

WWF BIODIVERSITY RISK FILTER TOOL FOR SUSTAINABILITY REPORTING: CASE OF FORESTRY AND PAPER SECTORS IN SERBIA

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Abstract. Industries such as Forestry and Logging and the Production of Paper and Paper Products significantly impact biodiversity and its conservation. Sustainable operations in these economic sectors involve balancing economic goals, social responsibility, and environmental protection by reducing emissions, supporting communities, and innovating in resource conservation. This paper emphasizes the importance of sustainable forest management and the application of Environmental, Social, and Governance (ESG) reporting principles in the operations of companies in the Republic of Serbia to ensure timely and adequate biodiversity protection. It includes the importance of responsible business practices for biodiversity conservation, the standardization and legislative framework for sustainable development in the EU and Republic of Serbia, and an impact assessment analysis of companies in Serbia in two economic sectors: Forestry and Logging, and the Production of Paper and Paper Products. Using the WWF Biodiversity Risk Filter (BRF) platform, data from 3111 active and registered companies were analyzed using 33 WWF BRF indicators to evaluate their influence and their dependence on biodiversity.

Keywords: *biodiversity, forestry and logging, non-financial reporting, paper industry, sustainable business*

Introduction

In modern business practices, responsible management and sustainable development have become key factors for long-term progress and successful business operations. In this context, ESG (Environmental, Social, and Governance) reporting is not only about meeting regulatory requirements but also serves as an effective tool for companies to transparently present their impact on the environment, society, and governance.

World Wildlife Fund Biodiversity Risk Filter (WWF BRF) is a highly useful digital tool that will increasingly be used as a means of assessing and improving companies' ESG performance, particularly in terms of biodiversity conservation. It provides a framework for evaluating all environmental aspects of business operations and ensuring alignment with sustainability principles. This paper explores the role of the WWF BRF tool (Biodiversity Risk Filter created by the World Wildlife Fund; more information: <https://riskfilter.org>) as a tool for ESG reporting, analyzing its advantages and limitations, and offering recommendations for its application in business practice.

The aim of this paper is to provide insight into the importance of applying this methodology in the context of ESG reporting while highlighting the potential benefits for companies striving for sustainable business practices.

Human activities, directly and indirectly in business settings or daily life, impact ecosystems and their biodiversity, highlighting the need for ecosystem conservation and biodiversity functionality (Parracciani et al., 2023). To benefit environmental health, human well-being, and the preservation of biological diversity, the EU is implementing the European Green Deal (EGD) (European Commission, 2024) with the goal of climate neutrality by 2050, which includes biodiversity conservation measures and emission reduction efforts (Fetting, 2020).

Nature and biodiversity protection are not equally applicable in urban and rural areas, especially concerning protected natural resources, and research increasingly focuses on the business impact on biodiversity. Correia and Lopes (2023) emphasize the importance of biodiversity for ecosystem stability as part of adaptive systems. According to Baynham-Herd et al. (2018), biodiversity concerns vary among countries and are not necessarily linked to economic wealth, rather, they depend on legal regulations and democratic systems.

Forest ecosystems absorb a significant amount of greenhouse gases globally, contributing to both environmental preservation and biodiversity conservation. Forest management is shifting from timber production to ecosystem service integration; however, intensive exploitation can negatively affect biodiversity (Aggestam et al., 2020; Felton et al., 2020). Integrated forest management (IFM) meets social demands in limited areas, balancing biodiversity protection with timber production (Aggestam et al., 2020).

Certain scientific sources underscore the importance of understanding the impact of forest management on biodiversity, along with international conservation efforts through policies such as the EU Biodiversity Strategy. This emphasizes the importance of Forestry and Logging techniques like selective logging, planting, and fire prevention for ecosystem conservation. UNECE (2020) highlights the role of forests in CO₂ absorption, and due to changes in land use, there is a risk of reducing these ecosystems' absorptive capacity and the forests' carbon sequestration capacity. The new EU Forest Strategy aims to cut emissions by 55% by 2030 and achieve climate neutrality by 2050, including biodiversity protection and forest expansion targets aligned with the Paris Agreement (EP, 2022).

Beyond timber, forests provide food, medicine, and other products of significant economic importance, though these products are often excluded from trade statistics and forest management policies. Annual revenue from these products amounts to billions of dollars, especially in lower-income countries where they require more attention to build sustainable forest bioeconomies (Chamberlain and Smith-Hall, 2024).

In Serbia, forest product gathering is a tradition, particularly in mountainous areas, where it contributes to family budgets and serves as a source of income. Unsustainable use of these forest resources can lead to their depletion, necessitating control over the quantities of forest goods collected (Ilic, 2016).

All sectors, especially those directly involved in the use of natural resources, must focus on the rational use of these resources, contribute to their recovery, and pay attention to biodiversity. This is essential for natural systems to function independently. Consequently, it has become imperative at the global level to begin thinking about and implementing systems that, in some way, compel companies to consider the negative or positive effects of their operations on nature and biodiversity. The path to this is through non-financial reporting, also known as sustainability reporting or ESG (Environmental, Social, and Governance) reporting.

According to Damjanovic (2021), non-financial reporting is a highly complex process involving the collection, systematization, processing, and publication of non-financial data or information, defining performance measures, and establishing sustainable business objectives for companies. This type of reporting at the corporate level serves as an effective tool for managing raw materials, processes, and natural and human resources. Sustainability reports include business planning as well as identifying all potential risks in the operations of any company, regardless of size. In collaboration between companies and their partners in the supply, production, and distribution chains, it is crucial to include all information, both financial and non-financial.

For sustainability reports to be sufficiently clear, precise, and applicable across various levels and not only in terms of the size of companies involved in business and supply chains, they must be applicable at both national and international levels.

EC Directive 95 (2014) mandates large companies to engage in non-financial reporting to enhance transparency in social activities, thereby providing stakeholders with better information. The directive encourages collaboration across sectors to improve business quality and achieve shared goals. EC Directive 2464 (2022) expands this obligation, emphasizing the importance of environmental protection and social responsibility. It introduces a shift from “non-financial information” to “sustainability information” to ensure transparency and facilitate business decision-making.

EC Directive 2772 (2023) complements EC Directive 34 (2013) by establishing sustainability reporting standards - European Sustainability Reporting Standards (ESRS). This regulation provides a legal framework requiring companies to report on sustainability following the guidelines in the directive and based on the ESRS.

ESRS standards are categorized into three sections, defining how companies should report on sustainability in areas such as governance, strategy, impact, risk management, opportunities, and sustainability measures and goals. Companies or groups with an average workforce of fewer than 750 employees during a financial year (within their annual consolidated reports) may, in the first two years of reporting, omit information specified in the disclosure requirements for ESRS E4—Reporting on Biodiversity and Ecosystem Status.

In Serbia, the only regulation that in some way mandates large enterprises (with over 250 employees) to submit sustainability information is the Accounting Law (2019), and it applies exclusively to large enterprises with more than 250 employees. This law requires from large legal entities to indicate whether they operate following the above-mentioned European sustainability reporting regulations.

However, the Serbian law does not impose a comprehensive obligation to disclose detailed ESG data, nor does it provide specific standards or guidelines for sustainability reporting. On the other hand, micro, small, and medium-sized enterprises (MSMEs) are not subject to any mandatory requirements in this regard and are still in the phase of voluntary sustainability reporting according to EU regulations.

Each company independently chooses the frameworks and guidelines for writing non-financial or sustainability reports. The selection of these frameworks and guidelines depends on the company's objectives, stakeholder expectations, and the feasibility of integrating these guidelines into internal processes and procedures. To adequately represent the impact of business activities on biodiversity and ecosystems, various programs and tools can be used. One of them is WWF BRF which was applied in this research.

The economic activities discussed in this paper are classified according to the Regulation on Classification of Activities of the Republic of Serbia (Law on

Classification of Activities, 2009): Forestry and Logging and Production of Paper and Paper Products. Forestry and logging include the production of roundwood, forest fruit collection, primary wood processing in forests, and the provision of forestry-related services. These activities occur in both natural and planted forests, while further wood processing is carried out in specialized production units within Area 16, related to wood processing and manufacturing. The area of Production of Paper and Paper Products includes pulp, paper, and converted paper products manufacturing, considering the interconnected production processes involved.

Materials and methods

Data on the impact of corporate operations on biodiversity was gathered from the global WWF BRF database. The data used for the analysis from the WWF BRF tool's portfolio manager module, which requires several key data inputs for each company, categorized as mandatory or optional. The following information was collected and used in the analysis:

1. Company name
2. Operational site(s), with the following attributes for each site:
 - (a) Industry/manufacturing sector (mandatory)
 - (b) Type of goods/services produced (optional)
 - (c) Activity group (optional)—for the purpose of the research, activity groups were organized by economic sectors within each geographical region of the Republic of Serbia, resulting in a total of 10 groups (2 economic sectors defined for each of the 5 regions)
3. Business relevance: high, medium, low, or unknown (mandatory)
4. Exact location: address or coordinates (mandatory)

These parameters were essential for conducting the risk assessment following with the WWF BRF methodology, and they provided the basis for regional and sectoral segmentation used in the analysis.

Since ESG reports are primarily adopted by large corporations, this research particularly analyzed companies operating in the sectors of Forestry, Logging, Forest Products Collection, and the Paper and Cardboard Industry.

The WWF BRF program is a free tool accessible through internet browsers. It allows users to search and identify priority business activities associated with biodiversity risks, enabling companies and other stakeholders to understand and evaluate risks at their operational sites. The WWF BRF can be a tool for preparing ESG reports that are essential for effectively presenting sustainability outcomes in corporate operations. This tool enables companies to correlate with ESG sustainability reports, helping them identify and assess biodiversity risks in their supply chains and understand how their business activities might impact biodiversity while identifying higher-risk areas for ecosystems. The program analyses data obtained from companies to assess Physical and Reputational Risks. Data gathered in this manner focuses on perceptions of corporate sustainability and responsibility toward biodiversity conservation, hence its designation as the Biodiversity Risk Filter.

Physical and Reputation Risks of companies are measured by their impact and dependencies on biodiversity. All these risks are divided into 33 indicators grouped into 8 risk categories (5 physical and 3 reputation risk groups).

Physical Risks relate to the status of ecosystem services that businesses or their suppliers depend on and they are divided into 20 indicators categorized into 5 risk groups:

- **Provision of Services**—Companies rely directly on natural resources for operations or production. A decrease in the quantity or quality of direct input resources such as food, raw materials, and genetic materials can lead to increased costs or production interruptions. This risk category identifies key types of natural resources required for production, including indicators such as: Water Scarcity, Forest Productivity and Market Distance, Limited Wild Flora and Fauna Availability, and Limited Marine Fish Availability.
- **Ecosystem Regulation and Support Services**—Companies depend on ecosystem services that regulate or support production processes, such as crop cultivation or livestock breeding. Lack of ecosystem support and investment in areas like soil health, water quality, and habitat provision can increase production costs or prevent operations. This risk group includes indicators like: Soil, Water, and Air Condition, Ecosystem Health, and Pollination.
- **Regulatory Services**—Mitigating regulatory services in response to natural disasters (e.g., landslides, fires, floods, storms) is crucial, as natural disasters can impact ecosystem value and result in severe damage to natural and urban ecosystems. This risk group includes indicators such as: Landslides, Fires, Diseases and Pests in Plants, Animals, and Water, Herbicide Resistance, Extreme Temperatures, and Tropical Cyclones.
- **Cultural Services**—Tourism locations and attractions, directly dependent on nature, ecosystems, and ecosystem services, are encompassed in this category through the: Tourist Locations/Attractions indicator.
- **Biodiversity Pressures**—Various business activities can negatively affect biodiversity and reduce ecosystem services through direct drivers or pressures, including: Land, Water, and Marine Ecosystem Use Changes, Forest Cover Loss, Invasive Species, and Pollution.

Reputational Risks directly impact product value, market position, and other factors influencing the overall business performance. The risk categories included here are indicators of a company's commitment to ESG principles and its sustainability level concerning biodiversity and ecosystem conservation. Reputational risks comprise 13 indicators classified into three categories:

- **Environmental Factors** display negative impacts on surrounding natural resources and biodiversity issues, with indicators such as: Protected Areas, Key Biodiversity Areas, Other Important Designated Areas, Ecosystem Condition, and Restricted Area/Range.
- **Socio-Economic factors** of the company significantly influence reputational factors through indicators like: Indigenous Populations, Land and Territories of Local Communities, Resource Limitations (Food, Water, Air), Human and Labor Rights, and Financial Inequality.
- **Other Reputational Risks** arise from the actual or perceived importance or value of ecological resources, socio-economic conditions, and the level of public attention toward a company's operations at a specific geographical location. This risk category includes indicators such as: Media Monitoring, Political Situation, Locations of International Interest, and Risk Preparedness.

According to the WWF BRF, Serbia is classified as a country with very low reputational risk, meaning that companies in Serbia generally perform well when it comes to sustainable and socially responsible business practices. However, Serbia ranks extremely high (189th place) when it comes to physical risks, which reflects insufficient attention to the state of the environment.

The Provision of Services risk category has received a very low-risk rating, indicating that companies in Serbia do not directly rely on natural resources for their operations or production. Based on global and Serbian data, a selection of industries was made for research, focusing on the “Paper and Forest Product Manufacturing” sector. According to the WWF BRF Industry Overview, this sector has:

- The largest negative impact on indicators such as Land-use change, freshwater, and marine ecosystems, Forest cover loss, Protected natural areas, Indigenous peoples, local communities, and land territories.
- The highest negative dependency on indicators such as: Water scarcity, Forest productivity and market distance, Soil condition, Landslides, Fire Hazards, Extreme temperatures, Tropical cyclones.

Based on this selection of industries, a national alignment was carried out between the global WWF BRF forestry sector and the National Classification of Activities in the Republic of Serbia. Further research will focus on the Agriculture, Forestry, and Fisheries Sector (Sector A) in Serbia, specifically the following industries:

1. Forestry and Logging sector includes:
 - (a) Branch: Forest cultivation and other forestry activities, covering the following groups: Forest cultivation and other forestry activities
 - (b) Branch: Logging, covering the following groups: Logging, Collection of forest products, Forestry-related services
2. Production of Paper and Paper Products sector includes:
 - (a) Branch: Pulp, paper, and cardboard manufacturing, covering the following groups: Pulp production and Paper and cardboard production
 - (b) Branch: Paperboard product manufacturing, covering the following groups: Production of corrugated paper and cardboard, Production of paper products for personal and household use, Production of office paper products, Wallpaper production and Production of other paper and cardboard products

Before entering data into the WWF BRF tool, 10 groups were formed for each of two business sectors according to the regional affiliation:

- Belgrade region
- Vojvodina region
- Sumadija and Western Serbia region
- Southern and Eastern Serbia region
- Kosovo and Metohija region

The WWF BRF tool exports the processed data of 3111 enterprises into 10 Excel tables. Each exported table represents the result of data entry for one group of data, with each table containing data for a specific economic sector in a given region. The data in each Excel table for each enterprise includes:

- Longitude and Latitude (geolocational data based on the precise address of the enterprise)

- River basin within which the enterprise operates or has an impact
- Physical and Reputational indicators (a total of 33 indicators grouped into 8 risk categories - 5 Physical and 3 Reputation risk groups)

The analysis was conducted for each of the five regions in the Republic of Serbia in the following manner:

- By the Number of Districts and Municipalities in the Respective Sectors: The data on the geographical distribution of enterprises by districts and municipalities within the two sectors was analyzed.
- River Basins: Data on the river basins to which the enterprises in each analyzed region belong were reviewed. This is important for understanding the environmental impact and the dependence of these enterprises on water resources.
- Impacts and Dependencies for Physical Risks: The impacts and dependencies of the enterprises in each region were analyzed according to the groups of indicators that fall under Physical Risks. These indicators reflect the risks related to natural conditions, such as land use change, forest cover loss, and water resource depletion, among others.
- Impacts and Dependencies for Reputational Risks: Similarly, the impacts and dependencies for Reputational Risks were analyzed. These indicators relate to social, environmental, and governance issues that could affect the reputation of the enterprises in each region. For instance, environmental sustainability practices or non-compliance with local regulations could influence public perception.
- Comparative Data for Both Sectors by Region: A comparative analysis was done between the two sectors for each region in Serbia. This helped highlight the differences in risk exposure and dependencies within the sectors.
- Presentation of Comparative Data for All Regions: After interpreting the data for all five regions, comparative data were presented for both sectors across the entire territory of Serbia. This comparison allowed for an understanding of the regional variations and trends in risk levels for both sectors.
- Statistical Analysis of Each Indicator by Sector: A statistical evaluation of each indicator was performed using Excel tools. This involved calculating the average values for each indicator within the two sectors. The statistical analysis helped assess the impact and dependency ratings for each of the 3111 enterprises on each indicator.
- Ranking of Indicators: Based on the statistical results, the indicators were ranked according to the severity of the risk. Indicators with very high risk (reflecting significant impact or dependency on biodiversity) were identified.
- Grouping of Indicators with Minimal Impacts and Dependencies: Indicators that showed minimal impacts and dependencies were grouped into a separate category. These indicators represent risks that are considered very low and may not need to be prioritized in ESG reporting for companies in these sectors.

By following this methodology, the analysis provided valuable insights into the environmental risks faced by enterprises in Serbia's Forestry and Logging and Production of Paper and Paper Products sectors and into the possibility of application of the WWF BRF as a tool for ESG reporting.

Legend 1 will be used to interpret the values of impact and business risks/dependences according to the WWF BRF tool and to present the research results in the following section.

Legend 1. Risk values according to the WWF BRF methodology

Color	Range of risk values			Type of the risk
	1.00	<=X=>	1.80	Very low risk
	1.80	<=X=>	2.60	Low risk
	2.60	<=X=>	3.40	Medium risk
	3.40	<=X=>	4.20	High risk
	4.20	<=X=>	5.00	Very high risk

Source: WWF BRF Methodology

Results

Based on the database of the Serbian Chamber of Commerce and Industry (SCC), assigned in January 2024, a total of 1703 companies are registered in the area of Forestry and Logging, while 1475 companies are registered in the area of Production of Paper and Paper Products, totaling 3178 companies.

Of the total number of registered companies, 67 companies in both sectors are in bankruptcy or liquidation. This means that 3111 active business entities are valid for research. In the area of Forestry and Logging, 1516 are registered as entrepreneurs and 168 as legal entities, while in the area of Production of Paper and Paper Products, 821 are registered as entrepreneurs and 606 as legal entities. Distribution of all companies by regions in the Republic of Serbia, in both sectors, is presented in *Figure 1*.

All companies operating in Serbia, in the two selected sectors, have aggregated data for all indicators across the five regions (*Table 1*). This approach allows the identification of similarities and differences between the considered sectors, aiming for a better understanding of both Physical and Reputational Risks (tightly related to all ESG factors) across all 33 indicators throughout the entire territory of the Republic of Serbia.

Based on the impact and dependences of business operations on biodiversity in two economic sectors (based on the *Legend 1* and on the results from *Table 1*) data can be interpreted and re-classified as follows:

- Maximum Impact and Dependencies: Both sectors have the highest impacts and dependencies related to the Water Condition indicator (within the Ecosystem Condition and Ecosystem Support group) and Fire Hazard (within the Regulatory Services—Mitigating group)
- Indicators and groups show moderate to low impact or pressure from all companies in both sectors are:
 - Under Scape Physical Risk: Water Scarcity, Forest Productivity and Distance to Markets, Limited Wild Flora & Fauna Availability (within Provisioning Services), Soil Condition, Air Condition, Ecosystem Condition, Pollination (within Regulating and Supporting Services—Enabling), Landslides, Plant/Forest/Aquatic Pests and Diseases, Herbicide Resistance, Extreme Heat, Tropical Cyclones (within Regulating Services—Mitigating), Land, Freshwater and Sea Use Change, Tree Cover Loss, Invasives, Pollution (within Pressures on Biodiversity)

- Under Scape Reputational Risk: Protected/Conserved Areas, Key Biodiversity Areas, Other Important Delineated Areas, Ecosystem Condition, Range Rarity (Within Environmental Factors), Labor/Human Rights, Financial Inequality (within Socioeconomic Factors) and within Additional Reputational Factors there are: Political Situation, Sites of International Interest and Risk Preparation
- Minimal Impact and Dependencies: Media Scrutiny (within the Additional Reputational Risks group) demonstrates minimal impact and dependency
- No Impact or Dependency: Indicators like Tourism Attractiveness (within the Cultural Services group of indicators belonging to Physical Risks) and Resource Scarcity: Food - Water - Air (within the Socioeconomic Factors group, which belongs to Reputational Risks) show no dependencies or impacts
- Unavailable Data: for both sectors, the indicators for Limited Marine Fish Availability (within the Provisioning Services group of indicators belonging to Physical Risks) and Indigenous Peoples (IPs); Local Communities (LCs) Lands and Territories (within the Socioeconomic Factors group, which belongs to Reputational Risks) have unavailable data

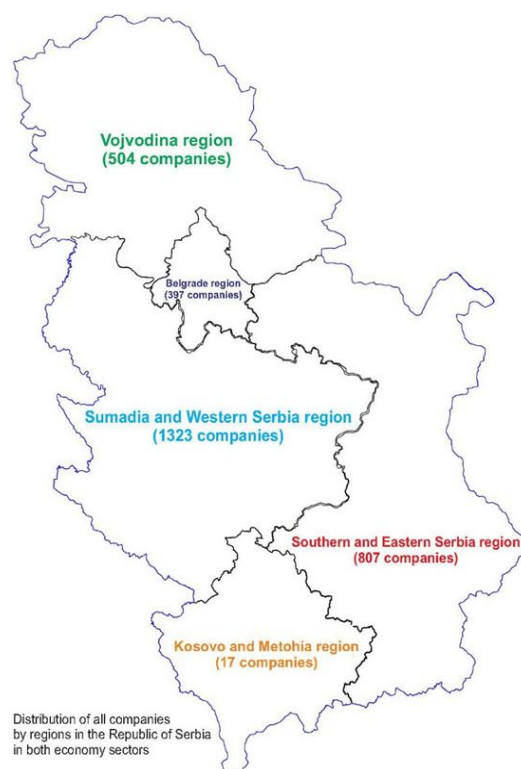


Figure 1. Distribution of all companies by regions in the Republic of Serbia, in both economic sectors: Forestry and Logging and Production of Paper and Paper Products. Source: Authors' interpretation based on the database of the SCC. (For the purpose of this work, the basic background images/maps were obtained from the website Geosrbija [<https://a3.geosrbija.rs>]. These backgrounds are georeferenced and have been imported into AutoCAD. The georeferenced backgrounds [each municipality separately from the Republic of Serbia] have been combined to represent the regions of Vojvodina, Belgrade, Šumadija and Western Serbia, Southern and Eastern Serbia, and the region of Kosovo and Metohija, thus forming a georeferenced border of Serbia. Once the borders of the regions and the entire Serbia were established, the image was exported from DWG format [drawing in AutoCAD] to PNG format)

Table 1. Comparison of the impacts and dependencies of all companies in the Forestry and Logging and paper sectors in Serbia, considering WWF BRF indicators and indicator groups

		Forestry and logging	Production of paper and paper products	Impacts and dependencies from both sectors
Scape physical risk	SPH	3.91	3.91	3.91
1. Provisioning services	SRC1	3.60	3.66	3.63
1.1 Water scarcity	S1_1	3.37	3.42	3.40
1.2 Forest productivity and distance to markets	S1_2	3.54	3.65	3.60
1.3 Limited wild flora & fauna availability	S1_3	3.40	3.36	3.38
1.4 Limited marine fish availability	S1_4	NA		
2. Regulating & supporting services - enabling	SRC2	4.11	4.14	4.13
2.1 Soil condition	S2_1	3.45	3.49	3.47
2.2 Water condition	S2_2	4.29	4.28	4.29
2.3 Air condition	S2_3	3.00	3.00	3.00
2.4 Ecosystem condition	S2_4	3.92	3.91	3.92
2.5 Pollination	S2_5	4.01	4.17	4.09
3. Regulating services - mitigating	SRC3	3.92	3.86	3.89
3.1 Landslides	S3_1	4.07	3.89	3.98
3.2 Fire hazard	S3_2	4.36	4.42	4.39
3.3 Plant/forest/aquatic pests and diseases	S3_3	3.47	3.49	3.48
3.4 Herbicide resistance	S3_4	2.95	2.98	2.97
3.5 Extreme heat	S3_5	3.63	3.64	3.64
3.6 Tropical cyclones	S3_6	3	3	3.00
4. Cultural services	SRC4	No dependencies or impacts		
4.1 tourism attractiveness	S4_1	No dependencies or impacts		
5. Pressures on biodiversity	SRC5	3.79	3.80	3.80
5.1 Land, freshwater and sea use change	S5_1	4.07	4.14	4.11
5.2 Tree cover loss	S5_2	3.41	3.39	3.40
5.3 Invasives	S5_3	2.03	2.01	2.02
5.4 Pollution	S5_4	3.65	3.65	3.65
Scape reputational risk	SRP	3.06	3.07	3.07
6. Environmental factors	SRC6	3.46	3.44	3.45
6.1 Protected/conserved areas	S6_1	3.84	3.71	3.78
6.2 Key biodiversity areas	S6_2	3.12	3.07	3.10
6.3 Other important delineated areas	S6_3	2.83	2.89	2.86
6.4 Ecosystem condition	S6_4	3.08	3.09	3.09
6.5 Range rarity	S6_5	2.16	2.15	2.16
7. Socioeconomic factors	SRC7	2.25	2.25	2.25
7.1 Indigenous peoples (IPs); local communities (LCs) lands and territories	S7_1	Na		
7.2 Resource scarcity: food - water - air	S7_2	No dependencies or impacts		
7.3 Labor/human rights	S7_3	2.50	2.50	2.50
7.4 Financial inequality	S7_4	1.99	2.00	2.00
8. additional reputational factors	SRC8	2.67	2.69	2.68
8.1 Media scrutiny	S8_1	1.50	1.50	1.50
8.2 Political situation	S8_2	3.10	3.11	3.11
8.3 Sites of international interest	S8_3	2.11	2.13	2.12
8.4 Risk preparation	S8_4	2.46	2.49	2.48

Source: Authors' interpretation based on WWF BRF data

When comparing the results of the two analyzed economic sectors—Forestry and Logging, and Production of Paper and Paper Products—it can be concluded that, according to the data presented in *Table 1*, the results are very similar, with minimal deviations across most categories. This indicates a comparable level of exposure to risks in the context of the Republic of Serbia. Although there are slight differences in certain individual indicators, both sectors demonstrate very similar risk and dependency profiles, suggesting that they face comparable challenges related to physical and reputational risk factors affecting their operations.

Based on these data, the indicators can be classified and ranked according to the general impact and dependency assessment for companies, and they are grouped into six categories:

- *First group:* This includes the indicators with the highest impacts and dependencies from all 3111 companies. These indicators are Fire Hazard and Water Condition. These indicators pose a very high risk due to climate change and inadequate forest management, leading to frequent fires that contribute to landslides and the degradation of water resources. Additionally, wastewater from the paper industry further contributes to pollution.
- *Second group:* These indicators have a significant impact on the environment and biodiversity. Included here are Pollination, Landslides, Ecosystem Condition, Forest Productivity and Distance to Markets, Plant/Forest/Aquatic Pests and Diseases, and Soil Condition. These indicators are crucial for the environment and biodiversity. Deforestation reduces the number of pollinators, while the loss of native forests threatens biodiversity and contributes to landslides. Forest productivity and the distance from markets are under pressure due to the decreasing areas of indigenous tree species in Serbia, replaced by planned plantings with non-native or invasive species. The loss of native tree species results in greater distances from markets, causing various environmental and economic issues, including the need for transport and additional resource use. Diseases and pests are expected to worsen in the near future due to temperature rising, the overuse of chemicals, and the resulting degradation of ecosystems.
- *Third group:* This group includes indicators with a medium impact on ecosystems, such as land use changes and the degradation of protected areas due to industrial activities. Pollution of water and air also threatens biodiversity. This is the largest group as natural habitats, especially protected areas, are increasingly threatened due to urban, industrial, agricultural, and tourism expansion. The narrowing of these areas, instead of their expansion, leads to more intense climate changes and the creation of new heat zones, reducing the natural cooling capacity of land and regulating atmospheric processes through evaporation. This, in turn, impacts aquatic ecosystems. Extreme temperatures caused by these changes endanger biodiversity by reducing organisms' resilience to stress. Indicators in this group include Land, Freshwater and Sea Use Change, Protected Areas, Pollution, Extreme Heat, Water Scarcity, Tree Cover Loss, Limited Wild Flora & Fauna Availability, Political Situation, Key Biodiversity Areas, Ecosystem Condition, Air Condition, Tropical Cyclones, Herbicide Resistance, and Other Important Delineated Areas.
- *Fourth group:* These indicators are subject to very low impacts and dependencies from companies. They include Labor/Human Rights, Risk

Preparation, Area/Scope Limitations, Sites of International Interest, Invasive Species, and Financial Inequality. These indicators are more relevant to socio-economic aspects such as human rights and financial inequality. For example, the exploitation of forest ecosystems leads to income loss in local communities, deepening social and economic inequality, as profits are largely concentrated in urban areas and large companies, while local communities and workforces often see minimal financial benefit. Forest cutting and the exploitation of forest resources, on which local communities depend, result in their loss.

- *Fifth group:* These indicators have the lowest impact on business operations in the Forestry and Logging and paper sector but can still be important for ESG reporting as they contribute to biodiversity conservation. These include Media Scrutiny, Tourism Attractiveness, and Resource Scarcity: Food - Water - Air. While Serbia is not yet a heavily tourist-developed country, in the last decade or two, tourist capacity in mountainous areas, rivers, and lakes (especially within protected areas) has started to intensify, with the construction of tourist facilities to increase tourist capacity and attract visitors.
- *Sixth group:* These indicators are not available in the WWF BRF data, yet they are related to biodiversity. They include Limited Marine Fish Availability (since Serbia has no direct access to the sea, this might be one reason for the unavailability of such data) and Indigenous Peoples (IPs); Local Communities (LCs) Lands and Territories (The World Wildlife Fund has not yet integrated this group of global data on indigenous and local communities' territories into their biodiversity conservation risk filter, though this will likely happen in the future).

Discussion

Using the WWF BRF tool as a strategic instrument for ESG reporting offers a valuable opportunity for companies, especially those in environmentally sensitive sectors like Forestry and Logging and Production of Paper and Paper Products. This user-friendly, free and applicable tool enables businesses to assess key environmental dimensions of their operations (such as biodiversity protection, climate impact, and natural resource use) and align them with sustainability values, including Corporate Social Responsibility (CSR) principles (Tsalis et al., 2020).

According to Jackson et al. (2020), CSR is a key approach in public policy, with a particular focus on corporate transparency through mandatory non-financial information reporting, or sustainability reports. Gogic (2022) points out that companies adopt CSR for various reasons, including compliance with legal requirements, cost reduction, and strengthening relationships with stakeholders.

ESG reports cover the environmental, social, ethical, and governance aspects of a company's operations, which are also key aspects of CSR and ESG. According to Manes-Rossi et al. (2018), non-financial reporting contains both "De facto" and "De jure" evidence. This evidence contributes to transparency, accountability, and a more comprehensive understanding of a company's impact on society and the environment.

Environmental stewardship and ethical ecological practices are essential for fostering ESG-oriented strategies across companies of varying sizes. Incorporating ecological considerations into business operations, such as minimizing their environmental impact and taking care of nature and biodiversity protection, companies can better balance

profitability, social responsibility, and environmental sustainability. This approach underlines socially responsible business conduct (CSR), which is deeply connected to sustainable operations and ESG standards (Kuzmanović et al., 2023).

By adopting ESG frameworks and harnessing digital tools such as the WWF BRF, companies can communicate their environmental performance transparently, strengthening stakeholder confidence and highlighting their dedication to biodiversity protection.

Incorporating the BRF into ESG reporting provides a more detailed picture of how corporate activities interact with ecosystems, enabling sustainability programs to be better focused and conservation resources to be deployed where they have the greatest impact (Liu et al., 2023).

Use of the WWF BRF tool is particularly crucial in regions like Serbia and its enterprises, where biodiversity is under big pressure from different economic activities and requires a balanced approach that integrates environmental issues into business strategies.

Furthermore, the relevance of this topic in today's business environment cannot be overstated. Climate change, biodiversity loss, and ecosystem degradation are now central challenges for sustainable development. ESG reporting is no longer optional—it is becoming a regulatory imperative and a strategic necessity. In sectors such as Forestry and Logging and Production of Paper and Paper Products, where environmental impacts are direct and often significant, identifying and addressing biodiversity-related risks is crucial for long-term resilience and responsible corporate positioning.

In Serbia's context, where biodiversity is rich but vulnerable, applying ESG principles through structured tools like the WWF BRF is especially important. It allows companies to evaluate and communicate their environmental dependencies and impacts more effectively, while aligning with EU sustainability directives and global best practices. In doing so, Serbian enterprises not only improve their ESG performance but also contribute to broader sustainability goals and enhance their reputational capital in both domestic and international markets.

This research addresses a timely and critical need: the integration of biodiversity conservation into ESG reporting practices. It offers a conceptual and empirical contribution that supports the transition of high-impact industries toward sustainable and responsible development.

Conclusion

This paper addresses the importance of applying the WWF BRF tool, which facilitates the analysis of risks that the Forestry and Logging and Production of Paper and Paper Products industries pose to forest ecosystems and social communities, through a set of indicators that assess physical and reputational risks to biodiversity.

The industries such as Forestry and Logging and Production of Paper and Paper Products in Serbia face various challenges in sustainable development and operations, particularly regarding the conservation of natural resources and biodiversity. These activities contribute significantly to the degradation of natural resources, and excessive logging and reduced areas of natural forests further increase risks to ecosystems and biodiversity.

In the context of ESG reporting, the importance of precise collection and organization of non-financial data is highlighted to transparently showcase the impact of

business operations on the environment. The application of ESG reporting allows companies to identify key risks and develop strategies to mitigate negative impacts, while the WWF BRF tool provides a foundation for risk assessment and helps companies understand where they can improve their business practices to minimize negative effects on biodiversity.

Based on the WWF BRF tool, key risk indicators have been identified, which are crucial for enhancing ESG practices in the Forestry and Logging and Production of Paper and Paper Products industries to achieve sustainable development goals, both nationally and internationally.

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