

Managing Environmental Risks Through ESG

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Abstract — This study examines the potential for using Environmental, Social and Governance (ESG) as a management framework for identifying, assessing and mitigating environmental risks within an organization. Against a backdrop of increasing regulatory pressure, climate uncertainty, resource constraints and heightened corporate reporting requirements, environmental risks are increasingly becoming a strategic management issue. This study argues that ESG should not be viewed solely as a tool for non-financial reporting, but as a conceptual and practical framework through which organizations can structure their mechanisms for monitoring, prioritizing and managing environmental impacts, dependencies and vulnerabilities. On this basis, the author proposes a model in which environmental risk is viewed as the interaction of three interrelated dimensions: exposure, impact and organizational vulnerability. The model allows different environmental issues to be compared using a unified logic, prioritized and linked to differentiated management responses. The study aims to establish a clearer link between regulatory frameworks, analytical risk management, and corporate governance.

Keywords — ESG, environmental risk, risk management, sustainable development.

I. INTRODUCTION

In recent years, environmental risks have emerged as one of the most significant factors affecting the sustainability, adaptability and long-term competitiveness of organizations. Processes such as climate change, depletion of natural resources, pollution and increasing pressure on ecosystems cannot be ignored by businesses [6], [12], [13]. They should not be limited to the sphere of environmental policy. Instead, they affect the way organizations operate, including their compliance with regulatory requirements [1], [2].

The scientific literature has seen an expansion of the analysis of environmental risks beyond the climate focus. The European Sustainability Reporting Standards (ESRS) structures the environmental dimension into five distinct strands. These cover climate change, pollution, water and marine resources, biodiversity and ecosystems, as well as

resource use and the circular economy [1]. Regulatory developments related to the circular economy further reinforce the strategic importance of material efficiency, waste reduction and resource traceability [15]. In parallel, Taskforce on Nature-related Financial Disclosures (TNFD) draws attention to nature-related dependencies, impacts, risks and opportunities along the entire value chain [4], [5].

This paper is based on the understanding that environmental risk is the result of the interaction between external exposure, potential impact, and internal organizational vulnerability. At the same time, many environmental risks require investment responses, which makes access to financing mechanisms for energy-efficiency and sustainability projects an increasingly important managerial consideration [14]. The three elements are considered in their interdependence. On this basis, a conceptual framework is proposed through which ESG can be used as a means of systematizing, prioritizing and limiting environmental risks.

The focus of this study is the management of environmental risks within organizations. The subject of the study is the potential of ESG to function as a management framework for identifying, assessing and mitigating environmental risks. The aim of this study is to clarify how ESG can be used not only as a reporting tool but as a systematic management framework for dealing with environmental risks, and on this basis to propose an analytical model for their structuring and prioritization. Previous studies on corporate social responsibility reporting have also emphasized the importance of information-system requirements for collecting, processing and disclosing sustainability-related data [16].

To achieve this objective, the following tasks are set: to track the development of the academic debate on ESG and environmental risk; to identify the main areas of environmental risk relevant to organizations; to analyze the limitations of prevailing reporting and indicator approaches; to propose a conceptual framework for assessing environmental risk through the interaction between exposure, impact and vulnerability; and to

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formulate management conclusions regarding the application of ESG in the decision-making process.

II. MATERIALS AND METHODS

Research on ESG is gradually shifting its focus from the general concept of corporate responsibility towards a more structured understanding of sustainability as a management and risk category. The early establishment of this logic was strongly influenced by the Task Force on Climate-related Financial Disclosures (TCFD) recommendations, which organize climate-related information around four key thematic areas: governance, strategy, risk management, metrics and targets [3]. Subsequently, International Financial Reporting Standard S2 (IFRS S2) further developed this framework and established it as a standard for disclosing climate-related risks and opportunities, including physical and transition risks, applicable to reporting periods beginning on or after 1 January 2024 [2], [7].

Although climate risk remains the most developed area, the newer European frameworks clearly demonstrate a broadening of the analysis beyond climate. The ESRS distinguishes the environmental dimension into five separate standards and organizes the information around management, strategy, processes related to impacts, risks and opportunities, as well as indicators and targets [1].

A similar broadening of scope is also evident in the TNFD, which is developing a framework for identifying, assessing, responding to and disclosing nature-related issues. The TNFD focuses on nature-related dependencies, impacts, risks and opportunities across the entire value chain. TNFD also proposes the LEAP (Locate, Evaluate, Assess and Prepare) approach as an integrated process for identifying interactions with the natural environment, assessing dependencies, analyzing risks, and preparing for response and reporting [4], [5].

It is precisely here that the main gap identified by this study lies. Consequently, the following sections of this paper propose an analytical framework that links regulatory standards with management practice. It should be noted that this study is of a conceptual nature. It is based on an analysis of the academic literature and regulatory frameworks.

This study employs a conceptual-analytical approach based on an analysis of the scientific literature, international ESG frameworks, and regulatory standards. A pilot test was conducted to verify the practical applicability of the proposed model. It was carried out in May 2026 at three manufacturing companies in Bulgaria operating in different industrial sectors.

III. RESULTS AND DISCUSSION

3.1. Proposed framework for managing environmental risks through ESG

In this context, this study proposes a framework according to which environmental risk should be viewed as a function of three interrelated dimensions: exposure, impact and organizational vulnerability. Exposure reflects the extent to which the organization is exposed to

environmental dependencies and impacts. It may stem from the location of assets, sector profile, raw materials used, energy intensity, water dependency, value chain sensitivity, or presence in environmentally vulnerable areas. Impact reflects the potential severity of environmental risk on the organization, including consequences for operational stability, costs, supply chains, legal compliance, reputation, access to finance and strategic sustainability. Organizational vulnerability, in turn, is the extent to which the organization is internally unprepared to identify, bear, manage and mitigate environmental risk.

For the purposes of this study, the following analytical framework is proposed:

$$\text{Environmental risk} = \text{Exposure} \times \text{Impact} \times \text{Organizational vulnerability}$$

The main elements of the model are summarized in Table 1. They are presented there together with their content and the corresponding management issues.

TABLE 1 PROPOSED MODEL FOR MANAGING ENVIRONMENTAL RISKS THROUGH ESG

Component	Content	Indicative management questions
Exposure	Degree of exposure to environmental dependencies and impacts.	Where is the organization most dependent on natural resources? Which assets, processes or parts of the value chain are most sensitive?
Impact	Potential severity of the consequences on operations, financial position and strategy.	What might be the impact on costs, operations, access to capital, regulatory compliance and reputation?
Organizational vulnerability	Internal unpreparedness to identify, manage and mitigate risk.	Are there reliable data, clear responsibilities, control mechanisms, scenarios and response capacity?

Source: Author's own research.

The logic behind this formula is that the three elements do not operate in isolation, but reinforce one another. Low exposure combined with high vulnerability may result in a manageable risk, but high exposure, combined with high impact and high vulnerability, leads to a significantly more severe risk profile. The advantage of such a model is that it allows for the construction of a clearer risk matrix, in which the organization is not limited to presenting its environmental issues, but prioritizes them according to their managerial significance.

For the practical application of the model, a five-point scale can be used, in which each of the three factors is rated from 1 to 5. This allows for the creation of an internal risk classification: low, moderate, high, very high and critical

risk. Such a scale should not be regarded as a universal regulatory standard, but rather as an internal management tool for comparison, prioritization and action planning.

3.2. Typology of environmental risks in the ESG framework

The application of the proposed model requires a clear distinction between the main environmental areas in which the risk manifests itself. The most logical basis for such a typology is found in the ESRS, where the environmental dimension is structured into five separate standards: climate change, pollution, water and marine resources, biodiversity and ecosystems, as well as resource use and the circular economy [1].

IFRS S2 distinguishes two main categories of climate-related risks: physical risks and transition risks. Physical risks are related to extreme weather events, prolonged climate changes, disruption of production and logistics processes, damage to assets and higher operational volatility. Transitional risks, on the other hand, arise in connection with regulatory changes, technological shifts, market expectations, investor pressure and the transformation of consumer preferences in the context of the transition to a low-carbon economy [2].

Risks related to pollution constitute a distinct category and should not be viewed as a secondary consequence of climate risk. They include air emissions, soil contamination, waste generation, hazardous substances, industrial accidents and the accumulation of environmental liabilities. Their impact is not only manifested through environmental damage. At the same time, secondary consequences are also observed, including sanctions, legal claims, business interruption, loss of trust and additional compliance costs [1].

Risks related to water and marine resources are particularly significant for industries with high water dependence. They may result from location in areas with water stress, intensive use of water resources or water

quality sensitivity. Their impact is manifested through production disruption, increased costs, stakeholder conflicts and regulatory pressures. The TNFD LEAP approach is particularly useful here because it guides the organization to identify effects on nature, assess dependencies and impacts, and only then to conduct a proper risk assessment [5].

Risks related to biodiversity and ecosystems are among the most complex to analyze [8]. They often do not manifest themselves immediately in financial and operational indicators. Nevertheless, over time they can significantly undermine the resilience of the business model.

The next area covers risks related to resource use and the circular economy. Here, exposure arises from dependence on primary raw materials, high waste streams and inefficient use of resources. The impact is expressed in higher costs, sensitivity to price changes, supply chain problems, loss of competitiveness and increased regulatory pressure. Vulnerability exists when an organization does not have sufficient traceability of material flows. It also manifests itself in the absence of circular business solutions and in the absence of measurement in terms of resource efficiency [1].

Climate risks, pollution, water stress, biodiversity loss and resource inefficiency are often intertwined and mutually reinforcing. These factors rarely operate in isolation. Therefore, the typology should serve not to mechanically categorize the topics into sections, but to build a matrix of priorities. It is precisely here that the three-factor model gains real value, because it allows the organization to compare different environmental risks according to a single principle.

In accordance with the logic outlined above, environmental risks can be systematized as presented in Table 2.

TABLE 2. TYPOLOGY OF ENVIRONMENTAL RISKS WITHIN THE ESG FRAMEWORK

Category	Typical sources of exposure	Potential impacts	Common manifestations of organizational vulnerability
Climate risks	Energy intensity, physical assets, sensitive locations, carbon footprint	Asset damage, business interruption, incidental costs, capital shortfall	Lack of scenarios, poor integration into risk management, limited data
Pollution	Hazardous substances, emissions, waste, incident risk	Fines, legal disputes, reputational damage, compliance costs	Inadequate control of flows, poor traceability, weak monitoring
Water and marine resources	Water-intensive processes, water-stressed areas, dependence on water quality and quantity	Production disruptions, higher costs, tension with stakeholders	Lack of efficiency plans and alternative sources, poor data
Biodiversity and ecosystems	Locations or suppliers in sensitive areas, dependence on functioning ecosystems	Supply chain risk, public pressure, regulatory restrictions	Lack of geographical analysis and expertise, low traceability along the supply chain
Resources and the circular economy	Material intensity, waste streams, dependence on primary raw materials	Price fluctuations, inefficiency, loss of competitiveness	Limited traceability, absence of circular solutions, poor performance

Source: Author's own research.

3.3. Application of the ESG model in environmental risk management

Within the proposed model, ESG is viewed not only as a tool for disclosure but also as a framework for management action [10]. IFRS S2 requires organizations to disclose information on the management, control and monitoring processes used, the strategy for managing climate-related risks and opportunities, the processes for identifying, assessing, prioritizing and monitoring them, as well as performance against relevant indicators and targets [2].

The practical application of the model requires a clear division of responsibilities. The governing body should have a clearly defined oversight function with regard to environmental risks, while senior management should have specific responsibilities for assessment, coordination and response [11]. Internal functions relating to risk, sustainability, finance, operations and legal compliance must be integrated into a single mechanism, rather than operating in a fragmented manner. It is precisely here that organizational vulnerability takes on a particularly managerial dimension: it measures not only weaknesses in processes, but also deficits in institutional coordination [4].

Environmental risk should not be treated as a separate issue, detached from the overall risk management framework. IFRS S2 requires organizations to disclose whether and how the processes for identifying, assessing, prioritizing and monitoring climate-related risks and opportunities are integrated into the overall risk management process. The TNFD applies much the same logic to nature-related risks [2], [4].

The effective application of the model is impossible without a reliable system of data, indicators and targets [9]. Similar data-driven approaches, including artificial intelligence applications in digital energy systems, demonstrate how environmental indicators can be continuously monitored and integrated into managerial decision-making [17]. Sustainability frameworks require organizations to disclose the indicators used to assess and manage material risks and opportunities, as well as progress towards set targets. It follows, therefore, that environmental risk management must be viewed not only as an assessment process, but also as a process of systematic measurement and internal control. In the absence of reliable data, traceability or verification procedures, organizational vulnerability remains high even when the exposure itself is not at its maximum.

Current frameworks also clearly demonstrate that environmental risk cannot be assessed solely within the confines of an organization's direct operations. The TNFD requires that dependencies, impacts, risks and opportunities be analyzed not only within direct operations but also across upstream and downstream value chains. This means that the proposed model should be applied not only at the corporate level, but also across individual business units, assets, geographical locations and key parts of the value chain [4], [5].

Where the risk assessment indicates a low risk, the focus may be on monitoring, periodic checks and limited corrective actions. Where the risk is moderate, clearer policies, internal responsibilities, indicators and routine monitoring are required. In the case of high risk, specific action plans, stricter controls, better coordination with suppliers and more active management involvement are required. In the case of critical risk, the organization must be prepared for structural changes to processes, assets, resource sources, technological solutions and strategic priorities.

The advantage of the proposed model lies in its flexibility. It can be used both in large organizations with formalized risk management systems and in more limited organizational contexts where a fully developed ESG infrastructure is lacking. At the same time, its strength lies primarily in its analytical and managerial aspects. It does not eliminate the problem of input data quality and does not claim to be a universal metric, but it creates a structured framework for assessment and response, suitable for internal management use.

3.4. Pilot Testing of the Proposed Model

To verify the practical applicability of the proposed model, a pilot test was conducted at three manufacturing companies in Bulgaria operating in different industrial sectors. The companies included in the sample have different profiles in terms of environmental exposure, resource dependence, and organizational complexity. The assessment was carried out through expert assessment on a five-point scale, in which the components of exposure, impact, and organizational vulnerability are rated on a scale of 1 to 5. The final risk score is calculated by multiplying the three components. The following factors were taken into account when determining the ratings: the company's industry profile, degree of resource and energy dependence, nature of environmental impacts, applicable regulatory requirements, and organizational mechanisms for environmental risk management and control.

In accordance with the logic outlined above, the main environmental risk areas for each of the companies have been identified. The results are presented in Table 3.

TABLE 3. PILOT TESTING OF THE PROPOSED ESG MODEL

Company profile	Main risk area	Exposure	Impact	Organizational vulnerability	Overall risk score
Food industry company with water-intensive production processes	Water resources and resource dependence	4	4	3	48
High energy-intensive mechanical engineering company	Climate and resource risks	4	3	3	36
A chemical industry company working with hazardous substances	Pollution and hazardous substances	5	5	3	75

Source: Author's own research.

The results clearly show distinct differences in risk profiles among the analyzed companies. For the food and beverage company, risks related to water resources and the dependence of production processes on constant access to water predominate. This results in a relatively high risk score. In the machine-building company, a more moderate risk profile is observed. It is mainly determined by the high energy intensity, dependence on raw materials and sensitivity to transitional climate policies and regulatory requirements. The highest risk score was recorded for the company in the chemical industry. This is due to high exposure to pollution, the handling of hazardous substances, and heightened regulatory requirements at the sectoral level. The pilot testing conducted shows that the proposed model allows for the comparative assessment and prioritization of environmental risks in companies with different sectoral profiles and organizational characteristics.

IV. CONCLUSIONS

This study is based on the understanding that environmental risks can no longer be regarded as a peripheral aspect of corporate sustainability. They should be viewed as an integral part of strategic and operational management.

The main conclusion of the study is that ESG is most valuable not when used solely as a reporting tool, but when it becomes a framework for managerial action. It is precisely in this context that the author proposes a model

in which environmental risk is viewed as the interaction of three interrelated dimensions: exposure, impact and organizational vulnerability. The advantage of this approach is that it allows different environmental issues to be compared using a consistent logic, prioritized, and linked to differentiated management responses.

The scientific contribution of this study can be summarized in three areas:

- Environmental risk is examined in the context of ESG, beyond a narrow focus on climate.
- A conceptual framework is proposed that links reporting standards to the organization's internal management logic.
- An analytical model is developed that can assist in identifying, assessing, and prioritizing environmental risks in various organizational contexts.

The proposed model is conceptual and aims to provide analytical and managerial clarity; it does not claim to be a comprehensive, universal metric that can be applied across all sectors without adaptation. Furthermore, its added value will depend on the quality of the input data, the maturity of internal processes and the organization's ability to work with spatial, chain and scenario dependencies.

The pilot testing of the model does not claim to be statistically representative or to constitute expanded sector-specific testing. Therefore, future research could focus on expanded sector-specific testing of the model in specific industries, the development of sector-specific indicators for assessing exposure, impact, and vulnerability, and a more in-depth analysis of the relationship between environmental risk, ESG reporting, and actual management decisions. The most significant conclusion, however, remains the following: the true value of ESG lies not in disclosure itself, but in its ability to structure managerial thinking and translate complex environmental interdependencies into well-reasoned decisions.

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