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ORIGINAL RESEARCH PAPER

Comparative Environmental Regulation of Mining and Oil and Gas Industries in Iran

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A B S T R A C T

The expansion of extractive activities in Iran's mining and oil and gas sectors has created significant challenges for environmental protection and sustainable development. Within the field of environmental and energy law, regulatory frameworks governing extractive industries play a critical role in balancing resource exploitation with environmental protection and legal accountability. Using a descriptive analytical methodology and a comparative legal approach, this study examines the environmental regulatory framework governing Iran's mining and oil and gas industries, with particular attention to the relevant statutory provisions, regulatory institutions, and environmental compliance mechanisms. The analysis assesses key legal instruments, including the Environmental Protection and Enhancement Act, the Mining Law, and sector specific regulatory mechanisms governing environmental impact assessment and environmental oversight. The findings demonstrate that the oil and gas industry benefits from greater institutional coherence due to centralized governance structures, stronger regulatory capacity, and the gradual integration of intelligent monitoring technologies. By contrast, the mining sector is affected by institutional fragmentation, limited data transparency, and weaknesses in environmental enforcement mechanisms. The study further shows that digital transformation, artificial intelligence, and ESG oriented regulatory frameworks are increasingly reshaping environmental regulatory practices in extractive industries. It concludes that achieving sustainable resource extraction in Iran requires strengthening sector specific environmental regulation, improving institutional coordination, and enhancing regulatory enforcement mechanisms within the legal framework governing extractive activities.



1. Introduction

Extractive industries constitute a major foundation of economic development in resource-rich states and play a central role in energy security, industrial growth, public revenue generation, and national development planning. Yet large-scale extraction activities are frequently associated with substantial environmental risks, including ecosystem degradation, biodiversity loss, soil erosion, greenhouse gas emissions, water contamination, and long-term ecological disruption [1]. These environmental risks have led to increasing emphasis in environmental law scholarship on the development of effective regulatory frameworks capable of ensuring that resource extraction occurs within enforceable environmental safeguards and institutional oversight

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mechanisms [2,3].

In this context, sustainable resource extraction refers to the legal regulation of extractive activities through statutory environmental obligations, environmental impact assessment procedures, compliance monitoring, and enforceable supervisory mechanisms designed to control environmental risks associated with resource exploitation [4].

The analysis therefore concentrates on the statutory and institutional mechanisms through which environmental protection is implemented within Iran's extractive sectors, including licensing procedures, environmental impact assessment (EIA), regulatory supervision, and enforcement guarantees [5].

In Iran, the environmental regulation of extractive activities is embedded within a multi-layered legal framework. Article 50 of the Constitution of the Islamic Republic of Iran establishes environmental protection as a public duty and prohibits activities that result in environmental degradation [6]. At the statutory level, the Environmental Protection and Enhancement Act of 1974 provides the primary enforcement mechanisms for environmental protection. Under Article 11 of this Act, the Department of Environment (DOE) may issue formal warnings to industrial operators whose activities cause environmental pollution and may order the suspension of operations if corrective measures are not implemented within the prescribed period. Article 12 further establishes criminal liability for non-compliance with such orders, providing for imprisonment or financial penalties in cases where operators continue environmentally harmful activities without authorization [7,8].

Sector-specific regulation of mining activities is primarily governed by the Mining Law of 1998 (as amended). Article 24 of this law requires governmental bodies to provide environmental and land-use clearance before exploration licenses are issued in protected areas or environmentally sensitive zones. These requirements are complemented by the Environmental Regulations for Mining Activities adopted in 2005 pursuant to Article 35 of the Mining Law [9-10].

The 2005 Regulations introduce more detailed environmental compliance obligations. In particular, Article 5 requires the preparation and approval of an Environmental Impact Assessment (EIA) report for several categories of mining projects exceeding specified extraction thresholds, including copper mines with an annual capacity of one million tons, iron ore mines exceeding six hundred thousand tons, and gold mines regardless of production capacity. Furthermore, Article 6 obliges mining operators to undertake environmental restoration and land reclamation measures at the end of the mine's operational life [10].

Despite the existence of these regulatory instruments, academic studies continue to highlight concerns regarding institutional fragmentation, overlapping regulatory authority, limited transparency of environmental data, and inconsistencies in the enforcement of environmental standards within extractive industries [11,12]. Existing research has frequently examined environmental protection in the mining and petroleum sectors separately or has focused primarily on general environmental principles rather than the detailed legal structure of sector-specific regulatory frameworks [11-13].

This gap in the literature underscores the need for a systematic comparative legal analysis of environmental regulation across Iran's extractive industries. Accordingly, this article adopts a descriptive-analytical and comparative legal methodology to examine the environmental regulatory frameworks governing Iran's mining and oil and gas sectors. The analysis evaluates the interaction between general environmental legislation, sector-specific mining regulations, and institutional enforcement mechanisms.

The originality of this research lies in three principal dimensions. First, it provides a comparative legal assessment of environmental regulation in both mining and petroleum sectors within a single analytical framework. Second, it links statutory environmental obligations _such as EIA requirements and restoration duties _with enforcement mechanisms provided under environmental legislation. Third, it evaluates the emerging role of digital monitoring technologies and ESG-oriented regulatory tools in strengthening environmental oversight within extractive industries.

This study focuses on the effectiveness, coherence, and enforceability of environmental regulation in Iran's extractive sectors. Section Three examines the legal frameworks governing mining and oil and gas activities. Section Four analyzes institutional coordination challenges and supervisory mechanisms. Section Five presents conclusions derived from the comparative analysis and proposes legal and policy recommendations for improving environmental regulation in Iran's extractive industries.

1.1. Environmental Regulation in Extractive Industries

Environmental protection in extractive industries is primarily structured through regulatory law, which defines binding obligations for operators, allocates supervisory authority to public institutions, and establishes enforceable compliance mechanisms. From a regulatory perspective, environmental effectiveness is not determined solely by the existence of environmental norms, but by the clarity of statutory mandates, the coherence of institutional competences, and the availability of administrative and legal enforcement tools [14].

Environmental regulation in resource-based industries typically operates through three interrelated components: substantive obligations, procedural mechanisms, and enforcement guarantees. Substantive obligations include environmental standards, pollution-control duties, and land-restoration requirements. Procedural mechanisms include licensing systems, environmental impact assessment procedures, and reporting obligations. Enforcement guarantees include administrative sanctions, suspension or revocation powers, civil liability, and criminal accountability [15].

Where regulatory systems lack effective enforcement structures or clear institutional coordination, environmental norms may remain formally valid but practically ineffective. Accordingly, regulatory performance must be assessed not only at the level of legislative design but also in terms of institutional capacity, supervisory continuity, transparency of regulatory processes, and the practical enforceability of environmental obligations [16].

These considerations are particularly significant in extractive industries. Mining and petroleum operations involve long-term ecological risks, complex industrial infrastructures, and multiple regulatory authorities. Their environmental consequences often extend beyond the operational life of projects. Environmental regulation in these sectors must therefore ensure preventive control before operations commence, continuous supervision during operations, and liability and remediation mechanisms after environmental harm occurs [17].

In legal systems characterized by dispersed administrative authority, overlapping supervisory competences may generate regulatory fragmentation and weaken accountability. The central analytical question is therefore not merely whether environmental rules exist, but whether regulatory competences are coherently structured and effectively enforceable within the institutional framework governing extractive activities [17].

1.2. Principles of Sustainable Extraction

The concept of sustainable extraction derives from the principles of sustainable development and intergenerational equity, according to which the exploitation of natural resources must be conducted in a manner that preserves environmental capacity for future generations [18]. In regulatory terms, this concept is expressed through legal principles that guide administrative decision-making, shape operator obligations, and justify preventive and corrective intervention by public authorities [18].

Among the principal legal foundations of sustainable extraction are the principles of prevention, precaution, environmental impact assessment, and the polluter-pays principle. These principles perform both normative and operational functions. They require environmental risks to be identified before extractive activities commence, harmful impacts to be minimized during operations, and responsibility for environmental damage to be assigned to the operator where harm occurs [19].

These principles are formally reflected in the Iranian legal framework. Under the Environmental Protection and Enhancement Act, environmentally harmful activities fall within the supervisory authority of the Department of Environment [7]. In addition, sector-specific legislation governing extractive industries incorporates environmental obligations into operational authorization processes. The Mining Law requires compliance with environmental standards and relevant regulatory approvals, while the legal framework governing petroleum activities integrates environmental considerations into operational and resource-management duties applicable to oil and gas projects [9,20].

However, the legislative incorporation of environmental principles does not automatically ensure effective implementation. In practice, environmental regulation in extractive industries may be shaped by competing economic priorities, fragmented institutional authority, limited monitoring resources, and difficulties in technical compliance assessment. As a result, the effectiveness of sustainable extraction depends not only on the formal recognition of environmental principles, but also on the institutional capacity to apply and enforce them consistently [16].

2. Method

2.1. Methodology

This study adopts a descriptive-analytical and comparative legal methodology to examine environmental regulation in Iran's mining and oil and gas sectors.

The research is based on doctrinal analysis of constitutional provisions, statutory legislation, implementing regulations, and institutional supervisory arrangements governing environmental protection in extractive industries.

The first stage of the analysis identifies the principal environmental obligations and regulatory mechanisms embedded in Iran's general environmental legislation and in sector-specific legal frameworks. Particular attention is given to licensing requirements, environmental impact assessment procedures, supervisory powers, and enforcement provisions.

The second stage consists of a comparative sectoral analysis of the mining and petroleum industries. This comparison focuses on the structure of environmental obligations, the allocation of regulatory authority, and the design of monitoring and enforcement mechanisms in each sector.

The third stage evaluates the practical coherence of the regulatory framework by examining how general environmental legislation interacts with sector-specific rules and institutions. In this regard, the study considers whether the distribution of administrative competences supports effective environmental oversight or instead contributes to fragmentation, overlap, and weakened enforcement.

2.2. Analytical Framework for Evaluating Environmental Regulation

In order to evaluate the effectiveness of environmental regulation in Iran's extractive industries, this study employs an analytical framework based on four core regulatory dimensions. Rather than focusing solely on the formal existence of environmental provisions, the framework examines how regulatory systems structure environmental obligations, allocate institutional authority, and ensure monitoring and enforcement. These dimensions also provide the basis for the comparative assessment of the mining and oil and gas sectors.

First, regulatory obligations are examined in order to determine whether sectoral legislation establishes clear and enforceable environmental duties for operators, including environmental impact assessment requirements, pollution-control obligations, land rehabilitation duties, and reporting requirements.

Second, institutional allocation of authority is assessed by examining how supervisory responsibilities are distributed among environmental authorities, sector-specific ministries, and licensing bodies, with particular attention to institutional coordination and potential overlaps in jurisdiction.

Third, monitoring and supervisory mechanisms are analyzed to determine whether the regulatory system provides continuous environmental oversight through inspection procedures, reporting systems, and supervision of environmental impact assessment implementation.

Fourth, enforcement mechanisms are evaluated by reference to the legal tools available to secure compliance, including administrative sanctions, operational restrictions, suspension or revocation of licenses, and environmental liability mechanisms.

Together, these dimensions form a regulatory effectiveness matrix through which the study compares the environmental regulatory frameworks governing Iran's mining and oil and gas sectors and identifies the structural factors affecting the practical effectiveness of environmental protection

3. Result and Discussion

3.1. Environmental Regulation in Iran's Mining Sector

Environmental regulation of mining activities in Iran is primarily governed by the Mining Law of 1998 (as amended), its implementing regulations, and the Environmental Protection and Enhancement Act of 1974 (EPA). In addition, Article 50 of the Constitution establishes environmental protection as a public duty and prohibits environmentally harmful activities [6,7,9,10]. At the macro-policy level, the governance of natural and energy resources in Iran is also guided by the General Policies of the Islamic Republic of Iran, including the General Policy on Energy (1998), the General Policy on Natural Resources (2001), and the General Policy on Environment (2015), which provide overarching policy directions for sustainable resource management and environmental protection [21-23].

3.1.1. Regulatory Obligations

Article 24 of the Mining Law requires that exploration and exploitation licenses in protected areas or environmentally sensitive zones be subject to prior environmental and land-use clearance. This provision establishes environmental approval as a legal precondition for licensing and reflects the integration of environmental considerations into the authorization regime governing mineral resource development [9].

Pursuant to Article 35 of the Mining Law, the Environmental Regulations for Mining Activities (2005) were adopted to detail compliance obligations. Article 5 of these Regulations mandates the preparation and approval of an Environmental Impact Assessment (EIA) report for specified mining projects exceeding defined production thresholds, including:

- Copper mines with annual extraction exceeding one million tons;
- Iron ore mines exceeding six hundred thousand tons annually;
- Gold mines regardless of production volume.

Article 6 further requires operators to undertake environmental restoration and land reclamation at the end of the operational lifecycle of the mine. These provisions embed preventive and restorative environmental duties within the mining regulatory framework and extend regulatory responsibility beyond the licensing stage to the post-extraction phase of mining operations [10].

In parallel, Articles 11 and 12 of the EPA (1974) provide general enforcement authority. Article 11 empowers the Department of Environment (DOE) to issue formal warnings and, in case of non-compliance, to order suspension of polluting operations. Article 12 establishes criminal liability where operators continue harmful activities despite administrative orders [7].

Thus, at the normative level, the mining sector contains identifiable environmental obligations, EIA requirements, and enforcement guarantees forming a legal framework that links environmental compliance to both the authorization and continuation of mining activities.

3.1.2. Institutional Allocation and Supervisory Structure

Despite the presence of formal regulatory duties, environmental supervision in the mining sector is institutionally dispersed. Regulatory authority is divided among:

- The Ministry of Industry, Mine and Trade (licensing authority);
- The Department of Environment (environmental supervision under EPA Articles 11,12);
- Natural resource and land-use authorities at national and provincial levels [13].

This distribution creates overlapping competences, particularly between the licensing authority and the DOE in relation to environmental approvals and operational monitoring. The absence of a unified supervisory chain weakens enforcement coherence and complicates accountability while also generating coordination challenges among institutions involved in licensing, environmental supervision, and land-use governance [8].

3.1.3. Monitoring and Enforcement Practice

Although EIA approval under Article 5 of the 2005 Regulations is formally required before project authorization, regulatory attention remains concentrated at the pre-licensing stage. Post-operational supervision and long-term compliance monitoring are comparatively less structured [10].

In practice, enforcement relies heavily on the EPA's general sanctioning powers (Articles 11,12), rather than on sector-specific, continuous monitoring mechanisms embedded within mining legislation. This structural reliance on ex ante authorization combined with reactive enforcement reduces the preventive capacity of environmental regulation and illustrates the institutional gap between environmental supervision and extractive licensing mechanisms [7].

3.2. Environmental Regulation in Iran's Oil and Gas Sector

Environmental regulation of petroleum activities operates within a more centralized institutional framework. The legal basis includes:

- Article 50 of the Constitution;
- The Environmental Protection and Enhancement Act (1974);
- The Petroleum Act of 1987 (as amended 2011);
- The Statute of the National Iranian Oil Company (NIOC);

The IPC contractual framework for upstream petroleum projects [6,7,20,24,25]. At the macro-policy level, environmental governance in Iran's petroleum sector is also influenced by the General Policies of the Islamic Republic of Iran adopted by the Expediency Discernment Council and communicated by the Supreme Leader, including the General Policy on Energy (1998) and the General Policy on Environment (2015), which provide overarching strategic directions for sustainable resource management and environmental protection [21-23].

Environmental regulation in the oil and gas sector should not be understood solely as a set of technical compliance requirements. Rather, it forms part of a broader sustainable development framework that integrates legal, economic, environmental, technological, and social dimensions. Recent legal analyses of sustainability governance in Iran's petroleum sector emphasize that fragmented regulatory measures are insufficient to address the complex risks associated

with hydrocarbon exploitation. Instead, effective governance requires an integrated and multidimensional regulatory architecture that aligns environmental protection with resource management, technological innovation, and long-term intergenerational considerations. Within such a framework, transparency, stakeholder engagement, and coordination among legal and institutional mechanisms become essential conditions for translating sustainability principles into enforceable regulatory practice [18].

3.2.1. Regulatory Obligations

Although the Petroleum Act does not contain a standalone environmental chapter, environmental obligations are incorporated through:

- Operational definitions including safety, health, and environmental (HSE) standards;
- Resource conservation principles;
- Contractual incorporation of environmental compliance under the IPC framework.

In addition, petroleum operations remain subject to Articles 11 and 12 of the EPA (1974), enabling administrative suspension and criminal liability in cases of environmental non-compliance [25,7,20].

3.2.2. Institutional Structure

Unlike the mining sector, petroleum regulation is institutionally centralized within specialized entities, notably the Ministry of Petroleum and NIOC. This concentration of authority facilitates regulatory coordination and systematic implementation of HSE standards. Centralization enhances institutional coherence, reduces overlapping mandates, and enables more structured supervision of environmental performance [26].

3.2.3. Monitoring and Enforcement

The petroleum sector increasingly integrates continuous HSE supervision within operational management. Contractual governance under the IPC model reinforces compliance obligations and embeds environmental performance within project management structures [25].

Digital monitoring tools—including satellite observation, IoT-based systems, and predictive analytics—have gradually strengthened oversight capacity. However, enforcement remains influenced by production imperatives and macro-economic considerations [27].

3.2.4. Structural Constraints

Despite stronger institutional capacity, the petroleum sector faces persistent challenges, including greenhouse gas emissions, gas flaring, oil spills, and marine contamination. Economic dependence on hydrocarbon revenues creates structural tension between environmental obligations and production priorities [28].

3.3. Comparative Regulatory Analysis

Applying the four-dimension analytical framework reveals structurally distinct regulatory configurations [1-28].

3.3.1. Regulatory Obligations

Both sectors formally incorporate environmental duties. However, mining legislation provides more explicit statutory EIA thresholds (Article 5 of the 2005 Regulations) and restoration duties (Article 6), whereas petroleum obligations are embedded more indirectly through HSE standards and contractual mechanisms [10,20,24,25,29].

3.3.2. Institutional Allocation

The mining sector is institutionally fragmented, with divided authority between licensing and environmental bodies. The petroleum sector operates under centralized sector-specific supervision, enhancing coordination [13,30].

3.3.3. Monitoring Mechanisms

Mining supervision remains predominantly licensing-oriented. Continuous monitoring mechanisms are less institutionalized [31]. In contrast, petroleum regulation integrates operational HSE monitoring and digital oversight tools [32].

3.3.4. Enforcement Capacity

Both sectors are subject to EPA Articles 11 and 12. However, centralized petroleum governance enables more coherent enforcement integration, while mining enforcement remains dependent on dispersed administrative coordination [7,13].

The comparative analysis can be structured around four core regulatory dimensions: legal structure, institutional configuration, monitoring capacity, and enforcement integration. Table 1 summarizes the main differences between the mining and oil and gas sectors in Iran.

Table 1. Core Regulatory Dimensions of Environmental Governance in Iran's Extractive Industries Results of the Sargan Test.

Dimension	Mining Sector	Oil and Gas Sector	Analytical Comparison
Legal Structure	Environmental obligations are explicitly articulated in the Mining Law (1998, as amended) and the Environmental Regulations for Mining Activities (2005), including EIA requirements and land reclamation duties.	Environmental obligations derive primarily from the Petroleum Act, the governance framework of the National Iranian Oil Company (NIOC), and operational HSE standards.	Mining regulation relies more on explicit statutory rules, whereas petroleum regulation is embedded within operational governance structures.
Institutional Configuration	Authority is institutionally fragmented among the Ministry of Industry, Mine and Trade, the Department of Environment, and other land-use authorities.	Regulatory authority is comparatively centralized within the Ministry of Petroleum and the NIOC.	Institutional fragmentation characterizes the mining sector, while the petroleum sector benefits from stronger organizational concentration.
Monitoring Capacity	Environmental supervision is largely concentrated at the licensing stage, with limited mechanisms for systematic post-licensing monitoring.	Monitoring is more integrated into operational management and increasingly supported by digital monitoring systems and HSE frameworks.	Monitoring mechanisms are structurally more developed in the petroleum sector.
Enforcement Integration	Enforcement depends mainly on the supervisory powers of the Department of Environment and coordination between multiple institutions.	Enforcement benefits from integrated institutional authority and operational control within the petroleum governance structure.	Institutional integration enhances enforcement capacity in the oil and gas sector.

Source: Authors' computation

As illustrated in Table 1, while environmental regulation in the mining sector is characterized by more explicit statutory obligations, its effectiveness is constrained by institutional fragmentation and limited monitoring capacity, whereas the oil and gas sector benefits from greater institutional concentration and operational monitoring mechanisms, resulting in comparatively stronger regulatory integration.

3.4. Digital Regulation and Artificial Intelligence

Digital monitoring technologies enhance supervisory capacity in both sectors. However, their regulatory effectiveness depends on integration within legally defined enforcement structures.

AI-based monitoring raises questions regarding:

- Evidentiary reliability;
- Administrative accountability;
- Data governance;
- procedural reviewability.

Technological modernization cannot substitute for coherent statutory authority and enforceable institutional mandates [33-36].

4. Conclusion

The comparative legal analysis demonstrates that differences in institutional configuration significantly affect regulatory effectiveness in Iran's extractive industries. While both sectors operate under the same constitutional and environmental enforcement framework (Article 50; EPA 1974, Arts. 11-12), sector-specific regulatory architecture shapes practical outcomes.

The mining sector exhibits structural weaknesses linked to fragmented authority and limited post-licensing supervision. The petroleum sector benefits from centralized governance and stronger integration of operational monitoring mechanisms, although economic pressures generate enforcement tensions.

Effective environmental regulation in Iran's extractive industries therefore requires:

1. Stronger institutional coordination between licensing and environmental authorities;
2. Enhanced post-operational monitoring mechanisms;
3. Clearer integration of digital oversight within statutory enforcement frameworks;
4. Reinforcement of enforcement guarantees under Articles 11 and 12 of the EPA.

Sustainable extraction ultimately depends not merely on legislative recognition of environmental principles, but on the coherence, enforceability, and institutional capacity of the regulatory system governing extractive activities.

Author Contributions

M. E. Shahrbabaki was responsible for conducting the investigation and performing the calculations; and Mehdi Piri provided supervision, managed the project, and contributed to writing the manuscript and editing the results.

Conflicts of Interest

The authors, while observing publication ethics in the referencing, declare the absence of interest of conflict.

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AI-Assisted

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