They also show that the environmental remediation of environmental mining legacies —allowing them to be repurposed and reintegrated into the socioeconomic cycle— is a challenge that still needs legal structures, cooperative models and methodological and financial contributions, based on the circular economy of waste and sustainability standards. The selected cases from beyond the Andean region are presented in the following section.

A. Analysis of case studies from outside the Andean region

This section presents six cases from Canada, Germany and Mexico, which vary widely in terms of their size and investment levels. In these examples, most of the interventions were primarily undertaken to control a potential danger following a determination of risk to human health and the environment.

1. Beythal, Germany: cooperative multi-stakeholder model[1]

Tailings disposal in the Beythal area (city of Düren, State of North Rhine-Westphalia) dates back to 1955, when the Mechernich-Maubach mine was in operation and lead and zinc were processed. Tailings produced by the flotation process between 1955 and 1969 were deposited in a dam structure with lateral retaining walls (see image VI.1) (Kreis Düren, 2021).

Image VI.1
Germany: aerial view of Beythal, 1959

Source: StuKrADN In Kreis Düren (2021). *Bodenschutzbericht 2021 (2021 Report: soil protection).* https://www.kreis-dueren.de/pdfs/publikationen/publikationen-bilder/Bodenschutzbericht-des-Kreises-Dueren-Internet-2021.pdf.

The Beythal tailings primarily contain lead and zinc, and, in lesser amounts, nickel, cobalt and copper, with considerable proportions of pyrite. The dam covers an area of 45 hectares (ha) and ranges in height from 10 to 40 m, giving an estimated volume of some 11 million m^3 (assuming an average height of 25 m).

[1] Part of the information used to prepare this section comes from the AAV project to protect groundwater against heavy metal contamination.

Between 1970 and 2002, the Stolberger Zink company (which took over the legal succession of the mine and tailings) removed about 1.7 million m^3 of quartz sand from the tailings to manufacture limestone, which was used in civil construction.

In 1999, the first outflow of acid drainage water containing heavy metals was detected at the base of the tailings dam,[2] contaminating fish ponds and surface water (the *Berzbuirer Knipp* citizens' initiative of the non-governmental organization St. Anna-Schützen Berzbuir, founded in 1893). The interventions —to control the outflow of acid drainage water towards vulnerable receptors by pumping and treating the tailings dam— have been ongoing since 1999. Beginning in that year, the outflow of acidic water with heavy metal contamination was controlled by means of horizontal drainage ditches and pumping the water back to the tailings dam. In 1996, the site was classified as a maximum-level environmental protection area (nature reserve) on account of the abundance of fauna and flora, both typical and rare. That was one of the reasons that hindered the installation of a water treatment plant, as it conflicted with the protected area.[3]

In 2007, the Stolberger Zink company filed for bankruptcy and cancelled its registration of site ownership and, as the closure plan's requirements were not fully met, an orphaned environmental mining legacy was created. This led the mining authority of the State of North Rhine-Westphalia to assume the execution of the intervention measures on a subsidiary basis to ensure the site's continued management and remediation.[4]

Initially responsible for the interventions until 2015, the North Rhine-Westphalia mining authority failed to fully implement its intervention plans, which entailed the construction of a 2.6 km pipeline to the pit or backfill. A pilot system was installed in 2012, but it could not be put into operation owing to questions about the final destination of the treated water and its impact on the environmentally protected area, in addition to the fact that it entailed high operating costs.

Faced with the complex legal situation, the level of risk that existed and the absence of a responsible party, in 2015 AAV took over the intervention measures at the request of the State of North Rhine-Westphalia. This responsibility enabled the association to obtain basic technical information to prepare and develop a definitive remediation plan. The aim of this plan is to control the risk —to reduce the formation of acidic water and the contamination of groundwaters— and, at the same time, to protect the fauna and flora of the biotope (AAV, 2015; Kreis Düren, 2021).

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[2] As a consequence of the oxidation of pyrite contained in the tailings, caused by the infiltration of rainwater.

[3] For more information, see https://www.aav-nrw.de/projekte/sicherung-und-sanierung-der-bergehalde-beythal#infos.

[4] Substitute execution of environmental remediation measures by the State *(Ersatzvornahme)*: the State, in cases of imminent risk, may intervene at the owner's expense.

AAV receives 100% of the cost of implementing the remediation measures at Beythal from the State and contributes technical expertise for project management.

At present, the project has an initial provisional system of water collection in drainage ditches that uses a pumping system to the tailings dam. The outflow of contaminated water to the fish pond has been controlled. The objective of the final remediation plan is to reduce the generation of mobile contaminants in the tailings deposit and control their spread. Another challenge relates to the design of an efficient and economically feasible treatment system (AAV, 2015). The delay in implementing the remediation measures is one of the criticisms made of the project.[5]

As noted above, since 1996 the legacy's area has been preserved and protected as a nature reserve. The remediation will ensure the continuity of this use without any negative repercussions for the protected area and will avoid the installation of a treatment plant on the legacy site. In addition, after 2002, the repurposing of waste was not taken into account, mainly because of environmental restrictions in protected areas. Box VI.2 sets out the main lessons learned from this case.

Box VI.2
Main lessons learned from Beythal

- The Beythal case is notable for the technical, operational and inter-institutional management of AAV, a body created to ensure the safe use of legacy sites without responsible parties in the State of North Rhine-Westphalia. AAV succeeded in sustainably converting the Beythal environmental mining legacy into an environmentally protected area, without affecting the biotope's ecosystems.
- The measures are funded by the State of North Rhine-Westphalia and AAV is responsible for their implementation, tendering, contract management and technical and financial oversight.
- The public-private cooperation model used by AAV, which included participation by the private sector, environmental agencies from various levels of government and the district mining authority, was a crucial element in the negotiation of the site remediation plan.
- One problematic point was reconciling the population's expectations and the current situation at the site. The *Berzbuirer Knipp* citizens' initiative criticizes the delay in implementing the actions.
- The intervention has not yet been completed and, to date, only the preliminary securing measure of pumping and re-infiltration has been implemented.

Source: Prepared by the authors.

[5] See the Berzbuirer Knipp citizens' initiative of the St. Anna-Schützen Berzbuir non-governmental organization at https://stanna.de/projekt/.

2. Canada

Given its long history of mining, the importance of its Indigenous Peoples, its observance of law and the existence of a consolidated institutional structure for dealing with its environmental and mining legacies that could serve as examples for other countries.

The following three examples illustrate the country's management of its environmental mining legacies: (i) Yankee Girl, (ii) Keno Hill District, and (iii) Colomac. These cases have been selected to showcase the public strategy for managing environmental mining legacies by means of decentralized governmental programmes for management and funding that are based on multi-stakeholder models and involve significant civil society participation.

(a) Yankee Girl tailings: technologies, repurposing and community participation

The Yankee Girl mine operated from the late nineteenth century until 1950. It primarily produced gold and silver and yielded 370,616 tons of ore with approximately 8.6 grams of gold and 44.5 grams of silver per ton. Its average concentrations of lead and zinc were, respectively, 1.5% and 2.8% (Government of British Columbia, 1991). The last owner of the mine, which relinquished ownership in 1989, was the company Kingsvale Resources.

Tailings generated from gold and silver processing were deposited on the banks of the Salmo River and Ymir Creek, near the town of Ymir (see image VI.2). The tailings area covers approximately 6 ha and, according to the Salmo Watershed Streamkeepers Society, a non-governmental organization,[6] an estimated 360,000 tons of waste are deposited at the site (Salmo Watershed Streamkeepers Society [SWSS], 2008).

The main risks to human health and the environment include the direct erosion of the tailings by the Salmo River and Ymir Creek, metal leaching and acid drainage to groundwater and other minor bodies of surface water and direct contact with contaminated tailings that may affect the receptors (humans and animals) who traditionally frequent the area for recreational purposes (Tinholt, 2008a). According to SWSS (2000 and 2008), the deposits have elevated concentrations of arsenic, lead and zinc, and the waters exceed British Columbia water quality standards for cadmium, iron, manganese, zinc and sulfur.

Since 2000, the Ministry of Environment and Parks and then the Ministry of Agriculture and Lands of the Province of British Columbia, supported by the Salmo Watershed Streamkeepers Society, have taken steps to investigate and remediate the tailings.

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[6] The organization is a local community initiative for the protection of the Salmo River watershed.

Image VI.2
Canada: Yankee Girl tailings area and the town of Ymir

Source: Prepared by the authors, on the basis of Google Earth, 2021.

The Ministry of Agriculture and Lands, through the Crown Contaminated Sites Program, funded the measures implemented at Yankee Girl. The programme covers environmental legacies of all kinds[7] and gives preference to on-site measures such as on-site management and consolidation of waste into a single repository with a smaller environmental footprint, the management of risk and water resources by watershed, local soil change and the application of coating systems with advanced techniques and materials, as shown in this example.

The intervention addresses two needs: first, mitigating the risk to fauna, flora and human life, in accordance with current provincial legislation and, second, meeting the community's demands for the site's conversion into a safe recreational area.[8] One on-site measure was prioritized, as the results of the risk assessment and cost-benefit analysis indicated that removing the waste to an off-site landfill would be costly and entail a high environmental impact. The intervention is at the long-term monitoring phase. In 2019, after 10 years of monitoring, the measures implemented were deemed to have been successful (Government of British Columbia, 2020; Nelsonstar, 2018).

To control the erosion of the environmental mining legacy on the banks of the Salmo River, a barrier was installed in the river in 2005 and, subsequently, several flooding optimization and adaptation stages were carried out. In 2007, based on the risk assessment, a remediation plan was developed. Under that plan, and within the framework of the Crown Contaminated Sites Program, the following measures were implemented

[7] Of the 18 ongoing remediations, 15 are environmental mining legacies, and of the 19 completed remediations, 9 were environmental mining legacies.
[8] For more information , see Tinholt (n.d.).

until 2009: (i) excavation and relocation (on-site consolidation) of several contamination hotspots in a single deposit, notably 17,000 m^3 of soil and waste from the former plant site, (ii) treatment of the consolidated material with lime and restoration of the excavation sites, (iii) covering the reservoir with a bentonite clay layer and a protective layer of 1 metre of natural soil, and installation of drainage works, (iv) landscape restoration to provide a recreational area and installation of a passive water treatment system using a bioreactor and an artificial wetland constructed with composted pulp mill residuals, and (v) revegetation (Runnells, 2019).

From the start of the intervention, the local community in Ymir has been involved through public consultations. In addition, the Salmo Watershed Streamkeepers Society, as an advocate for environmental and social interests, provided technical and scientific input (e.g. monitoring of aquatic fauna) and participated in sampling and research campaigns on the risk potential of the tailings that the organization conducted in other parts of the watershed. It also played an active role in outreach, awareness raising and formal community participation in the decisions taken by the provincial authorities in conjunction with the population (SWSS, 2008).

According to the Crown Contaminated Sites Program, the site is in the post-remediation monitoring phase and is safe for the environment, water resources and reuse as a recreational area (community park). Risk control and mitigation through the consolidation and on-site containment of waste and bioremediation was successfully completed in accordance with the applicable legal and technical standards for contaminated site management.

The British Columbia Ministry of Agriculture and Lands, the agency in charge of the intervention, received special recognition in 2008 for the successful management of the Yankee Girl tailings.

There were several elements behind the success of the intervention:

- The administrative and technical leadership assumed by the ministry through its provincial contaminated sites department.
- A programme specifically created to address environmental legacies with its own budget.
- The existence of consolidated standards and legislation for the remediation of contaminated sites and legacies, regardless of their origin (e.g. mining, industry or waste deposits).
- Joint management with organized civil society (non-governmental organizations and local community representatives) to convert the legacy site into a public recreational area.

- The concept of risk-based intervention, with innovative on-site remediation technologies (consolidation of various wastes into a single deposit, chemical stabilization and passive bioremediation) and repurposing.

(b) Keno Hill District: public-private stakeholder partnership

The Keno Hill case involves a group of 35 mines located in an area of more than 15,000 ha in the Yukon Territory. Between 1913 and 1989, 217 million ounces of silver (almost 7,000 tons) were produced from very high grade ore: 1,390 grams of silver per ton, along with 5.6% lead and 3.1% zinc.

The legacy site includes mine shafts with acid drainage and high concentrations of zinc,[9] dry tailings piles, six tailings dumps, abandoned buildings and processing plants, and hazardous waste located in the vicinity of the 35 mines (Spagnuolo, 2014).

After United Keno Hill declared bankruptcy in 1999, the property and legacies passed to the Government of Canada under the responsibility of Crown-Indigenous Relations and Northern Affairs Canada (see box VI.3). The legacies were admitted to the Northern Abandoned Mine Reclamation Program as a type II mining site: i.e. legacy sites with no funding or identified responsible party (orphan sites), prioritized for remediation owing to the immediate need to control the danger and the absence of a responsible owner.

Box VI.3
Legal and institutional framework of the Keno Hill case

- Since 2003, the Government of Canada, through Indigenous and Northern Affairs Canada and Crown-Indigenous Relations and Northern Affairs Canada, has ceded ownership of federal lands and assets in the Northern Territories, including Yukon. The legal basis for this decentralization is the Devolution Transfer Agreement.
- The abandoned mining district in Keno Hill is one of those ceded sites.
- In accordance with the Canadian government's Contaminated Sites Management Policy, the Northern Contaminated Sites Program deals with environmental legacies, and the Northern Abandoned Mine Reclamation Program was created to specifically assist provincial governments and Indigenous communities in remediating mining legacies in the region.
- The Northern Abandoned Mine Reclamation Program has a 15-year budget of 2.2 billion Canadian dollars to remediate the most significant environmental mining legacies, including the Keno Hill District.

At Keno Hill, remediation is being implemented in conjunction with the Yukon Territory Government, representatives of Indigenous Peoples (First Nations) and the private sector.

Source: Prepared by the authors.

[9] This endangers water resources and is toxic to aquatic fauna.

In 2006, the Government of Canada sold the Keno Hill District to Alexco Resources Corp., and Alexco was, in turn, acquired by the Hecla Mining Company of the United States in 2022.

Following its acquisition by Alexco Resources Corp., the Keno Hill site had a remediation plan that included such innovations as the injection of dissolved carbon into the mine to enhance the reductive action of anaerobic bacteria, whereby toxic metals were fixed and precipitated in stable sulfite forms. The maintenance measures were to be implemented through a public-private management and financing model (Alexco, 2018).

When Keno Hill was taken over by Hecla, the company assumed the site's environmental oversight and maintenance, as well as the management of the remediation project. According to its 2023 sustainability report, Hecla began work on a new legacy remediation plan and is preparing management and remediation plans for the water pollution on the property. According to reports, the company is encouraging civil society participation, including the First Nation of NaCho Nyäk Dun, through information meetings and updates on planned activities (Hecla Mining Company, 2023).

On the basis of the above, the following factors have been identified as key elements in the successful management of environmental mining legacies:

- The Government of Canada's sale of the district to a private company, including its legacy sites. This sale was accompanied by an agreement that assigned shared responsibility for remediation to the company (Alexco Resources Corp.), the provincial government, the federal government and the First Nation of Na-Cho Nyäk Dun (Government of Canada, 2011), whereby a public-private partnership was created.
- Alexco Resources Corp. was the driving force behind the financial and technical care and maintenance of the legacies. It also participated in preparing the remediation and closure plan and established financially favourable conditions for the government as the contractor (Spagnuolo, 2014).
- Alexco's business plan included obtaining the mining concession and water rights. Starting in 2013, mining exploration work was carried out in some parts of the district with a view to resuming mineral extraction in the future. The company also agreed to contribute a minimum of 10 million Canadian dollars to the remediation of the legacies and to pay 1.5% of future production royalties into a remediation trust fund (Alexco, 2018).
- Alexco Resources Corp. was a mining exploration and environmental engineering company. This innovative strategy allowed it to purchase the property and evaluate the feasibility and cost-benefit ratio of remediation or exploration (The Northern Miner, 2010; Spagnuolo, 2014).

- According to the press, this was one of the very few cases in which public-private partnerships were used for environmental mining legacy remediation in Canada.[10]
- Under Alexco's remediation plan, the closure costs totalled 6,566,730 Canadian dollars, to be covered primarily by bonds deposited with the Yukon Government, providing the legal and financial security necessary for a public-private operation (Alexco, 2018).
- The process was based on significant financial resources from the Government of Canada through the Northern Contaminated Sites Program and coordination between the federal government, the provincial government and the Indigenous Peoples.

(c) Colomac: public programme for remediation and Indigenous community inclusion

Canada has a wide range of programmes, institutions and organizations that work to remediate environmental mining legacies and that are engaged with the development and self-management of regions and Indigenous Peoples, since many legacy sites are located on First Nations' lands (Chong and Basu, 2023).[11]

Notable at the national level is the Federal Contaminated Sites Action Plan which, since 2005, has treated a total of 2,200 sites. One of the plan's success stories is the Colomac gold mine legacy site in the Northwest Territories (Government of Canada, 2019e). The mine ceased operations after being abandoned in 1999, leaving a significant legacy: three open pits, waste rock piles, a tailings dam with risk of overflow, sediments and soils contaminated with hydrocarbons, buildings and disused plants (see image VI.3).

To control the risk it posed to bodies of water, the site required contingency actions, followed by definitive interventions. The measures adopted included remediation work, which was overseen and funded by the federal government through Crown-Indigenous Relations and Northern Affairs Canada. The intervention, which was completed in 2011, comprised the following actions: (i) confinement of tailings and raising the level of the dams to control water runoff, (ii) demolition and removal of infrastructure and buildings, and (iii) soil and sediment remediation (see image VI.4).[12]

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10 Investing News (2019). https://investingnews.com/innspired/alexco-environmental-remediation/

11 The term "First Nations" is the modern name for the Indigenous Peoples of Canada and their descendants. It does not include the Inuit or the Métis.

12 For an illustrative summary of the remediation, see the ArcGis application. *Remediation of Colomac Mine*. https://www.arcgis.com/apps/MapJournal/index.html?appid=bf1c9c70b8d64fc1850e3da9434edf39.

Image VI.3
Tailings dam with dike

Source: Nahir, M. and Hockley, D. (2003). Selection of remediation measures for abandoned mine sites [Presentation]. https://www.slideserve.com/magee-berger/selection-of-remediation-measures-for-abandoned-mine-sites-powerpoint-ppt-presentation.

Image VI.4
Remediation project at Colomac

Source: Aboriginal Affairs and Northern Development Canada. (2012). Colomac Mine Remediation Project: Post-Reclamation Monitoring and Residual Hydrocarbon Remediation Management Plan. http://registry.mvlwb.ca/Documents/W2009L8-0003/W2009L8-0003%20-%20Colomac%20-%20Post%20Reclamation%20Monitoring%20and%20Residual%20Hydrocarbon%20Management%20Plan%20-%20Oct%2015_12.pdf.

Two important points should be highlighted in connection with this case:

(i) The participation of the Tlicho people, an affected Indigenous community, in the planning and management of the remediation (North of 60, 2013). Some of the maintenance activities involved contracts with local Indigenous companies (Government of Tlicho, 2017).

(ii) Substantial job creation and training for local civil society. The site is in the long-term monitoring phase and has received several awards, including the Award of Environmental Excellence of the Consulting Engineers of Alberta organization (Government of Canada, 2019e).

3. Parral, Mexico: voluntary removal and reprocessing of tailings[13]

The voluntary intervention consists of the removal and reprocessing of mining waste stockpiled in a tailings deposit located in an urban area. The tailings, located in the northeastern part of the city of Hidalgo del Parral, were created during the operation of the La Prieta underground mine, where silver and base metals were extracted between 1629 and 1974. Grupo México removed part of the tailings for fluorspar recovery between 1970 and 1990. The residue generated after the process was, however, redeposited into the tailings dam. In 2008, the municipality of Parral purchased the tailings from Grupo México.

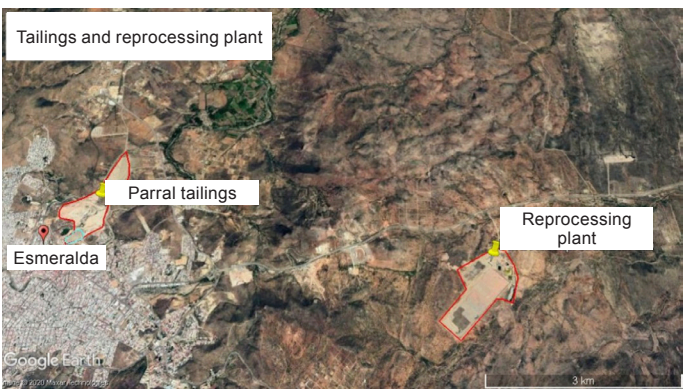
Although the land where the tailings are located is municipal property, the rights to the deposited materials belong, since 2012, to GoGold Resources Inc. Under an option agreement entered into in 2011 (amended in 2016), a monthly rental payment to the municipality for variable surface rights was agreed to, in an amount ranging from US$ 47,500 to US$ 87,500 depending on the market price of silver. At present, the rights to the area's use and occupancy remain in place, and no royalties are paid on the project. The company funds its reprocessing operations entirely with its own resources (capital contributions and equipment leasing). The operation currently generates a cash inflow of US$ 700,000 a month.

The environmental mining legacies under management are drained tailings (without water), which are deposited in five-metre thick layers on flat ground up to a final height of 50 m. The material has a uniform physical consistency and an average particle size of 0.225 mm. In mineralogical terms, it comprises gangue minerals, such as quartz, clay, feldspar and calcite, which are associated with sulfates, sulfides and fluorspar. Arsenic,

[13] Part of the information comes from documents provided by Lilia González, on behalf of Grupo Coanzamex S.A.

cadmium, chromium, lead and zinc are potentially toxic elements (González et al., 2015). Most of the tailings are uncovered, in an area of 80 ha that holds an amount slightly above 20 million tons (see image VI.5).

Image VI.5
Parral tailings and reprocessing plant



Source: Prepared by the authors, on the basis of Google Earth, 2020.

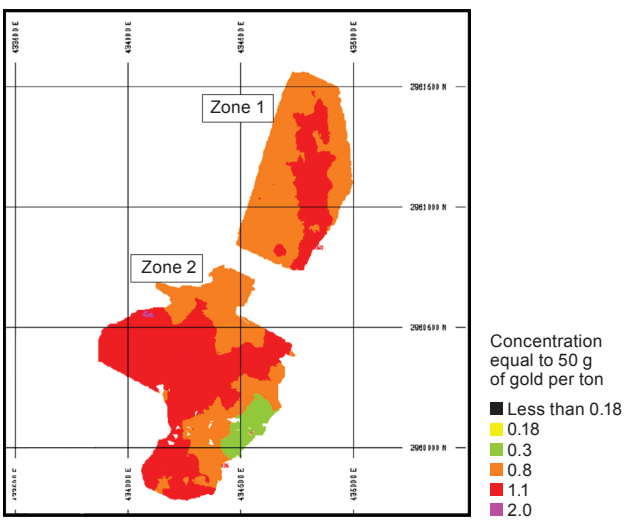
Rodríguez et al. (2013) reported the presence of particulate matter containing heavy metals derived from the tailings. According to the authors, strong winds at different times of the year increase the effects on public health and the environment; they also point to the presence of concentrations of heavy metals in the surface soil of the populated area that exceed the limits set by both national and international standards. Acid drainage from the infiltration of rainwater is also considered a risk.

According to the prefeasibility study conducted by Dood, Duncan and Kuchling (2013), the tailings material has average concentrations of 0.31 grams of gold per ton and 38.4 grams of silver per ton (see image VI.6). The project is designed to process a minimum of 5,000 tons of tailings a day. It also includes transport by truck to the reprocessing plant, located approximately 10 km south of the deposit (see image VI.5) (GoGold Resources Inc., n.d.), where gold, silver and copper are extracted by the cyanide heap leaching process (*Mexico Business News*, 2020). The gold and silver are then recovered from the cyanide solution through precipitation with zinc using the Merrill-Crowe process.[14] The tailings removal plan is a crucial part of the intervention. It is carried out according to the concentrations of the metals and consists of

[14] Dood, Duncan and Kuchling (2013). The high silver content in the ore makes the process more cost effective than a carbon pile or carbon-in-pulp process. The new sulfidization, acidification, recycling and thickening (SART) process plant removes copper and thus makes the use and recycling of cyanide for leaching more efficient.

detailed sampling to determine the extraction blocks, the schedule and the method for material removal (see image VI.7). Residue from the process is deposited near the plant.

Image VI.6
Extraction blocks by gold grade distribution in Parral tailings



Source: Dood, D., Duncan, D. and Kuchling, K. (2013). Parral tailings project: prefeasibility study. *Independent Technical Report 43-101*. https://www.miningdataonline.com/reports/Parral%20Tailings%20Project_02202013_PFS.pdf.

Image VI.7
Metallurgical complex of Industrial Minera México S.A. de C.V. in San Luis Potosí

Source: Prepared by the authors, on the basis of Google Earth, 2020.

According to the information gathered during the interviews with the experts (see annex A1), the company enjoys social acceptance, as it is an important source of employment for the local inhabitants and collaborates with the municipal authorities in social projects (Marker, 2022). From the environmental point of view, the company complies with the regulations set by the three levels of government. The primary factors for the project's acceptance are economic, relating to investments and job creation: 600 jobs were created during site preparation and construction, 150 during the project's operation and 50 during the close-down phase.

As of 2019, GoGold Resources Inc. had extracted over 6.5 million silver equivalent ounces from the Parral project and it remains one of the country's leading low-cost producers of silver. According to GoGold Resources Inc. (2019), the continued removal of tailings material and implementation of the closure plan will improve the landscape and air quality and decrease the exposure risks for the population of the city of Hidalgo del Parral.

In accordance with Mexican Official Standard NOM-155-SEMARNAT-2007, the processed tailings are neutralized to make up the occupied areas of the plant and allow for their rehabilitation in the future. Box VI.4 sets out the main lessons learned from this notable case.

Box VI.4
Main lessons learned from Parral

- One of the main technological factors behind the project's success is the detailed determination of how the concentrations of silver (Ag) and gold (Au) were distributed in the tailings. This allows optimizing extraction and transport to the plant and the use of state-of-the-art technology (best techniques available) for mineral processing (heap leaching plant equipped with the sulfurization, acidification, recycling and thickening (SART) system).
- Other factors include the creation of a significant number of local jobs, the very low price set for obtaining rights to the environmental mining legacy and the favourable prevailing economic conditions (the main mineral has a market value that makes its extraction worthwhile).
- Reprocessing is an additional industrial process that can have an impact on the plant area by generating waste and affecting the surface area, but its long-term effect is poorly understood.
- The sustainable use of the environmental mining legacy area has not yet been achieved, which means that its situation has not been fully resolved.

Source: Prepared by the authors.

4. San Luis Potosí, Mexico: urban revitalization of a remediated legacy and job creation[15]

Between 1892 and 2010, Industrial Minera Mexico S.A. de C.V. operated lead, copper and arsenic smelting plants in the city of San Luis Potosí. This led to the generation of metallurgical waste that affected the soil on the site. Over time, housing was built in the area around the plant and conflicts arose owing to the proximity between the sources of contamination and the population; this, together with the obsolescence of the facilities, led to the final close-down of operations in 2010. The first investigations into the legacy site date back to 1985 and the remediation measures to 1990 (General Directorate for the Integral Management of Hazardous Materials and Activities, Ministry of Environment and Natural Resources [DGGIMAR SEMARNAT], 2015; Government of Mexico, 2017).

The environmental mining legacies of Industrial Minera México S.A. de C.V. comprise: (i) contaminated and non-contaminated surface soils, (ii) hazardous industrial waste, estimated at 172,700 m^3, and (iii) two slag dumps, which are considered non-hazardous waste. Image VI.7 shows the company's installations, which cover a total of 600 ha (blue polygon in the image).

The remediation of the environmental mining legacy, which included the installation of a contaminated soil confinement system, was carried out from 2011 to 2017 in accordance with the standards and requirements established in Mexican law in force for the remediation of contaminated sites. The investments were made by Grupo México, a conglomerate that contributed a total of US$ 65 million for the interventions.[16]

Identifying the damage through a human health and ecosystem risk assessment and setting the limits for the remediation were essential in determining the quantity, depth and extent of soils for removal and confinement at the site. Using a physiologically based extraction test,[17] the risk of human ingestion and gastric absorption of contaminants was determined. Once the remediation limits for arsenic (190 parts per million), cadmium (229 ppm) and lead (547 ppm) were established, a total of 632,320 m^3 of soil were removed. Thus, a total surface area of 193 ha was remediated and prepared for safe use and future inclusion in urban development, for a final result of 432 ha remediated and ready for reuse.

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15 This section is based on information from the lecture "Rehabilitation of the site of former copper and arsenic plants in San Luis Potosí", given by Romero (2017), and from an interview with Miguel Ángel Galván Solís of Grupo México.

16 The investment amount includes the slag confinement and stabilization system and the preparation of the site for future use.

17 The test provides a method for determining remediation limits using bioaccessibility assays. The methodology has been approved by Mexican health and environmental authorities.

Prior to the intervention, the possibility of chemically stabilizing the contaminants was evaluated.[18] However, the alternative of soil removal and on-site confinement was chosen. In addition, an analysis was conducted of the stability of the slags consisting of silicate compounds, which, after formation, encapsulate arsenic, lead and other potentially toxic elements and do not allow them to leach under acid drainage conditions.

The intervention included the excavation and selective removal of contaminated soils. These activities were supervised and carried out with portable energy dispersive X-ray fluorescence equipment, which enabled the remediation limits in the removal and transport process to be monitored. The contaminated surface soils and hazardous wastes were deposited in landfills located to the north (5.7 ha and 740,000 m^3) and to the south (8.1 ha and 890,000 m^3) (see yellow area on image VI.7). The landfills were located above ground in the centre of the site, in accordance with waste management legislation. The two slag dumps, because of their chemical stability, did not require special confinement systems, and so a simple cover was authorized. In addition, the slopes were seen to have stabilized.

The control and mitigation of risks at the former Industrial Minera México S.A. de C.V. plant were the main reasons for the intervention. The reuse of the remediated property was a notable added value that is expected to offset the remediation investments.[19] The San Luis urban revitalization plan —which includes real estate projects, a wind farm, a water treatment and reuse system and the repurposing of historic industrial sites— is still pending and its implementation depends on the approval of the change in the area's land use for its integration into the urban fabric of San Luis Potosí.

According to an interview with authorities from Grupo México, the company is expected to allocate an initial investment of US$ 50 million to the development of primary infrastructure (such as roads, forestation, electric power and drainage) in the San Luis Plan urban project. It is also expected that more than 2,000 direct jobs will be created (a total of 20,000) and that 7,500 housing units for 30,000 inhabitants will be built over a ten-year period (Noticieros Canal 7 SLP, 2020).

The zinc refinery continues to operate in the north-central part of the Industrial Minera México S.A. de C.V. site.[20] The confinement areas are completed and the slag dumps are beginning to be integrated into what

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[18] Especially arsenic, on account of the oxidation and precipitation with barium observed in laboratory and pilot tests at the site.

[19] Thanks to the repurposing of the 432 remediated hectares and the sale of land to investors (construction companies), the investment is expected to be recovered five fold. These results are subject to the municipal government's approval of the urban land use change.

[20] Astrolabio (2020). The zinc plant has a permit from the Ministry of Environment and Natural Resources to continue operating until 2069.

was an administrative area. The legally required final verification sampling found that the remediation limits established for the future safe residential and commercial use of the entire remediated area had been met.[21]

The municipality's plan regarding the land use change to enable construction of a new real estate project (which is still under evaluation) confirms the willingness of the local government to support and approve the intervention. However, there are still criticisms from society and real estate developers (land owners) regarding emissions from the zinc plant and the competition that the real estate development poses to other interests. Acceptance by academia and civil society is still a matter for debate (Astrolabio, 2020).

Box VI.5 identifies the main lessons learned from this case study.

Box VI.5
Main lessons learned from San Luis Potosí

- The evaluation of remediation alternatives is an integral part of controlling health and environmental risk, and it was carried out in a comprehensive and cooperative manner among the different stakeholders (the company, the academic sector, the municipality and the authorities), in accordance with the specific legislation in force in Mexico. These factors are paramount, as they provide a secure foundation for remediation work, as well as confidence and security in the reuse of the large legacy that, prior to the intervention, posed a significant risk.
- Remediation by encapsulation does not completely eliminate the environmental mining legacy; it does, however, confine it safely for future generations. Its reuse for a real estate project is a crucial factor that can guarantee the economic feasibility and sustainability of the intervention. This type of intervention has not yet been implemented, as the municipal authorities have yet to approve the change of land use.
- The municipal government's interest in cooperating with the company in pursuit of urban development, added to the presence of the real estate market, are positive and central factors that can boost the repurposing of the legacy site.

However, some viewpoints are opposed to the real estate project. Undoubtedly, all the possible interests and factors must be considered and aligned in order to arrive at a comprehensive solution and ensure its long-term success.

Source: Prepared by the authors.

Table VI.1 summarizes the analysed cases and identifies, *inter alia,* the reason for remediation (risk control or economic reasons).

[21] For more information, see https://iresiduo.com/noticias/mexico/unam/17/08/30/san-luis-potosi-escenario-mayor-remediacion-suelos-mexico.

Table VI.1

Canada, Germany and Mexico: summary of data and characteristics of the environmental mining legacy management case studies

Environmental mining legacy	Country	Remediation agency	Investment in intervention	Size		General setting	Health and environmental risk assessment	Reason for intervention	Type of value added by the intervention
				Area *(Hectares)*	Volume				
Beythal	Germany	Association for Land Recycling and Remediation of Contaminated Sites (AAV) (public)	Ongoing. No information	45	11 million m³	Semi-urban or rural	Quantified	Risk control	Conversion into a protected natural area
Yankee Girl	Canada (British Columbia)	Agriculture and Agri-Food Canada (public)	C$ 6.5 million	6	360,000 tons	Semi-urban or rural	Quantified	Risk control and new public use	Post-remediation reuse as a recreational area
Keno Hill	Canada (Yukon)	Alexco Resources Corp. (private and voluntary)	More than C$ 10 million	No information	No information	Wilderness	Quantified	Risk control	Resumption of remediation in conjunction with exploration
Colomac	Canada (Northwest Territories)	Crown-Indigenous Relations and Northern Affairs Canada	No information	No information	No information	Wilderness	Quantified	Risk control	Use maintained
San Luis Potosí	Mexico	Grupo México (private)	US$ 65 million	432	1.63 million m³[a]	Urban	Quantified	Risk control and economic reasons	Confinement of the environmental mining legacy and total reuse of the site
Parral	Mexico	GoGold Resources Inc. (private and voluntary)	No information	80	21 million tons	Urban	Quantified	Risk control and economic reasons	Secondary silver mining, removal of environmental mining legacy and partial land reuse

Source: Prepared by the authors.

[a] Confinements, no slag.

B. Lessons learned from the notable cases outside the Andean region

1. Remediation programmes and institutional structures in the public sphere

In general, the management of legacy sites in Germany and Canada is carried out under the responsibility of the government —usually shared between the federal, provincial or State and municipal levels— and with public financial resources. Consolidated federal systems, such as those in place in Germany and Canada, distribute, share and decentralize powers and financial resources. In both cases, the enforcement of laws and the institutional framework or competent authority for environmental legacies are established at the State or provincial level, while federal laws set the general framework.

In the Canadian cases, the programmes and the role played by the public are notable. Financially well-supported programmes transfer resources to the relevant federal agencies, which, in turn, direct and disburse those resources in cooperation with provincial governments, according to the federal rules and regulations established for the remediation of contaminated sites by Environment and Climate Change Canada. For example, under phase II (2011–2016) of Canada's Federal Contaminated Sites Action Plan, a total of 1.225 billion dollars was handled and allocated on behalf of custodian federal agencies[22] (Government of Canada, 2017 and 2023b).

Notable at the provincial level in Canada is the Crown Contaminated Sites Program of the British Columbia Ministry of Agriculture and Lands, which handles sites without a responsible party in the province. The programme identifies and prioritizes sites for remediation by means of a risk assessment based on scientific methods, as was the case at Yankee Girl. Site remediation under the programme follows the federal rules and regulations set by Environment and Climate Change Canada (Government of British Columbia, 2020).

In Germany and Mexico, as well as at Keno Hill in Canada, different implementation models are used in which cooperation with the private sector is an important factor.

[22] For legacies located in the North (Yukon and Northwest Territories), the custodian agency is Crown-Indigenous Relations and Northern Affairs Canada, which is responsible for disbursing federal resources at the Colomac and Keno Hill remediation projects.

2. Public-private and private cooperative management models

As seen in the cases of Beythal in Germany, San Luis Potosí and Parral in Mexico and Keno Hill in Canada, different mechanisms exist to encourage the private sector's voluntary participation in remediation processes.

In Germany, the unfeasibility of the industry taxation model —whereby companies were obliged to contribute resources for legacy remediation (as under the Superfund programme in the United States)— became apparent in the 1990s. In response, the State of North Rhine-Westphalia adopted a public-private, multi-stakeholder cooperation model, implemented by AAV. The central idea of this model is the participation of State, municipal and private sector representatives in a cooperative management framework financed in a participatory manner by its public and private members.

The substantial voluntary participation of the private sector, whereby private actors contribute financial and technical resources, is motivated by the various benefits they stand to obtain. For example, AAV supports its private members with expertise and services in investigating legacy sites, selecting the appropriate techniques and planning remediations, as well as in discussions with the competent sectoral authorities. It may also assume guarantees through the Altlasten Risiko Fond, a legacy risk fund, in post-remediation processes. The role of AAV is crucial in enabling new land use, post-remediation obligations and the repurposing of legacy sites, most of which are brownfields or abandoned waste sites in urban environments (AAV, n.d.). Today, this mechanism —which relies heavily on private sector participation, investment and implementation— is the main driver of remediation in the State of North Rhine-Westphalia and other industrialized regions.

At the Beythal site, AAV is legally and technically responsible for the remediation measures, as it assumes responsibility for implementation in accordance with technical and legal standards. One notable feature of this intervention is that it is not privately financed: 100% of the resources come from the State. Likewise, the remediation's management and implementation is carried out jointly with public agencies: specifically the various ministries, the district government, the municipality and the State mining authority, which was, in principle, responsible for remediation.

Also significant is the work being carried out in Canada through the National Orphaned/Abandoned Mines Initiative. Founded in 2002, this initiative involves multiple actors at the national level and its actions include publicizing success stories, contributing studies and proposals for the development of legal frameworks and developing sectoral plans and management and funding models for legacy sites and mine closures in Canada. Unlike AAV, it has no mandate for undertaking remediation measures.

It takes action through working groups in six thematic areas (Tremblay and Hogan, 2006). It also brings together representatives from all levels of government, the productive sector, non-governmental organizations and Indigenous communities in an advisory committee to provide the country's mining ministries with support and information through studies, workshops, round tables, training and strategic legislative proposals (National Orphaned/Abandoned Mines Initiative [NOAMI], 2017).

Lastly, the experience in Mexico involves a leading role for the private sector, with strategies that potentially add economic value by reprocessing the ore and obtaining valuable products —such as gold and silver— or selling the remediated land as part of urban development projects. The interventions follow a market-oriented logic based on real estate values. Although there are no programmes or structures for the remediation of mining legacies in Mexico, there are recognized examples of publicly funded remediation projects at industrial and infrastructure legacy sites, backed by consolidated legislation that includes technical standards for the remediation of contaminated sites based on risk assessments (Schmidt, Flores and Ruiz, 2013).

3. Intervention strategies for environmental mining legacies

The main objective of intervention strategies for environmental mining legacies must be to control or mitigate the inherent risks to human and environmental receptors, irrespective of the type of technical measures adopted.

The case studies of interventions in Canada, Germany and Mexico were mainly motivated by the need to control socioenvironmental risks. In most of them, the aim was to contain and cover the surface of the waste and install hydraulic barriers (Yankee Girl, Keno Hill, Colomac and Beythal), to enable remediation supported by biological processes (Yankee Girl and Keno Hill), and to remove and encapsulate contaminated soils (Yankee Girl and San Luis Potosí). These measures are considered effective, as they prevent waste from emitting pollutants into the environment through contact, water flows and dust dispersion. Thus, receptors are distanced and protected from exposure to contaminants, and the socioenvironmental risk is controlled.

The reuse of remediated surfaces (following decontamination, containment or risk control) is a strategy that adds value to successfully completed interventions. This practice is very common in the revitalization of contaminated land and sites in urban environments. The reuse of contaminated surfaces requires that two conditions be met: first, the verification of the absence of risk for the new use (through a detailed risk assessment of the contaminated site) and, second, the existence of a real demand for the new use of the property, accompanied by favourable socioeconomic conditions that enable the site of the remediated, removed or secured environmental

mining legacy to be given a new use. Collaboration between civil society, the public sector and the private sector is essential to achieve win-win solutions. Cooperative models, such as the one used by AAV, are of the utmost importance in this process.

Successful examples of public investments that have led to environmental mining legacies being given a new use include Beythal (a naturally protected area) and Yankee Girl (a riverside recreational area). Although these cases involved no contributions from private investors, the participation of the population as the driving force behind the sites' protection and upkeep is a notable factor.

In both of the Mexican cases, and especially at San Luis Potosí, real estate development projects, with private investment, have been carried out on the sites of the environmental mining legacies. Both projects have the potential to become important drivers of legacy remediation and win-win situations that, under favourable conditions, will help cover remediation investments. The latter condition is generally found in populated, urbanized areas, where physical space is scarce and therefore valuable. In addition, as noted in the case of the San Luis Plan urban development project, interventions can also multiply the return on remediation investments.

At the same time, mining waste reprocessing strategies are mainly driven by economic considerations, as in Parral, Mexico, and in most cases in the Andean region. At Parral, for example, reprocessing is carried out in accordance with environmental criteria and the applicable regulations of the three levels of government. Another benefit of remediation is the reuse of secured or confined tailings areas and, above all, significant long-term job creation.

4. Management, social responsibility and participation

In Canada, social management and the participation of Indigenous Peoples are an integral part of the measures adopted by public authorities to promote and implement remediation projects. The existence of agencies such as Indigenous Services Canada and Crown-Indigenous Relations and Northern Affairs ensures compliance with the rights of First Nations peoples in remediation projects. This is essential, given that the Indigenous Peoples are the affected communities and, at the same time, share an important part of the responsibility for the governance of their territories and rights.

This can be clearly seen in the case of Colomac, where Indigenous Peoples play an integral role in the environmental monitoring and obtain benefits related to job creation and the promotion of the local economy through the local companies' contracting for remediation work. Similarly, at Keno Hill, Indigenous Peoples are part of the cooperative agreement on

the management of environmental mining legacies, alongside the federal and territorial governments and the company Alexco Resources Corp. (today Hecla).

5. Competences and legal framework for the management of environmental mining legacies

In Canada and Germany, the competent bodies responsible for implementing measures at environmental mining legacy sites are the environmental authorities at all levels of government; site owners, however, must also comply with their mine closure plans. Legacy management is based on specific legislation governing contaminated sites and a decentralized institutional structure that promotes the implementation of standards at the federal, State, territorial and even municipal levels.

The management of environmental mining legacies[23] in accordance with specific environmental laws governing contaminated sites is justified on the grounds that such legacy sites can be sources of contamination for soils, ground and surface waters, the atmosphere, fauna and flora. To handle such complex situations, a legal regulatory framework and specific tools are needed to address all the individual and combined risks they pose. At present, those rules are consolidated only as regards contaminated site management and are mainly applied in industrialized countries.

Central elements in managing environmental legacies that pose threats of soil or water contamination are shared legal and financial responsibility (joint and several responsibility) and the legal establishment of economic and cooperative instruments and models (for example, as at Beythal). Other vital elements include technical regulations or rules, covering standards for environmental quality, emissions and pollutant load or mass, and mandatory technical protocols for sampling, laboratory analysis and risk assessment.

Environmental quality standards,[24] intervention values and quantifiable and verifiable remediation targets are essential to ensure legal certainty, especially for voluntary investors assuming responsibility for remediating legacies, who need legally established and reliable targets to plan and protect their investment.

6. Innovative technologies for remediation and risk control

Conventional technologies are used for risk control and mitigation. At Beythal, for example, pumping and treatment of acid water and groundwater were used, while waste encapsulation was implemented in San Luis Potosí.

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[23] Including prioritization, investigation, risk assessment and remediation.
[24] For soils, water and air.

In addition, bioremediation technologies were applied at Yankee Girl and, at Keno Hill, the remediation plan called for the deployment of dissolved carbon to precipitate and remove cadmium and zinc from acid drainage water.

C. Analysis of case studies from the Andean region

The three cases selected in the Andean region, located in Chile and Peru, involve various physicochemical, environmental and socioeconomic characteristics. Their analysis reveals a moderate level of heterogeneity in the size of the operations, although at all three the responsible parties are volunteers from the private sector, as no examples of publicly funded remediation were considered. Likewise, the legacy sites' location between the urban and rural environments is a key factor in their potential for risk. Lastly, it should be noted that not all the interventions were aimed at risk control.

1. Andacollo, Chile: voluntary removal of tailings deposits, environmental health safety and community spaces

The Chilean commune of Andacollo, located in the Coquimbo Region, is notable for its problems with environmental mining legacies. The region has the largest amount of tailings in the country, many of which are concentrated in this commune. Within the urban radius and central perimeter of Andacollo there are approximately 90 historical tailings deposits, most of them abandoned (Araos, 2017).

In 2009, the Ministry General Secretariat of the Presidency declared Andacollo a saturated zone for particulate matter (PM_{10}),[25] which allowed the establishment of the Atmospheric Decontamination Plan for Andacollo and Surrounding Sectors.[26] According to the inventory of emissions, the second largest source of emissions in the urban area was the tailings deposits of the Compañía Minera Teck Carmen de Andacollo and Compañía Minera Dayton mining companies (Ministry of the Environment of Chile, 2014).

In addition, beginning in 2011, public-private agreements were entered into for the remediation of the tailings, including the voluntary removal described below and the remediation of other deposits abandoned by the Compañía Minera Dayton in the city (Fundación Chile, 2018; Oblasser, 2016). The Andacollo tailings were produced by the underground mining of copper and gold ore. In the 1950s, the processing plants, including mills, were located in urban areas and their tailings were deposited near human settlements. The proximity of the tailings to the population, together with the presence

[25] Decree No. 8 of 2009. https://ppda.mma.gob.cl/wp-content/uploads/2018/05/DS-8-2009-Zona-declarada-saturada-por-MP10-como-concentracion-de-24-horas-y-como-concentracion-anual-a-la-localidad-de-Andacollo-y-sectores-aledanos.pdf.

[26] The Atmospheric Decontamination Plan was established by Supreme Decree No. 59 of 2014.

of mercury and the fine granulometry of some of the tailings, posed a risk to human health, especially on account of the inhalation of contaminated dust (Araos, 2017; Fundación Chile, 2018).

The contaminant risk analysis conducted by Salinas, Rebolledo and Cortés (2011) concluded that the sites where the nine identified contaminants were present[27] did not pose an imminent health risk to children or adult residents of the Andacollo urban area and that, while immediate action was not necessary, it would be advisable to restrict access to the tailings deposit area in order to avoid excessive exposure to arsenic.

The voluntary intervention by Compañía Minera Teck Carmen de Andacollo involved a total investment of US$ 410,000 (Fundación Chile, 2018) and the removal of more than 255,000 tons of tailings covering an area of more than a hectare (Peralta and Gutiérrez, 2015). Several steps were conducted prior to this intervention: (i) the purchase of the property, (ii) the preparation and processing of the environmental impact statement, (iii) contracting the services of local companies, (iv) obtaining the sectoral environmental permits, (v) the adoption of occupational health and environmental measures, (vi) sanitary, legal and technical studies, and (vii) the development of designs for community infrastructure (Peralta and Gutiérrez, 2015). One key factor in the intervention was the cooperation between national, regional, local authorities and the company itself, which enabled the environmental permits (the environmental impact statement and the sectoral environmental permits) to be processed efficiently.

The removal of two tailings deposits from the Andacollo urban area[28] and their final disposal on the mining site of the Compañía Minera Teck Carmen de Andacollo reduced the population's exposure to particulate matter contaminated with mercury and other dangerous metals. In addition, the reuse of the land after the removal served to revitalize the landscape (see image VI.8) and to create community social and recreational spaces through the Andacollo Verde Project (Araos, 2017; Peralta and Gutiérrez, 2015). The initiative contributed to the appreciation of property values near the reclaimed lands (Peralta and Gutiérrez, 2015).

To continue with the removal of other tailings from the urban area, a study on emissions compensation instruments for corrective interventions was prepared (SISTAM Ingeniería, 2016), which included tailings removal. At Andacollo, the removal of the abandoned tailings in the city's urban core provided Compañía Minera Teck Carmen de Andacollo and Compañía Minera Dayton with an additional mechanism to achieve the particulate matter (PM_{10}) reduction goals set in the Atmospheric Decontamination Plan.

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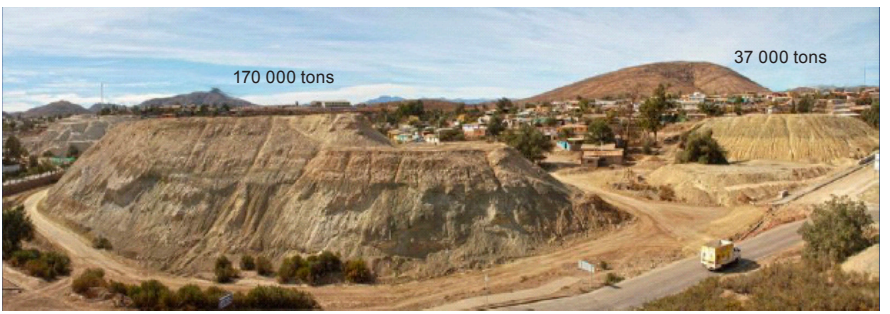
[27] The analysed contaminants were mercury (Hg), arsenic (As), cadmium (Cd), lead (Pb), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn).

[28] Peralta y Gutiérrez (2015). Identified as tailings U and tailings V.

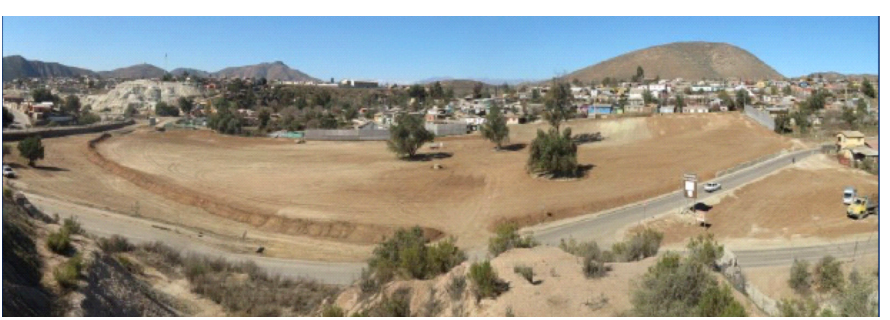
Image VI.8
Evolution of the new land use of tailings U and V after removal

A. 2011



B. 2012

C. 2013



Source: Peralta, C. and Gutiérrez, M. (2015). *Teck. Extracción de relaves Andacollo.* https://sangeronimo.files.wordpress.com/2015/09/ppt-teck-carmen-de-andacollo.pdf.

Box VI.6 lists the main lessons learned from this case study.

Box VI.6
Main lessons learned from Andacollo

- The agreement between the Undersecretariat of the Environment and the Compañía Minera Teck Carmen de Andacollo was fundamental in formalizing the voluntary initiative.
- Human health risk assessments were a crucial element in managing the environmental mining legacies located in urban areas. The conclusion regarding that risk was not completely clear, however, possibly owing to the absence of national standards for its evaluation.
- The intervention has a strong preventive component and made a major contribution to the improving the environment in a region identified as a priority on account of tailings and air pollution.
- The intervention is a good practice that can be replicated to relocate other tailings, as the removed material was safely disposed in the active tailings deposit of Compañía Minera Teck Carmen de Andacollo and reprocessing (secondary mining) is proposed as a future option.
- The reuse of the land for social and recreational purposes following removal was an added value.
- The development of an air emissions compensation instrument that is linked to investments in tailings removal could motivate the region's two mining companies to contribute to tailings remediation.

Source: Prepared by the authors.

2. San Rafael, Peru: tailings reprocessing, mine life extension and job creation

San Rafael is the main tin mine in South America and the fourth largest in the world (Minsur, 2025). Since 1977, it has operated as Minsur S.A. and has installed a tin processing plant. It currently mines tin ore at a rate of 66.97 tons a day (Minsur, 2025).

Tailings management, which began commercial operations in 2020, consists of reprocessing tailings from the B2 deposit, located in the southern part of the mine. The reasons for this intervention include the depletion of the tin reserves, the 2.05% grade of the concentrate and global metal prices (Huere, 2020), which generated a positive financial balance that boosted the strategy's implementation. Operation of the B2 project began in late 2019[29] and, by 2024, had produced 7,868 tonnes of concentrate (Minsur, 2025; *Revista Energiminas,* 2023). Tailings B2 covers some 35 ha, and the total stockpiled tailings reserve is estimated at 7.6 million tons, with a tin grade of between 1% and 1.5% (Huere, 2020).

The intervention, with an investment of US$ 209 million, involved removing the tailings using front loaders, transporting them to the reprocessing plant and processing the material (grinding, gravimetric separation and

[29] Construction began in 2018.

flotation) to obtain tin concentrate (Minsur, 2020). This initiative will yield 5,000 fine tons of tin per year for nine years (Institute of Mining Engineers of Peru, 2018).

Tailings from the reprocessing plant are placed in the B4 deposit (located south of B2), which has a basal confinement system with underdrain pipe, backfill material and geomembranes (bottom to top). The lake water above the tailings is recirculated to the reprocessing plant through a closed system. The use of ore sorting technology enables separation by means of x-ray transmission sensors, which detect the presence of tin inclusions and separate them with pneumatic ejectors, resulting in higher grades and higher levels of recovery in downstream processes. Once B2 is exhausted, it will be reused as a deposit for new tailings.

In terms of environmental impact, acid drainage was detected in the tailings, along with elevated concentrations of heavy metals as measured by the environmental quality standards for soil, groundwater and surface water, attributed to the nature of the parent material in the area. Regarding air quality, values above the environmental quality standards were also recorded in some parameters as a result of mining operations and the existence of exposed waste.

According to the Modification of the Environmental Impact Study of the Tailings Reuse Project at the Nueva Acumulación Quenamari Mining Unit –San Rafael (Ministry of the Environment of Peru, 2017), the following impacts were observed on the landscape during the operations stage: (i) moderate, (ii) moderate and reversible through the diversion of water courses, and (iii) moderate to significant caused by the lowering of the water table. No impacts from migration of chemicals through surface water and groundwater were detected. The potential impact from particulate matter emissions ($PM_{2.5}$ and PM_{10}) is considered to be low intensity, short term and reversible.

The implementation of the company's sustainability strategy is expected to reduce the impact footprint in the area over the next nine years, as it contributes to sustainable water use, reuse of the B2 tailings area after depletion and reduction and control of acid drainage,[30] as well as increased job opportunities for the community during project implementation (Huere, 2020). Specifically, the B2 project will provide some 120 jobs over the next few years.

The evaluation of the project's efficiency and effectiveness is based on the following expected and probable impacts:

- Reprocessing of tailings and waste rock dumps using state-of-the-art hydrometallurgical technology.

[30] The confinement of secondary tailings in suitable licensed tailings impoundments will reduce the acidic water by 90%, especially in the Cancha 35 tailings impoundment.

- Once depleted, the reuse of the B2 tailings impoundment as a deposit for new tailings will reduce the need to build new tailings dams and waste rock dumps, generating environmental and operational benefits.
- The economic and employment benefits derived from the extension of the mine's useful life.
- Environmental improvements associated with water management and acid water control in the process. Although the tailings will not be eliminated, but will instead be relocated to new deposits (specifically to the B4 deposit), they must be managed in accordance with the Mine Closure Plan.

3. Los Rosales, Peru: reprocessing of mining waste and support for neighbouring communities[31]

SMRL Acumulación Los Rosales is a Peruvian company that produces precious metals and is engaged in the reprocessing of 10 environmental mining legacies of the decommissioned Los Rosales mine[32] (owned by Minera Los Rosales). It operates under a processing concession that allows it to extract and concentrate gold from mine tailings, flotation tailings and waste rock (Canchanya, 2020).

The Los Rosales mine is located about 1.5 km northwest of the processing concession and its main products are copper, gold and silver (The Diggings, n.d.). The environmental mining legacies, created by primary ore processing, are located within the perimeter of the processing concession and comprise 160,000 m^3 of tailings deposited across an area of 4 ha.

The legacies pose the following potential risks: (i) acid drainage, (ii) erosion of historic tailings by rain and wind, and (iii) contamination of nearby livestock fields. The tailings and concentration plant are located at an adequate distance from human settlements, so it is unlikely that the population will be exposed to potential emissions from stored tailings and mine waste. According to the Geological, Mining and Metallurgical Institute, waste from Los Rosales may cause acid drainage and have a regional impact (Geological, Mining and Metallurgical Institute [INGEMMET], 2015). However, no specific evaluations or environmental risk assessments were conducted in the region's watersheds.

[31] Some information came from the 2020 interview with Jaime Canchanya and Oliver Huaman of Minera Los Rosales.

[32] Reprocessing rights have been granted with respect to 10 environmental mining legacies (3 in 2012 and 7 in 2014), out of a total of 19 (Ministry of Energy and Mines of Peru, 2012 and 2014).

The intervention involves removing the tailings and waste rock for processing in the adapted concentration plant. There, gold is extracted through a cyanidation process in agitation tanks, with a capacity of 120 tons a day.[33] The process generates tailings that are deposited in a tailings dam located near the site in accordance with current regulations. The project includes the recirculation of process water and the treatment of acidic water from historical tailings and mine tailings in a dedicated treatment plant (SMRL Acumulación Los Rosales, 2020a). Under the Closure Plan, the tailings will be encapsulated once they have been reprocessed.

Between 2021 and 2022, artisanal and small-scale miners signed three-year exploitation contracts with SMRL Acumulación Los Rosales. This enabled progress to be made with the formalization of mining workers by incorporating them into the formal economy.[34] In the long term, cooperation with the miners can ensure that ore reserves are processed in the existing plant. The citizen participation plan provides for participation by community and local authorities in performing environmental monitoring (SMRL Acumulación Los Rosales, 2020). At the time of writing, the implementation of the reprocessing is still in progress.

Box VI.7 sets out the main lessons learned from this case.

Box VI.7
Main lessons learned from Los Rosales

- The reprocessing uses the existing flotation plant, adapted for the gold extraction process.
- The benefits of reprocessing tailings for gold extraction will extend to the environmental remediation of the environmental mining legacies, which includes the treatment of acidic waters throughout the progressive closure of the legacies.
- The importance of participation by community and local authorities.
- As an extra added value, SMRL Acumulación Los Rosales, in partnership with the non-governmental organization Solidaridad Network, will support local informal mining groups in achieving formalization. In the long term, cooperation with the miners can ensure that ore reserves are processed in the existing plant.

Source: Prepared by the authors.

Table VI.2 summarizes a series of important features that justify the selection of the case studies and indicates the reasons why remediation was undertaken (risk control or economic considerations).

[33] A projected expansion of up to 340 tons a day is planned.

[34] For more information, see https://solidaridadlatam.org/news/mineros-artesanales-de-puno-firman-contrato-de-explotacion-con-smrl-acumulacion-los-rosales/ and https://www.gob.pe/institucion/minem/noticias/666975-mineros-artesanales-firman-24-contratos-de-explotacion-con-smrl-los-rosales-en-puno.

Table VI.2
Andean region: summary of data and characteristics of the environmental mining legacy management case studies

Environmental mining legacy	Country	Owner or occupier	Investment in intervention	Size		General setting	Health and environmental risk assessment	Reason for intervention	Type of value added by the intervention
				Area *(Hectares)*	Volume				
Andacollo	Chile	Compañía Minera Teck Carmen de Andacollo (private and voluntary)	US$ 410,000	1	257,000 tons	Urban	Quantified	Risk control	Removal of the legacy and partial land reuse
San Rafael	Peru	Minsur S.A. (private and voluntary)	US$ 209 million	35	7.6 million tons	Rural[a]	Qualified	Economic reasons	Secondary tin mining and inactive tailing removal
Los Rosales	Peru	Minera Los Rosales (private and voluntary)	No information	4	160,000 m³	Rural	Qualified	Economic reasons	Secondary gold mining and removal of the legacy

Source: Prepared by the authors.
[a] Meaning an area away from settlements or sparsely populated.

D. Conclusions

Sixteen lessons were drawn from the analysis and, while they cover only part of the study's scope, they provide valuable information on strengths, weaknesses, opportunities and challenges related to the management and remediation of environmental mining legacies.

It should be noted that the cases' replicability and relevance may be limited in institutional and legal contexts different from those of the Andean region. In fact, in the reviews carried out, the projects' success cannot be dissociated from the institutional and legal framework of each country, which hampers the replication of the lessons learned from countries outside the region. A distinction is therefore drawn between the lessons learned from individual or local interventions and those resulting from the countries' institutional and regulatory structure.

In the Andean region, the replicability of successful cases of mining waste reuse by extracting valuable substances has great potential, especially when undertaken by owners of large-scale mining operations with state-of-the-art technology. At the same time, the conditions that allow the voluntary repurposing of environmental mining legacies —through either reprocessing or site reuse— must be reviewed, as their review would enable a better structuring of the responsibilities, environmental criteria and feasibility assessment methodologies.

Private sector participation in managing and financing the remediation of environmental mining legacies also shows promise throughout the Andean region, particularly through individual Good Samaritan interventions. This type of initiative is based on public-private contracts that limit voluntary remediators' liability, especially in countries without legislation on voluntary remediation. The adoption of cooperation models to promote and efficiently fund the remediation of environmental mining legacies and the participation of private investors in the restoration of legacy sites is a goal with medium- and long-term potential.

Although no cases of publicly funded remediation were studied, institutional frameworks and State promotion and financing programmes play an important role as drivers of remediation. In Peru, for example, the company Activos Mineros S.A.C. was created to remediate the nation's priority legacy sites with resources from the National Environmental Fund and the Ministry of Energy and Mines, and there are mechanisms that allow private companies to participate in remediation.

Generally, the environmental authority is the institution in charge of remediating environmental mining legacies in countries outside the Andean region, such as Canada, Germany and the United States. The existence of

a well-structured environmental institutional framework, decentralized at the different levels of administration and endowed with adequate financial resources, is clearly vital.

Civil society participation is another essential factor. Some of the lessons learned can be replicated in the Andean region, but this depends on the structure, internal training, and financial and legal conditions of each non-governmental organization and on the individual countries' economic situation and social cohesion. For a case to be fully successful requires further development of social links between the remediating entity and society (for example, access to information and participation).

Innovative remediation and risk control technologies with potential for replicability include bioremediation, used at the Yankee Girl site, and the application of dissolved carbon to precipitate and remove cadmium and zinc from acidic drainage water, as in the Keno Hill remediation plan. Remediation by biological processes is particularly suited for replication in the Andean region. In addition, the slag and contaminated soils confinement and securing project in San Luis Potosí, Mexico, demonstrates that major real estate projects can be developed on land affected by legacy sites and generate economic returns. However, technological issues —such as mining waste reprocessing technologies— need to be addressed in more detail, as these are mainly technical and scientific matters.

The replicability conditions described in the previous sections are broad and tend to generalize the situation on the ground. It should be noted that economies that depend on the exploitation of natural resources and commodities face challenges in balancing economic gains and employment, on the one hand, with the protection of the environment and public health, on the other. In recent years, spending on environmental protection has been very low in all the countries of Latin America and the Caribbean: between 2016 and 2019, it barely averaged 0.4% of central government spending and, in 2020, it fell to 0.2% (ECLAC, 2022).

Replicating lessons learned requires consolidated legal, institutional and technical standards that guarantee environmental and health sustainability and protect the health of the population and natural resources. The successful cases of environmental mining legacy remediation analysed in this chapter reveal challenges as well as achievements and, consequently, opportunities to guide the next steps in the Andean region.

Lastly, table VI.3 below describes these lessons, organized into five thematic groups:

(i) Revaluation as part of the remediation process.

(ii) Private sector participation in the management and financing of remediation.

(iii) Importance of the institutional framework and of development and financing programmes.

(iv) Social management and civil society participation.

(v) Good practices and technologies applied to remediation and risk control.

Table VI.3
Compilation of lessons learned, grouped by thematic area

Lesson	Description
1. Revaluation as part of the remediation process	
1	Controlling the risk posed by the environmental mining legacy and adding additional economic value to the remediation measure constitute success factors. The reprocessing of tailings at ore processing plants that are already installed or can be adapted is a logical solution that can generate economic gains for the owner and reduce the impact of the existing environmental mining legacy (removal from a vulnerable setting and relocation to a reprocessing plant). Reprocessing also involves the principle of efficient natural resource management through recycling.
2	Reprocessing can generate social and environmental impacts, and a licence issued by the authorities is therefore generally required. The potential impacts of environmental mining legacy reprocessing have not yet been comprehensively assessed. According to the United States Geological Survey, no globally consolidated methodology currently exists that balances the economic benefits of reprocessing and its impact. In that regard, the following factors must be considered: (i) the cost-benefit ratios of reprocessing and of remediation by stabilizing or securing, (ii) secondary impacts, such as the long-term safety of new (secondary) tailings, and (iii) the ecological footprint of the process in terms of energy consumption, transport and the use and occupation of unoccupied greenfield sites. The long-term impacts of the intervention acquire greater relevance when the waste or tailings are removed from urban settings, trucked to a dedicated plant and reprocessed there. Benefits to the public, such as partial and sequential risk elimination and job creation, must always be assessed transparently.
3	Reprocessing requires highly efficient technologies that often demand more energy and inputs. In general, large companies have access to state-of-the-art technologies and use the best available mineral processing practices. In contrast, small and medium-sized producers face more difficulties in using reprocessing technologies at their legacy sites. The final assessment of the feasibility of those technologies must, however, be made on a case-by-case basis.
4	The reuse of the legacy's surface area following intervention is another important mechanism for the revaluation of environmental mining legacies, as it can generate both economic gains and urban and social benefits. Undoubtedly, the legacy's urban and residential context is an essential factor that encourages repurposing or reuse and makes it possible. On the one hand, the need to control risk is high because of the nearby human settlements and, on the other, the repurposing of the remediated land can generate urban or economic gains. The reuse of a legacy's surface area is a multi-stakeholder process that requires a significant degree of cooperation between environmental authorities, municipal urban planning offices, the private sector and investors. Cooperative models focused on revitalization are of great importance in this process. Non-commercial revitalization efforts can generate community benefits by creating public, recreational and protected natural areas. Such initiatives are excellent examples of environmental mining legacy management; however, their implementation depends on inter-institutional agreements addressing such issues as land use change and the business model to be used for upkeep.

Lesson	Description
5	One precondition for the adoption of broader policies covering the reuse of mining sites and brownfields is the existence of legal regulations that: (i) regulate and guide risk management, (ii) set remediation goals based on the site's contamination and intended use, and (iii) transparently communicate the risks of remediation to the population to encourage their acceptance of the intervention. Transparency and community involvement from the very start of the intervention are critical to its success.
6	Often, the reuse of environmental mining legacies or remediated contaminated land in rural or sparsely populated settings has no revaluation potential owing to lack of demand. However, freed-up spaces on the mine site can be managed and given new uses.
2. Private sector participation in the management and financing of remediation	
7	The participation of the private sector in cooperative models for the governmental management and financing of legacies is important. Cooperation among stakeholders and at the inter-institutional level must be encouraged. Private sector participation in formulating policies and setting priorities must also be promoted, along with financial contributions from the private sector.
8	Most voluntary actions carried out under public-private agreements or specific legislation usually involve decision-makers from the private sector seeking economic gains through the reprocessing of abandoned or inactive tailings, which ensures the added value of benefits for the environment. Limitation of liability for historical damage and impacts inherent to environmental mining legacies can be included in public-private agreements that establish shared responsibility for remediation between the company and government agencies. Instruments and standards are indispensable for creating liability regimes that guarantee legal certainty. The absence of legal certainty against possible future environmental claims from the authorities reduces the Good Samaritan's motivation to invest in legacy remediation.
9	The revitalization of contaminated land through voluntary remediation, generally by private actors, can generate economic gains. Efforts must be made to ensure that there are no risks for the new use and to develop standards, tools and protocols based on a specific environmental legal framework for contaminated site management. The legal protection that determines current environmental legacies and limits future ones is crucial to provide investors with guarantees. Cooperative instruments and models support this process and provide investors with legal, institutional and financial backing.
10	Remediation carried out by a company that has mining exploration as its core business, has proven experience in the environmental remediation of legacy sites and uses innovative, state-of-the-art technology is particularly valuable. Technical competence in remediation contributes greatly to the feasibility of a voluntary action as regards environmental and legal risk.
3. Importance of the institutional framework and of development and financing programmes	
11	In Canada, Germany, Mexico and the United States, the management of environmental mining legacies is based on the specific environmental legislation governing contaminated sites. Legacy sites can pollute soils, ground and surface waters, the atmosphere, flora and fauna. To handle such complex situations, regulatory frameworks and tools are developed that can be applied to the management of contaminated sites in general. In line with the above, countries with federal structures distribute, share and decentralize powers and financial resources. The enforcement of laws governing environmental mining legacies is the responsibility of the competent institutions or authorities at the State or provincial level, while federal laws set the general framework. This provides an efficient, decentralized system, but technical and administrative skills at all levels are required.
12	Canada's remediation programmes, which have sound financial support and are based on laws governing contaminated sites, transfer resources to the federal agencies with territorial competence, which then manage and disburse the funds in collaboration with the provincial governments. Programmes also exist at the national level, which provide resources for the remediation of legacy sites, including environmental mining legacies.
13	The promotion and financing of cooperation models —the most recent management mechanisms— require a high degree of willingness and negotiation. Since they involve several stakeholders, such models allow for a higher level of private sector participation and inter-institutional cooperation. In addition, the experiences presented show that cooperation models can manage and finance remediation or encourage the remediation process by supporting cooperative structures, drafting legislation, managing information, providing professional training and advising authorities. These are examples of good practices related to efficient participation by public and private actors.

Lesson	Description
4. Social management and civil society participation	
14	The participation and empowerment of Indigenous and local communities are fundamental to the remediation of environmental mining legacies. Communities should be involved in all phases of the process (including post-remediation monitoring) and benefit from professional training, job creation and increased local economic activity as a result of the intervention. The participation of small-scale miners' collectives in reclamation processes should be part of a strategy to generate social benefits and promote both their training and formal organization.
15	Civil society organizations must play a leading and articulating role, since it is they who report environmental problems, jointly monitor the measures adopted and provide the community with information on the subject. They are also important promoters of mining memory and the preservation of mining historical heritage. For example, the conversion of abandoned mines into museums is an interesting contribution that, while not a financing instrument for remediation, adds value to environmental mining legacies. Notable in this regard are cultural initiatives undertaken by non-profit organizations, which need substantial financial contributions to survive.
5. Good practices and technologies applied to remediation and risk control	
16	The cases presented include few examples of the use of innovative technology in the remediation of environmental mining legacies. The use of chemical and biological processes in the Yankee Girl and Keno Hill remediation projects in Canada is notable. Methods and technologies that aim to reconcile risk control with the future use of contaminated land, as in the case of San Luis Potosí in Mexico, require complex interventions, combining confinement, stabilization, groundwater decontamination and usage restrictions. This is an emerging topic of great interest, and it should be explored further in specific studies and its applicability should be evaluated on a case-by-case basis.

Source: Prepared by the authors.

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Chapter VII

Conclusions and recommendations

The right of citizens to live in a healthy and pollution-free environment obliges the State to prevent environmental impacts caused by industrial or mining activities and to eliminate threats to people and the environment. The analyses presented in this book show that the continued presence of environmental mining legacies in the region, particularly in the Andean countries, is the result of accumulated shortcomings in regulations, institutional frameworks and the planning and financing of mine closures, rather than a structural incompatibility between mining and sustainability.

Mining has been and continues to be a strategic sector for the region's economic development and makes significant contributions to gross domestic product, employment and exports. However, its historical evolution —characterized by inadequate regulatory frameworks and limited oversight capacities— has led to the creation of a large number of environmental legacies that affect territories, ecosystems and communities and represent a growing public policy concern.

This book describes how those countries that have steadily reduced their legacies have adopted comprehensive regulatory frameworks, clear operational definitions, standardized risk assessment methods, robust inventories and stable funding mechanisms. The comparison of those experiences shows that regulatory clarity, institutional coherence and continued efforts are key factors for the effective management of environmental mining legacies.

The Andean region still faces significant challenges in this regard. The coexistence of multiple definitions of legacies and methods for assessing and systematizing risk makes it difficult to compare and prioritize them.

National inventories have gaps in their coverage and updates, and institutional responsibilities are often fragmented among environmental, mining and territorial agencies. This limits both prevention —based on environmental impact assessments, financial guarantees and closure plans— and corrective interventions. Overcoming those limitations requires specific and comprehensive regulatory frameworks designed to offer legal certainty and clearly guide the actions of the State and the private sector.

The allocation of responsibilities is essential to apply the "polluter pays" principle and to carry out the subsequent remediation work. For determining who should assume the remediation of environmental mining legacies, systems exist that use both fault- or negligence-based liability (subjective liability) and strict or risk-based liability (objective liability). In general, the industrialized countries have chosen the option of risk-based liability.

Risk assessment is also a key element in plan design, prioritization and resource allocation. International experience shows that complete, interoperable and publicly accessible inventories that are associated with rigorous risk analysis methods enable the detection of the most critical sites and the optimization of government interventions. Although the Andean region's inventories are partial, outdated or non-existent, around 12,000 environmental mining legacies have been inventoried. Accordingly, the generation, management and transparency of information must be strengthened to promote data-driven decision-making.

Financing is another strategic component, since the challenge of funding cannot be met by means of a single mechanism. Effective models combine public resources from general revenues, levies imposed on the mining sector, financial guarantees to avoid the creation of new legacies, public-private partnerships and incentives for voluntary participation. The remediation of orphaned legacies requires stable and predictable public funds, and well-designed closure guarantees are essential to ensure prevention. The stability of resources is particularly important, since remediation processes require technical, administrative and budgetary continuity over time. The aim of the financing system must be to put an end to the accumulation of environmental mining legacies within a reasonable time. The existence of a prioritized inventory of the legacy sites to be remediated is therefore important, along with an estimate of the resources needed to undertake the remediation actions.

Climate considerations must also be incorporated into environmental mining legacy management policies. The rise in extreme weather events associated with climate change increases the risk of structural failures, erosion and contaminant dispersion; accordingly, adaptation measures, scenario analyses and the strengthening of territorial resilience must be included in closure and remediation plans.

The case studies examined in this book show that remediation has a transformative potential when linked to territorial development strategies, the promotion of the circular economy and productive reconversion. Secondary mining, waste reprocessing and repurposing of remediated land can create local jobs, boost regional economies and facilitate new uses for communities, provided they are carried out under strict environmental standards.

Environmental governance is a cross-cutting issue. In addition, transparency, access to information and citizen participation strengthen the legitimacy of decisions, help to prevent conflicts and facilitate the implementation of complex interventions. The effective observance of the commitments set out in the Escazú Agreement represents an opportunity to consolidate a more inclusive, open and sustainable model for the management of environmental mining legacies and for preventing the creation of new ones.

In view of the above, progress should be made with the development of a strategic agenda to manage environmental mining legacies that includes the following elements:

- Comprehensive regulatory frameworks with clear definitions, risk assessment systems, well-defined responsibilities and standardized procedures.
- Strengthened institutions with precise mandates, adequate technical capacities, effective oversight and mechanisms for inter-institutional and intergovernmental coordination.
- Updated and interoperable national inventories that include risk assessments and are accompanied by transparent public information.
- Diversified and stable financing systems that combine public funds, sectoral instruments, robust financial guarantees and public-private partnerships.
- The systematic inclusion of climate risk management in closure and remediation planning.
- The promotion of secondary mining and the circular economy as complementary mechanisms to reduce risks and generate territorial value.
- Effective citizen participation, risk communication mechanisms and the inclusion of local and Indigenous communities.
- Specific policies for small-scale mining and for informal and illegal mining, combining technical assistance, incentives for formalization, gradually enforced environmental standards and measures to punish environmental crimes.

In this way, the Andean region's countries will be able to move towards a more effective and transparent management of their environmental mining legacies, in keeping with the principles of sustainable development. Legacy remediation is not only an environmental obligation: it also offers an opportunity to strengthen institutions, promote social cohesion and foster a more balanced relationship between mining, territories and well-being.

Annex A1

Table A1.1 contains a list of the experts and institutional representatives consulted for the selection of the notable cases of environmental mining legacy management and remediation.

Table A1.1
Experts and representatives consulted

Country	Name	Institution	Information gathered by
Argentina	Leonardo Pflüger	Environment Undersecretariat of the Ministry of the Interior	Email
Bolivia (Plurinational State of)	Ana María Aranibar Jiménez	Cumbre del Sajama	Document
Chile	Eduardo Zúñiga Acosta	Ministry of Mining	Interview
	Angela Oblasser	Fundación Chile	
	Grecia Pérez de Arce Jaramillo	Consultant at the Economic Commission for Latin America and the Caribbean (ECLAC)	
Spain	Vicente Gabaldón	Association of Iberoamerican Geological and Mining Surveys	Interview
Mexico	Lilia Aidé González Bermúdez	Grupo Coanzamex, S.A. de C.V.	Document
	Ulises Ruiz Saucedo	Former Ministry of Environment and Natural Resources	Interview
	Miguel Ángel Galván Solís and David Buchan	Grupo México	
Peru	Gaby Palacios Valdivia and Katherine Matos Meza	Ministry of Energy and Mines – General Directorate of Mining	Interview
	María Chappuis	ECLAC Consultant	
International organization	Members of the Expert Group on Environmental Mining Legacies	Association of Iberoamerican Geological and Mining Surveys	Presentation and interview
		Latin American Network for the Prevention and Management of Contaminated Sites	Email

Source: Prepared by the authors.

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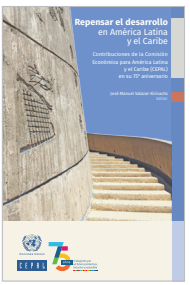

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Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean: guide on gender mainstreaming

Gobernanza endógena: teoría, datos y herramientas para salir de la trampa de gobernanza poco efectiva en América Latina

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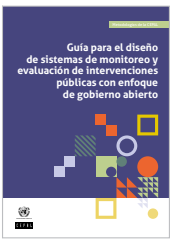

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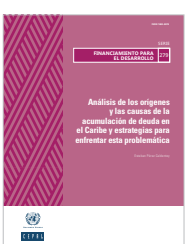

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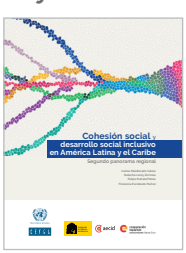

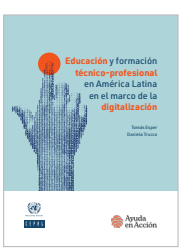

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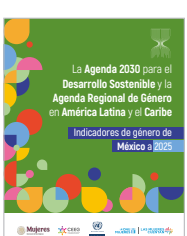

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Extractive activities are a driver of economic growth in many Latin American and Caribbean countries. For that growth to be inclusive and sustainable, however, past and future risks and pressures that affect the health of people and the environment need to be properly managed.

This book provides an overview of the risks and damages that have become environmental legacies and offers examples of how economic activities can generate a negative environmental legacy if robust regulatory and institutional frameworks are not in place. It also analyses mechanisms for assigning responsibilities and proposes alternatives for financing the remediation of environmental legacies and contaminated sites.

It argues that the remediation of an environmental legacy must be geared toward controlling risks and must involve effective, timely and transparent community participation. Remediation should also help to increase the economic value of contaminated sites, create jobs, expand land use possibilities, provide urban and social benefits and improve the protection of nature.

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