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Preface

In recent decades, the discourse on sustainability and climate change has evolved from academic reflection to an urgent global priority. The interconnected nature of environmental, social, and economic systems highlights the pressing need for coordinated efforts to address climate-related challenges. Climate change, driven largely by human activities such as greenhouse gas emissions, deforestation, and industrialization, has already resulted in severe environmental disruptions. Rising global temperatures, shifting weather patterns, and the increasing frequency of extreme weather events will result in significantly increased risks to ecosystems, economies, and societies.

Recognizing the need for innovative solutions and interdisciplinary collaboration, the *Albanian Journal of Economy and Business* has dedicated this special issue "*1Future Issue: Climate and Sustainability*" to exploring diverse research paths on sustainability and climate change. The contributions to this issue aim to bridge the gap between research and practical implementation, fostering dialogue among scholars, policymakers, and practitioners. A critical objective of this initiative is to enhance research output and scholarly engagement in the Western Balkans, where climate change and sustainability research remain underrepresented.

This special issue is an outcome of the " jOiNEd For sUsTainability - bUilding climate REsilient communities in WB and EU -*n1FUTURE* project", a project funded by the European Union in the framework of the Erasmus+ Program. Through an open-access model, the journal seeks to disseminate knowledge widely, making research accessible to a broader audience. The inclusion of interdisciplinary perspectives ensures that contributions span natural sciences, social sciences, engineering, business, health, and humanities, reflecting the multifaceted nature of sustainability challenges.

Guest Editorial Board

The Albanian Journal of Economy & Business Special Issue, 2025

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The Strategic Contribution of Green Intellectual Capital and Green Ambidexterity to Eco-Innovation in the Indonesian Manufacturing Sectors

Aisyah Pia ASRUNPUTRI[1], Vilah Silviatul ALIAH[2]

Abstract

In the pursuit of a green economy, Indonesia's manufacturing sectors must fulfil environmental responsibilities by accelerating the development of eco-innovation. Manufacturing companies necessitate a strategic approach to adapt to these demands. This study aims to investigate the impact of green intellectual capital and green ambidexterity on eco-innovation in the Indonesian manufacturing sector. Data were collected through an online survey aimed at managers in Indonesia's manufacturing sectors and analysed using IBM SPSS Statistics 26. Multiple regression analysis is employed to investigate the relationship among variables. The results indicated that green intellectual capital significantly influences eco-innovation, with green human capital being the most robust predictor among all components of green intellectual capital. Green ambidexterity is essential for predicting eco-innovation, with exploitative green ambidexterity being paramount for advancing eco-innovation in Indonesian manufacturing sectors. This research indicates that companies must consistently cultivate an innovative environment and acknowledge that the pursuit of eco-innovation is a collective endeavour involving all the stakeholders as intellectual actors in advancing eco-innovation.

Keywords: *Green Intellectual Capital, Green Ambidexterity, Eco-Innovation, Indonesian Manufacturing Sectors, Strategic Approach*

Jel code: 013, 015, 032

1. Introduction

Indonesia's efforts to pursuit the development of green economy can have a positive impact, particularly on the development of environmentally friendly products, services, and business processes that are not only intended to meet environmental goals but also to strengthen and accelerate innovation in the national industry. Such innovation necessitates agility for businesses to change their strategic and operational approaches in order to gain a competitive

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advantage and allocate existing resources to better product innovation. Green manufacturing principles can help manufacturers reduce negative environmental impacts by creating, transforming, and protecting long-term value (Deloitte, 2021).

Green manufacturing principles are followed by manufacturing companies that recognize the potential of eco-innovation to meet social responsibilities, protect the environment, and succeed economically. Eco-innovation helps achieve the sustainable development goals (SDGs) and meet market pressures that force companies to adopt green practices to combat climate change. Thus, companies must adopt resilient technologies and sustainable industrialization strategies to foster eco-innovation (Javed et al., 2024).

The motivation of the study is to examine the critical functions of green intellectual capital and green ambidexterity in fostering eco-innovation. Yong et al. (2023) studied the role of green intellectual capital in manufacturing sustainability. Individuals and organizations' eco-innovation-related intangible assets, knowledge, competencies, and relationships make up green intellectual capital. This concept includes green relational, structural, and human capital (Chen, 2008). Green intellectual capital can accelerate environmentally sustainable technological innovation, but the literature does not adequately address its importance in eco-innovation (Di Vaio et al., 2024).

Green ambidexterity enables green manufacturing firms to enhance processes through the exploration of sustainable and innovative technologies and practices. Green ambidexterity synthesizes traditional and contemporary knowledge for advancement. Green ambidexterity fosters a learning-oriented mindset that harmonizes exploitative and exploratory innovation to integrate environmental sustainability, enabling organizations to identify new opportunities. Notwithstanding its advantages for eco-innovation, green ambidexterity remains inadequately comprehended (Javed et al., 2024).

Thus, the primary aim of this study is to address the research question: (1) Does green intellectual capital positively influence the advancement of eco-innovation? (2) Does green ambidexterity positively influence the advancement of eco-innovation? A theoretical model was created using primary data from Indonesian manufacturing firms, particularly in Jakarta, from July to August 2024 to assess variable relationships. This study aims to provide empirical evidence on variable effects and improve sustainable manufacturing discourse.

This study examines the strategic role of green intellectual capital and green ambidexterity in promoting environmentally friendly innovation in Greater Jakarta's manufacturing sectors to fill these knowledge gaps. The study illuminates the strategic importance of companies' ability to leverage eco-innovation and sustainable business processes while adapting to consumer demands.

This research adheres to a systematic structure, commencing with an introduction, followed by **Section 2**, which is a literature review that elucidates the theoretical framework of the study to enhance the empirical examination of the research. **Section 3** encompasses the formulation of the research methodology employed. **Section 4** presents the research results derived from the analysis, while **Section 5** discusses the findings, articulates the primary conclusions, and outlines the research limitations along with recommendations for future studies.

2. Literature review

2.1. Theoretical background

2.1.1. Natural Resource-Based View

This study pertains to the concept of Natural Resources Based View (NRBV) developed by Harts (1995). Natural Resource-Based View originally came from the Resource-Based View (RBV) theory with a firm-centric approach (Andersén, 2021). According to the Natural Resources-Based View (NRBV) theory, firms with strong eco-innovation capabilities will have a competitive advantage (Suleman et al., 2024). Linking to the NRBV theory, green intellectual capital encapsulates the primary components (i.e., knowledge, systems, relationship dynamics) that shed light on eco-innovation, a company's ability to create environmentally friendly products, processes, or technologies (Marco-Lajara et al., 2023). Green ambidexterity also allows companies to explore and exploit environmental issues, boosting their competitiveness (Baquero, 2024).

2.1.2. Natural Resource Orchestration Theory

Resource Orchestration Theory (ROT) and Natural Resource Orchestration Theory (NROT) emphasize managers' role in achieving competitive advantage by understanding the organization's strengths and weaknesses (Sirmon et al., 2011). Meanwhile, NROT is used to evaluate green resources to improve resource utilization and innovation (Zhou et al., 2024). According to NROT, green intellectual capital helps companies identify intangible resources needed to improve environmental performance (Baquero, 2024). In this light, companies with high level of green ambidexterity can innovate sustainably because they exploit existing competencies while exploring new ones, making these two aspects of organizational learning inseparable (Asiaei et al., 2023).

2.2. Green intellectual capital

Intellectual capital is a collection of knowledge-based company resources (Jirakraisiri et al., 2021). Meanwhile, green intellectual capital transcends

traditional intellectual capital by emphasizing a commitment to environmentally sustainable practices (Anser et al., 2024) and is defined as the quantity of intangible resources pertaining to environmental protection or innovation (Wang & Juo, 2021). Green intellectual capital comprises three components: green human capital, green structural capital, and green relational capital.

2.2.1. Green human capital

Green human capital refers to the knowledge, skills, attitudes, behaviors, and communication skills possessed by company members that contribute to the development of innovations within the company (Xi et al., 2023). Green human capital is considered a factor that can accelerate eco-innovation development. This happens because with the higher the level of green human capital, the more available skills, innovations, capabilities, capacities and responsibilities in assurance and protection in the company which can later encourage these trained employees to achieve the company's sustainability goals (Ali et al., 2021).

H1a. Green human capital positively affects the development of eco-innovation in Indonesian manufacturing sector.

2.2.2. Green relational capital

Green relational capital is the value of employee-public relations for environmental protection (Hina et al., 2024). Relational capital gives companies access to external resources and expertise to improve strategic collaboration and co-innovation with academia, industrial experts, and other stakeholders (Abdelfattah et al., 2024). Putri et al. (2024) explained that focusing on Indonesian manufacturing companies, green relational capital enhances solidarity with stakeholders, facilitates engagement with external suppliers or clients in research and development and reinforces ongoing experimentation.

H1b. Green relational capital positively affects the development of eco-innovation in Indonesian manufacturing sector.

2.2.3. Green structural capital

Green structural capital encompasses various aspects of organizational operations, including procedures, processes, management philosophy, culture, intellectual property rights, information systems, information resources, and technology. Green structural capital constitutes a framework that underpins green human capital. This form of capital enhances companies' capacity to adapt to change by integrating sustainability principles and long-term perspectives. Effective corporate governance and environmental stewardship,

manifested through systems, philosophy, and work ethic, can foster eco-innovation and advance sustainable business practices (Wei et al., 2024).

H1c. Green structural capital positively affects the development of eco-innovation in Indonesian manufacturing sector.

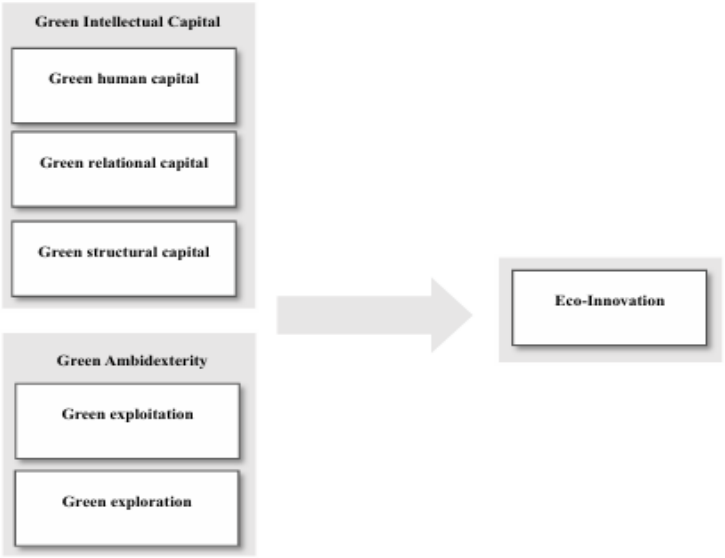

Figure 1. Theoretical framework

Source: Authors‘ work

2.3. Green ambidexterity

Ambidexterity refers to the capacity to excel in both established technologies and industries, as well as to thrive in emerging sectors, prompting companies to foster both exploratory and exploitative initiatives for environmental sustainability (Cheah & Tan, 2024). Green exploitation can motivate companies to invest in innovative eco-friendly technologies, thereby ensuring a competitive advantage in the industry. Exploratory abilities can enhance the creative cognition of employees, promoting the execution of innovative enhancements within an ecological context (Hafeez et al., 2024). Martínez-Falcó et al. (2024) emphasized that the two components of green ambidexterity, specifically green exploitation and green exploration, promote eco-innovation. The study elucidates that the implementation of eco-design and sustainable sourcing strategies in the manufacturing sector is facilitated by the utilization of the opportunities presented by the organization's capacity to exploit and explore avenues for innovation.

H2a: Green exploitation is positively related to eco-innovation.
H2b: Green exploration is positively related to eco-innovation.

3. Methodology

This study employs a survey administered to managers in the manufacturing industries (specifically food, electronics, plastics, construction, and textiles) during the period of July to August 2024.

The manufacturing sectors were selected for this study based on their substantial research and development (R&D) investments, which exceed those of other sectors and account for over 50% of the total expenditure (United Nations Industrial Development Organization, 2024). Furthermore, on a global scale, the manufacturing industry demonstrates the highest level of productivity, as evidenced by the significant proportion (57%) of green patents it generates in comparison to other sectors (United Nations Industrial Development Organization, 2024).

This study utilizes the "10-times rule" formulated by Hair et al. (2014) and yielded a minimum sample size of 130. A structural equation model examines research variable relationships. Online surveys from manufacturing managers were conducted using Google Form. Online channels spread the survey, which received 307 responses over two months. Men make up 64% and women 36% in Table 1. The manufacturing industry employs 38.1% and 30.6% of 32-38, 25-31, and 25-31-year-olds. The study included high school graduates, undergraduates, and postgraduates, with 71.35% having postgraduate degrees. 34.2% worked in food and beverage, 13.3% electronics, 27.7% plastic, and textiles.

Table 1. Respondent Demography

Demography		Frequency	Percentage
Gender	Male	196	64
	Female	111	36
Age	18-24	6	1.95
	25-31	94	30.6
	32-38	117	38.1
	39-45	53	17.26
	>45	37	12.05
Educational level	High school graduate / diploma	2	0.6
		86	28
	Undergraduate	219	71.35

	Postgraduate		
Work experience (Years)	<5	10	3.26
	5-10	89	29
	>10	208	67.7
Sector	Food & Beverage	105	34.2
	Electronic	41	13.3
	Plastic	85	27.7
	Textille	76	24.8

Source: Authors'work

The measures were originally developed in English and then translated into Indonesian using a translation-backward translation approach. The ratings for all measures were determined using a five-point Likert scale, where a rating of 1 represented strong disagreement and a rating of 5 represented strong agreement.

Green intellectual capital was measured by Green Intellectual Capital instrument developed by Yong et al. (2023). The scale consists of three subscales: green human capital (two items, e.g., "Employees in our company have stronger competencies in environmental protection compared to employees in competing companies, green structural capital (two items, e.g., "Our company demonstrates more innovation in environmental protection.") and green relational capital (two items, e.g., "We can meet customer satisfaction related to environmental protection through our products or services.").

The assessment of green ambidexterity was conducted using a modified iteration of the scale created by Úbeda-García et al. (2022). The subdivision comprised of two subscales: green exploitation, which included two items, such as "Our company is actively improving environmentally friendly products, processes, and services," and green exploration, which also consisted of two items, such as "Our company is actively developing environmentally friendly products, processes, and services."

The assessment of eco-innovation was conducted using a scale that was originally developed by Mukhtar et al. (2023). Only six out of the original ten scales were evaluated in this study, specifically the scale titled "The raw materials utilized by our company result in minimal pollution".

4. Results & Discussion

Results

Table 2 displays descriptive statistics, including means, standard deviations, correlations, and the main variables. The results demonstrate a positive correlation between green intellectual capital and eco-innovation. Moreover, there is a correlation between green ambidexterity and elevated levels of eco-innovation.

Table 2. Results of means, standard deviations, correlations, and reliabilities

	Mean	SD	Reliability	1	2	3
1 Green intellectual capital	3.7034	0.53680	0.960	1		
2 Green ambidexterity	3.5022	0.56453	0.805	0.753	1	
3 Eco-innovation	3.3603	0.54609	0.782	0.790	0.731	1

Source: Authors 'work

Hypothesis testing

The study employed linear regression analysis to ascertain the primary effects of the hypotheses formulated in this research. The results of the hypothesis tests presented in Table 3 demonstrate the impact of green intellectual capital and green ambidexterity on eco-innovation. The study discovered that there is a positive correlation between green intellectual capital and eco-innovation. This outcome corroborates hypothesis 1. The presence of green ambidexterity has a significant and positive impact on eco-innovation. This finding provides support for hypothesis 2.

Table 3. Results of multiple regression

	Unstandardized coefficients		Standardized coefficients	t	Sig
Model	**B**	**Std Error**	**Beta**		

1	(Constant)	0.817	0.152		4.882	0.000
	Green human capital	0.758	0.138	0.566	3.554	0.000
	Green structural capital	0.690	0.162	0.493	3.765	0.000
	Green relational capital	0.705	0.122	0.564	3.982	0.000
	Exploitative green ambidexterity	0.822	0.129	0.435	4.091	0.000
	Exploratory green ambidexterity	0.801	0.144	0.557	4.889	0.000

Note(s): Dependent variable: Eco-innovation

Source: Authors 'work

The ANOVA results are displayed in Table 3. The regression coefficients of the explanatory variables have a positive impact on the relationship between the studied variables. The reliability and significance scores suggest that green intellectual capital and green ambidexterity have positive influence on eco-innovation. Thus, the hypotheses were supported.

The aforementioned results indicate that each dimension of the variables positively influences eco-innovation. The findings indicate that green human capital (*H1a* = 0.758) is the most significant predictor of eco-innovation, succeeded by green relational capital (*H1b* = 0.705) and green structural capital (*H1c* = 0.690). Wang & Juo (2021) illustrates the endorsement of the aforementioned finding, which asserts that green human capital is essential for eco-innovation, owing to the expertise of employees that fosters the advancement of eco-innovation. Consequently, a company with a greater amount of green human capital is more likely to succeed in eco-innovation development.

In the context of green ambidexterity, exploitative green ambidexterity demonstrates a more significant contribution to eco-innovation (*H2a* = 0.822) than exploratory green ambidexterity (*H2b* = 0.801). This finding suggests that the manufacturing sectors in Indonesia demonstrate a pronounced inclination towards exploitative strategic actions in response to foster eco-innovation. Moreover, companies in the manufacturing sectors tend to address stakeholder demands through short-term eco-friendly practices (Jakhar et al., 2020).

Table 4. Results of model summary

Model	R	R square	Adjusted R square	R square change	F change	Sig
1	0.887	0.632	0.628	0.632	189.533	0.000

Source: Authors 'work

Table 4 presents a summary of the model derived from the regression test outcomes of this study, indicating an R-squared value of 0.632. The R-squared value demonstrates that the explanatory variables, green intellectual capital and green ambidexterity, account for 63% of the variation in eco-innovation, indicating the appropriateness of this research model.

Discussion

This study investigates the impact of green intellectual capital on eco-innovation. Consistent with Tram & Ngoc (2024), this demonstrates that companies with employees who have superior knowledge, capabilities, and management systems have higher innovation performance, particularly in terms of environmental management. Companies benefit greatly from the integration of intangible assets in addressing ecological challenges. Furthermore, companies that focus on eco-innovation policies create green assets that can improve their capabilities in terms of knowledge, structure, and relationships by incorporating factors related to the company's assets as well as employee pro-environmental behaviour.

Based on this study, out of a total of three (3) dimensions of green intellectual capital, Green human capital has the greatest influence on eco-innovation, particularly with the statement item with the highest value, "Employee contributions related to environmental protection are better than contributions made by employees in competing companies". This may happen due to the increasing level of environmental awareness in Indonesia's manufacturing industry. This is reflected in the survey conducted by Aswicahyono & Rafitrandi (2019). The survey focuses on the awareness of technology adoption among Indonesian manufacturing companies. The survey explained how respondents understood the importance of robots in their businesses. Respondents recognized the benefits of technology adoption and digitalization in the manufacturing industry, including (1) increased productivity, (2) energy efficiency, and (3) improved planning and budgeting performance. With a strong understanding of Indonesia's manufacturing industry, they have the opportunity to develop new business opportunities, reduce environmental

impact and improve social welfare through green technology (Ministry of Finance Republic of Indonesia, 2020a).

A good understanding of human resources related to environmental protection can also influence the use of raw materials that emit the least amount of pollution when processed by manufacturing companies. As coined by Mansoor et al. (2021), green human capital has a vital role in helping organizations achieve their eco-innovation performance. With the availability of skills, employees' ability to innovate, capacity and sense of responsibility can increase the chances of meeting the goals of eco-innovation.
Human capital is also considered as an organizational resource where organizational innovation is formed by the skills, competencies, and experience of employees who have the ability to innovate in the company. Previous literature underlines the need for organizations to enrich the knowledge and skills of employees to develop environmentally friendly processes and product innovation. So that when the company has a high level of green human capital, employees will tend to contribute more actively to environmental protection. Therefore, to improve the performance of eco-innovation, companies must develop green human capital to generate creative ideas and new opportunities (Marco-Lajara et al., 2023).
As for the second strongest dimension in this study, it is owned by green relational capital with the strongest statement item, namely, "Customer satisfaction related to environmental protection can be met by the company in the form of products or services". This means that the company can maintain good relationships with customers, as evidenced by the sufficient customer satisfaction related to environmentally friendly products or services provided by the company. As pointed out by Suhartanto et al. (2024), customer demand is changing, and companies are increasingly focusing on environmentally friendly products, processes, and services. Customers' environmental concerns stem from their intention to buy a product or service.

Wang et al. (2022) explain that this concern stems from environmental issues such as waste, deteriorating health, a lack of environmental responsibility, and wasteful energy consumption. With these concerns, customers are more critical in deciding which products to buy, such as looking for eco-labels on packaging or researching the CSR programs offered and carried out by product manufacturers. Customers do this to ensure that the company's environmental values align with the values they believe in, allowing them to maximize customer trust in companies or brands that have proven to fulfil their environmental responsibilities.

Green structural capital, as the third dimension of green intellectual capital, is thought to be quite supportive of the opportunity to create corporate eco-innovation, particularly with regard to the statement item, "Our company is

more innovative in terms of environmental protection than other companies". Environmental protection innovations are closely related to the company's use of energy-efficient production raw materials. One example of eco-innovation in Indonesia's cement industry is a collaboration between the government and industry players to promote the use of two types of green cement: Portland composite cement (PCC) and Portland pozzolana cement. Green cement has a lower clinker content. The production and use of PCC and PPC reduces carbon emissions by replacing clinker with other supporting materials. The Cement Association of Indonesia (ASI) estimates that PCC and PPC can help Indonesia reduce carbon emissions by up to 26% (Antara News, 2024).

Meanwhile, out of a total of two (2) dimensions of green ambidexterity, green exploitation play a role in accommodating the company's strategy to apply knowledge about the environment, capabilities, and also processes to optimize green products, processes or services is considered to be able to affect the company's success in managing waste. Cao et al. (2022) emphasize that companies with a high level of green exploitation are more likely to actively engage in meeting customer demand for green products, processes, or services. Green exploitation can also help businesses maintain their competitive advantage in the industry. This is consistent with a study by Shehzad et al. (2023), Green exploitation is the strongest predictor of increased eco-innovation in companies that develop environmentally friendly products, processes, and services. Green exploitation assists businesses in utilizing internal competencies and intangible resources, which are critical for organizations to develop eco-innovations.

Another aspect of green ambidexterity is green exploration, which assists businesses in developing fundamentally new knowledge. Green exploration makes it easier for businesses to discover new information, opportunities, and technologies. Green exploration-based innovation can put companies in a superior position in the industry, strengthen the company's green image, and create barriers that competitors find difficult to overcome (Cao et al., 2022). The study reveals that the strongest statement item belongs to "Our company actively develops environmentally friendly products, processes and services".

This findings further implies the influence of company’s environmentally fiendly products, processes and services on the advancement of green product innovation. Putra et al. (2023) highlight the use of green extraction methods for natural products in Indonesia. Green extraction techniques are a set of methods for extracting beneficial components from natural products such as plants, herbs, and fruits. The techniques aim to reduce the negative effects of traditional extraction methods, especially those that use raw materials that are hazardous to human health and the environment.

5. Conclusions

Indonesian manufacturing sectors prioritize environmental issues, highlighting the importance of green intellectual capital and ambidexterity. Intangible assets from environmentally conscious companies can drive eco-innovation and long-term sustainability.

Nonetheless, referring to the report of Ministry of Finance Republic of Indonesia (2020b), to promote green growth in the Indonesian economy, businesses, the government, and higher education institutions must take a proactive approach. Companies should focus on digital and green competence, encourage knowledge sharing, and provide green rewards. Strategic partnerships with government and academia are also necessary for lifelong eco-organizational learning.

This research presents numerous prospects for future investigation. Firstly, by examining the impact of green intellectual capital and green ambidexterity on different types of eco-innovation, specifically eco-product innovation and eco-process innovation, to determine if there is a positive correlation. Furthermore, by incorporating the endorsement of both internal and external stakeholders as a determinant of eco-innovation. Ultimately, by directing the attention towards lower-level employees as research respondents.

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Importance of Climate-related Risk Management from a Regulatory Perspective: What are the Challenges for the Albanian Banking Sector?

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Abstract

As climate-related risks increasingly influence global economic stability, banks must actively assess and manage these challenges to ensure sustainable operations. This paper aims to explore the main regulations of climate-related risks and their perceived importance from a regulatory perspective considering the challenges they bring for financial institutions. It highlights the importance of integrating climate risk into the banking sector's governance frameworks, risk identification, assessment, mitigating, and monitoring models. An evaluation of the relevant regulations that focus on climate-related risks is performed to evaluate current regulatory frameworks and industry best practices, to recommend a comprehensive approach for banks in Albania, to enhance their resilience towards climate-related threats. According to the relevant reports and guidelines, this can be achieved by adopting a robust climate risk disclosure practice and encouraging collaboration with stakeholders to promote sustainable finance. Embracing climate risk as a core component of risk management can not only mitigate potential losses but also build foundations for innovation and growth in an evolving regulatory environment.

Keywords: *Climate change, Operational risk management, Natural disasters*

Jel code: G18, Q54

1. Introduction

It is no surprise that climate change can significantly affect banks' loan portfolios. This is why climate change, and its consequences, have always been hot topics of discussion when drafting new regulations applicable to the banking sector. According to the European Banking Authority's final guidelines on the management of ESG risks, climate change, environmental degradation, biodiversity loss, social issues, and other environmental, social, and governance (ESG) factors pose considerable challenges to the economy (European Banking Authority, 2025).

European Central Bank in its role as a supervisor of European banks, considers climate change a source of financial risk and has been intensifying its quantitative work aimed at capturing climate-related risks to financial stability

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by estimating the financial system's exposures to these types of risks, upgrading banking sector scenario analysis and monitoring the developments in the financing of the green transition (European Central Bank, 2021). The Financial Stability Report (2021) emphasizes that the climate-related risks to euro area banks, funds, and insurers could be significant if climate change is not mitigated in an orderly manner. Additionally, the need for policy action is seen as essential to ensure the financial system's resilience to climate-related risks.

Considering the transversal nature of climate-related risks, it is expected that their impact on banks' risk profile will be significant, affecting all types of risks to which banking activity is exposed. The table below summarizes the main issues related to the effects of climate change on credit risk (Bandt, et al., 2023). The effects of climate-related events are measured in terms of lending spreads.

Type of risk	**Climate-related events and their effect on the lending spreads**
Credit Risk	Agriculture loans: ▪ *underestimation of the riskiness of loans when climate-related risks are not considered* ▪ *larger exposure of poor countries due to the importance of the agriculture sector in the GDP of these countries*
	Floods: ▪ *increase in the probability of default of a non-insured property* ▪ *increase in the interest rates*
	Heat and Drought ▪ *higher interest rates charged for borrowers located in drought-located areas*
	Sea Level Rise (SLR) ▪ *Higher interest rates charged for mortgages on residential real estate exposed to more SLR*

Source: Basel Committee on Banking Supervision – The effects of climate change-related risks on banks: a literature review

Nevertheless, credit risk is only one of the main risks affected by climate-related events and regulations. Non-financial risks such as operational risk – defined as the risk of loss resulting from inadequate or failed internal processes, people, and systems or external events (Basel Committee on Banking Supervision, 2003) – and sound management plays an important role when it comes to addressing environmental, social and governance issues. Bank for International Settlements (2021) highlights that climate risk drivers

can be grouped into two main categories: 1) physical risks, which arise from the changes in weather and climate that impact the economy, and, 2) transition risks, which arise from the transition to a low-carbon economy. Furthermore, it mentions that climate risk drivers have several distinct features, including unprecedented frequencies, speeds, and intensities and the non-linear form that the risks are expected to take.

This paper aims to present an overview of the main regulations on climate-related risks and explore the regulatory environment in Albania to identify the gaps that need to be addressed by financial institutions. In addition, the link between climate-related risks and operational risk management will be explored by going through the relevant regulations. The following sessions of this paper will provide some more details regarding the methodology used and then will dive deep into the relevant body of literature addressing issues of climate change risks from a regulatory perspective.

2. Methodology

This paper consists of exploratory research methods, involving an analysis of the relevant regulations that focus on climate-related risks. These regulations are developed by reputable international regulatory bodies and their guidelines set the standards for countries' local regulations. In this regard, the main reports and guidelines that address climate change risks published by the Basel Committee on Banking Supervision, European Banking Authority, European Central Bank, Financial Stability Authority, etc., are consulted.
In the context of the Albanian banking sector, regulations developed by the national supervisory authority (Bank of Albania) tend to be in line with international regulations. In most cases, these regulations tend to address more extreme situations of climate change effects, focusing on managing disasters and recovery. Analyzing the requirements of these regulations will help to draw conclusions and recommendations on the importance of proper management of climate-related risks.

3. Literature review

i. Operational risk management and climate change risks faced by the banking sector

Climate change and its consequences can pose significant threats to banking activities. For this reason, climate change risks are often treated as operational risks. The official taxonomy of operational risks consisting of seven main categories, has a dedicated category of risks related to damage to physical assets, whose definition links climate change to operational risk (detailed in the table below).

Event-type category (Level 1)	Definition	Activity examples (Level 3)
Internal fraud	-	-
External fraud	-	-
Employment practices and workplace safety	-	-
Clients, products, and business practices	-	-
Damages to physical assets	Losses arising from loss or damage to physical assets from natural disasters or other events	1. Natural disaster losses 2. Human losses from external sources (terrorism, vandalism)
Business disruption and system failures	-	-
Execution, delivery, and process management	-	-

Source: Basel Committee on Banking Supervision – Calculation of RWA for operational risk

Natural disasters due to climate change are a growing concern for risk managers due to the difficulties that represent the assessment of their impact and probability. In the meantime, the impact of this change is more visible than ever and their impact on the operational risk profiles of firms can be broad. Grimwade (2022) considers extreme weather events, gradual/chronic changes to the Earth's climate, and weakened control effectiveness as the main physical risks related to climate change. Even though the weather cannot be controlled, it can still be monitored, and operational risk should consider weather risks during risk assessment (Girling, 2013). Elements such as the location of a branch or main office of a firm might significantly change the level of exposure to the risks related to weather and their assessment might lead to a residual risk level that may require developing action plans.

When assessing the potential losses due to natural disasters, the best practices in operational risk management offer a wide range of tools. A useful one applied by most banks is scenario analysis, which goes through several steps starting from preparation and ending in the incorporation of results into the capital requirements calculations. Scenario assessment is the most challenging task in the scenario analysis process (Chapelle, 2018).

According to the roadmap on the management and supervision of climate-related financial risks in the financial sector, the most direct effects of physical hazards on banks are through direct effects of the hazard on banks' branch networks, and consequently on the operational risk of the bank, as well as through the exposure of bank's loan portfolio to these risks and consequently

an increase of credit risk (Bank of Albania, 2023). According to the report, progress has been made by most banks in integrating climate risks into the operational risk management framework. Physical risks are being considered when defining business continuity plans and cover the most relevant physical risks through insurance which are not for climate-related and environmental risks specifically but that do cover damages stemming from these risks.

ii. Regulatory trends on climate change risks for the banking sector

The World Economic Forum has raised the alert of climate risks the world may be facing in its report on global risks published in 2024 (World Economic Forum, 2024). Among the key findings, it has listed a deteriorating global outlook based on its analysis through four structural forces deemed to be shaping the materialization and management of global risks over the next decade. Moreover, this report states that the environmental risks could hit the point of no return. These findings are based on the results of the Forum's Global Risk Perception Survey (GRPS). Since this risk is transversal, banking supervisors have also emphasized the importance of its proper management.

In its Overview of Pillar 2 supervisory review practices and approaches, BCBS has highlighted the importance of integrating climate-related risks into the supervisory review process (Basel Committee on Banking Supervision, 2019). It stresses the importance of banks' awareness of climate-related risks as well as the expectations from the supervisors to address the prudential risk from climate change through their existing risk management frameworks. Several supervisors are preparing to embed climate-related risks in the supervisory approach.

According to the European Central Bank, climate change affects the safety of the banking sector through physical risks, such as extreme weather events, as well as transition risks, such as uncertainties relating to the shift towards a low-carbon economy (European Central Bank, 2024). It reaffirms its role as a supervisor of banks operating in Europe and its role to ensure that the banks detect, manage, and disclose risks properly, including those stemming from climate change by helping them become more resilient to prevent adverse events that may impact the banking sector and financial system. The European Banking Authority has also launched an EU-wide pilot exercise on climate risk that aims to map banks' exposures to climate risk and to provide insight into the green estimation efforts banks have carried out. Among the main results published in its report, it is mentioned that more than half of banks' exposures are allocated to sectors that might be sensitive to transition risk (European Banking Authority, 2021). In addition, the scenario analysis shows that the impact of climate-related risks across banks has different magnitudes and is concentrated in some sectors. Financial disclosure for climate-related risks is an urgent challenge in all business sectors, including the financial

sector (Chiba, Mori, & Shimizu, 2017). However, potential financial risks posed by climate change to the financial sector have not been adequately understood while the financial risks are more likely to be significant. In 2015, the Task Force on Climate-related Financial Disclosures (TCFD). In 2023, the Financial Stability Board (FSB) whose role is the promotion of international financial stability, announced that the TCFD work was completed (International Financial Reporting Standards, 2024). This Task Force has issued recommendations around four thematic areas that represent core elements of how organizations operate: governance, strategy, risk management, and metrics and targets (Task Force on Climate-related Financial Disclosures, 2017). Regarding governance, TCFD recommends the disclosure of the organization's governance around climate-related risks and opportunities by describing the board's oversight of climate-related risks and opportunities as well as describing management's role in assessing and managing climate-related risks and opportunities. When it comes to strategy, TCFD recommends the disclosure of the actual and potential impacts of climate-related risks and opportunities for the organization's businesses, strategy, and financial planning where such information is material by describing the climate-related risks and opportunities that the organization has identified, describing the impact of climate-related risks and opportunities for the organization's business strategy and financial planning and describing the resilience of the organization's strategy, taking into consideration different climate-related scenarios. While the first two recommendations have a more holistic approach, the third and the fourth ones offer a more practical approach. About risk management, organizations must disclose the methodologies they apply during the climate-risk identification, assessment, and management process by specifically describing how these processes are integrated into the organization's overall risk management. This is done by disclosing the metrics and targets used to assess and manage relevant climate-related risks and opportunities (fourth recommendation).

Many banks have committed to adopting a business model that is aligned with the goals of the Paris Agreement, and they have already achieved several commitments in several ways. Analysis of industry-authored documents, press statements, and SEC disclosure reveals that banks are adopting a range of private governance measures to address climate change that converge around eight types of measures adopted by at least two major banks operating in the U.S. such as: 1) reducing the firm's footprint, 2) portfolio analysis and negative screens, 3) financing clean technology, 4) providing equity/advisory services, 5) climate philanthropy, 6) developing climate "best practices" through voluntary associations, 7) developing market mechanisms for carbon emissions reductions, and 8) improving reporting and disclosure of climate risk (Light & Skinner, 2021).

The Prudential Regulation Authority in England highlights three unique characteristics that pose challenges for firms in managing them effectively (Bank of England, 2021). According to this report, these risks are systemic, meaning that they affect every customer, every corporation, in all sectors, and all geographies, with correlated, non-linear, irreversible impacts. Climate change risks are simultaneously uncertain and yet totally foreseeable, meaning that the exact combination of physical and transition risks that will emerge is uncertain. Finally, the size and balance of the future risks we face will be determined by actions we start to take now which means that once physical risks begin to manifest systemically, it will already be too late to reverse many effects through reductions.

The ways through which Banks will address climate change will occupy the agendas of board and shareholder meetings in the forthcoming years. Since banks have a social aspect to their purpose, they must intermediate lending to remain profitable and maintain the welfare of their shareholders but also contribute to the development of the economy. Nevertheless, pursuing ambitious climate change policies will remain a challenge, since it cannot be met through adopting conventional risk regulations only, but by considering both qualitative and quantitative analysis of the effects associated with these changes (Heyvaert, 2011).

Regarding the regulatory framework for climate change risks in Albania, the Bank of Albania published in August 2024 the Guidelines on Financial Risks Related to Climate and Environment. These guidelines aim to better prepare the banking sector in Albania to assess, measure, manage, and control financial risks related to climate and environment. This will be achieved by orienting banks to address on an effective and comprehensive basis climate-related financial risks when assessing and implementing their business strategy. Local guidelines also set clear expectations when it comes to the increase of human resources that will be responsible for analyzing climate change. In compliance with international guidelines, other expectations refer to defining proper models to be used by the banks during self-assessment processes as well as increasing transparency and disclosing the information and data for climate-related risks (Bank of Albania, 2024). According to the guidelines, when reviewing their risk appetite, banks develop appropriate risk indicators and set appropriate limits for climate-related environmental risks at counterparts, sectors, and geographical areas. Specifically for operational risk management, it is advised that the banks should assess the impact of physical risks arising from climate change on their operations, including their ability to quickly restore their capacity to continue providing services to customers. They should also consider the impact of climate change on the provision of critical functions whenever those are assessed. Due to the reputational damage that operational risks may cause, banks should also consider the extent to which

the nature of the activities they carry out may affect the reputation of the organization in the future.

4. Analysis & Discussion

International regulations and guidelines raise awareness of the potential impacts of climate-related risks and highlight the importance of taking the necessary measures to address these risks in a proactive way by financial institutions. This is easier said than done and there are difficulties that banks face when developing strategies and implementing measures to address these risks. These difficulties appear to be present in several dimensions but mostly relate to the fact that the impacts of climate-related issues on organizations are not always clear or direct and the assessment of the potential impact as well as ensuring that the material issues are reflected in financial filings may be challenging (Task Force on Climate-related Financial Disclosures, 2017).

Limited knowledge of issues that relate to climate may be a potential reason when it comes to incorporating impact assessment in respective policies. This is because major climate-related risks have not materialized in the history of humankind, nevertheless, successive natural disasters may serve as a relevant early warning indicator of what can follow. Under these circumstances, there is a vast amount of speculation regarding the real effects of climate change which is oftentimes used for political reasons and manipulation of public opinion.

On the other hand, the fact that banks are profit-oriented organizations and risk management is not a profit but a cost center, justifies to some extent their need to focus mainly on near-term risks to the detriment of long-term vision. This is further amplified by what was mentioned in the previous paragraph – the fact that these risks are not considered probable, it is not deemed necessary to invest in managing them.

Finally, it is difficult to quantify the costs of climate-related issues. In addition to the first two points stated above, not being able to assess the impact of climate-related risks with confidence while the scenarios are considered remote, makes it difficult for organizations to perceive the benefits of proper risk management.

5. Conclusions and Recommendations

Climate-related risks build up an important block of operational risks, and as so, their proper management is important for financial institutions. Financial institutions must incorporate climate-related risks during the Risk and Controls Self-Assessment exercise to provide a complete view of all the potential threats that the institution may face. They should develop tools and methodologies that contribute to all stages of climate risk management –

starting from the identification of potential scenarios that are specific depending on where the institution is located, continuing with the assessment of potential impacts, development of mitigation measures, and continuous monitoring. Furthermore, regarding the recommendations of the Task Force on Climate-related Financial Disclosure, the disclosure of the governance of these risks is necessary for stakeholders to better understand the bank's exposure and risk management practices and will also fulfill the expectations set by supervisors.

Banks should develop proper strategies that aim to address the impacts of these risks in the long term. Implementation of these strategies should be done by ensuring the right tone from the top and should include all organizational levels. Key Performance Indicators should be implemented to monitor the effectiveness of policies and procedures that ensure the follow-up of the strategy while Key Risk Indicators should be implemented as key metrics to forecast potential threats. This will enable a continuous monitoring and proactive attitude toward emerging climate-related risks.

Banks should assess climate-related risks when developing new products, offering new services, or consider expanding into new markets. This can be achieved by having a proactive risk management approach incorporated into change management. Opinions from both business areas and risk experts can be an added value in assessing these risks before they materialize.

Banks should develop proper scenario analysis methodologies that aim to evaluate with significant levels of confidence the impact that climate-related scenarios can have on their risk profile. As per recommendations issued by the European Banking Authority (2025), banks should develop forward-looking approaches and perform scenario analysis to identify business risks and opportunities, assess the vulnerabilities of their portfolios to physical and transition risks, and test their resilience to the potential negative impacts of ESG factors, with special attention paid to climate change. This can be achieved using bottom-up and top-down approaches when identifying potential scenarios. The results should be incorporated into the calculations of the capital requirements to ensure that adverse potential impacts are absorbed and do not threaten the existence of the organization.

Finally, banks should consider climate-related issues when developing business continuity management policies. This is achieved by first identifying the potential threats that the institution may face that stem from climate change and then developing strategies and concrete plans for facing unexpected situations. This would provide the continuity of operations in case climate-related scenarios materialize and ensure effective crisis management without creating disruptions in the organization's operations.

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The Role of Governing Bodies and Value Chain Partners in the Transition to Sustainable Business Practices in a Developing Country- A Case Study of the Agro-Industry of Albania

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Abstract

Global value chains (GVCs) are facing growing scrutiny regarding their environmental sustainability. Since many GVC operations are based in developing countries, it's essential to understand the factors influencing the sustainability of the GVC participant businesses in developing countries. Our study examines the roles of governing entities and value chain partners on the sustainability of agro-industrial businesses in Albania. Through 12 interviews with business executives, academics, governing body representatives, and a consultant, we find upstream (local) partners have a negative impact, downstream (foreign) partners to have a positive impact, governmental structures a slightly negative impact, and international organizations a positive impact. This study contributes to GVC sustainability literature and offers practical insights for Albanian businesses and policymakers looking to expedite the country's sustainable development.

Keywords: *sustainability, global value chains, agro-industry, developing economy.*

1. Introduction

Amid the rapid pace of globalization, it is no longer only trade that spans borders, but also the issues that come with it. Of such issues, sustainability is a notable one. Global value chains (GVCs) are facing increasing scrutiny when it comes to their operations and their environmental responsibility. Furthermore, in part thanks to GVCs, sustainability is a pressing concern, as well as opportunity, worldwide, including and even highlighting developing countries (Pulver, 2007). For this reason, it is imperative to study sustainability in the context of these developing countries.

Abundant evidence shows that participation in global value chains (GVCs) offers significant benefits to developing countries, including increased regional connectivity, enhanced economic productivity, and export diversification (Kowalski et al., 2015), (Raei et al., 2019). While the economic impacts of GVC participation are well-documented, less is known about the

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sustainability practices of companies in these developing countries, with existing studies offering mixed optimistic and pessimistic results (Pulver, 2007). Notably, a company's environmental sustainability in developing nations is influenced by specific external conditions (Pulver, 2007). This paper aims to investigate the sustainability efforts of GVC-participating businesses in developing countries, focusing on how external conditions, such as governing bodies and value chain partners, promote or hinder these efforts (Figure 1).

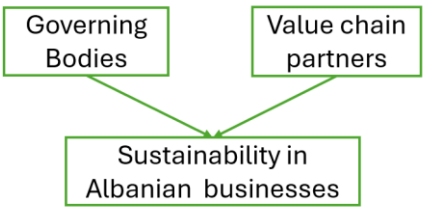

Figure 1. Research question diagram

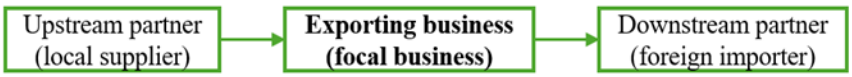

Figure 2. Diagram of focal business and its value chain partners

In this paper, "governing bodies" encompass national governmental structures as well as NGOs or supranational bodies such as the EU, while "value chain partners" include upstream partners, which are usually made up of local suppliers, and downstream partners, in this case explicitly made up of foreign importers (Figure 2). The reason for studying these two groups of stakeholders together is that value chain partners are unique for a specific business, while governing bodies are unique for a specific country. Combined, they can create a somewhat comprehensive picture of the external environment or conditions these focal businesses are operating in, for any given country, and how this environment affects their sustainability efforts.

In pursuit of the exploratory aim of this research paper, interviews are conducted with representatives of exporting companies in Albania's agro-industrial sector and other relevant stakeholders. According to Jovanović et al. (2021), the challenges posed by the COVID-19 pandemic have shifted supply chain trends, highlighting the Western Balkans' potential for nearshoring. Therefore, due to the possibility of GVCs expanding in this region, studying a

developing country in this region enhances the relevance of this paper. The agro-industrial sector is particularly significant as a key economic pillar and a major driver of environmental concerns (Schiller-Merkens & Machin, 2023). In Albania, there is a growing awareness of sustainability issues, supported by various international and local initiatives promoting sustainable (business) practices. However, it is essential to gather business perspectives and assess how business owners perceive the current situation.

The rest of this paper is structured as follows: The literature review outlines the variables used and relevant academic literature. The context explains the current situation in Albania. The methodology section details the data collection and analysis methods. The analysis and discussion section presents results for each stakeholder group. This section also connects the findings to existing literature while discussing implications, limitations, and future research avenues. Finally, the conclusion summarizes the findings and offers closing thoughts.

2. Theoretical framework

For this paper, sustainability is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, p. 292), with a focus on environmental sustainability. In global value chains (GVCs), sustainability is becoming increasingly important as an answer to rising stakeholder concerns. Simultaneously, GVCs involve complex multi-stakeholder interactions across different countries, meaning that businesses within them are subject to unique pressures, requirements, and structures inherent to the country in which they operate (Buckley & Liesch, 2023). These country-specific conditions mean that sustainability initiatives and requirements affecting businesses are largely influenced by the governing bodies in each location (Dybvig & Spatt, 1983). Public governance, as a representative of governing bodies, is shown to correlate positively with a country's sustainability (Handoyo, 2018), and international political bodies like the EU have a significant impact on regional sustainability goals and enforcement (Selin & VanDeveer, 2015).

In addition to governing bodies, other businesses in the GVC play a key role in influencing the sustainability practices of each participant business (Lee, 2010). Power asymmetries and varying levels of coordination within GVCs also affect individual business efforts toward sustainability (Gereffi et al., 2005). According to Buckley & Liesch (2023), three factors affect a GVC participant's tendency to address negative externalities: awareness of externalities driven by GVC integration, motivation to address them driven by GVC accountability, and the capability to implement changes, driven by GVC leadership. This suggests that value chain partners, particularly those with more power, have a considerable influence on the sustainability of other

participants. Thus, stakeholders like governing bodies and value chain partners play a major role in a business's sustainability journey (Rebs et al., 2019). Studying the exact effect of their role in the context of a developing country can help further the sustainability agenda.

Studies also show that governmental pressure is linked to improved sustainable supply chain performance (Rebs et al.,2019), while other findings report significant results on the influence of political, economic, or ecological stakeholders on sustainable practices in different sectors (Sharma & Henriques, 2005) (Bulgacov et al., 2015). Meanwhile, a study in Portugal found that only a few CEOs mentioned stakeholders like the state, suppliers, or society as relevant actors in corporate sustainability (Rego et al., 2019), suggesting the importance of exploring these dynamics in various socio-economic and political contexts. Literature reviews also present mixed findings on stakeholder influence on sustainability and management practices (Haleem et al., 2022). Large multinational enterprises (MNEs) within GVCs often extend their influence to enhance sustainability efforts among value chain partners (Lee, 2010). However, due to significant heterogeneity across countries, including varying regulatory levels (Scherer, 2016), business responses to sustainability pressures differ greatly (Scherer et al., 2013b). It is, therefore, necessary to study different environments individually. The Western Balkans is a relatively unexplored area in this regard, and with trends pointing to increasing GVC activity (Jovanović et al., 202), (Mandras & Salotti, 2020), studying this region adds relevance to the paper. In addition, agricultural products are among the dominant products in the trade basket within the Western Balkans. For this reason, as well as the importance of industry improvement in pursuing further growth (OECD,2019), it is of most value to study the agro-industrial sector in this area.

Contextual background

Albania is progressively embracing circular economy principles to transition from a linear model to a more sustainable and regenerative system. This shift is driven by environmental challenges, economic opportunities, and alignment commitment with the Green Agenda for the Western Balkans (Regional Cooperation Council, 2020). A pivotal development is the OECD's Roadmap towards Circular Economy of Albania, which identifies areas for reform such as circular business models for SMEs and economic instruments to promote sustainable consumption and production (OECD, 2024). Furthermore, according to the 2023 Balkan Barometer Business Opinion (2023), factors like regulatory compliance and supply chain pressures could encourage businesses toward sustainable solutions, highlighting the importance of studying the related actors.

In agriculture, circular economy efforts are in early stages,with ongoing efforts to transition towards a more sustainable sector. Agriculture remains a cornerstone of Albania's economy, contributing significantly to employment (around 40%) and GDP (20%) (World Bank, 2024). A study on livestock farming identifies policy gaps, economic constraints, and technological limitations as barriers to circularity, stressing the need for supportive policies, education, and collaboration (Marku et al., 2024). Numerous governing bodies, including the Ministry of Agriculture and Rural Development, GIZ Albania, FAO Albania, and UNDP Albania, are working to promote sustainability in Albanian agriculture. Yet, the impact of these entities from the business perspective remains largely unexamined and warrants further research.

3. Methodology

To address the research question, a qualitative study was conducted, ideal for capturing perceptions about the phenomena under examination. Twelve interviews were conducted to gather a comprehensive understanding of stakeholders' perceived impact on sustainability in the agro-industrial sector. Of these, four involved executive officers from Albanian export companies focused on medicinal plants, olive oil, and animal byproducts—industries representing some of the biggest agricultural exports of the country. The companies were already implementing sustainable practices, as verified through both online research and discussions with the interviewees. Four additional interviews were held with representatives from governing bodies, including the Ministry of Agriculture and Rural Development, the Circular Economy Directorate within the Ministry of Tourism and Environment, the Albanian Investment Development Agency (AIDA) under the Ministry of Economy, Culture, and Innovation and GIZ Albania, an international organization engaged in economic development, training and employment, climate, and good governance. Three more interviews involved academics with a background in sustainability from the University of Tirana, who provided a semi-external view. Finally, one interview was conducted with a consultant from a sustainability-consulting organization in Amsterdam, adding a specialized external perspective. While business representatives' views were central to the research question, insights from other stakeholders provided balance and cross-verification of perspectives.

Half of the interviews were semi-structured and conducted in person or through video meetings, allowing flexibility to explore responses in greater depth and formulate theories reliably. This format also enabled adjusting questions for the not good English speakers and for the interviews conducted in Albanian. The remaining interviews were written responses, providing convenience to interviewees. These responses were generally appropriate,

with some participants offering additional documents for clarity. The interviewees, aged 25-62, were two-thirds female and one-third male, providing a reasonably representative sample.
Each interview included 9-12 questions, tailored to the interviewee's position. Initial questions focused on describing the business or institution, understanding of sustainability, and general views on sustainability in Albania and the agro-industrial sector, serving as a warm-up and validation of their sustainability knowledge. Subsequent questions centered on current sustainability initiatives, either specific to the organization or known by academics, and were highly relevant to the research question for government bodies. The core section of each interview contained 5-6 questions about the role of governing bodies and value chain members in the sustainability efforts of the focal business, followed by 1-2 broader questions about suggestions and future directions. The live interviews were recorded and then transcribed, and together with the written responses they were hand-coded according to the grounded theory method developed by Glaser & Strauss (1999). An example of questions for business representatives can be found in the appendix.

4. Analysis & Discussion

After analyzing the interviews, two main subunits for both governing bodies and value chain partners emerged. The findings from the analysis are separated according to these subunits. Governing bodies are divided into Albanian governmental structures and international organizations, while value chain partners were divided into upstream (local suppliers) and downstream (foreign importers). Figure 3 below shows the explanatory scheme of the results.

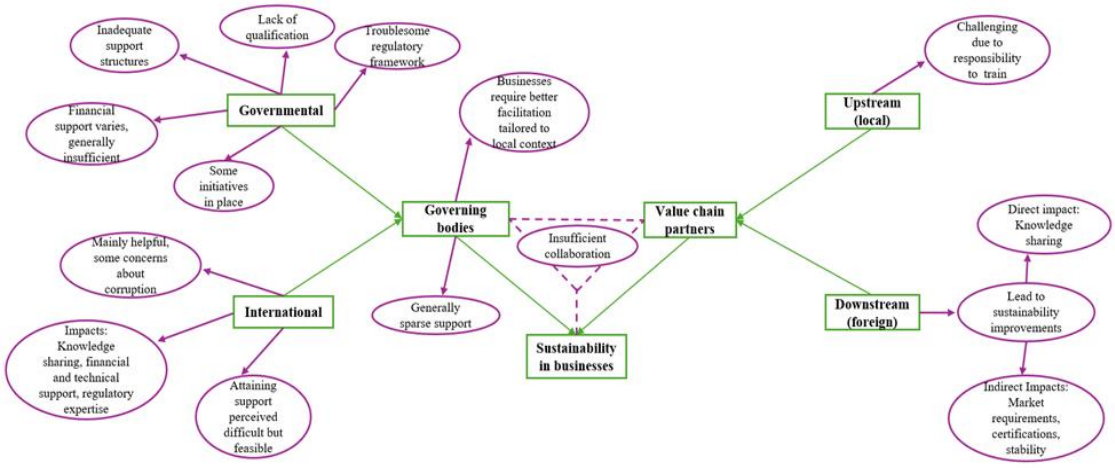

Figure 3. Explanatory scheme of results

*Stakeholders and focal business represented by the green rectangles
**Findings represented by the purple ovals

5. Role of Value Chain Partners

5.1. Downstream value chain partners

Downstream value chain partners connect Albanian businesses in this study to global value chains, introducing sustainability impacts beyond domestic experiences. A key finding was that, in the agro-industrial sector, foreign value chain partners led to notable sustainability improvements; a point confirmed by nearly all stakeholders interviewed.

Businesses mentioned how the positive impact of these foreign partners could either be direct or indirect. As for direct impact, the most prevalent answer was knowledge sharing. The foreign partners are often bigger companies with more experience in the market and in issues of sustainability. Thus, their knowledge is usually very valued in a developing country such as Albania. Only one business mentioned the direct impact of financial support.

The indirect impact of foreign partners on sustainability was equally, if not more, significant. Businesses noted that their sustainability improvements often resulted from exporting to foreign markets, primarily in the EU or USA, where stricter standards prevail, rather than from specific partner support. The study by Lee et al. (2012) also attests to the big impact that the quality standards in agrifood GVCs have on the operations of businesses in developing countries. Rising to meet these standards oftentimes requires sustainable practices to be implemented. Another indirect impact of foreign partners is providing enough stability of demand and income for the businesses in Albania to allow them to be able to think long-term and strategically, and in this way including sustainability concerns in their business's strategies. According to the Balkan Barometer study (2023) supply chain pressure was one factor that can improve the implementation of environmentally sustainable practices. Our findings further elaborate on this idea by specifying that it is the downstream (foreign) part of the supply chain, at least for exporting companies, that has a positive impact, directly and indirectly

5.2. Upstream Value Chain Partners

Upstream value chain partners unfortunately negatively impact the sustainability of exporting businesses. Each company interviewed relies on local Albanian suppliers, but due to challenges like informality in agriculture, farmers' lack of education, and limited government support (which is discussed further down), exporters bear the responsibility for ensuring sustainable practices. As a result, they invest significant time and resources in training and monitoring suppliers' sustainable practices, making it both costly

and challenging to secure sustainably sourced inputs and diverting resources from potentially higher-impact internal sustainability initiatives.

5.3. Role of Governing Bodies

While between governmental structures and international organizations there seemed to be quite a difference, there were also two findings from the interviews that were more universal. The first one was that, in general, businesses perceive – as well as are perceived by academics - to have undertaken most of their sustainability initiatives individually. There seems to be an overbearing sentiment of generally sparse possibilities to them being supported in increasing their sustainability efforts.
The second general finding is that businesses require better facilitation that is tailored to local context. This adaptation to the local context was strongly stressed also by the consultant interviewed, who stressed multiple times that whatever support any governing body could offer, it had to take into consideration the local context. Further on the same thing was found to be a concern among businesses too. In line with our findings, Ansell et al. (2022) and Pupphachai & Zuidema (2012) also stress the importance of localizing sustainability goals so that they can reflect local needs, norms & values, and contextual circumstances.

5.4. Governmental structures

Governmental structures, unfortunately, appear to have a limited positive impact on business sustainability, even bordering on a negative effect. While some sustainability initiatives do exist, as noted by all interviewees and evidenced by the recent establishment of formal bodies like the Circular Economy Directorate, tangible outcomes remain minimal. Though goodwill appears to be present, numerous challenges seem to diminish the effectiveness of these initiatives. Interviews with government representatives also acknowledge the obstacles in implementation. On the other hand, as sustainability initiatives are relatively new in Albania, these challenges may be part of a learning curve, potentially leading to more effective government support in the future. The main pain points highlighted include regulatory issues, lack of expertise, inadequate support structures, and limited financial backing. This also confirms some of the findings from the OECD (2024) report mentioned previously.

Regulatory frameworks were noted as a hindrance to sustainable development in Albania, described as incomplete and inconsistent, creating challenges for both businesses and international organizations. While improvements are underway, partly with support from international organizations and academics, much remains to be done to make these frameworks clear and effective as a true roadmap for businesses on what to do and importantly, what not to do.

Additionally, enforcement of these regulations is seen as inefficient and uneven. Although enforcing regulations is resource-intensive, it is essential to support and secure sustainable development in the business sector.

Furthermore, a perceived lack of qualification among government officials was a major concern for most interviewees. Although the concept of sustainability is relatively new within government structures and may contribute to this, it is crucial for institutions to enhance the skills and knowledge of their personnel in this area. Ineffective public governance can leave businesses feeling unsupported in their sustainability efforts. This concern was evident during the interviews with government representatives as well. The responses of these representatives were noticeably less detailed compared to those from businesses, ranging from vague and standard and theoretical to indirect, literature-based answers rather than direct insights. Without further knowledge as to the reason why they chose to respond like this, it can be indirectly deduced that the perceived lack of qualification claimed by the business representatives might be true.

Support structures were seen as inadequate for promoting business sustainability, with infrastructure for green transportation and waste management frequently highlighted. The lack of proper infrastructure forces businesses to invest in building it themselves before making sustainability investments, increasing costs and extending ROI timelines, sometimes making the whole venture financially unviable. Equally important are educational and training support structures in sustainable agriculture. These would relieve export businesses of the burden of training suppliers, allowing them to focus on higher-impact investments rather than ensuring supply chain compliance. Lastly, the government should support businesses by facilitating the process of joining international markets, as participation in global value chains was seen as beneficial for sustainability. Governmental efforts should include providing necessary support, such as ensuring product safety documentation for exports to regions like the EU.

Finally, financial support is a common request from businesses looking to become more sustainable. Initial sustainability investments are often expensive, particularly when involving structural changes such as new production lines for waste management or installing solar panels. While these investments may or may not become profitable over time, their benefits extend beyond business to society, the environment, and the local economy. Moreover, businesses that pioneer positive, impactful solutions can accelerate such development within the country. For these reasons, businesses and academics feel there should be increased government financial support for sustainability efforts. Although some support exists, especially in more

formalized sectors like olive oil, there remains a significant gap between what is provided and what is needed.

While Rebs et al. (2019) illustrated the positive impact of governmental pressure on sustainable value chain management, it seems that for that impact to manifest it is crucial for the right policies, structures, and competencies to be in place. Without them, any amount of pressure can lead to negative instead of positive consequences.

5.5. International organizations

Despite the opinion of sparse general support, after diving deeper both businesses and academics perceived international organizations as helpful and having a positive impact. While concerns about corruption and incompetence exist, as supported by incidents like the recent IPARD agricultural fund mismanagement scandal (Erebara, 2024), optimism about their efforts to aid businesses and drive change was evident. All interviewees reported successful firsthand experiences with such organizations. Key positive impacts, also backed by the international organization representative, included knowledge sharing, financial and technical support, and regulatory expertise. Notably, these organizations not only assist businesses but also aid the government in developing effective regulatory frameworks.

Attaining support from international organizations can be described as challenging but achievable. While all interviewees reported successful collaborations, the process was neither easy nor always successful. However, the positive impact was clear, with all businesses noting direct benefits from these organizations. This is in line with literature that supports the positive role international organizations play in furthering the sustainability agenda (Ponte,2019). While Ponte emphasizes the growing influence of GVCs in steering this agenda, the role of international organizations and states remains crucial for facilitative, regulatory, and distributive interventions.

5.6. Collaboration

A key finding noted by all 12 interviewees was insufficient collaboration. This collaboration could be between any and all 3 parties: businesses themselves, government and international organizations. This lack of collaboration hinders stakeholders' ability to contribute effectively to sustainability efforts, as synergies formed through cooperation are essential. Increased knowledge sharing and resource pooling are needed for businesses to receive adequate support and maximize efficiency. Unsurprisingly, literature on sustainability also emphasizes the critical role of cooperation among stakeholders for knowledge sharing, policy formulation, financing, implementing investments,

and creating synergies (Ansell et al., 2022), (Siems et al., 2023), (Adenle et al., 2019).

5.7. Implications and Limitations

This research enhances scholarly understanding of the interplay between governing bodies, value chain partners, and business sustainability within GVCs, particularly across different national contexts. By examining Albania as a developing country, scholars can then better integrate sustainability principles or analysis into future research, based on practical insights into the differences between developing and developed countries, and within different developing countries themselves, simultaneously enriching GVC literature.

The findings of this research indicate practical implications for businesses and governing bodies in Albania. Stakeholders, including businesses, governments, international organizations, and NGOs—should enhance collaboration by sharing knowledge and forming synergies. Improved collaboration can help policymakers develop tailored initiatives that effectively utilize local resources and capabilities. Collaboration between businesses themselves, from the same or different sectors, can establish synergies that can help either business become more sustainable. Exporting businesses should insist on better cooperation with foreign partners, leveraging their expertise and exploring additional forms of collaboration beyond knowledge sharing. Additionally, governmental structures, in partnership with universities, should allocate more resources to train their staff, farmers, and other agricultural suppliers on sustainability practices. They must also focus on establishing adequate support structures. By collaborating with international organizations, the government can develop a comprehensive and consistent regulatory framework that can guide businesses, while pairing that with fair and consistent compliance monitoring. Furthermore, the government should enhance quality assurance and support structures to facilitate exports, allowing Albanian businesses to leverage the benefits of international partnerships. Finally, international organizations should improve their communication channels and transparency to foster a fair and transparent collaborative process and ensure relevant initiatives reach interested businesses,

While the interviews conducted for this study were generally informative, there were limitations in data collection that future research could address. There was a lack of concrete measurements for each stakeholder's impact; while the general direction and magnitude of their influence were clear, a follow-up study quantifying these effects could yield more actionable insights. Regardless, this research has established a foundation for understanding the factors affecting business sustainability in the agro-industry, facilitating

further research and practical implementations to promote sustainable development in Albania. Future studies in other sectors or countries could further enrich the literature on GVC sustainability.

6. Conclusion

This study aimed to explore the role that governing bodies and value chain partners play in the sustainability efforts of exporting business in the agro-industrial sector in Albania. By conducting 12 interviews with business executives, academics, governing bodies representatives and a sustainability consultant, it was discovered that upstream value chain partners hinder sustainability efforts while downstream partners enhance. In addition, governmental structures play a slightly negative role by making it challenging for businesses to be sustainable, while international organizations have a positive impact. The findings of this study can further the literature on GVC sustainability in developing countries, particularly by explaining the impact of different stakeholders. In addition, the study provides practical implications that can advance sustainable development in Albania, simultaneously helping the country reach the goals of the Green Agenda for the Western Balkans.

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Appendix

Table 1. List of questions for businesses

Questions for businesses
1. Can you briefly introduce your business to me?
2. How do you understand sustainability in business, and why do you think it is important?
3. What is your opinion on the current state of sustainability in Albanian businesses?
4. Can you paint an overall picture of sustainability in your business (initiatives, challenges)?
5. What are the key factors that contributed to the success of your sustainability initiatives?
6. What role do external stakeholders such as government, international organizations, NGOs, etc play in your efforts to become more sustainable?
7. What would you need from these stakeholders to feel supported?
8. What role do the (foreign) partners that you export have in your sustainability?
9. What role do upstream partners have in your sustainability?
10. What would you need from business partners on both sides to become more sustainable?
11. What is the role of local businesses in furthering sustainability in Albania?
12. What unique challenges do you see for Albanian companies regarding sustainability compared to other countries/regions?

Comparative Analysis of Sustainability Practices in Western Balkans

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Abstract

Although climate change and sustainability have been set as a high priority by the authorities of the Western Balkans countries, the implementation of the necessary regulations and mitigation strategies is not satisfactory.
Economic and social development is affected by the consequences of climate change, and the business sector, which is not immune to them, is making slow progress in building its own resilience and implementing sustainable practices.
This paper presents the findings of a survey conducted within the Erasmus+ project "jOiNEd For sUsTainability - bUilding climate Resilient communities in WB and EU- 1FUTURE" that targeted representatives of companies in Albania, Bosnia and Herzegovina, and Montenegro. It aimed to identify attitudes toward cooperation for achieving sustainability goals, to assess business needs in terms of capacities and knowledge in the area of climate action and sustainability, and finally to investigate the willingness of the business sector to participate in projects and activities focused on emission/pollution reduction and the introduction of circular economy practices.
The research findings were very important in development of a flexible, needs oriented and user-friendly Collaboration 1FUTURE Platform. The survey also identified specific capacity and knowledge needs in areas of climate action and sustainability among business communities and other stakeholders.

Keywords: *climate action, sustainability, business sector, Western Balkans*

Jel code: Q01, Q56

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1. Introduction

Climate change and their consequences present global challenges that require urgent response. The business sector as a major contributor to climate change needs to adopt sustainable practices that include a range of actions that could reduce their impact and promote sustainability. Furthermore, Concept of "green entrepreneurship" should be recognized by the law (Silajdzic, I., et al. 2014).

The 17 Sustainable Development Goals (SDGs) outlined in Agenda 2030 represent a comprehensive framework for global action. These ambitious goals (UN General Assembly, 2015) serve as a roadmap for addressing world's most pressing challenges, from poverty and inequality to climate change and environmental degradation.

Although the Western Balkans region is diverse in historical, economic and cultural context, three countries included in this research share the common challenge of finding a balance between economic growth and environmental care. With aspiration to European Union membership, they all had to adopt certain legislation that requires efforts to address sustainability challenges but also additional funding as well. Some businesses across Western Balkans have started to implement certain sustainable practices as energy saving, waste separation, recycling and reuse that provided them with a range of economic benefits. This paper explores and compares strategies and activities used by businesses to mitigate their environmental impact, increase social responsibility and ensure long-term economic sustainability.

During the initial phase of the 1FUTURE project, an analysis was conducted to assess EU and associated Third Country practices aimed at fostering climate initiatives and collaborative efforts among government, business, and academia. This analysis highlighted discrepancies between climate and sustainability actions in the EU and the Western Balkan countries (WBC).

The subsequent task involved conducting surveys and interviews with public and private institutions, business communities and other stakeholders in the three WBCs with the aim of identifying key drivers and barriers to sustainable business practices and proposing recommendations to foster a more sustainable future.

2. Methodology

Questionnaires for this task were prepared by teams in the WBC and reviewed by EU Higher Education Institutions.

Data collection process took place between 2023 and 2024 encompassing a total of 901 companies from the Western Balkan region.

The questionnaires used varied slightly since they had to be adapted to specific conditions and regulations in countries included in the research. All three countries have different legal formulations of companies in terms of size,

which is determined by the incomes, income taxes, number of employees, etc. and it had to be adapted. Questionnaires consisted of 25 close-ended questions, which were formulated based on the conceptual framework (Yadav et al. 2018) set forth and adopted for all three countries.
The responses were measured on a four-point Likert scale (always / frequently / sometimes / never), with an "I don't know" option. Respondents' opinions about the importance of different green business practices were also measured on a four-point Likert scale (unimportant / slightly important / somewhat important / very important), with an "I don't know" option. The list of potential practices was adapted from Smerecnik and Andersen (2011) and Bohdanowicz (2006) and it included practices related to waste, recycling, supply, energy, water, and transportation.

3. Analysis & Discussion - Comparison Between WB Countries

3.1. Survey Methodology Comparison

A quota sampling technique was used in Albania to determine a representative number of businesses in each industry and the goal was to comprise at least 0.5% of companies from each sector in the study. In Bosnia and Herzegovina and Montenegro stratified sampling technique was used and numerous companies were contacted (e-mailing, phone calls, visits, etc.).
The survey in Albania was conducted face to face interviews with business representatives, in Bosnia and Herzegovina hybrid: face to face interviews with business representatives and online, and in Montenegro exclusively on-line using Google form. Albania managed to achieve the target value; other two countries had rather unequal distribution as some sectors were reached at very low rate as 0.1% in Bosnia and Herzegovina and at 0.05% in Montenegro mainly due to the uncooperativeness of the contacted respondents.
Overall, the research included a total of 901 companies from the Western Balkans. More than 90% of the participating companies from Albania were in the capital, Tirana[9]. The survey dataset was cleaned to eliminate duplicate, incomplete, or erroneous entries (123 in total) and the final sample consisted of 478 observations, which were analyzed further.
A survey in Bosnia and Herzegovina was designed targeting representatives from companies located mostly across the Federation of Bosnia and Herzegovina[10]. The territorial distribution is satisfactory and includes most of the 10 cantons, and the majority of companies (headquarters and production facilities) are located in Lukavac (20%), Sarajevo (13%), and Tuzla (10%).

[9] Tirana hosts 30% of all enterprises and produces 41% of Albania's gross domestic product (INSTAT, 2023).
[10] Federation of Bosnia and Herzegovina hosts 68.7% of all enterprises and produces 65% of state gross domestic product (Agency for statistics of Bosnia and Herzegovina, 2023)

The companies ranged in size from micro to large. The survey dataset was cleaned to eliminate duplicate, incomplete, or erroneous entries (30 in total). The final sample consisted of 207 observations in Bosnia and Herzegovina.
More than 54% of the responses in Montenegro were obtained from companies headquartered in Podgorica, the capital of Montenegro, 10% from companies based in Niksic, and around 7% from companies based in Bar[11]. The companies ranged in size from micro to large. Final sample in Montenegro included 216 companies.

3.2. Participating Businesses Comparison

In all three WB countries companies that participated in survey ranged in size from micro to large, and predominant legal status of companies was limited liability (Figure 1). Albania, Bosnia and Herzegovina and Montenegro have different legal formulations of companies in terms of size, which is determined by the incomes, income taxes, the number of employees, etc.
Nearly half of sample in Albania is comprised of limited liability companies and more than half were large corporations. Only 10% are joint stock companies. More than half of sample in Bosnia and Herzegovina is comprised of limited liability companies (60%); 55% "small & micro" companies and around 16% of large and 16% medium companies[12].
Over 75% of sample in Montenegro were micro companies and only 2,8% were large companies; legal status of 90,7% is limited liability.

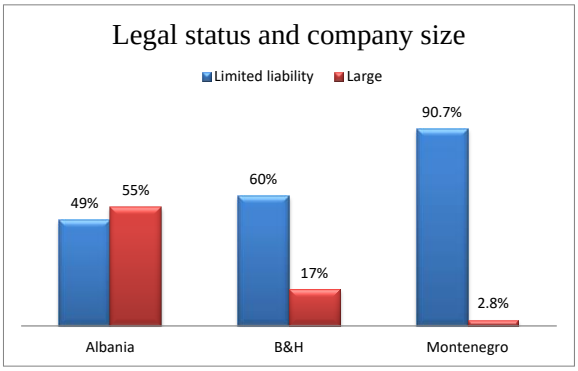


Figure 1. Percentage of LLC companies and large companies that participated in the study

[11] According to available statistical data (Statistical Office of Montenegro, Release 40/2023 - Number and structure of business entities in Montenegro - 2022), for the year 2022, active companies in these municipalities respectively constituted 35.6%, 5.2%, and 9.3% of the total number of active companies.

[12] criteria of company size that was used for questionnaire is annual income - Law on Accounting and Auditing of The Federation of Bosnia and Herzegovina

The importance of including a higher number of large companies lies in their capacities and greater resources for environmental management. Low number of large companies covered by this study in Montenegro is because the share of large companies in the total number of enterprises is only 0.1% (micro and small enterprises constitute 99.2%).

The difference in the sample in all three countries is noticeable in average years of operation as well as the average number of employees (Figure 2). In Albania, the sample is heterogeneous in terms of years of operation in the market (1-99 years), average years in operation in Montenegro is 15. Survey conducted in Bosnia and Herzegovina included companies that stand out by number of employees (with over 1000 or 2000 employees) and by the years in operation compared to other two WB countries.

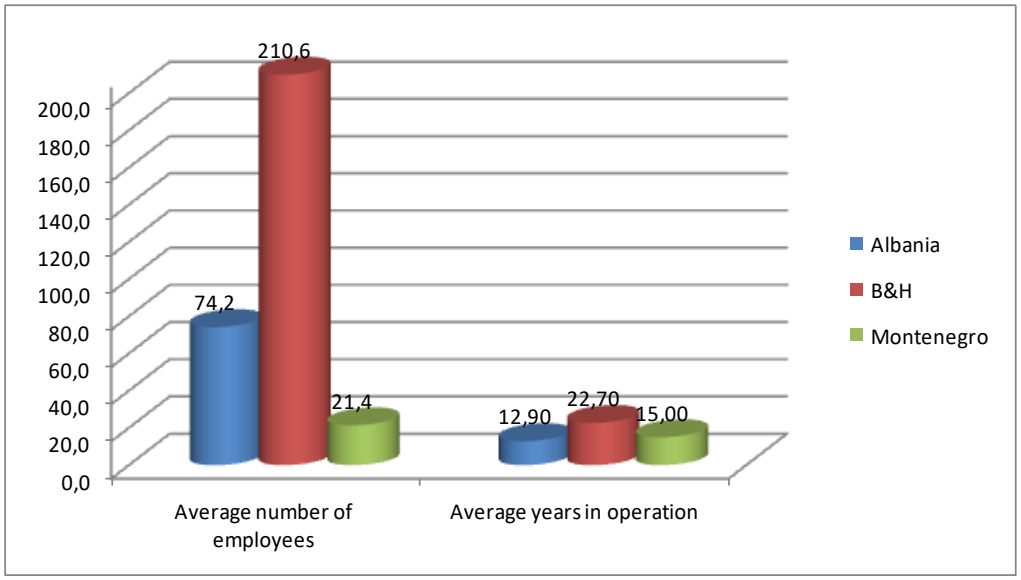


Figure 2. Average years in operation and average number of employees

Very low number of companies is led by woman (Figure 3) which can be seen as very unfortunate knowing that some research suggest that female-led companies tend to be more environmentally friendly (Glass, Cook, and Ingersoll 2016).

The reason for the very low percentage in Bosnia and Herzegovina could be the fact that 38% of companies have more than one owner and most of them have women in management structures.

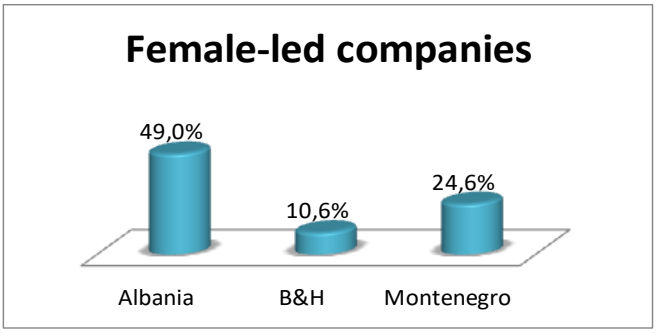


Figure 3. Percentage of female led companies

Overall, the low findings in gender equality in company management structures can be linked to the patriarchal and traditional context common to all 3 countries and represent a problem that must be seriously addressed in the future.

3.3. Drivers of Green Practices Comparison

Green businesses measures adoption rates in Albanian companies are generally low. The most popular measures overall are small interventions to protect the environment, estimates of energy consumption or loss (which affect costs and revenues), and measures to reduce pollution.

In Bosnia and Herzegovina companies, adoption rates are generally low, only one measure is above 50%. The most popular measures overall are measures to reduce pollution, estimates of energy consumption or loss (which affect costs and revenues) and engagement in community-based environmental initiatives with adoption rates respectfully 64.7%, 49.3% and 44.4%.

The most popular green businesses measures, among companies in Montenegro, are those to protect the environment, reduce pollution, and engaging in community-based environmental effects.

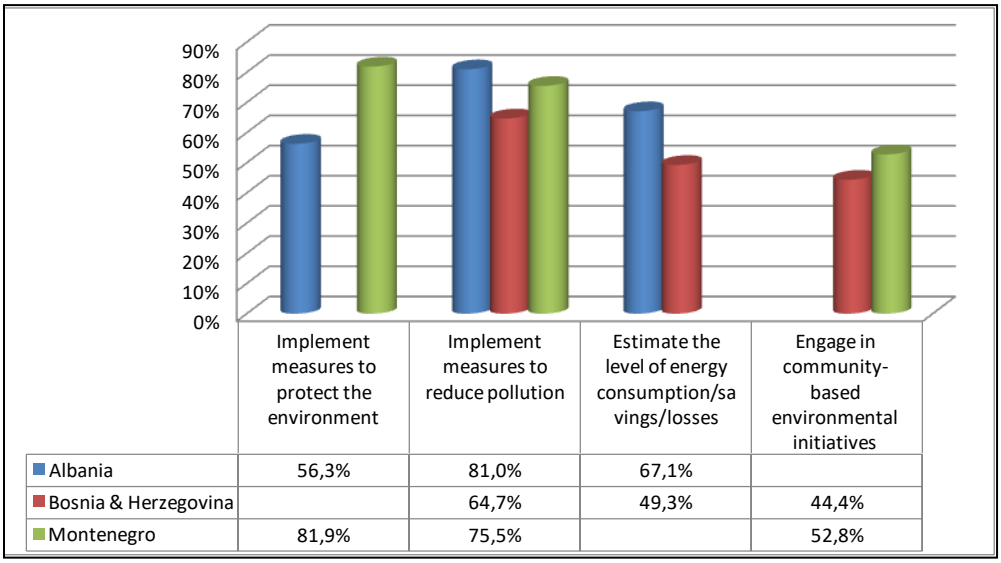
Table 1 gives an overview of the green measures adopted by companies in 3 countries with reference to all companies (entire sample) and separately for large companies. Findings presented in this table are only for top rated measures.

Table 1. Adoption of green businesses measures by all and all companies (top rated)

Country and company size	Green business measures	Level of adoption
	Implement measures to protect the environment	56.3%

Albania - all companies	Estimate the level of energy consumption/savings/losses	67.1%
	Implement measures to reduce pollution	81%
Albania - large companies	Estimate the quantity of solid waste discharged	70,8%
	Have a green transport plan/procedure (for staff, customers, freight)	72%
	Have adopted a national/international environmental certification program	79,1%
B&H - all companies	Engage in community-based environmental initiatives	44.4%
	Estimate the level of energy consumption/savings/losses	49.3%
	Implement measures to reduce pollution	64.7%
B&H - large companies	Implement measures to reduce pollution	60%
	Send delegates to environmental conferences/activities; Estimate the level of energy consumption/savings/losses	62.8%
	Engage in community-based environmental initiatives	65.7%
Montenegro - all companies	Engage in community-based environmental initiatives	52. 8%
	Implement measures to reduce pollution	75.5%
	Implement measures to protect the environment	81.9%
Montenegro - large companies	Have a detailed plan to reduce the environmental impacts; Designate an employee/team/structure for environmental management; Conduct environmental management training for staff; Engage in community-based environmental initiatives; Inform customers about their environmental effects; Implement measures to protect the environment; Implement measures to reduce pollution	100%

All companies have some top-rated measures in common as illustrated in the overview of the Western Balkan countries (Figure 4) and as can be seen in the chart below, they all implement measures to reduce pollution to a significant extent.



	Implement measures to protect the environment	Implement measures to reduce pollution	Estimate the level of energy consumption/savings/losses	Engage in community-based environmental initiatives
Albania	56,3%	81,0%	67,1%	
Bosnia & Herzegovina		64,7%	49,3%	44,4%
Montenegro	81,9%	75,5%		52,8%

Figure 4. Top rated green measures in common for WB countries (all companies)

Most of the companies which implement some kind of green business measure are large corporations, rather than micro, small, or medium-sized enterprises. Prior research has emphasized that smaller companies are often financially unable to engage in environmental management.

Large companies in the three countries surveyed of the Western Balkans mainly differ in adopted green practices as shown in Table 1. There are only a few measures in common such as engagement in community activities and measures to reduce pollution.

Surprisingly high percentage of green measures adopted by large companies (100%) in Montenegro can lay in fact that only 6 large companies participated in the study.

Top rated gaps between big and all companies in green measures adoption are illustrated in Figure 5.

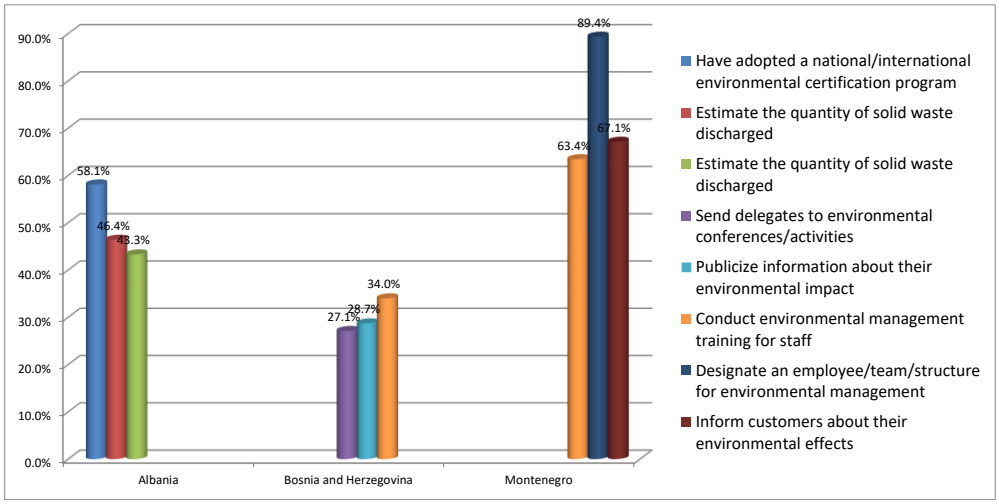


Figure 5. Gap among big and all companies in green measures adoption (top rated)

Figure 6 contains graphical presentation about the respondents' attitude regarding the importance of different green business practices. It includes practices related to waste; recycling; supply, energy, water, and transportation. The scale ranges from 1 (unimportant) to 4 (very important). In general, the level of knowledge and awareness of green business measures and their importance is not high. As illustrated, only one measure with highest Likert analyses mean score is common for all three countries - separating hazardous waste.

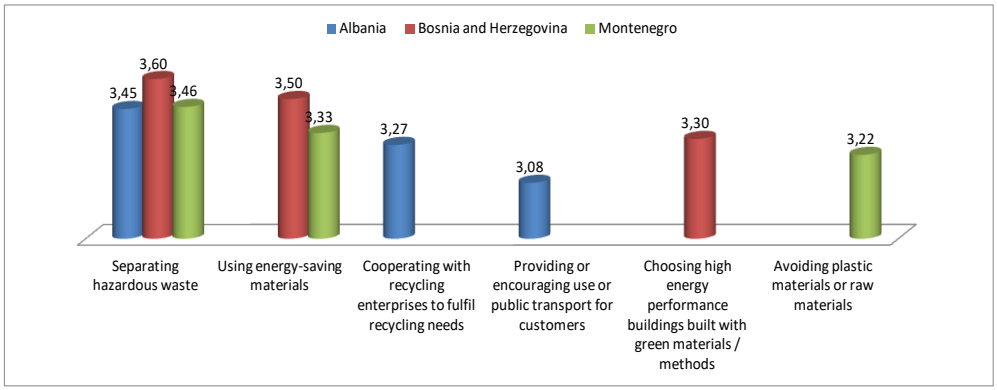


Figure 6. Company representatives' views on green business practices: top rated

Figure 7 illustrates lowest Likert analyses mean scores. In this comparison only one measure is common for all three countries - using rain or snow water (recycled water).

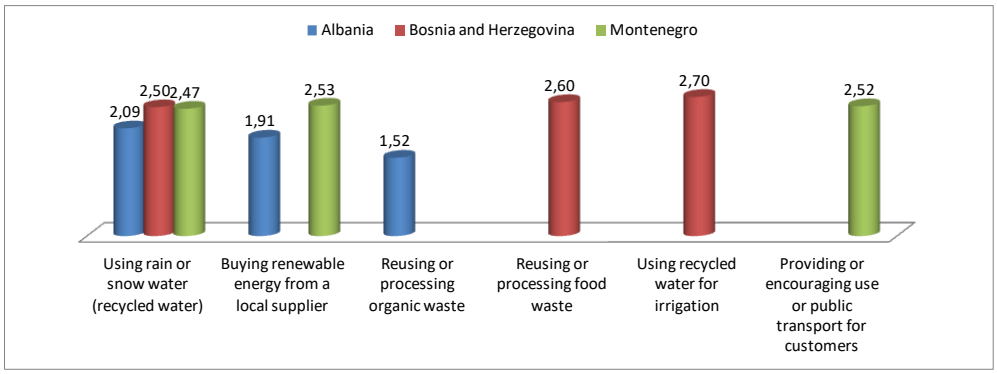


Figure 7. Company representatives' views on green business practices: least rated

In Albania, little interest is shown in measures such as reusing or processing organic waste, buying renewable energy from local suppliers, and collecting and reusing rain or snow water. The lowest score in Bosnia and Herzegovina is in using rain or snow water (recycled water) or using recycled water for irrigation as well as reusing or processing food waste and organic waste, while in Montenegro measures in the field of energy are the least commonly implemented.

The reason for such respondents' views on the importance of measures "for achieving the environmental goals of your entity" lies in the fact that not all measures are inherently applicable to all types of business.

4. Conclusions and Recommendations

Companies, especially larger ones, in Albania, Bosnia and Herzegovina and Montenegro have started implementing various green business practices. These practices range from waste recycling and green transportation policies to providing environmental information to customers.

Many companies will prioritize cost-effective environmental measures that directly impact their bottom line, often neglecting more significant environmental issues. Additionally, a lack of understanding regarding the importance of environmental preservation and sustainability can hinder the adoption of certain measures.

This study confirmed critical role of education in raising awareness and promoting sustainable business practices within Albania's business ecosystem. Training programs should be tailored to the specific characteristics of businesses and to respond effectively to the needs of business sector.

In Bosnia and Herzegovina, a comprehensive institutional-legal framework for monitoring adaptation and mitigation efforts is still lacking. This research revealed there is an awareness of business entities about the seriousness of

climate change, but for a systemic response and building resilience, it is necessary to continuously educate the public and decision-makers.
In Montenegro, there is insufficient understanding of green business practices importance for environmental preservation and sustainability. It is essential to increase awareness of funding opportunities designed to support sustainable development, green and circular economic measures, and climate change prevention and mitigation initiatives.
It can be concluded that the limited financial resources also hinder the full implementation of necessary measures.
Research within the business sector has also indicated that business entities are aware of the seriousness of climate change. However, to facilitate a systemic response and enhance resilience, ongoing public and decision-maker education is essential. This can be accomplished through a variety of methods, including media campaigns, informational days, workshops, scientific conferences, and various educational and training programs. Thematic and agenda should be developed based on survey results and findings.
The 1FUTURE Platform as a means for collaboration between HEI, business sector and other stakeholders will be developed within Project to raise interconnections between stakeholders. Since collaboration with the business sector can be considered as the key for achieving long-term sustainability goals, this survey provided important inputs for Platform design, and it served to investigate their knowledge needs and willingness in engaging in climate and sustainability action.

Acknowledgments

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GIS-based Flood Vulnerability Assessment in Spreca River Basin

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Abstract

Vulnerability and risk assessment of flood-prone areas is a fundamental component of spatial management and planning for response to natural disasters. As a result of climate change and urbanization of the valley area (settlement, intensive agriculture, industry, transportation infrastructure, etc.) in the Tuzla Canton, which is located on the watershed of the Sava River, flood damage has been increasing over the past twenty years. The intensity of floods has ranged from medium to catastrophic floods.
This study aims to assess vulnerability to floods in the catchment area of the Spreca River, which is the dominant watercourse in the Tuzla Canton, by applying geographic information systems and multicriteria analysis.
The methodological approach adopted in this study is based on the general principles of the Analytic Hierarchy Process (AHP) using GIS techniques. Eight criteria were selected for vulnerability analysis based on available data. The preliminary vulnerability assessments conducted provide a good initial foundation and open space for further research and initiatives to reduce disaster risk through responsible spatial planning.

Keywords: *floods, climate change, GIS, AHP, preliminary vulnerability maps, Spreca river basin.*

1. Introduction

Floods account for approximately one-third of global natural hazards, with more people affected by floods than by any other geophysical phenomenon (Smith, 1998). The evident occurrence of increasingly frequent and intense flooding events (Aerts, 2020), likely influenced by climate change, threatens the safety and health of the population, the economy, and cultural and ecological heritage. Floods are one of the most common natural disasters in the world (**Figure 1**).

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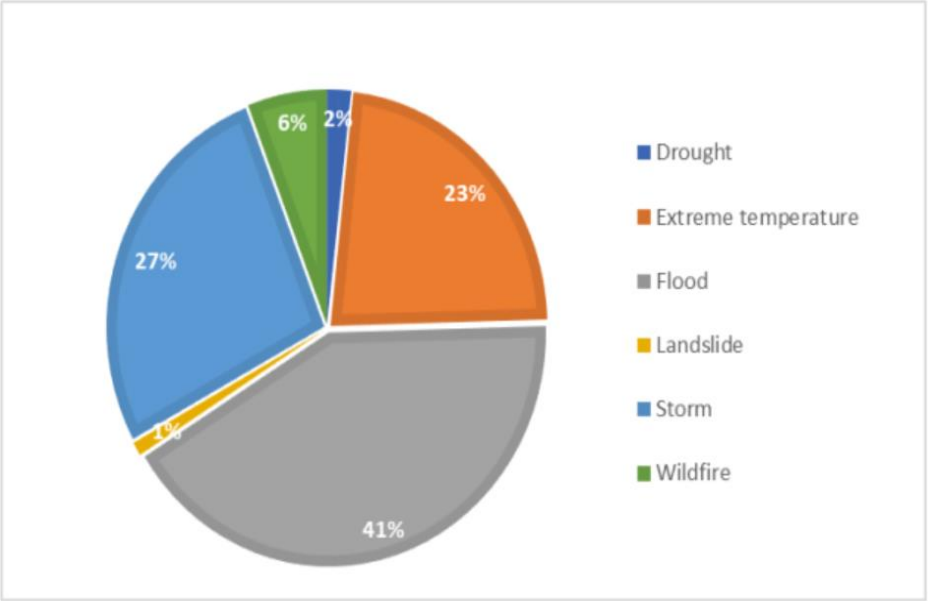

Figure 1. Occurrence of weather-related disasters by type, 2001-2020 (CRED, 2024)

Examining the period from 2001 to 2020, there were 999 natural disasters in Europe, of which 951 were related to hydrological, meteorological, and climatological hazards. Combined, these events killed more than 150,000 people, affected over 11 million others, and cost more than 217 billion USD (CRED, 2024).

An overview of the International Disaster Database shows that, in the last two decades, floods in Bosnia and Herzegovina have become more common and intense. The database collects data on natural and technological disasters at the country level. For the purposes of this study, only the reported natural disasters for the territory of Bosnia and Herzegovina have been extracted, as shown in **Table 1**.

Table 1. Natural disasters in Bosnia and Herzegovina from 2000 to 2024. (CRED, 2024)

Disaster Group	Disaster Subgroup	Disaster Type	Disaster Subtype	ISO	Location	Start Year	Total Deaths
Natural	Hydrological	Mass movement	Landslide	BIH	Velika Broda (Zenicko-dobojski district)	2000	6
Natural	Biological	Epidemic	Viral disease	BIH	Tensaj	2000	
Natural	Climatological	Drought	Drought	BIH	FBiH	2000	
Natural	Hydrological	Flood	Riverine flood	BIH	Brcko district, Tuzla district	2001	
Natural	Climatological	Drought	Drought	BIH	Republika Srpska province, Posavina	2003	
Natural	Hydrological	Flood	Riverine flood	BIH	Bugojno, Gonji Vakuf	2004	
Natural	Hydrological	Flood	Riverine flood	BIH	Posavski, Srednjebosanski, Unsko-sanski, Zenicko-Dobojski	2004	
Natural	Hydrological	Flood	Riverine flood	BIH	Bihac, Velika Kladusa	2005	
Natural	Meteorological	Storm	Blizzard/Winter storm	BIH	Knezevo	2005	4
Natural	Meteorological	Extreme temp.	Heat wave	BIH	Stolac, Trebinje, Bileca	2007	
Natural	Hydrological	Flood	Riverine flood	BIH	Rastoci, Otok, Rupe, Pridvorci villages (Trebinje)	2009	
Natural	Meteorological	Extreme temp.	Severe winter conditions	BIH	Sarajevo district	2009	1
Natural	Hydrological	Flood	Riverine flood	BIH	Kardaglije, Jablanica, Dobro poljie, Mekisn Bukva,	2009	
Natural	Hydrological	Flood	Riverine flood	BIH	Tomislavgrad, Drvar	2010	3
Natural	Hydrological	Flood	Riverine flood	BIH	Gradacac, Doboj Istok, Gracacina, Srebrenik, Celic, Tuzla	2010	
Natural	Meteorological	Extreme temp.	Cold wave	BIH	Banja Luka	2010	2
Natural	Meteorological	Extreme temp.	Cold wave	BIH	Sokolac, Cajnice, Kalinovik, Stari Grad, Kladanj	2012	4
Natural	Hydrological	Flood	Flash flood	BIH	Cazin	2014	
Natural	Hydrological	Flood	Riverine flood	BIH	Banja Luka	2014	
Natural	Hydrological	Flood	Riverine flood	BIH	Sanski Most	2014	25
Natural	Hydrological	Flood	Riverine flood	BIH	Banja Luka	2014	1
Natural	Hydrological	Flood	Flash flood	BIH	Bosanska Dubica, Kozarska Dubica	2015	
Natural	Hydrological	Flood	Flood (General)	BIH	Lukavac, Banovici, Tešanj, Doboj Jug, Sanski Most	2019	1
Natural	Hydrological	Flood	Flood (General)	BIH	Tuzla	2019	
Natural	Hydrological	Flood	Flood (General)	BIH	Tuzla Canton	2020	
Natural	Hydrological	Flood	Flash flood	BIH	Ilidza, Trnovo	2021	
Natural	Geophysical	Earthquake	Ground movement	BIH	Ljubinje and Capljina	2022	1
Natural	Hydrological	Flood	Flood (General)	BIH	Novi Grad, Gradiska, Sanski Most	2022	1
Natural	Hydrological	Flood	Flood (General)	BIH	Novi Grad, Prijedor, Kostajnica, Bihac, Bužim	2023	
Natural	Meteorological	Storm	Storm (General)	BIH	Brcko District	2023	1
Natural	Hydrological	Flood	Flood (General)	BIH	Donja Jablanica, Konjic, Fojnica, Kiseljak and Kreševo	2024	27

By presenting data on disasters through geographic, temporal, social, and economic dimensions, the creators of the database provide an objective basis for vulnerability assessment, rational decision-making, and prioritizing in emergencies (CRED, 2024).

The recent floods in October 2024 that affected Jablanica, Konjic, Fojnica, Kresevo, and Kiseljak caused enormous material damage and claimed more than 20 lives (**Figure 2**).

The increase in the frequency and consequences of both floods and other natural hazards caused by climate change in Bosnia and Herzegovina highlights the urgent need to reduce existing risks through economic, social, cultural, and environmental measures that address issues of exposure and vulnerability, thereby strengthening resilience. By analyzing the vulnerability of a specific area, the impacts from various sources on natural and built resources, the population, the economy, infrastructure, and other activities occurring in the analyzed area are assessed.

Figure 2. Floods in Bosnia and Herzegovina, Fojnica, October 4, 2024. (Slobodnaevropa, 2024)

The subject of this research is flood risks in the area of the Spreca River basin and the development of an integrated model using geographic information technologies, which will enable a proper assessment of the vulnerability of the analyzed area. The development of the integrated model ensures support for the flood occurrence forecasting system, as well as for alternative analyses of future projects in the field of flood protection and the creation of decisions aimed at preventing harmful impacts on the environment.

2. Area of Research

The Spreca River is the right tributary of the Bosna River and belongs to the catchment area of the Sava River. It flows in a northwestern direction with a length of 127 km. It flows into the Bosna River near Doboj. The total catchment area is 1947 km². The source of the Spreca River is located at an elevation of 261.32 m above sea level, while its confluence is at 137.70 m above sea level, indicating a height difference of 123.62 m, and the average longitudinal slope of the river course is 0.00098 (Spreca, 2016). The relief of the catchment area of the Spreca River is mountainous, encompassing the Spreca Valley, where larger settlements such as Tuzla, Zivinice, Banovici, Kalesija, Lukavac, Gracanica, and Doboj are located (**Figure 3**).

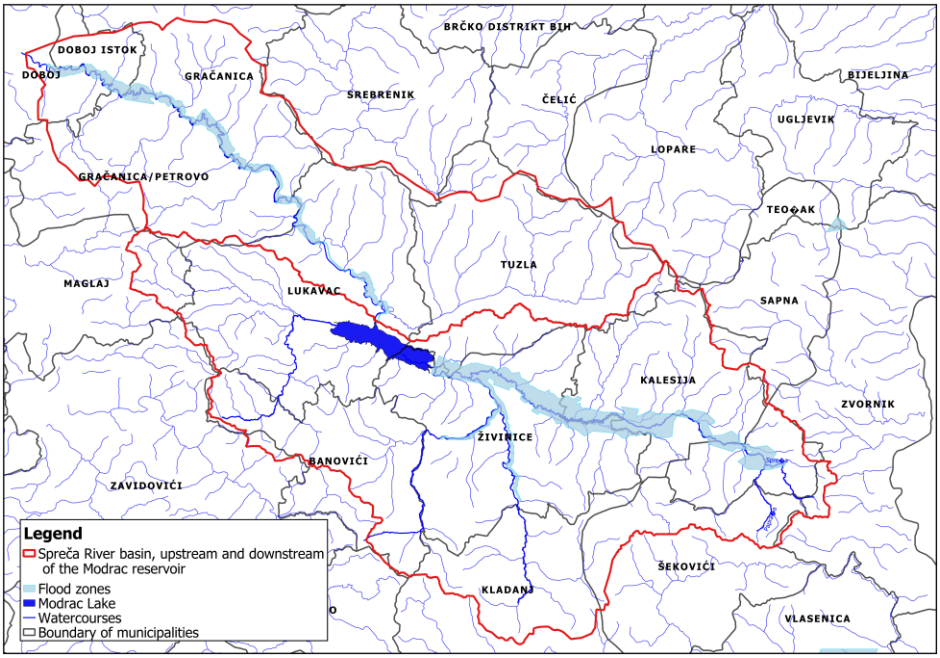

Figure 3. Spreca River Basin (Spreca, 2016)

Due to the artificial accumulation of Modrac, the floodplain of the Spreca River has been divided into two parts in most previous studies: upstream of the Modrac accumulation and downstream from the Modrac accumulation to Doboj. The Spreca River is very significant in terms of economic, agricultural, industrial, and ecological factors, as its potential is utilized in providing water for the needs of the population, supplying water for industry, and developing tourism, recreation, and water sports, etc.

According to the Preliminary Flood Risk Assessment for Category I and II Watercourses in the Federation of Bosnia and Herzegovina (AVP Sava, 2013), the flood risk in the catchment area of the Spreca River is assessed as

potentially significant, and additional measures are needed to reduce flood hazards. In the past, various projects have been implemented to regulate the riverbed of the Spreca, mainly in the areas of the municipalities of Zivinice and Lukavac. This measure reduces the flood risk in those areas, but the water is diverted further into Gracanica, Petrovo, and Doboj, which face an increased flooding risk, as it can be expected that a faster and greater intensity of water will reach the areas downstream of the regulated waterways.

3. Model for assessing vulnerability in a GIS environment by incorporating the AHP multicriteria decision-making method

In the development of the model in a GIS environment for the purposes of this study, all collected data from available spatial planning documents, as well as from flood hazard maps published in the preliminary flood risk assessment (AVP Sava, 2013), have been placed in a spatial database repository including their structuring, definition, valuation, and classification of criteria necessary for vulnerability analysis. The establishment of the spatial database was conducted according to ISO standards (ISO/TC211, 2024), taking into account all principles of the OpenGIS Consortium (OGC, 2024), to ultimately achieve an acceptable level of interoperability (data exchange with other institutions). All datasets used in the analysis were stored in the database. For the vulnerability analysis based on available data, eight criteria were selected (relief and slope of the terrain; population number, i.e., population density; agricultural land; buildings; road infrastructure; construction land; industry; and forests) (E. Ferhatbegovic, 2017), which were placed in the spatial database. For the purposes of further analysis, a new attribute, i.e., a weight factor of flood exposure, was added to all criterion tables. The process of defining criteria generally involved their conflict, i.e., the inability to simultaneously and uniformly consider all, therefore, AHP analysis was included in the analysis of data placed in the previously created geospatial database repository. In preparation for conducting the multicriteria analysis, all tables in the database were expanded with an additional column into which optional values for individual criteria were entered. The evaluation of criteria was performed using numerical values (weight factors of 1, 3, or 5), where 1 indicates a low level of flood exposure, 3 indicates a medium level of flood exposure, and 5 indicates a high level of flood exposure. Before obtaining the actual values of corresponding criteria for vulnerability assessment, the procedure includes evaluating the importance of each individual criterion. Considering the number of defined criteria and four dimensions of vulnerability (social vulnerability, environmental vulnerability, physical vulnerability, and economic vulnerability), a total of 28 comparisons were made. The comparison of criteria was performed using Saaty's scale (Saaty, 2008) for the specified dimensions of vulnerability. After ranking the criteria

at the given level of hierarchy, they were placed into the corresponding comparison matrices (**Figure 4**). Given that eight criteria were defined that configure the analysis, a reciprocal matrix with eight columns and eight rows was formed. It should be noted that the scores are transposed over the main diagonal of the matrix, so that the corresponding scores (from 1 to 8) receive a reciprocal value, symmetrically along the main diagonal (Ferhatbegovic, 2016).

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} & a_{17} & a_{18} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} & a_{26} & a_{27} & a_{28} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} & a_{36} & a_{37} & a_{38} \\ a_{41} & a_{42} & a_{43} & a_{44} & a_{45} & a_{46} & a_{47} & a_{48} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{55} & a_{57} & a_{58} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & a_{67} & a_{68} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & a_{78} \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88} \end{bmatrix}$$

Figure 4. Comparison matrix

From the comparison matrix, the weights of individual criteria are calculated, determining the influence of each criterion in the aggregate rating of each alternative solution from the lowest level of the hierarchy. Based on the results of the previous step, each criterion received a corresponding weight coefficient that defines its relative value in relation to the established goal. The weight values of the criteria range between 0 and 1, with a higher coefficient value indicating a greater value of that criterion. Since the vulnerability analysis is conducted according to previously defined dimensions of vulnerability, specific criteria were assigned values depending on the dimension of vulnerability and the importance of that criterion for that dimension.

The multicriteria analysis in GIS is realized by applying cartographic algebra over factor (criteria) maps, which requires data classification, assigning each data entry an additional attribute (weight value, data classification). After the data classification, the creation of factor maps for all criteria was undertaken. Given that the collected data are in vector format (except for the DTM), they were converted into rasters (grids) on which the geospatial analysis is performed. The rasterization of vector data was carried out in the GIS software MapInfo Pro using the Raster module.

After creating the factor maps for each defined criterion, the next step involves the creation of preliminary vulnerability maps. To define vulnerability zones, a scale with 5 levels of ranking was used, with qualitative descriptions: 1 - very low vulnerability; 2 - low vulnerability; 3 - moderate vulnerability; 4 -

high vulnerability; 5 - very high vulnerability. The essence of zoning consists of determining the boundaries of different degrees of hazard in the field.

3.1. Limitations of available data

Since the catchment area of the Spreča River spans across the territory of two entities with divided responsibilities, it is not possible to obtain identical data for the entire catchment area, as the data is not collected at the same time intervals, or with the same accuracy and resolution. This paper uses official data from various institutions and levels of government, such as cadastral data from the relevant municipal authorities, data from the Civil Protection Administration of the Tuzla Canton, data from the statistical agencies of the Federation of Bosnia and Herzegovina and the Republic of Srpska entities, public company Spreča, etc. Given this, the greatest challenge is the collection of adequate data.

4. Research Results

The generation of preliminary vulnerability maps was accomplished by summing the products of normalized weight factors with factor maps for each defined criterion. This generation was carried out in the MapInfo Pro software package using the Raster module with the 'Calculator' option.

For the preliminary vulnerability assessment, the following formulas were used:

Social Vulnerability

SV=" terrain_slope * 0.33 + "population_density" * 0.227 + "buildings" * 0.156 + "transport_corridors" * 0.107 + "agriculture" * 0.073 + "industry" * 0.05 + "construction land" * 0.034 + "forests" * 0.024

Environmental Vulnerability

EnV= " terrain_slope " * 0.33 + "agriculture" * 0.227 + "forests" * 0.156 + "transport_corridors" * 0.107 + "population_density" * 0.073 + "buildings" * 0.05 + "construction land" * 0.034 + "industry" * 0.024

Physical Vulnerability

PV=" terrain_slope " * 0.33 + "transport_corridors" * 0.227 + "industry" * 0.156 + "buildings" * 0.107 + "construction land" * 0.073 + "agriculture" * 0.05 + "population_density" * 0.034 + "forests" * 0.024

Economic Vulnerability

EcV=" terrain_slope " * 0.33 + "industry" * 0.227 + "buildings" * 0.156 + "agriculture" * 0.107 + "construction land* 0.073 + "transport_corridors" * 0.05 + "forests" * 0.034 + "population_density" * 0.024

In general, the first concrete step in reducing vulnerability and managing flood risks is to determine the areas where flood vulnerability is high, where the flood risk is unacceptably high, and where most activities should be directed towards preventive flood defense. The preliminary vulnerability maps contain displays of vulnerability ratings for the entire Spreca River catchment area, highlighting zones 4 and 5 (zones of high and very high vulnerability). Factor maps for each analyzed criterion are shown in **Figure 5**.

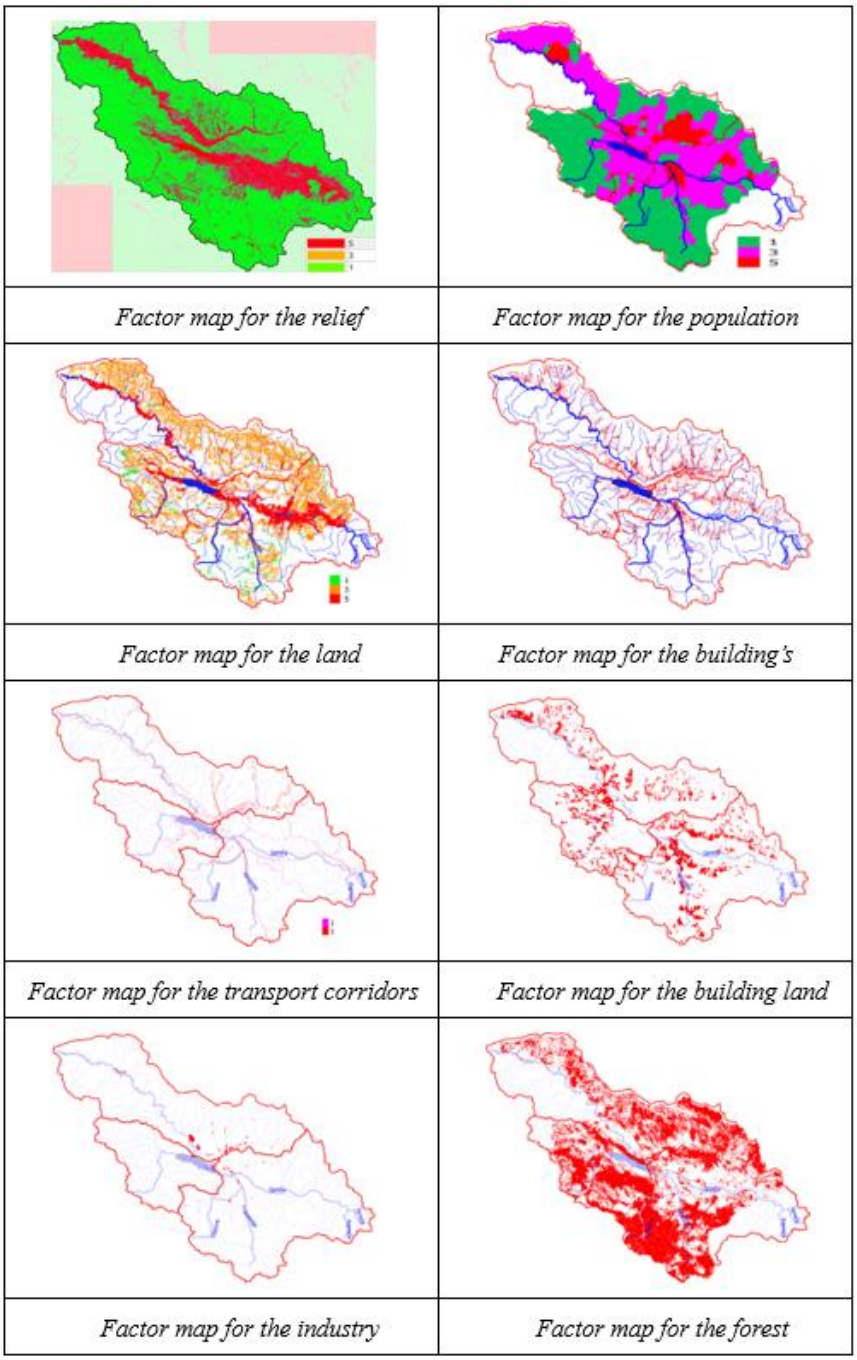

Figure 5. Factor maps for each selected criterion

Analysis of the generated maps of social vulnerability (**Figure 6**), maps of environmental vulnerability (**Figure 7**), maps of physical vulnerability

(**Figure 8**), map of economic vulnerability (**Figure 9**), revealed that significant areas of the analyzed region fall within high and very high vulnerability zones.

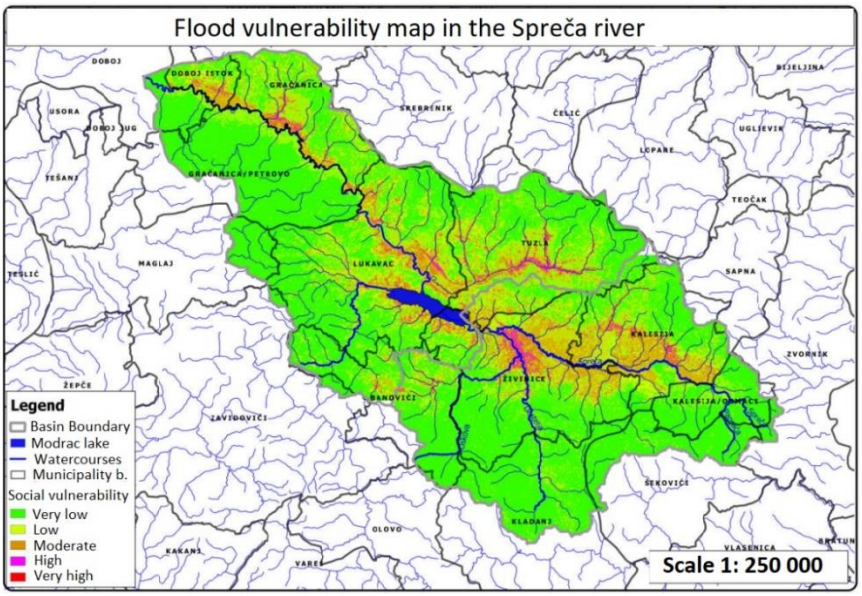

Figure 6. Preliminary map of social vulnerability

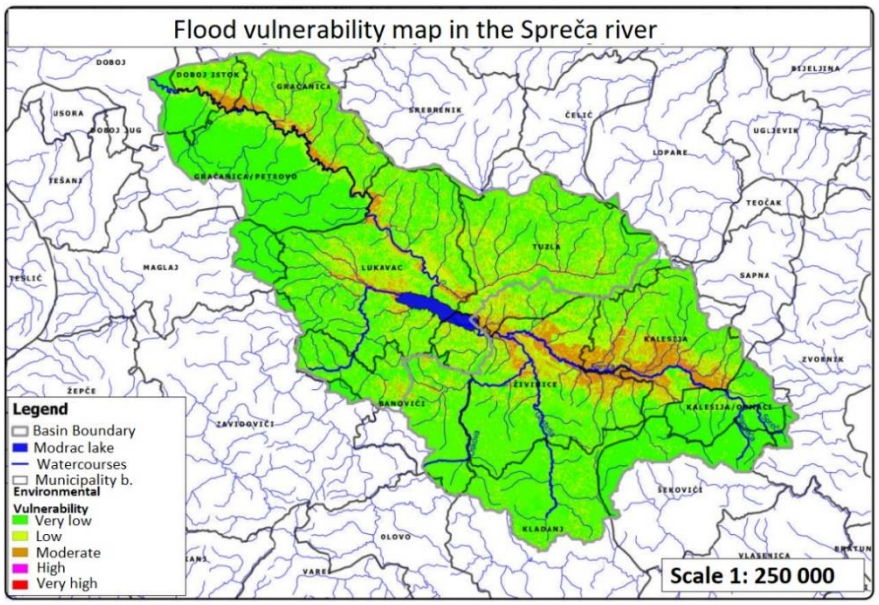

Figure 7. Preliminary map of environmental vulnerability

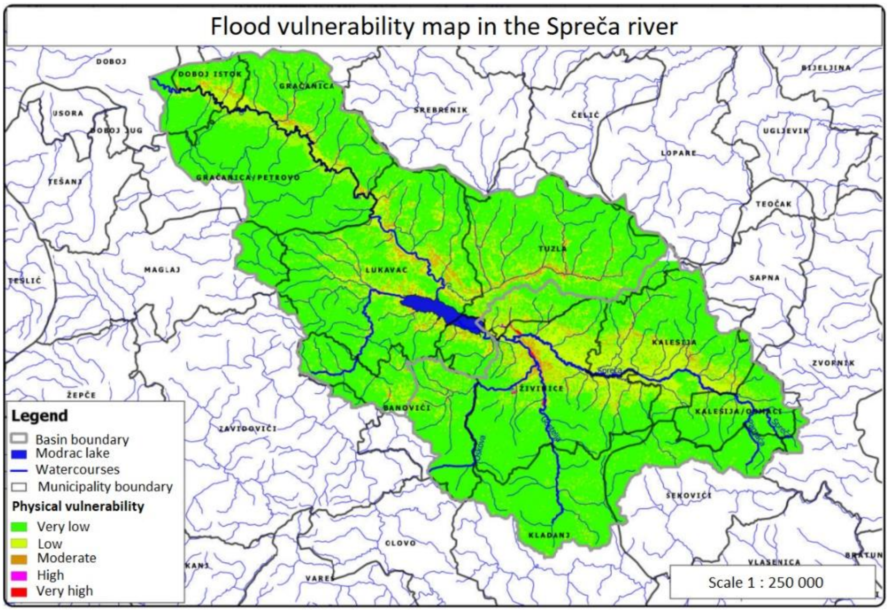

Figure 8. Preliminary map of physical vulnerability

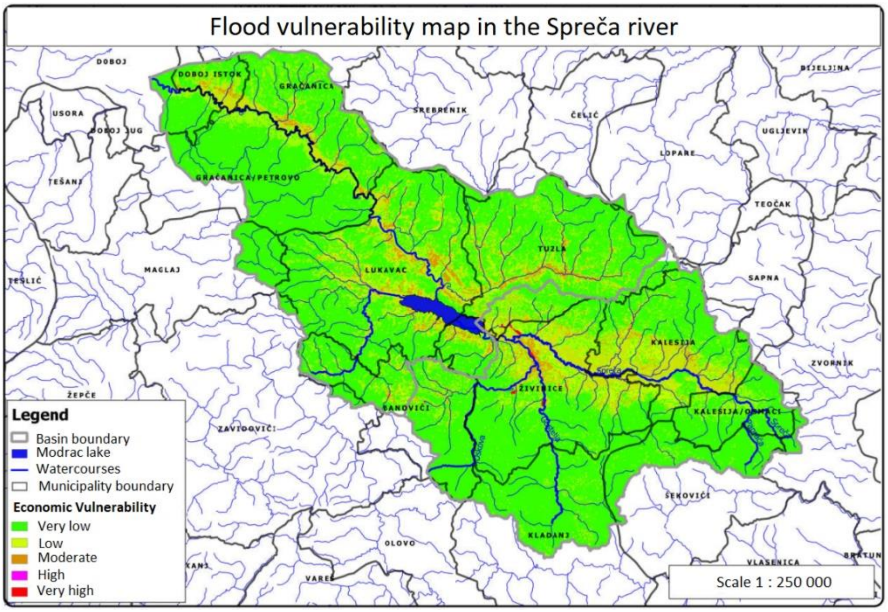

Figure 9. Preliminary map of economic vulnerability

From the perspective of social vulnerability, it was found that approximately 0.77% (about 15.2 km²) of the total area of the Spreca River catchment has high and very high vulnerability. Out of the total number of buildings (155,120), around 10.5% of these buildings are located in zones of high and very high vulnerability.

From the perspective of environmental vulnerability, the analysis has shown that approximately 0.83% (about 16.45 km²) of the area of the Spreca River catchment has high and very high vulnerability. In the zones of very high and high vulnerability, there are 7.13 km² of mostly high-quality arable agricultural land.

In the area of the Spreca River catchment, there is a total of 440.33 km of road infrastructure, of which 172.86 km are main roads, 24.38 km are regional roads, and about 243.09 km are other road routes. It is important to note that smaller local roads were not considered in the analysis. In addition to the road network, there is approximately 127 km of railway lines in the catchment area. The most critical infrastructure is the road network, where in the identified zones of high and very high flood vulnerability, there are 16.4 km of main roads, 0.6 km of regional roads, and 8.16 km of other road routes, along with 9.16 km of railway lines. In the zone of high and very high vulnerability, there are 1,807 buildings, which represents 1.165% of the total number of buildings.

According to the economic dimension of vulnerability, it was found that in the zones of very high and high vulnerability, there are approximately 8.42 km² of agricultural land, 4.2 km² of forest land, and 2.31 km² of urban areas.

These indicators provide a picture of the actual state, reflecting the exposure of the population, inhabited areas, and their (un)preparedness to recover from floods. Additionally, this may indicate poor social integration that affects people of low economic status, the unemployed, the sick, etc. On the other hand, indicators related to the environmental vulnerability dimension point to the fact that the area has developed from the perspective of technological rationality, which has long-term detrimental consequences for arable land, vegetation, and all other aspects of the environment. This indicates the conclusion that development based on technological rationality should be altered, and development should be based on the principles of ecological rationality.

The presentation of vulnerability maps through web-based geoportals contributes to better public awareness as well as to potential investors, enabling them a quick and easy way to determine the level of flood vulnerability at a location of interest for construction (**Figure 10**).

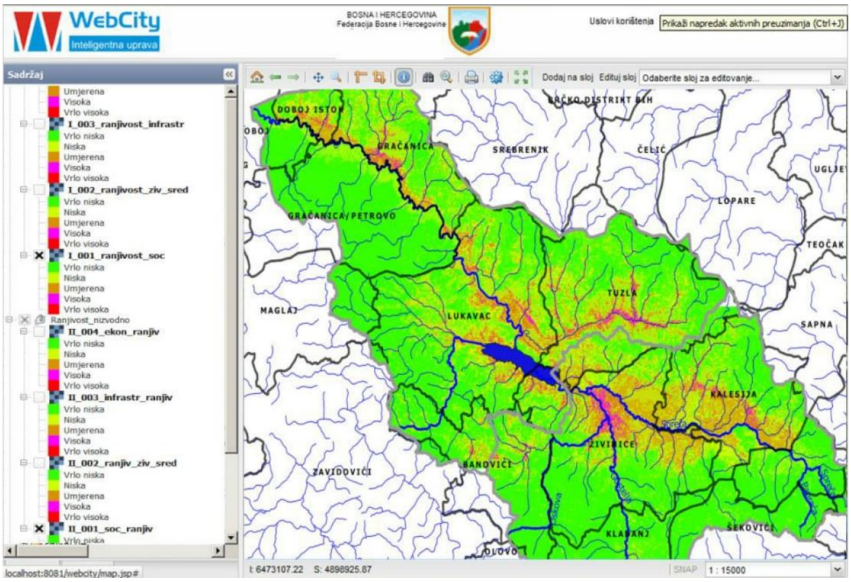

Figure 10. Web presentation of flood vulnerability maps

4. Conclusion

Floods are a natural phenomenon that cannot be prevented, but with a high degree of probability, they can be predicted. Unplanned anthropogenic activities significantly contribute to the increased likelihood and harmful effects of extreme floods, which manifest in direct damage and losses that particularly affect vulnerable categories of the population. Sustainable development requires reducing disaster risk, strengthening the resilience of communities, and implementing preventive measures aimed at mitigating the negative impacts of floods on socio-economic development.

Geoinformation tools (GIS), combined with multicriteria analyses, are indispensable tools for mapping, modeling, and various analyses in disaster management at different levels. This study demonstrates a straightforward way of utilizing geoinformation tools in monitoring, modeling, analyzing, planning, and ultimately making effective decisions in the context of reducing vulnerability and managing flood risks toward sustainable development.

The obtained preliminary maps and continuous monitoring can significantly contribute to the establishment of an early warning system for floods, reducing flood damages, and of course saving lives. The presentation of vulnerability maps through web-based geoportals enhances public awareness as well as that of potential investors, providing them with a quick and easy way to determine the level of flood vulnerability at locations of interest for construction.

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Overview of Sustainability Practices in Higher Education Institutions in Albania, Bosnia and Herzegovina, and Montenegro

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Abstract

In the last decade we are facing climate change, by adopting different strategies and plans. Higher Education Institutions (HEIs) have a pivotal role to counteract climate change by implementing sustainability practices and projects, within their curricula, study programs, and research activities. The aim of this study was to identify the climate change and sustainability practices in six HEIs of the Western Balkan Countries (Albania, Bosnia and Herzegovina, and Montenegro). This research is done in the framework of 1FUTURE project, where all these higher education institutions are partners. The results showed a lack in institutional frameworks focused on climate change and sustainability. While curricula review revealed a variation within and between HEIs of WBCs related to the percentage of climate change and sustainability practices offered from each program type (Bch, MSc, PhD). Moreover, it was reported the involvement of these universities in various projects, focused in solving real problems, and disseminating knowledge and sustainable practices.

Keywords: *Climate Change, Sustainability, Higher Education Institutions, Western Balkan Countries, Curricula.*

1. Introduction

Climate changes has affected almost all European countries, especially the south of Europe exposing these countries to a different climate cycle and

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challenges. European Union countries have already adopted many strategies aiming to reduce the impact of climate changes in the future. The most important one is the European Green Deal (2019), which is part of the strategy for the implementation of the United Nation's 2030 Agenda and the Sustainable Development Goals (SDGs). Since Western Balkan Countries are willing to adhere in the EU, these plans and activities aims to affect also their policies in terms of implementation of new strategies toward climate changes and sustainability. It has been showed that although some of these countries have adopted new policies, the implementation of specific activities is at low level (Knez et al., 2022). However, almost all countries have already addressed some big issues by redirecting their electricity production toward hydropower and solar panels, which itself will bring a more sustainable and independent economy (Korzeb et al., 2024).

Many actors can help with the adoption and implementation of new strategies for climate change including governative bodies (ministries, national agencies, etc.), non governative bodies, organization of civil society, media through the raise of public awareness, etc. Lately, literature considers as the most important actor the Higher Education Institutions HEIs, which can lead the process through research, education and community engagement (Lozano et al., 2013; Serafini et al., 2022; Alfathy, 2024; Sart, 2022). However, curricula, study programs and approach in these higher education institutions should adopt many changes following the new EU regulations and strategies (Biancardi et al., 2023; Omazic et al., 2021).

To achieve this, researchers, professors and students from Western Balkans should collaborate with each other in order to produce and understand their new path toward sustainable development in different dimensions such as environment, green economy, responsible water and other natural resources management. The role of the Higher Education Institutions HEIs can be crucial in solving the main issues of climate changes and sustainability through innovation, research, intellectual capacities and public credibility.

The aim of this study is to analyse the climate change and sustainability practices in each of HEI of the Western Balkan Countries, in specific Albania, Bosnia and Herzegovina, and Montenegro. This research is done in the framework of 1FUTURE project, where all these higher education institutions are partners.

2. Methodology

The research presented in this article is based on one of the findings of 1FUTURE project. This project has been funded with support from the European Commission, within ERASMUS + programme. This section presents the methodology used during the completion of the task related to all sustainability practices at Higher Education Institutions in Albania,

Montenegro and Bosnia and Hercegovina. For this purpose, from each Higher Education Institution HEI part of the 1FUTURE project was collected the following information by completing a word document with these sections:

- National legal and strategic framework for the development of climate and sustainability initiatives.
- The institutional framework for the development of climate and sustainability initiatives.
- Review of curricula related to climate and sustainability.
- List of projects related to climate and sustainability.
- List of services related to climate and sustainability.

The purpose of classifying the sustainability practices as mentioned above was to create an overview of the current situation at WBC HEIs, and then to compare these findings. The detailed information was reported from six Higher Education Institutions:

- three HEIs in Albania: Polytechnic University of Tirana (PUT), University of Tirana (UT), and Luarasi University (ULA);
- two HEIs in Bosnia and Herzegovina: University of Tuzla (UTZ), and University College CEPS Kiseljak;
- one HEI in Montenegro: University of Montenegro (UoM).

From these Higher Education Institutions, four of them are public (Polytechnic University of Tirana (PUT) and University of Tirana (UT) in Albania, University of Tuzla (UTZ) in Bosnia and Herzegovina, and University of Montenegro (UoM) in Montenegro) while two are private (Luarasi University (ULA) in Albania and University College CEPS Kiseljak in Bosnia and Herzegovina.

The data related to national legal and strategic framework for the development of climate and sustainability initiatives were collected from each HEI and are reported at the country level in the results section.

All other datas were reported at the institutional level for each HEI of Albania, Montenegro and Bosnia and Hercegovina.

Regarding the information about the review of the curricula related to climate and sustainability was reported at the institutional level for all study programs offered from each HEI, as well as with the number of study programs in which some subjects are related to climate change and sustainability practices, and the percentage that this subject has for each program type (Bachelor/Master/PhD).

3. Analysis & Discussion

Facing the urgent need to combat with the impacts of climate change, the first part of this research was focused on the analysis of laws, regulations, strategies

and other legal initiatives related to climate and sustainability in the Western Balkans (Albania, Bosnia and Herzegovina, and Montenegro). This analysis revealed a good commitment of the policy makers in these WBCs as it is shown in figure 1 where the information is categorized in three main areas:

1. National Strategy, Action Plans, Framework Cooperation
2. Law on Environmental protection
3. By-Law or DCM or Decree on Environment protection.

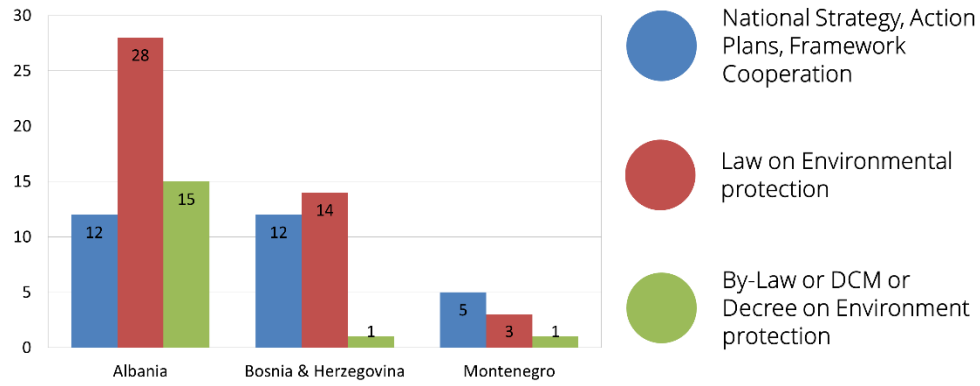

Figure 1. Legal and strategic framework for the development of climate and sustainability initiatives in Albania, Bosnia and Herzegovina, and Montenegro.

As can be seen Albania and Bosnia and Herzegovina has the same number of National Strategy, Action Plans, and Framework Cooperation, respectively 12, followed by Montenegro with 5. Moreover, Albania and Bosnia and Herzegovina have more approved Laws on Environmental protection than National Strategy, Action Plans, Framework Cooperation, while Montenegro has less. Whereas if we refer to the third category, Albania has a 15 approved By-Law or DCM or Decree on Environment protection, while Montenegro Bosnia and Herzegovina have only one.

In relation to the institutional frameworks for the development of climate and sustainability initiatives, a lack of them was noticed in each of the higher education institutions involved in this study. Almost all HEIs from Albania and Bosnia and Herzegovina reported mainly the higher education laws, and some internal regulations or strategies.

Recognizing that in each higher education institutions in the Western Balkans the sustainability practices can be different, depending on specific needs and capabilities of individual institutions since some of them are public and some other private, we were focused on the review of curricula related to climate

and sustainability. In figure 2, 3 and 4 are given the statistics related to the total number of Bachelor/Master/PhD programs for each HEI in Albania, Bosnia and Herzegovina, and Montenegro, and the percentage of those programs offering Climate Change and Sustainability Practices.

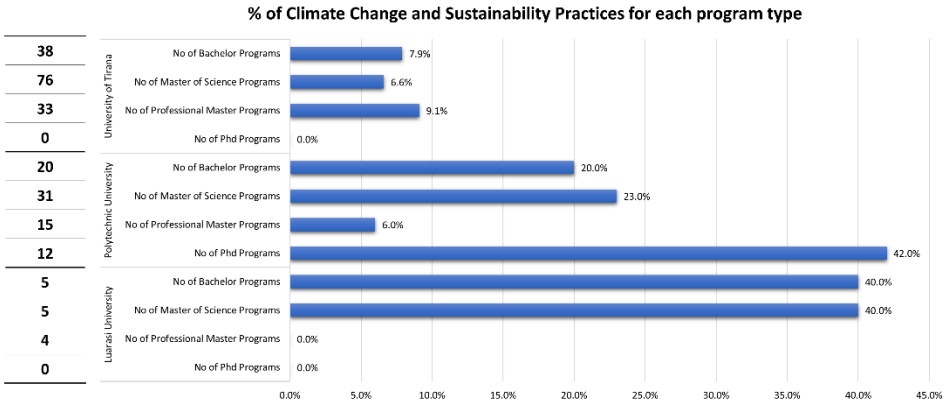

Figure 2. Study programs offered from each Higher Education Institution in Albania and the percentage of climate change and sustainability practices for each program type.

As can be seen in Figure 2, Albanian HEIs offers different study programs at all three levels, both in terms of quantity and curriculum.

The University of Tirana offers the largest number of study programs (33 Bachelors, 76 Master of Sciences and 33 Professional Masters) varying from economic science, natural sciences to social sciences, while the Polytechnic University of Tirana offers study programs related to engineering sciences in 20 Bachelor programs, 31 Master of Sciences, 15 Professional Masters and 12 PhD programs. Luarasi University offers in total 14 study programs in economic sciences, medical sciences, to law, from which 5 Bachelors, 5 Master of Sciences and 4 Professional Masters.

The study programs which offers at least a course in Climate Change and/or Sustainability field at each of the public and private Albanian Universities differs as follow: 3 Bachelor, 5 Master of Sciences and 3 Professional Masters at the University of Tirana; 4 Bachelor, 7 Master of Sciences, 1 Professional Masters and 5 PhD programs at the Polytechnic University of Tirana; and 2 Bachelor, 2 Master of Sciences at Luarasi University.

The PhD programs at the Polytechnic University of Tirana and specific PhD thesis at the University of Tirana offer more climate and sustainability related initiatives than any other program. This is due to the focus of the PhD projects on topics related to the impact of climate change on the environment, sustainability, and not only.

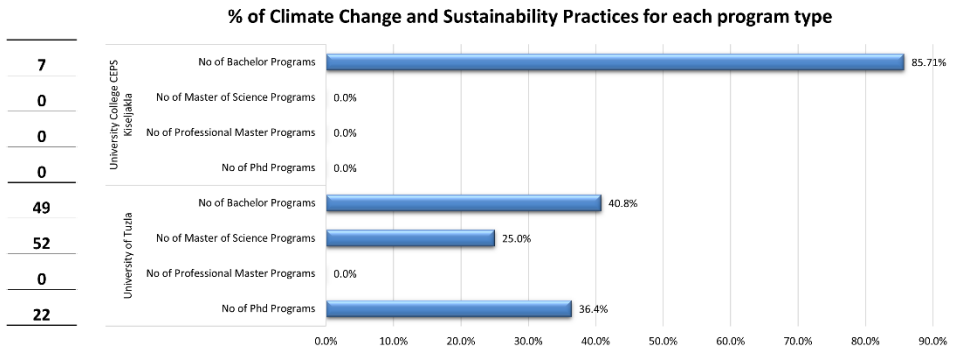

Figure 3. Study programs offered from each Higher Education Institution in Bosnia and Herzegovina, and the percentage of climate change and sustainability practices for each program type.

The review of curricula for HEIs in Bosnia and Herzegovina is shown in figure 3. The University College CEPS Kiseljakla in Bosnia and Herzegovina offers only 7 Bachelor programs, where 6 of them offers in their curricula topics or practices related to climate change and sustainability. The 7 bachelor study programs offered by the University College CEPS Kiseljakla are focused on engineering sciences, economic sciences and health sciences.

While, the University of Tuzla offers a variety of bachelor, Master of Science and PhD study programs, respectively 49, 52 and 22, focused in engineering sciences, economic sciences, health sciences, sport sciences, social sciences, law, natural sciences etc. The number of study programs offering climate change and sustainability practices is respectively: 20 Bachelors, 13 Master of Sciences, and 8 PhD programs.

The review of curricula at the University of Montenegro in Montenegro it is shown in figure 4, where the huge number of Bachelor and Master of Science programs stands out. Since the University of Montenegro is the only state university in Montenegro, offers study programs related to engineering sciences, art, economic sciences, health sciences, sport sciences, social sciences, law, natural sciences etc, in 64 Bachelor programs, 67 Master of Sciences, 6 Professional Masters and 24 PhD programs.

The study programs which offer at least a course in Climate Change and/or Sustainability Field at UoM are: 17 Bachelor, 16 Master of Sciences, 3 Professional Masters and 2 PhD programs.

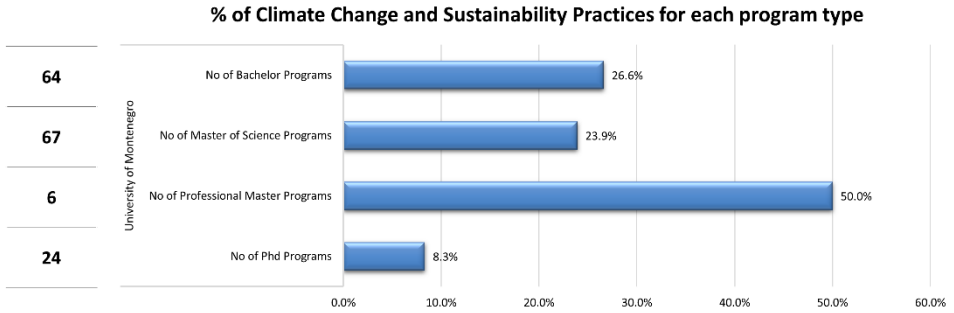

Figure 4. Study programs offered from the Higher Education Institution in Montenegro and the percentage of climate change and sustainability practices for each program type

Another category taken into analysis within this research is the participation of HEIs in the WBCs in sustainability-related projects. These projects are financed from different founds, like national entities, European Commission or other international organizations, which has in focus a better future in terms of economic, social and environmental issues. In Albania there are still most of the projects on-going, which will improve the climate change and sustainability problems, by taking into consideration all the factors. Montenegro and Bosnia and Herzegovina have already finished the majority of these projects, which were numerous in number, variety of topics, and funding sources.

Table 1. Projects dealing with sustainability issues in each Higher Education Institution in Albania, Bosnia and Herzegovina, and Montenegro.

		No of project related to climate change and sustainability	ongoing	No of SDGs
Albania	Polytechnic University of Tirana	13	7	5
	University of Tirana	16	13	8
	Luarasi University	2	2	7

Bosnia and Herzegovinia	University of Tuzla	9	2	7
	University College CEPS Kiseljakla	5	2	6
Montenegro	University of Montenegro	78	10	13

Finally, the analysis of the services related to climate and sustainability offered from each HEI, revealed that most of them are indirectly linked with the climate change and sustainability issues. These services include trainings; professional courses; scientific activities (Conferences, workshops, etc.), expertise to the government; expertise in writing and developing different projects; testing for the certification of experts for environmental impact assessment and environmental audit; Technical and scientific evaluation of development and infrastructure projects; Management in crisis situation; etc.

Moreover, some of the HEIs organize raising awareness activities and promoting environmentally friendly practices to all students and staff and participating in various events and activities.

4. Conclusions and Recommendations

In summary, at the country level an overview of legal and strategic framework related to climate change and sustainability was provided, and it can be concluded that WBCs are in the process of adopting the necessary regulations and strategies towards climate change sustainability initiatives.

Based on the analysis, none of the higher education institutions has already approved or in use institutional frameworks focused in climate change and sustainability.

HEIs in Albania, Bosnia and Herzegovina, and Montenegro performed the review of the curricula for all study programs offered at each HEI, by giving the information related to climate and sustainability practices included in each study program. Curricula review revealed a variation within and between HEIs of WBCs related to the percentage of climate change and sustainability practices offered from each program type (Bch, MSc, PhD). This variation was evident even between public and private HEIs, due to the differences in the number and types of offered study programs. Study programs offered in Albanian HEIs, Bosnia and Herzegovina HEIs, and University of Montenegro

has already almost the same inclusion values of sustainability practices part of their curricula.
Higher education institutions have good experience regarding the various climate change and sustainability related projects in which they have been or are involved, since some of them are currently on-going. The large number of these projects shows the commitment of each country as well as the European Union or other organizations for financial support and not only for these Western Balkans Countries.

The curricula of each program type (Bch, MSc, PhD) in Albania, Bosnia and Herzegovina, and Montenegro's HEIs should include more topics or practices linked with the climate change issues and sustainability development. Moreover, HEIs in these WBCs should prepare and implement specific plans or strategies in their institutional framework for a more sustainable development environment.

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Hydroponic Farming in Albania: A Cost-Benefit Analysis of Sustainability and Innovation

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Abstract

With an emphasis on its potential to transform conventional agriculture and its compatibility with sustainable development goals, this study investigates the viability and socioeconomic effects of hydroponic farming in Albania. A soilless cultivation technique that uses nutrient-rich water solutions, hydroponic farming has many advantages, including increased yields, lower water usage, and year-round production in controlled conditions. Because of these qualities, it is very useful for tackling issues with resource efficiency, food security, and climate change.

The study assesses the advantages, disadvantages, opportunities, and dangers related to hydroponic farming in Albania using a combination of SWOT and cost-benefit analysis. Reduced labor and pesticide use, higher crop yields, and low land needs are some of its main advantages; on the other hand, its high starting expenses and reliance on technical know-how are its main disadvantages.

According to the cost-benefit analysis, hydroponic farms can produce a profit in three years with a positive net present value and internal rate of return, even with a large initial expenditure. Additionally, by increasing food security, lowering greenhouse gas emissions, and encouraging innovation in agriculture, hydroponic farming advances larger socioeconomic objectives. The study comes to the conclusion that hydroponic farming is a practical and sustainable way for Albanians to grow their own fruits and vegetables. In order to overcome implementation obstacles and facilitate the broad adoption of this cutting-edge agricultural technique, policy recommendations include financial subsidies and strategic support.

Keywords: *Vertical Farming, Cost-benefit Analysis, Sustainability, Hydroponic Farm, Swot Analysis*.

Jel code: Q01, Q16, Q25

1. Introduction

This study examines the feasibility and possible effects of hydroponic farming

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in Albania, highlighting how it fits in with the objectives of sustainable development and the growing need for effective agricultural solutions worldwide. Growing plants in a nutrient-rich water solution without soil is known as hydroponic farming, and it offers benefits such as year-round production, lower water consumption, and higher yields than traditional farming (MyGreenTerra, 2023). The report highlights prospects like resource efficiency, environmental advantages, and market demand for sustainable products while evaluating implementation constraints including high startup prices and energy demands.

According to a cost-benefit analysis (CBA), hydroponic farming can earn a profit in three years despite hefty startup expenses, provided that it has a high internal rate of return and positive net cash flows. Strengths like year-round production and resource efficiency are highlighted by the SWOT analysis, coupled with weaknesses like high startup costs and reliance on energy. Threats from consumer mistrust and opportunities in sustainable agriculture are also taken into account.

The results highlight how hydroponic farming has the potential to revolutionize Albanian agriculture by increasing food security, encouraging environmental sustainability, and stimulating economic growth. Policy steps to lower implementation costs and improve technical assistance are among the recommendations, which will guarantee the long-term viability and scalability of hydroponic farming endeavors.

2. Literature review

The necessity for nations to demonstrate progress on the 17 UN goals is becoming increasingly pressing as the 2030 agenda deadline approaches. However, how would this be best accomplished? Which objective is more important than the others? Where should we direct our attention, and more significantly, where can each of us personally devote our time, effort, and resources to affecting constructive change in the world?

The answer to a seemingly modern question was answered just 25 years ago, when Dickson Despommier, a professor at Columbia University, and his students designed a vertical farm model. They claimed that "plants grown in high-rise buildings erected on now vacant city lots and in large, multistory rooftop greenhouses could produce food year-round using significantly less water, producing little waste, with less risk of infectious diseases, and no need for fossil-fueled machinery or transport from distant rural farms" (Despommier, 2009, quoted in Growing Skyscrapers: The Rise of Vertical Farms, 2009,).

Vertical Farming is not a new invention. One of the first sightings of this concept was seen by the Babylonians over 2500 years ago when the prototype of vertical farming was manifested in the form of a hanging garden (The Editors of Encyclopedia Britannica). As the technology involved and the need for a higher quantity of crops grew, but the land to potentially grow these crops didn't, we decided to look for an alternative where we could optimize the use of land with the number of crops and vertical farming as an official term was created.

Vertical Farming encompasses several systems, including hydroponics, aquaponics, and aeroponics (Eden Green Technology). Aquaponics is a method that combines hydroponics with fish farming. Hydroponics is a method in which the roots of the plants are immersed in a nutrient-rich water solution. As the name implies, the main goal of aeroponics is to grow plants in a nutrient-rich mist solution while ostensibly leaving them in the air.
The kind of system you can use to make a profit depends on what country in where you live or wish to run a vertical farm. Hydroponics is the most popular vertical grow system. The plant-growing technique is much simpler to comprehend and apply, making it user-friendly for beginners. Because the equipment needed for this system is easier to locate, the expenses of putting it into place are comparatively lower than those of the other approaches.
One benefit of hydroponic vertical systems is undoubtedly their ease of implementation, but there are further benefits as well. The potential for ongoing agricultural production is the first benefit. As long as the conditions necessary for the crops' development are continuously monitored, a hydroponic system enables you to sustain and grow crops throughout the year. When considering the number of crops produced each season, Despommier claims that "a single indoor acre of a vertical farm may generate more than 30 acres of farmland" (Dickson Despommier,2009).

The second advantage is that a hydroponic system enables a reduction in the overall quantity of pesticides used for plants. Many vertical arms utilize ladybugs to control any potential infestation (Birkby, 2016). This makes the plants more organic and healthier and reduces the health risks associated with improper usage of herbicides used to grow and defend plants from insects.

The third benefit has to do with how much water the system uses. We know from the system's name that it requires water, and although this type of vertical farming may appear to use a lot of water, it actually uses it quite efficiently. In addition to being filtered and utilized frequently by the system, the water in which the plants are submerged is rich in nutrients that support their growth. Compared to conventional farms, hydroponic farms use 70% to 95% less water (LED iBond, 2022).

The fourth benefit derives from a design position. Hydroponic farms are particularly climate-friendly, although all vertical farms are. It is less expensive to grow crops indoors since you would need to cultivate four times as much land to produce the same number of plants as you could in a smaller area. Both the amount of CO2 and the amount of fossil fuels burned by the equipment that would be used to pot the plants are decreasing.
Although a hydroponic system has numerous advantages, just like anything else in the world, it also has drawbacks. It should be mentioned that the system's operating side features are its drawbacks rather than the farm's functionality or design. The system's productivity is higher than that of traditional farming since, like anything else, it is costly.
The expense of land and construction is the first drawback. Since the equipment must be purchased at a special store and ordered especially for your farm, the installation costs are typically significant (Bendanillo, 2023). A large area is also required to develop a farm in order to make a high profit; these farms are typically found outside of large cities so that customers are close by and the farmer can reduce the cost of transportation to the businesses or customers.

The energy consumption is the second drawback. The cost of electricity to keep the machinery working constantly, to maintain the temperature through heat and lightning, and to keep the water constantly filtering and flowing through the system is expensive, even though the cost of transportation for the fuel used is less than on typical farms (Barnes, 2023).

The third drawback is that there are only so many crops you can grow. Various plants require varied amounts of water and light, and they also have different growth cycles (Growee, 2023). It will be more expensive to maintain both sorts of plants together if these types are mixed. Keeping plants with comparable growing cycles and requirements is therefore advised; this results in a smaller number of plants but a better profit.

The process of pollinating the crops is the fourth drawback. Insects are responsible for pollination in nature, but when it comes to vertical farming, insects are typically excluded entirely. Since there is no other option in this situation, pollination must be done by hand, which can be expensive and time-consuming (Agrotonomy, 2018).

There are benefits and drawbacks to every technique, but in the case of hydroponic farming, the drawbacks are more operational in nature than they are impact related. The implementation phase is when the drawbacks are most apparent, but business breaks even and then turn a profit three to four years later.

This has not taken back a lot of farmers or businessmen to take an interest in hydroponic farming as the interest only grows year after year 10 as studies show that hydroponic farms have a higher yield of crops compared to traditional farming (Khan, 2018). The most prominent country that uses hydroponic practices is the Netherlands where these practices make up over 10% of countries' produce (Agrifarming, 2022).

While today the Netherlands is considered the motherland of hydroponic farming in Europe, the origin of this concept was created almost 2500 years ago in the form of hanging gardens created by the Babylonians (The Editors of Encyclopedia Britannica, 2019b). These gardens were mostly constructed of bushes and trees but as technology and the human race were involved these gardens were transformed into farms in controlled environment agriculture.

Other nations also noticed this pattern, in addition to the Netherlands. Many nations, including Albania, are becoming increasingly interested in educating farmers about the potential to transform their farms as the UN's 2030 plan draws near. EU projects like Prover PROJECT (PROVER, 2024), which focuses more on vertical armament and aims to bring this idea to Balkan nations like Greece, North Macedonia, Montenegro, and Albania, are providing the education.

The vocational education training school "Charles Telford Erickson," a professional high school where pupils are taught agriculture, has partnered with this program. The high school even has a farm, where they have joined the students as partners in this initiative after learning more about how to make their farm better throughout the training. The significant social impact that hydroponic farms have, despite their implementation expenses, is another factor contributing to the success of this endeavor. A hydroponic farm has a positive impact on 15 of the 17 Sustainable Development Goals (SDGs) of the UN framework. Although all of the SDGs are significant and have a significant impact on society, we will only discuss three of them in this paper: Zero Hunger (SDG 2), Clean Water and Sanitation (SDG 6), and Climate Action (SDG 13).

Starting off with the Zero Hunger goal where we can say that hydroponic farming is an innovative solution to address global food security challenge (Vijaykumar et al., 2023). By enabling year-round crop production in controlled environments, hydroponic systems can provide consistent, high-quality yields regardless of external conditions such as soil quality or climate. This is particularly impactful in urban areas and regions with limited arable land, where traditional agriculture struggles to meet growing demands.

Moving on to the Clean Water and Sanitation goal where one of the most significant advantages of hydroponic farming as we mentioned is its water efficiency, using up to 90% less water compared to traditional agriculture. This

is achieved through closed-loop systems that recycle water and nutrients, drastically reducing waste and minimizing runoff that could contaminate nearby water sources (Cultivators, 2021). These systems are particularly valuable in regions experiencing water scarcity, where sustainable water use is crucial for agricultural and human needs.

The Climate Action aim comes last but certainly not least. Through a number of methods, hydroponic systems improve climate resilience and mitigation. Because hydroponics reduces the need for land, it prevents land degradation and deforestation, two major causes of greenhouse gas emissions. Furthermore, hydroponic farms can be located in metropolitan areas, reducing the carbon footprint associated with the movement of food from rural to urban areas. Additionally, these systems reduce reliance on chemical fertilizers and pesticides, which are significant sources of nitrous oxide emissions.

There are several practices around the world for vertical farming, where the most notable ones in Europe are in the Netherlands such as Grow (Farm, 2023), in the United States of America is Agrotonomy (Agrotonomy, n.d.) located in Arizona which also offers the equipment and plants for every business to operate their own vertical farm. These are the biggest cases in these places, but that doesn't mean that there are no cases in smaller countries as well. For example, in Albania, there is a hydroponic farm operating from 2014 called "HidroFarm" (HIDROFARM, 2024) and an aquaponics farm called "AquaPonics Albania" (Aquaponics, 2024), both farms are located near Tirana and going strong for almost 10 years now.

3. Methodology

3.1 The Study Area

The study area analyzed is located in Vora, near Tirana, Albania, characterized by a subtropical Mediterranean climate. This region experiences distinct seasonal variations, with winter rainfall and dry summers. The average annual temperature reaches approximately 24°C in July, while in January, it averages around 7°C. The area receives a significant amount of precipitation, totaling 1,189 mm annually (Wikipedia, 2005). These climatic conditions, particularly the moderate winter temperatures and ample rainfall, make Vora a suitable location for agricultural practices, including hydroponic farming, as they provide a stable environment conducive to year-round crop production.

3.2 Methodological Background

This paper employs a technique that combines qualitative and quantitative methodologies to thoroughly examine the prerequisites and potential impacts of investing in hydroponic farming in Albania. The qualitative analysis employs a SWOT (Strengths, Weaknesses, Opportunities, and Threats) framework to evaluate the internal and external aspects affecting hydroponics

investments. This approach delineates critical strengths and prospects, including resource efficiency and market potential, while also confronting problems such as initial expenses to technological adoption.

According to (Kenton, 2024) SWOT analysis pinpoints important advantages and characteristics, like market potential and resource efficiency, For many years, SWOT analysis has been a crucial tool in strategic planning. It is separated into two primary sections that concentrate on the external and interior environments of phenomena or investments, respectively.
While "Weaknesses" are restrictions, flaws, or defects that impact a project's success, "Strengths" are the elements that can be managed in a company's internal environment and help a project be completed. In order to determine if a project is successful or not, the latter includes "Opportunities" and "Threats," which include the elements of the external environment that are indicated in each favorable change of some type and neglected necessity) and any negative circumstance, respectively.
A Cost-Benefit Analysis (CBA) framework serves as the foundation for the quantitative analysis. By calculating and contrasting the costs and advantages of hydroponic farming, this methodical technique assesses the socioeconomic effects of the practice. The CBA framework gives stakeholders a thorough grasp of the possible risks and benefits associated with putting hydroponic farming systems into place, making it especially useful for assessing the financial sustainability and wider economic impact of such investments.

Examining whether investing in a hydroponic farm may be both practical and economical is the study's primary research question. Through the website of “Grow Shop Mania” (Grow Shop Mania, 2024) were provided data on all costs and benefits associated with the greenhouse farm's annual operation in 2024 (Year 0). Circular economy concepts are adopted by the particular construction that is the subject of this article. All the equipment that isn't available at Grow Shop Mania in Albania will be purchased from another store in North, Macedonia. This will take a little longer, but the cost will be the same as it is on the website.

Three categories were used to group the expenses. First, the cost of the greenhouse structure, irrigation, electrical equipment (such as an irrigation system and generator), and installation labor are all included in the installation price. Second, the labor expenses associated with farm management are separated into two categories: family labor costs and labor costs for specialized and non-specialized workers.

Third, the acquisition of plants, fertilization and plant protection, water and energy, certifications, and any other charges are considered variable capital costs. Third, the acquisition of plants, fertilization and plant protection, water

and energy, certifications, and any other charges are considered variable capital costs.

Table 1. The installation cost for a hydroponic farm

Installation Cost	Cost (€)
Main greenhouse structure	35,000
10 Axial Fans	3,836
Electricity Generator	1,000
Drip irrigation system	236
Drainage collection system	502
Total	**40,574**

Source: Grow Shop Mania website

Table 2. The Labor cost for a hydroponic farm

Labor Cost	Cost (€)
Owner's labor	4.2 EUR/h × 1,440 h/year = 6,048
Specialized personnel's labor	5.3 EUR/h × 2400 h/year = 12,720
Non-specialized personnel's labor	3 EUR/h × 1200 h/year = 3,600
Total	**19,128**

Source: Interviews conducted with local stakeholders in Vora, Albania, including farmers (September 2024).

Table 3. Variable capital costs for a hydroponic farm

Variable Cost	Cost (€)
Plants	3,000
Fertilization 20l	2966.8
Plant protection	2,000
Energy (heating)	1,350
Consultancy	100
Accountancy	400
Fuel	500
Total	**10,316.8**

Source: Interviews conducted with local stakeholders in Vora, Albania, including farmers (September 2024).

4. Analysis & Discussion

Table 4. Outline of Net Cash Flows in the Cost Benefit Analysis.

Financial Indicators	(€)
Annual revenues (EUR)	45,000
Annual expenses (EUR)	29,444.8

Annual net cash flows (EUR)	15,555.2
Installation costs (EUR)	40,574
Discount rate (%)	6

The costs for setting up a vertical farm have been estimated based on an operational area of 2,000 m², which is in line with what we often see in the industry for smaller facilities. According to CambridgeHOK, the installation costs for vertical farms can vary quite a bit, typically falling between €1,400 and €1,800 per square meter, depending on how advanced the technology and automation are (CambridgeHOK, n.d.). So, for a farm of that size, we're looking at a total installation cost between €3.2 million and €4.6 million.

However, the proposed installation cost of just €40,574 indicates a much simpler setup. This means the farm would consist of basic greenhouse structures, some axial fans and when it comes to smaller-scale vertical farms, a simpler setup like drip irrigation and minimal automation can really be the way to go. This budget-friendly approach helps keep initial costs down while still getting the job done. It's interesting to see how experts, including those at AvazInc (AvazInc, 2019), emphasize that low-tech systems can actually save a lot of money in the long run.

The result of the CBA analysis validates the hydroponics farm's financial sustainability during the course of its six-year existence. While the NPV is likewise positive and equals EUR 6,901.6 in the third year, the IRR is positive (7%). Since the payback period is 3 years, the net cash flows by the third year of operation fully offset the initial capital of € 40,574 as well as the yearly running expenses.

Table 5. SWOT analysis for a hydroponic farm.

Strengths	**Weaknesses**
1. Increased yields throughout the year 2. Low labor and pest control expenses 3. Agricultural land is not required. 4. Circular economy ideas are	1. The high initial costs 2. The need for specialist contractors 3. the lack of technical expertise and advisory support. 4. the vulnerability to

followed during construction and operation.	waterborne illnesses.
Opportunities 1. Boosted demand for fruits and vegetables. 2. Customers with an interest in environmentally friendly production. 3. The potential for CEA goods to be certified as organic.	**Threats** 1. Customers believe that soilless products are not natural. 2. Reliance on the supply of water and electricity. 3. Absence of specific financing for these kinds of investments.

Table 5 provides a SWOT analysis of Albanian hydroponics investments. The anticipated economic turnover is one of the most noteworthy strengths. This is a result of reduced labor and pest management expenses, as well as increased yields because production can be sustained throughout the year. According to earlier studies, hydroponic crops grow 30–50% more quickly than traditional ones (Pomoni et al., 2023). For instance, the output of a tomato crop grown in hydroponics can reach 180–200 tons per acre, but the yield in open agriculture is typically 5–12 tons per acre (Swain et al., 2021).

Furthermore, because of the increased automation and industrialization of production brought about by the use of specialized equipment, this kind of farming does not require a lot of labor (Sela Saldinger et al., 2023). Nonetheless, labor continues to be the primary source of farm expenses. Even however, labor still accounts for 65% of agricultural expenses (Quagrainie et al., 2017), and as plants are cultivated in a protected setting, pest management expenses are also reduced. Furthermore, hydroponic production can be used to value low-productivity areas where other agricultural production cannot be supported because it simply requires land for the greenhouse's construction.

Furthermore, hydroponic farming and the greenhouse hydroponics that have been studied in other articles both align well with the circular economy's tenets (Elvanidi et al., 2020); thus, a suitable investment offers a chance with a smaller environmental impact. This technique creates a sustainable and effective system by conserving and reusing energy, water, and nutrients.

The primary drawback of establishing and maintaining a hydroponic system is the substantial cost outlay for supplies and equipment, with the size and breadth of the farm having a commensurate impact. Although tractors and other open-field cultivation equipment are not necessary for a hydroponic system, specialized equipment and machinery—often imported—are required,

which raises installation costs considerably. Additionally, the relatively new nature of this investment involves uncertainties regarding the equipment's availability. For the same reason, technical expertise and specialized advisory help are typically lacking.

Given the opportunities, it is evident that after the COVID-19 pandemic in Europe (CBI Ministry of Foreign Affairs, 2024), people have been much more interested in fruits and vegetables as they seek healthier options to maintain their health and strengthen their immune systems. Furthermore, a third of consumers, particularly younger ones, are willing to pay more for sustainable products, indicating that consumers are interested in sustainable production, according to "The Global Sustainability Study 2021" (Jain, 2023). As a result, hydroponics farm's sustainable elements might be valued as appealing qualities for customers, improving the financial success of these projects.

One of the risks to investing in hydroponics is that consumers who are unfamiliar with hydroponic farming are hostile to it because they think that hydroponic farm products are unnatural because they are the product of artificial growth (Gonnella & Renna, 2021). The fact that hydroponic farming cannot be practiced in distant locations without access to water and electricity poses an additional risk, as it raises the expense of infrastructure. More precisely, the irrigation system and pumps that circulate the nutrient solution are powered by electricity, while water is utilized to mix and deliver the nutritional solution to the plant roots. It should be mentioned in all of the foregoing that there is a dearth of funds for these kinds of initiatives. For many farmers, this is a significant challenge.

5. Conclusions and Recommendations

This study investigated the implications of implementing a hydroponic farm in Albania. The primary finding reveals that the investment holds potential profitability under current conditions. Specifically, the cost-benefit analysis (CBA) demonstrates that, despite the significant construction and operational expenses, the investment proves viable within the context of prevailing market dynamics and price levels, as positive annual net cash flows surpass the initial installation costs. Furthermore, implementing cost-based subsidies for these expenses could significantly support farmers during the initial stages of their ventures.

The economic feasibility of such investments is intricately linked to the broader socioeconomic development of the region. Hydroponic farms contribute to enhancing local food security and ensuring access to fresh, locally produced food for the surrounding communities. Additionally, these ventures have the potential to stimulate entrepreneurship and foster innovation in agricultural practices. Consequently, it is imperative to explore and

implement policy measures and strategic toolkits at both national and European levels to promote and support hydroponic farming initiatives.

In conclusion, hydroponic farming within greenhouses represents a viable and sustainable alternative for the cultivation of fruits and vegetables. With the capacity to deliver high-quality yields throughout the year, conserve critical resources, and reduce greenhouse gas emissions, this approach aligns with the goals of sustainable agriculture. Moreover, adopting such innovative methods enhances competitiveness within the agri-food industry, enabling farmers to distinguish themselves in an increasingly demanding market.

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Evaluation of the Governance of the Important Wetland Complexes

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Abstract

Good governance through a participatory approach is essential for the conservation of Albania's ecologically valuable wetlands like Lake Shkodra, Kune-Vain, Divjaka Karavasta, and Prespa. These areas are protected and have management plans, but face threats such as illegal fishing and hunting, uncontrolled development, and climate change impacts. Limited awareness and knowledge of wetland management among institutions further hampers conservation efforts. The Regional Administration of Protected Areas (RAPA) struggles to address these threats alone and requires strong collaboration with authorities like municipalities, fishermen, farmers, and water management bodies and better communication and support from local communities. The Management Committee (MC) for Protected Areas, established to aid in governance, currently lacks decision-making and evaluation capabilities due to limited member understanding and capacity. The self-assessment tool and the rapid assessment and planning framework have been crucial in identifying governance issues and facilitating discussions with relevant authorities to address them. This ensures proper management plan implementation and biodiversity conservation. By assessing governance using the METT tool and RAPAs' collected data, the roles of various actors in improving conservation and supporting sustainable local development are identified and discussion and assessment of management, policy-making, and appropriate financial and human resources have been encouraged

Keywords: *Wetland, Government, Management Committee, sustainable development.*

1. Introduction

Wetlands have always been a very important source of biodiversity and human well-being. Wetlands are particularly essential for sustainable management of water resources, both in terms of quality and quantitative terms. Coastal wetlands are important to help mitigate climate change impacts.

Albanian wetlands represent the most sensitive and important environment of Albania. They are areas of numerous ecological and economic values and uses, as they offer fish and wildlife habitats, support complex food web, absorb water to reduce flooding and storm damage, provide erosion control, improve water quality and in particular provide aesthetic value. It is estimated that

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coastal lagoons, as specific ecosystems between land and sea, are the most productive aquatic ecosystems.

Albania is one of the Mediterranean countries where until the 1940s, wetland ecosystems were formed by a very rich and coherent network of wetlands. In the early 1950s, Albanian's coastal area included 250,000 ha of natural area, of which 60,000 ha were swamps (Gjiknuri and Peja 1992). After the 1950s, Albanian wetlands were profoundly changed through the promotion of a bog reclaiming scheme and the expansion of agricultural land against coastal forest lands. More than 50% of coastal wetlands and most of the inland marsh areas were lost due to the development of drainage projects. These actions resulted in (i) loss and fragmentation of habitats and (ii) habitat degradation and poverty of flora and fauna.
In Albania there are 5 separate types of wetlands for the origin of their formation and function. They cover about 90,000 ha or 3.2% of the national territory. The largest area is covered by hydropower lakes followed by natural lakes (tectonics, glacial, karst) and coastal lagoon systems. Less than 3.2% of the national territory are home to more than 70% of the country's vertebrates, especially birds, reptiles and mammals. About 65 of the wetland vertebrates have been identified as globally threatened species.
Currently, the preservation of these environments depends on human intervention and the correct selection of management strategies. Most of the wetlands are included in the national system of protected areas. At least four wetlands (Lake Shkodra and Buna River, Karavasta Lagoon, Prespa Lake and Lake of Butrint, are known as Ramsar area (wetlands of international importance)).

2. Material and method

The overall objective of this study is to contribute to the preservation of wetlands with high ecological values in Albania, through the promotion of good, effective and equitable governance. To this end, the quality of governance assessment was conducted in four protected wetland areas (RNM Liqeni i Shkodra, NNM Kune Vain, PK Divjake-Karavasta, PK Prespa).

These areas represent a variety of wetland ecosystems (coastal lagoons, inland lakes). They are located in four different regions (Shkodra, Lezha, Fier and Korça) and include territories of several municipalities (the main ones include Shkodra, Lezha, Divjaka and Pustec). They are close to some important urban areas (the city of Shkodra and Lezha, and the city of Divjaka) and include within their borders a significant number of villages.

Three of the selected areas are designated as RAMSAR zones for their importance in hosting important species of aquatic birds. All areas are identified as part of the Emerald network and included in the list of potential

areas of conservation interest as part of the Natura 2000 network in Albania. All areas are known as Important Bird Areas. Prespa National Park has also been declared as a Cross-Border Biosphere Reserve.

All selected areas are shaped by human interaction with nature and in addition to preserving important biodiversity values provide useful services in support of local livelihoods. Improving governance and proper implementation of the management plan through better coordination and cooperation of the various stakeholders will promote sustainable development without jeopardizing biodiversity values.

Although declared as protected areas, all four selected wetland areas are facing different threats. Lake Shkodra is suffering from solid waste and sewer discharge as well as fishing and illegal hunting. The Kune Vain Managed Nature Reserve is suffering from abusive intrusion into riverbeds and uncontrolled urban and tourist development. Divjake - Karavasta National Park is suffering from unsustainable fishing and increased pollution due to intensive agriculture. Prespa National Park has problems with illegal forest logging and unsustainable fishing. All areas have problems in limited knowledge and awareness on the issues of wetland area management.

The Regional Administration of Protected Areas (RAPA) is unable, alone, to cope with all the threats the areas face and to deal with them properly as this requires strong cooperation with other authorities (municipalities, fishing groups, farmers, water management authorities) and better communication and support from local communities. All wetland areas selected as pilot zones have been identified as managed protected areas and already have their own management plans. However, the implementation of the management plan itself is hampered by governance issues.

Governance is related to all-inclusiveness, the unification of interests and numerous sectors of society, around a real or virtual table to achieve the common vision. Without good, efficient and equitable governance, best management efforts can be wasted, successes can be short-term, and progress slow or even negative.

> *Governance – who holds the authority and responsibility de facto to make and implement decisions, how they are made, how effective, effective and accountable they are.*

Governance is about politics (aims expressed and supported by power) and practice (direct actions of people who influence nature). In theory, politics and practice should work in harmony; Policy guides practice and practice in return informs policy. The government is not just a government-run process. Smart governance guarantees appropriate social and economic use of natural

resources and ecological services, biodiversity conservation and the proper functioning of ecosystems within ambitious but operationally realistic frameworks.

The main elements that the quality of government should be assessed are:

(i) *Framework - the preconditions required to successfully implement the plan of action:* The preconditions required for the successful implementation of an area action plan. In general, these serve as governance objectives by taking care of whether governance structures are put in place, whether groups of users impacted by a program's actions understand and support management goals and measures.

(ii) *Strategy - leading to changes in behavior during implementation:* Targets behavioral changes that occur during implementation. Changes in behavior of targeted groups of users, changes in behavior of key institutions and changes in how and where financial investments are carried out. These are mainly related to capacity building and the development of a programme of action.

(iii) *Change Agenda - measures results and benefits through delivering the action plan:* Measures practical outcomes and benefits through action plan p.sh., improved water quality, financial investments and motivating stakeholders and institutions to make the behavioral changes required to achieve successful governance.

(iv) *Common Vision - the appropriate balance between environment and human society – sustainable development:* The right and accepted balance between natural resource conservation and socio-economic development. Common goals towards sustainable development.

Governance, which also has the opportunity to learn, develop and fulfill its role and responsibilities in a meticulous, smart, appropriate and satisfactory way for all parties involved, is vital and appropriate. The concept of vitality and adaptability focuses on five simple but rather qualitative questions which are defined below.

1. Is the government conscious and self-directed, able to guide and respond to environmental conditions, the emergence of problems and opportunities; Is it self-disciplined and self-criticism, able to take on responsibilities effectively and independently?
2. Does the government make decisions that find important implementation? Is it motivated by the common good and solidarity? Does it offer to promote the engagement of as many relevant stakeholders of society as possible?
3. Is governance resilient, reflective and committed to the exchange of knowledge, dialogue and debate, able to learn from experience, able to balance opportunities and make quick and important decisions?

4. Is the government open to new ideas, able to reinvent and renew as it does with a living organism, ensuring innovative choices, supporting the emergent new rules and norms, responding positively to change and continuing to evolve?
5. Are there sufficient, important and systemic interactions with the presence of a range of actors of different levels of society and sectors (including actors who properly convey decisions through political, social and financial support)?

The Management Committee3 for Protected Areas is seen as a useful governance tool to address such issues of coordination and cooperation. The Management Committee (COM) for protected areas is the forum appropriately designed to address some of these governance issues. The Management Committee gathers all stakeholders and is charged to support the implementation of the protected areas management plan. However, the functioning of The CoM is not yet up to its expected role. The capacities and understanding of the members of the Management Committee as well as the capacities and engagement of RAPAs are not at the same level throughout Albania.

Focusing on governance, the assessment will help RAPAs, as well as other stakeholders, understand their role and importance in addressing these issues to the benefit of improving nature conservation and support for sustainable local development.

The Mediterranean Coastal Wetland Governance Manual provides guidance on how to achieve this common vision for each wetland area and how to move forward effectively in partnership with all local stakeholders. The use of the Self-Assessment Tool4 from the Governance Manual helps identify potential governance issues and facilitates discussion with appropriate authorities to address them, ensure proper implementation of the management plan and preserve biodiversity and ecosystems. This toolkit outlines a process for integrated assessment, providing methods to explore the connections between biodiversity, economics, and livelihoods in wetlands. It aims to identify and address conflicts between conservation and development goals. The toolkit enables practitioners to evaluate wetlands based on their combined biodiversity, economic, and livelihood values, with a strong focus on pro-poor wetland management. By addressing current gaps in wetland assessment methodologies and information, it helps incorporate wetland values into decision-making and management planning for conservation and

[3] Established since 2019, following the government's decision to establish Management Engagements for Protected Areas

[4] From the Mediterranean coastal wetland of governance manual (https://medwet.org/wp-content/uploads/2019/12/Mediterranean-Coastal-Wetlands-Governance-Handbook.pdf)

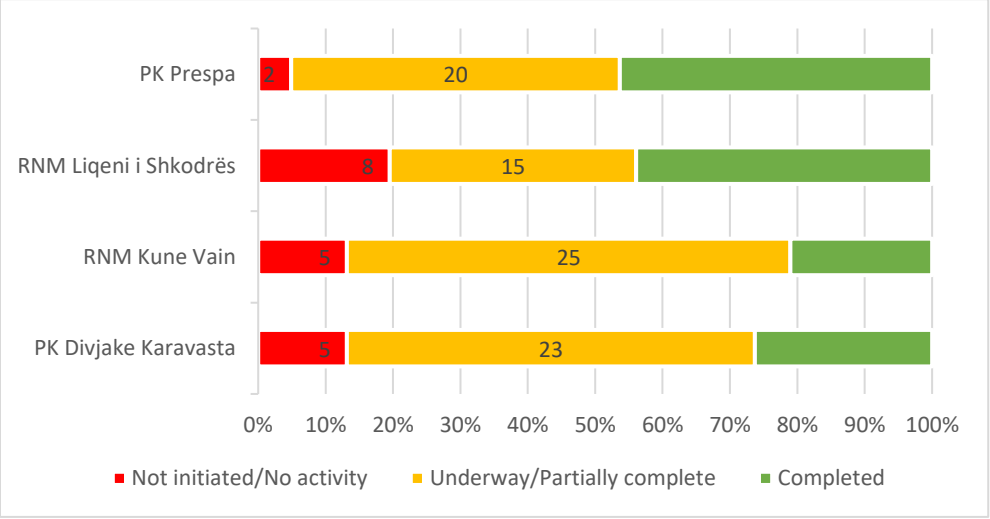
development. The toolkit is versatile, applicable to various types and scales of wetlands. Although not primarily designed as a village development planning tool, it can be adapted to provide necessary information for such planning processes.

The evaluation process was conducted during a workshop in each of the four areas for supplementing the self-assessment instrument with the participation of RAPA staff and key stakeholders for assessing the governance situation in each pilot area.

3. Results and discussions

The evaluation instrument is divided into three parts and includes: Rapid Assessment; Assessment of Adequacy and Vitality, Detailed Assessment. The rapid assessment is completed based on the preliminary feedback of the evaluation team and without being in depth in supporting documents or supplemental arguments for the results given.

The results show a similar situation in PK Divjake Karavasta and RNM Kune Vain where only 21-26% of governance issues have been addressed so far. These results are presented in chart 1. The situation is somewhat better in RNM Lake Shkodra and PK Prespa where 44-46% of the issues are addressed. However, RNM Lake Shkodra has a considerable number of issues addressing which has not yet begun.



Graph 1. Rapid assessment results

The Adaptability and Vitality Assessment (graph 2) shows that all four selected areas are on track towards ensuring good governance, although results

fluctuate from 58/100 for Divjake Karavasta National Park to 74/100 for Prespa National Park.

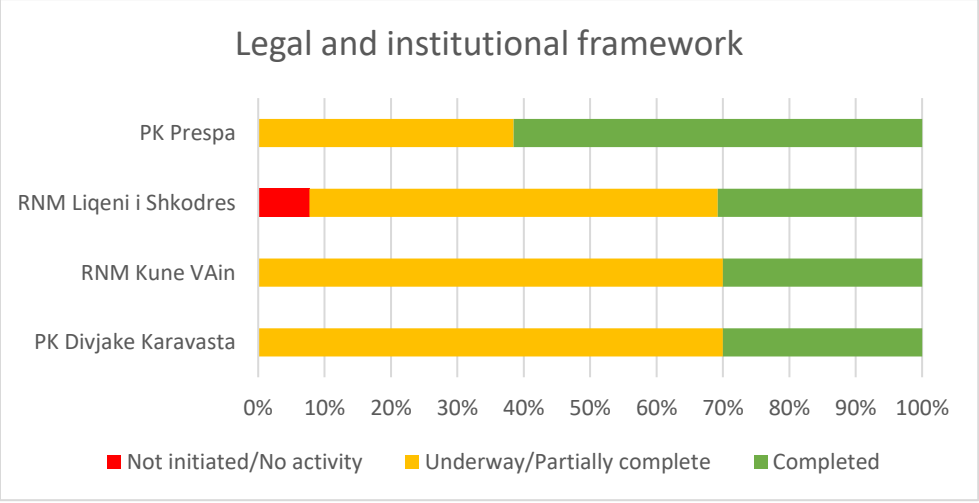
Elements of evaluation	PK Divjake Karavasta					RNM Kune Vain				
	Power	Ingeniousness	Eligibility	Creativity	All-Inclusive	Power	Ingeniousness	Eligibility	Creativity	All-Inclusive
Formal structure of government	1	1	1	1	3	2	3	2	2	4
The area management staff...	1	3	3	3	4	3	3	3	2	3
Leading actresses...	2	2	3	3	2	2	2	2	3	3
Partner institutions....	2	2	3	3	2	2	3	3	2	3
The area management plan...	3	3	2	3	3	2	2	2	2	3
TOTAL (maximum 100)	58					63				

Elements of evaluation	RNM Shkodra Lake					PK Prespa				
	Power	Ingeniousness	Eligibility	Creativity	All-Inclusive	Power	Ingeniousness	Eligibility	Creativity	All-Inclusive
Formal structure of government	3	3	3	2	3	2	2	2	3	4
The area management staff...	2	3	3	3	3	2	4	4	4	3
Leading actresses...	3	3	2	2	2	2	1	3	3	3
Partner institutions....	3	3	3	2	3	2	3	4	3	3
The area management plan...	2	2	2	2	2	3	4	3	3	4
TOTAL (maximum 100)	64					74				

Graph 2. Vitality and Adaptability

The issues that need to be improved are mainly related to key stakeholders and partner institutions, especially smart, adaptive and creative management. The management plan should also be a living instrument that is constantly updated and updated to reflect new knowledge and problems in the natural resource management of the area.

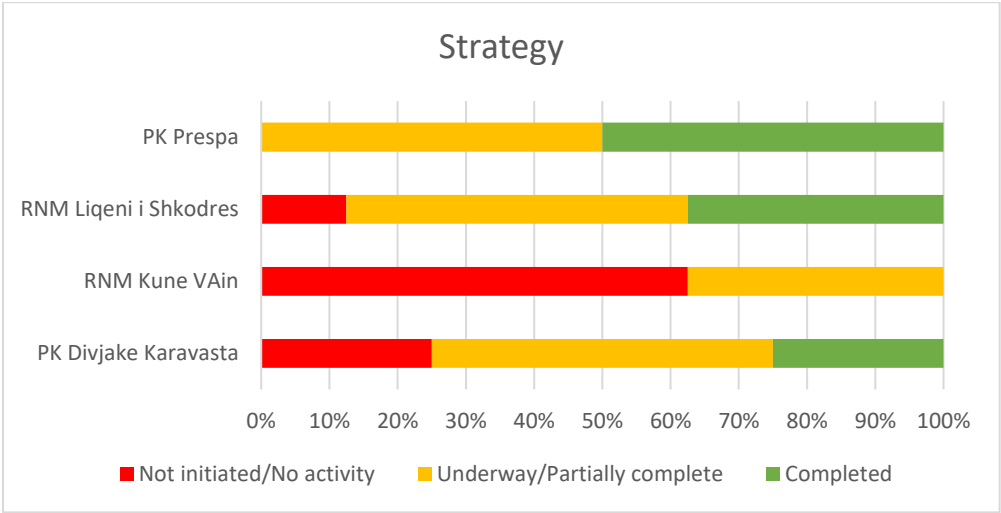
The legal and institutional framework (graph 3) necessary to guarantee good governance is largely partially completed or concluded. The Prespa PK has the best result in this element of governance. The governance structure (Management Committee) is officially established, and its operating regulation has been adopted. However, there are still issues related to identifying and evaluating the interests and influences of all interested stakeholders. Although the National Agency for Protected Areas (NAPA) provides substantial funding for management (area control, limited monitoring), there is no adequate budget to provide for full monitoring of biodiversity elements and no funding for conservation measures. Institutions responsible for protected areas understand and support its objectives and cooperate in their realization. Users and the local community understand and support the purposes of the protected area. However, some conflicting interests (development versus conservation), as well as overlapping of authorities and limited resources of both stakeholders and institutions prevent full cooperation and support of management objectives.



Graph 3. Legal and institutional framework

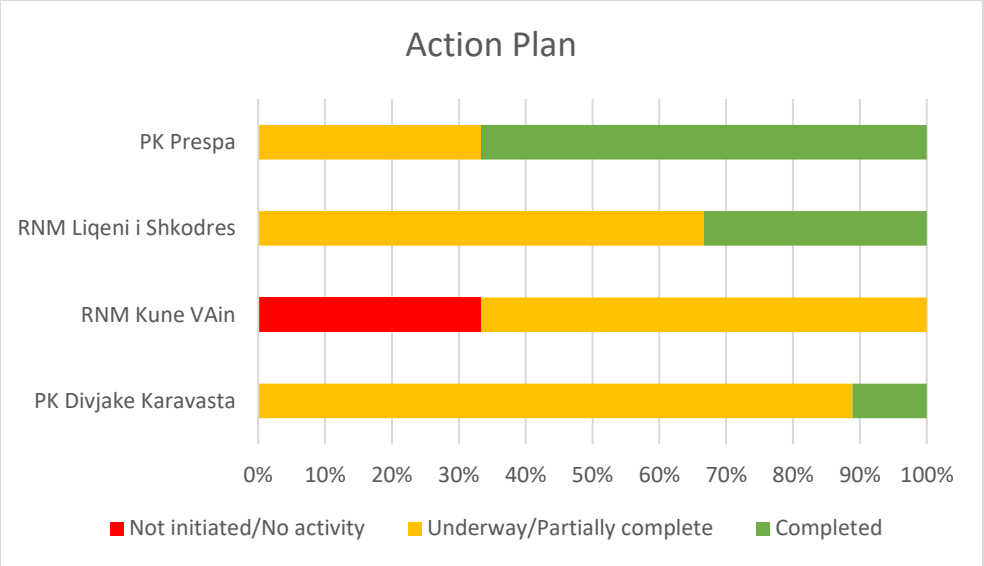
Governance is not entirely linked through recognition and mutual representation within other governance structures that relate to wider territories and beyond protected areas. The only actions that have not started in RNM Lake Shkodra are related to cross-border cooperation. Although there are policies that enable common governance of cross-border areas, there are no effective joint governance regimes in place for cross-border wetlands. This is due to the authorities' intermittent commitment to cross-border joint governance and lack of adequate funding.

In terms of *strategy* (graph 4) that leads to changes in behavior during the results are different according to areas. Prespa National Park is more advanced in this regard, while RNM Kune Vain still has many issues that have not yet begun to be addressed. Key environmental, social and institutional issues and risks are identified and documented in the management plan. However, it is necessary to identify data sources or conduct research to complete the assessment of some basic conditions (the spread of habitats and species). Although there are several studies in this area, there is no coordination of research efforts and no lists of research priorities developed by governing bodies. Management plans have identified SMART objectives, as well as have an action plan that identifies institutional responsibilities and financial means. However, lack of funding and limited capacity hinders the implementation of these measures. Although some monitoring activities are in place, there is no agreed and resourced monitoring program. Lack of funding and limited staff expertise also affect the lack of effectiveness in controlling the territory and preventing illegal activities.



Graph 4, Change strategy

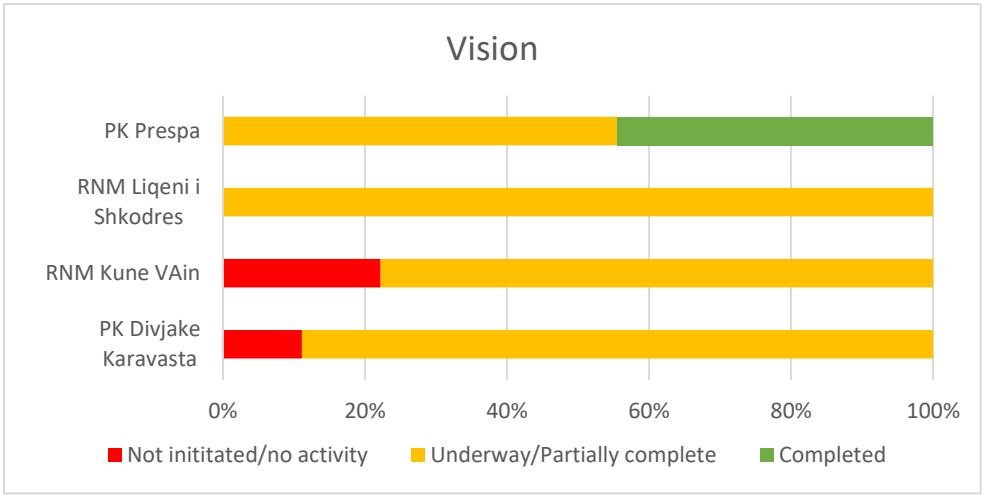
Regarding the *Action Plan for Good Governance* (graph 5) the results show a good performance for NP Prespa and RNM Liqeni i Shkodra, where most issues are addressed or being addressed. The situation is even worse for the other two areas. Although the management plan is officially approved by the Ministry of Tourism and Environment and implemented in accordance with priorities set through budgets allocated by the NAPA, inadequate funding and personnel capacities limit the proper implementation of this plan. Through donor funding some RAPAs are implementing pilot actions to test capacity, promote partnership work and help provide support and public awareness.



Graph 5. Action plan

In general, national, regional and local policies as well as spatial plans align with the needs and goals of protected areas. However, there are still some conflicting development interests (tourism). RAPAs are using the Management Effectiveness Tracking Tool (METT) to monitor the effectiveness of managing protected areas. Given the lack of funding and staff capacities, the adaptive management approach is used to address urgent issues and resolve situations as they occur. Various donor-funded projects are supporting RAPAs in collaboration with other stakeholders to implement some activities that support changing the behavior of key stakeholders. In general, management activities support the status of favorable conservation of biodiversity values although there is limited funding for conservation measures and no proper monitoring of conservation status.

In relation to the *Common Vision* (graphic 6) – the results mainly indicate activities in progress or partially completed. Overall, the behaviors of key partners align with management and action plans. There is limited monitoring and interpretation of social trends and ecosystem development. Some investments in the necessary physical infrastructure have been made although more funding is needed.



Graph 6. Vision

The achievement of the goals is generally documented in reports submitted to the NAPA. Stakeholders participate in the management of the area although in some cases overlapping interests/tasks. As already mentioned, basic funding is provided by the NAPA on an annual basis. However, there is no long-term, sustainable financial support, and management's long-term financial needs have not been identified. In the Prespa, the mid-term review of the management plan has been completed. The results of the review will be used to adjust priorities and policies to reflect the experience and changing social/environmental conditions. Mid-term review of the management plan allows new identified issues or areas to be included in the revised management plan.

4. Conclusions and recommendations

The evaluation instrument is an important tool for capacity building and raising awareness of various stakeholders on their role in managing and preserving protected wetland areas. We hope this will bring about a behavioral change on issues related to illegal activities (illegal fishing, poaching) and environmental quality (water pollution, waste management). The assessment promotes the important role and values of the wetlands and helps improve the community's sense of ownership and pride in these values.

Practitioners of this assessment tool are key stakeholders responsible for and managing wetlands. They apply the self-assessment methodology to first assess baseline conditions and then monitor changes in those conditions across a wide range of ecosystem types, including all wetland types, but also important species types and habitats found in wetlands. The assessment aims to improve the measurement of ecological integrity, providing critical

information needed to restore natural ecosystem patterns and processes in order to conserve species and the ecosystem services that depend on them.

The experience and capacities created during the implementation of this instrument can be easily used by RAPAs to continue the participatory management process and to address governance issues in the future. The tools tested during the evaluation can be used as a basis by RAPAs and other stakeholders in the future.

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Natura 2000 sites - A model for the protection of natural values

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Abstract

The Wild Bird and Habitat Directives play a vital role in European conservation, overseeing the protection of endangered species and habitats through the Natura 2000 network. Albania has identified preliminary Natura 2000 zones to present to the European Commission. The "Innovative Approach for Identification of Natura 2000 Zones" pilot project in Shkodra Lake, Vlora Bay, and Shebenik National Park helped pinpoint potential areas and fostered conditions for sustainable management through stakeholder dialogue. This process, essential for evaluating and analysing natural values, threats, current and potential pressures, and conservation measures, highlighted issues such as unreliable data on wildlife habitats and species and insufficient monitoring of natural resource use. A biodiversity conservation conceptual model links natural values to socio-economic sectors, outlining the benefits of healthy habitats and the necessary measures for their preservation. Comprehensive management of natural values associated with specific vegetation or habitats is ensured through the identification of the users and activities that benefit from these natural values. This approach is crucial for determining the most appropriate boundaries for Natura 2000 areas, based solely on ecological values.

Keywords: *Natura 2000, conservation of habitats and species, sustainable development, conceptual model.*

1. Introduction

The Wild Bird and Habitat Directives are fundamental to Europe's conservation initiatives. These critical directives govern the protection of the continent's most significant and endangered species and habitats, ensuring their preservation through the establishment and proper management of a network of protected areas, collectively known as the Natura 2000 network. The implementation of the Natura 2000 network is the most important nature conservation effort in Europe, forming the world's largest network of protected areas. Good natura 2000 area management practices strengthen the links between natural and cultural heritage in the EU and create additional opportunities for economic activities that use natural resources (environmental

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tourism, outdoor activities, promotion of local products, etc.) and create new jobs and additional income for residents of the area.

The selection of areas to be included in the Natura 2000 network is a shared responsibility between the new EU Member States and the European Commission and it is based exclusively on scientific criteria (i.e. population size and target species density, area and ecological quality of the species of target habitat present in the area). Albania has prepared an initial list of Natura 2000 zones across the country, which will be submitted to the European Commission. This step aids in aligning the nation's regulatory framework with the EU's environmental regulations.

2. Methodology

Implementing the "Innovative Approach to Identifying Natura 2000 Zones" in the three pilot zones proved to be a positive experience. This initiative not only streamlined the process of identifying potential Natura 2000 areas but also established the necessary conditions and tools for fostering and maintaining a constructive dialogue among various stakeholders. This collaboration aims to ensure sustainable management of the area's natural values, preserving vital habitats and species.

The assessment has revealed several deficiencies and challenges in the process of identifying and evaluating natural values. Notably, there is a lack of reliable data on the identification and distribution of critical wildlife habitats and species, including charismatic species. Also, the good work that has started in identifying and inventorying and monitoring these species should continue in the future by expanding the list of species and constantly updating existing databases (BIONNA, WiMS). Additionally, there is a lack of monitoring data on natural resource utilization activities, complicating the assessment of their impact on the conservation status of natural values.

On the other hand, much work remains to be done in consolidating and engaging the wider stakeholders in the socio-economic development of these areas, in the process of managing natural resources to ensure long-term conservation of biodiversity values. Generally, groups of natural resource lore (farmers, fishermen, tour operators, local authorities) are unorganized and difficult to represent in discussion forums on sustainable use and conservation of natural resources. Also, civil society, in general, lacks the necessary capacities and skills to mobilize and represent worthily all level and interest groups in local communities around protected areas.

To enhance understanding of the relationships between natural values, users, benefits, activities, and potential risks that threaten these values, a conceptual model for biodiversity conservation and sustainable development has been developed. This model connects natural values (such as habitats and species) to socio-economic sectors (including agriculture, livelihood, forestry,

fisheries, tourism, and infrastructure). It illustrates how the preservation of well-functioning habitats can generate benefits for sustainable development and identifies the necessary measures to maintain these benefits. Additionally, stakeholders and activities that benefit from specific vegetation or habitats have been identified. This approach is crucial for accurately delineating the Natura 2000 area's boundaries, ensuring that important elements are integrated into the area assessment criteria, which should be based solely on ecological values as defined by the Habitats Directive.

3. Results and discussions

3.1. Shkodra Lake

Based on the results of the analysis of values and threats for the Area of Shkodra Lake, we would propose four separate areas to be announced as part of the Natura 2000 network.

The first and largest area on the surface includes the central and northwestern part of Lake Shkodra. This area includes environments suitable for the conservation of many species of fish and aquatic birds, and as such will be proposed as spa (Bird Directive) and SCI (Habitat Directive). The proposed area has an approximate area of 6,942 ha.

The second area includes the lakeshore habitats in the northern part of the lake, which includes some important community habitats, which are also important for the breeding of some fish species in the area. The proposed area has an approximate area of 3,677 ha. The third area includes meadows and lakeshore habitats in the southeastern part of the lake, near the city of Shkodra, which are also important both for some fish species and for the aquatic birds that populate the lake. The area of this proposed area is 1,225 ha.

The fourth area lies mainly along Mount Tarabosh and includes separate paschal and rocky habitats listed in the annexes of the Habitats Directive. This area may also include part of the lake shore near the village of Zogaj, which presents high natural values. The approximate area of this area is 1,543 ha.

Of the four areas proposed to be included in the Natura 2000 network, the third and fourth zones have more areas where the conflict between preserving natural values and their use by local communities is high. However, if we excluded these areas from the area proposed for Natura 2000, we will lose the opportunity of preserving some very specific and important habitats (inshore and mountain habitats) that are used by large and diverse numbers of wildlife.

However, given the type and nature of the activities or threats analyzed, we assess that careful engagement and better control of the territory by the administration of protected areas and a better awareness of the inhabitants of

the important values of the area would contribute significantly to the reduction of conflicts and to ensure the preservation of natural values.

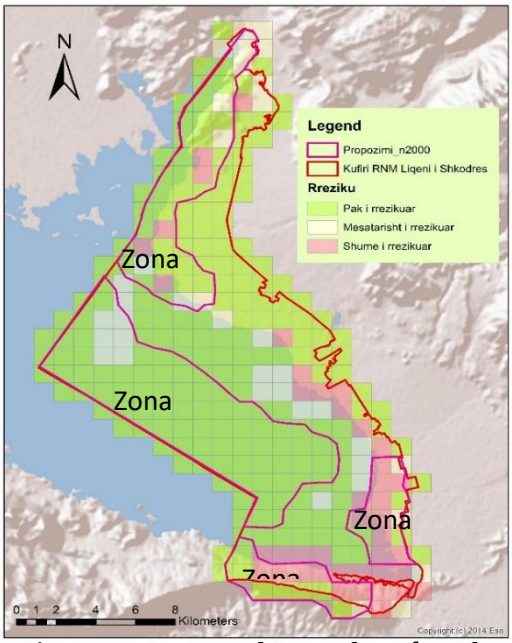

Figure 1. Proposed Boundary for The Natura 2000 Area with Conflict Areas

3.2. Shebenik National Park

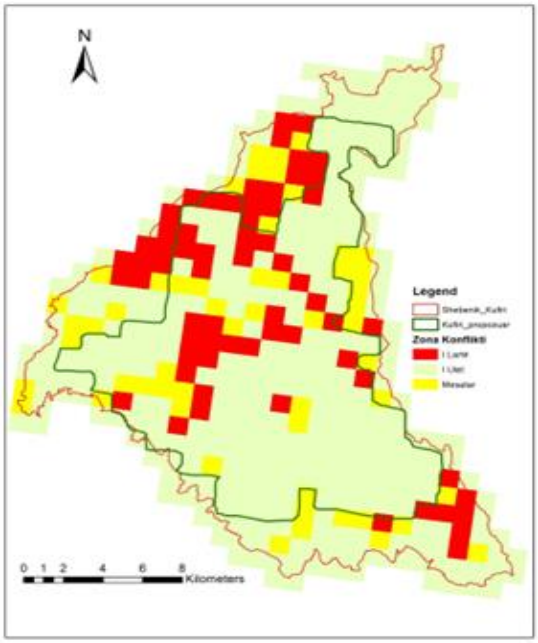

Figure 2: Proposed Boundary for The Natura 2000 Area with Conflict Areas

The proposed limit for the Natura 2000 area only takes into account surfaces classified as most suitable for incorporation into the Natura 2000 area, as they have high natural values and are not significantly threatened by human activities or other uses of natural resources. The proposed area would be entirely within the Shebenik National Park and will have a total area of 21,732.57 ha.

The proposed limit includes 34 high-conflicted frames, which means that they have high natural values but at the same time are areas used by residents for various economic activities. If we excluded these areas from the area proposed for Natura

2000, the area would not only be reduced by about 3400 ha, but the protected area would have a limit far from normal and a form that makes it very difficult to normally manage its natural values. For this reason, it is necessary to work to mitigate conflicts between the preservation of natural values and their use by the inhabitants.

In a broader look, even the proposal that the current park boundary be the same as the proposed Nature 2000 area may be acceptable, as most territories to be included in the Natura 2000 area are classified as moderately suitable. In this case, the management of the Natura 2000 area would require closer cooperation with stakeholders and specifically with natural resource users in the area to minimize the impact of their activities on the area's natural values by guaranteeing favorable conservation status for important species and habitats.

3.3. Vlora Bay (Sazan Karaburun Marine National Park)

Considering the areas classified as most suitable for nature conservation, as they have high natural values and are not significantly threatened by human activities or other uses of natural resources, in the Vlora Bay area we can identify three suitable areas to be included in the Natura 2000 network.

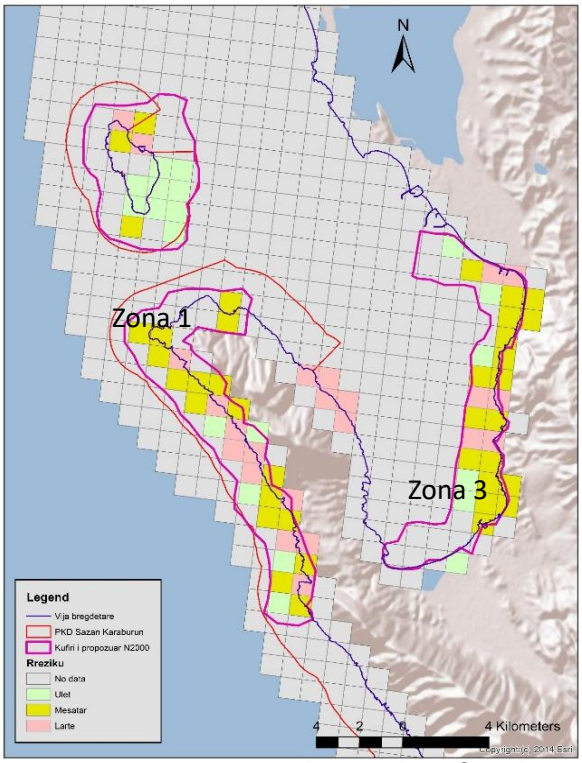

Figure 3. Proposed Boundary for The Natura 2000 Area with Conflict Areas

The first proposed area coincides with the Sazan-Karaburun Marine National Park, although it does not cover the entire western coast of Karaburun. The area of this area is 4'402.25 ha. The second area also coincides with the Marine Park as it includes the entire coastal part around Sazan Island. This area has an area of 3,669.58 ha. The third area lies in the inland Gulf of Vlora and includes the entire coastline from Vlora to Radhima to Orikum and has a total area of 3,177.02 ha.

The three areas proposed for the Natura 2000 network include territories classified as high or medium conflict, especially areas in the western part of Karaburun and that in the interior of Vlora Bay. For this reason, it is necessary to work to mitigate conflicts between the preservation of natural values and their use by the inhabitants.

In this case, the management of the Natura 2000 area would require closer cooperation with stakeholders and specifically with natural resource users in the area to minimize the impact of their activities on the area's natural values by guaranteeing favorable conservation status for important species and habitats. It remains worrying that almost half of the area of the study area has no data either for natural values or for activities that are carried out in it related to the use of natural resources.

4. Conclusions

The experience created during the implementation of this methodology again highlighted the difficulty of correctly implementing the participant processes in Albania and the hard work that still needs to be done, not only for informing and raising awareness of different stakeholders, but also for promoting their sense of representation and creating the necessary capacities for active participation in the good governance of natural resources. Simultaneously, it is crucial to collaborate with government institutions, both at central and local levels, to enhance cooperation and establish inclusive mechanisms in decision-making processes concerning natural resource management and governance.

The process of identifying and analyzing natural values, as well as the threats and pressures they face, is crucial for understanding the conservation measures and activities needed in the area. Engaging all interested parties in this process enhances efforts to preserve the natural heritage, both locally and on a national and international scale.

Based on the above conclusions, for correct application of the proposed methodology, we can recommend the following:

- The Innovative Approach to Identifying Natura 2000 Zones is used as a standard approach to the entire process of identifying and evaluating proposed areas as part of the Natura 2000 network in Albania.
- Support the scientific research work of universities and other research groups, in particular in the collection and deepening of knowledge concerning the identification and cartography of habitats and areas of the spread of species of conservation importance, listed in the annexes of the Habitats Directive and the Bird Directive.
- To work more towards information and education of various stakeholders regarding the concepts of the Natura 2000 network.

- To work to strengthen the capacities of local stakeholders' groups and improve their representation.

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Climate Variability in the Durmitor Region, Montenegro: A 30-year of Research

Gordana JOVANOVIC[1]

Abstract

The focus of this article is on climate variability in the massif of Durmitor, Montenegro, in the period (1991-2020). Data from three meteorological stations: Žabljak, Šavnik and Nikšić were used. Climatic variables such as the amount of precipitation and temperature are analyzed in two semi-annual periods, from November to April and from May to October. The influence of the North Atlantic Oscillation (NAO), measured by positive or negative NAO index, on these climatic variables is studied. It is shown that the changes in precipitation and temperature are much more pronounced in the winter part of the year (November-April) than in the summer part of the year (May-October). This is primarily reflected in the increasing trend of average precipitation and temperature in the whole Durmitor region for (November-April). The reduction in the size of the Debeli Namet glacier was used to illustrate the constant rise in temperature over the observed 30-year period.

Keywords: *climate variability, NAO, precipitation, temperature, Durmitor.*

Jel code: Q51, Q54

1. Introduction

Climate change is generally believed to lead to an increase in climate variability and in the frequency and intensity of extreme events (Hughes, 2008; Cattiaux et al., 2010; Seager et al., 2010; Colluci et al., 2017; Hofstätter et al., 2018; Huss et al., 2017; Sommer et al., 2020; Burić et al., 2020; Rousi et al., 2023). The consequences of these events are visible all over the world and are often called the climate crisis. Scientists debate the natural and anthropogenic causes of this crisis and the potential for natural climate drivers to mitigate anthropogenic footprints in future twenty-first-century climate developments (Marsh, 2014; Singh & Bhargawa, 2020; Spiegl & Langematz, 2020; Zharkova, 2020). It is important to study changes in the frequency of extreme events (related to temperature and precipitation), because such kinds of events are known to be a serious threat to human health, ecosystems and the economy (Giorgi, 2006; Loarie et al., 2009; Sandel et al., 2011). In Europe, pronounced summer (June-August) warming of approximately 1.3°C was

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recorded in the period (1986-2015) (Luterbacher et al., 2004; Schär et al., 2004; Della-Marta et al., 2007; García-Herrera et al., 2010; Barriopedro et al., 2011; Rahmstorf & Coumou, 2011; Field et al., 2012; Beniston, 2015; Russo et al., 2015). Also, in the summer of 2018, a persistent high-pressure anomaly over Scandinavia caused high temperature and drought anomalies in Northern Europe from May to July, while Southern Europe was unusually wet (Yiou et al., 2020; Bakke et al., 2020; Wilcke et al., 2020; Peters et al., 2020).

The increase in the air temperature, from the so-called period of the Little Ice Age (AD 1300-AD 1850) to the present, has caused the disappearance of glaciers in many parts of the world (Grunewald & Scheithauer, 2010; Huss & Fischer, 2016; Hughes, 2018; Gachev, 2020). Montenegro has also been exposed to climate change, especially at the end of the 20th and at the beginning of the 21st century (Hughes, 2008; Gachev & Mitkov, 2019; Knez et al., 2022; Burić & Doderović, 2022). The consequences are hot summers, lack of precipitation, low water levels of rivers and lakes, forest fires. In this paper we study the climate change in the Durmitor region in the last 30 years. We analyze the climate variables such as the amount of precipitation and temperature in the winter part of the year (November-April) and in the summer part of the year (May-October).

The recorded fluctuation of temperature and precipitation, especially in the winter part of the year, motivated this research. This fluctuation is the most pronounced in the amount of snowfall in December/January. Also, the mountain Durmitor is a national park in Montenegro and as such is the least susceptible to human influence. Therefore, it is convenient for the study of the natural causes of climate variability. One of them is the North Atlantic Oscillation, the leading climate factor in the North Hemisphere (Scaife et al., 2008; Herceg-Bulić & Kucharski, 2014; Rousi et al., 2020). It is the inter-annually varying pressure gradient between the Icelandic low and Azores high pressure systems. The North Atlantic Oscillation (NAO) has been found to influence rainfall amounts, especially in winter, in the north-western Mediterranean and, more remotely, in the eastern Mediterranean. The NAO influence is measured by the NAO index (Hurrell & Deser, 2010).

A relatively strong pressure gradient between the Azores high and the Icelandic low yields a positive NAO index (NAO+) while a relatively weak gradient yields a negative NAO index (NAO-)(Polonsky et al., 2004; Li & Wang, 2003; Woodward, 2009; Mu et al., 2022).

During NAO+ warmer conditions in northern and central Europe and cooler conditions over the Mediterranean are recorded. This NAO+ phase also leads to a decrease in precipitation over the Mediterranean and Southern Europe (south of 45°N) and an increase over Northern Europe.

During NAO- warm moist air enters the Mediterranean region and cold air enters northern Europe (Criado-Aldeanueva & Soto-Navarro, 2020; Rousi et al., 2020).

Montenegro is located on the border of these different influences and therefore it is scientifically justified to analyze the NAO effect on the climate variables especially in the northern part of Montenegro where the Durmitor Mountain is located. The size of the Debeli Namet glacier, the only current Durmitor glacier, will be used as an illustration of climate variability in the Durmitor massif.

It has been suggested that El Niño and La Niña events may affect Mediterranean climates. The Walker circulation is an east–west atmospheric circulation pattern of rising air above Indonesia and the western Pacific and sinking air above the eastern Pacific. Under normal conditions, Indonesia is wet and the eastern Pacific is dry. During El Niño events there is a weakening of the Walker circulation. During La Niña events the Walker circulation is especially strong. The effects of an El Niño period are directly linked to areas within the Pacific basin, causing droughts over Indonesia and intense rainfall events, flooding, and landslides in Peru. More importantly, its influence on seasonal weather conditions has been detected as far away as India, Africa, Antarctica, and North America (Bromwich et al. 2000). In the eastern Mediterranean there is some evidence that El Niño events are positively correlated with winter rainfall (Kadioglu et al. 1999; Price et al. 1998). Other relationships between Mediterranean weather conditions and El Niño/La Niña events have been suggested, but these are generally weak or impermanent.

2. Durmitor National Park, Montenegro

Montenegro is in the middle part of the temperate zone of the northern hemisphere with a latitude between 42°52’ N and 43°32’ N and longitude between 18°26’ E and 19°22’ E. Durmitor is a limestone massif located in the northwestern part of Montenegro and belonging to the Dinaric Alps or Dinarides. It is characterized by high peaks, abundant forests, and deep gorges. On September 6th 1952, the Assembly of the Republic of Montenegro proclaimed the mountain Durmitor as National Park. The Assembly of the Socialist Republic of Montenegro broadened National Park Durmitor with a canyon of Tara on February 3rd, 1978.

Durmitor National Park is located in a wide mountain region (Figure 1). It includes the Durmitor mountain massif, the canyons of the Tara, Draga, and Sušica rivers, and part of the Komarnica Canyon valley. There are 48 mountain peaks that are over 2,000 m a. s. l. One of them is Bobotov kuk, the highest peak in Montenegro with 2,522 m a. s .l. (Djurović et al., 2010). The Park covers an area of 34,500 ha and is known for its 18 glacial lakes -“mountain

eyes". The largest and the most famous is Crno jezero (eng. Black Lake). Crno jezero consists of Veliko and Malo jezero, which are connected by a narrow isthmus. The water from Veliko jezero flows into the Tara River and water from Malo jezero flows into the Piva River. This phenomenon represents an exceptional rarity in nature, the so-called bifurcation. The nearby towns are Nikšić, Šavnik and Žabljak, which is in the heart of the Durmitor region. Since 1980 Park and Canyon of Tara are under the protection of UNESCO.

Figure 1. Durmitor Mountains, Montenegro

3. Methods and Results

Weather and climate are different concepts. Weather is related to short-term and small-scale strong fluctuations of the atmosphere conditions (temperature, rain, humidity, etc.) of the planet or of the local region, while the climate regards the long-term average of the same parameters (Scafetta et al., 2017).
Climate variables for the periods (1961-1990) and (1991-2020) in the Durmitor region for cities Nikšić, Šavnik and Žabljak are shown in Table 1 (for precipitation) and Table 2 (for temperatures). Data from Nikšić, Šavnik and Žabljak meteorological stations of the Institute for Hydrometeorology and Seismology of Montenegro for aforementioned periods were used.
Žabljak is located in the middle of the National Park Durmitor but its meteorological station is not completely representative for the climate conditions in the Durmitor massif due to its leeward position to the atmospheric advections from the southwest, which serves as the main sources of precipitation. That is why we consider the stations situated on the windward side, such as Šavnik and Nikšić.
Table 1 shows that the average annual amount of precipitation in Nikšić in two consecutive 30-year periods decreased by about 5% while a small increase in the average annual amount of precipitation (about 0.7%) was recorded in Žabljak in the same periods.

Table 2 shows that the average annual temperatures are constantly increasing in Nikšić and Žabljak. In Nikšić (647 m a. s. l.) the temperature rise is 0.8°C and in Žabljak (1456 m a. s. l.) a temperature rises of about 1.3°C was recorded.
It can be noticed that a city at a lower altitude has a smaller increase in temperature than a city at a higher altitude, which is, in a way, an unexpected situation.

Table 1. The average annual amount of precipitation in two consecutive 30-year periods for Nikšić, Šavnik and Žabljak. There is no data for Šavnik for the period (1961-1990).

Years	Nikšić	Šavnik	Žabljak
(1961-1990)	1990 mm	No data	1494 mm
(1991-2020)	1896 mm	1941 mm	1505 mm

Source: The Institute for Hydrometeorology and Seismology of Montenegro.

Table 2. The average annual temperatures in two consecutive 30-year periods for Nikšić, Šavnik and Žabljak. There is no data for Šavnik for the period (1961-1990).

Years	Nikšić	Šavnik	Žabljak
(1961-1990)	10.7℃	No data	4.6℃
(1991-2020)	11.5℃	9.6℃	5.9℃

Source: The Institute for Hydrometeorology and Seismology of Montenegro.

In the following text, we will apply seasonal analysis and divide the year into two parts - the winter part of the year from November to April and the summer part of the year from May to October (Scafetta, 2021). We will analyze the amount of precipitation and average temperatures in these parts of the year to understand which part of the year has a greater potential for changing climate variables.

3.1. Precipitation data

Amount of precipitation for three cities: Nikšić, Šavnik and Žabljak in the Durmitor region will be presented according to the two semi-annual periods- from November to April (in subsection 3.1.1), and from May to October (in subsection 3.1.2).

3.1.1. Precipitation data for (November-April)

The amount of precipitation for Nikšić, Šavnik and Žabljak for (November-April) in the period (1991-2020) is presented in Figure 2.

The average amount of precipitation for this period in Nikšić is 1261 mm. The years with precipitation, more than 30.0% higher than average, are 2004, 2005, 2010, 2013, and 2018. The highest precipitation was recorded in 2010 and 2013, with an increase of 57.0% and 65.0% respectively in regard to average value. Years with low precipitation, more than 25.0% lower than average, are 1993, 1995, 2002, 2017, and 2019. The lowest precipitation was recorded in 1993 and 2017, with a decrease of 56.0% and 39.0% respectively.

The average amount of precipitation for (November-April) in Šavnik in the period (1991-2020) is 1235 mm. The highest precipitation was recorded in 2010 (46.0% higher than average) and in 2018 (55.0% higher than average). Years with the lowest precipitation are 2000 (33.0% lower than average), 2002 (30.0% lower than average), 2003 (28.0% lower than average), 2007 (31.0% lower than average), 2017, and 2019 with the amount of precipitation about 25.0% lower than average.

In Žabljak, the average amount of precipitation for (November-April) in the 30-year period (1991-2020) is 885 mm. The years with positive deviations concerning the average amount of precipitation are 2010 (40.0% higher than average), 2011 (48.0% higher than average), 2013 (34.0% higher than average), and 2018 (56.0% higher than average). The years with negative deviations, more than 30.0% concerning the average amount of precipitation are 1993 (32.0%), 1995 (33.0%), and 2017 (30.0%).

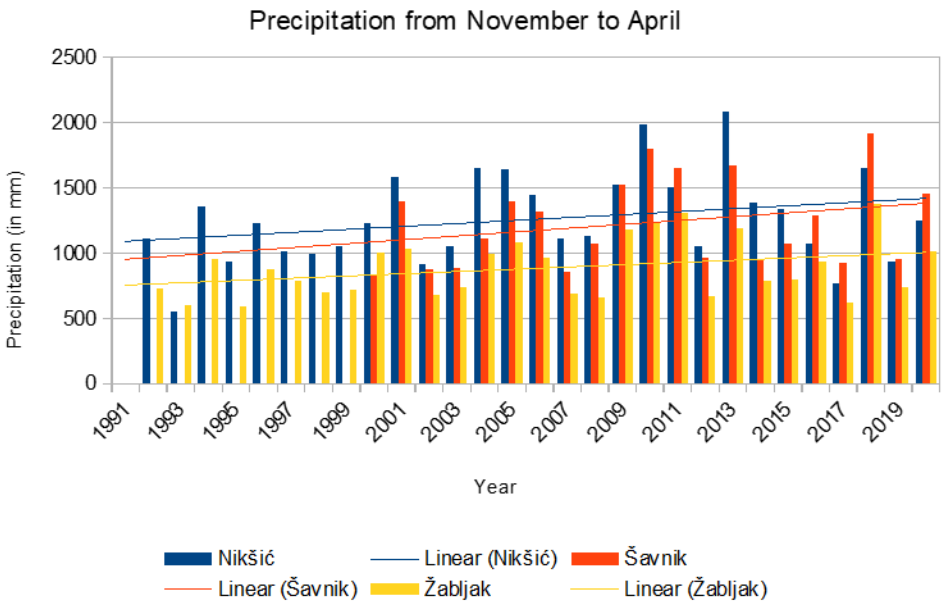

Figure 2. Precipitation from November to April for Nikšić, Šavnik and Žabljak.

3.1.2. Precipitation data for (May-October)

The amount of precipitation for Nikšić, Šavnik and Žabljak for the season (May-October) for the period (1991-2020) is presented in Figure 3.

The average amount of precipitation in this part of the year for Nikšić is 643 mm. The years with positive deviations of more than 30.0% concerning the average amount of precipitation are 1992 (42.0%), 1996 (41.0%), 2002 (47.0%), 2010 (32.0%), 2014 (31.0%), and 2020 (40.0%). The years with negative deviations, more than 30.0% concerning the average amount of precipitation are 1997 (62.0% without data for May), 1999 (36.0%), 2001 (32.0%), 2007 (35.0%), 2011 (32.0%), and 2017 (42.0%).

The average amount of precipitation for Šavnik in (May-October) is 671 mm. The years with the highest amount of precipitation in this period are 2014 (39.0% higher than average), 2016 (26.0% higher than average), and 2020 (38.0% higher than average). There are years with the amount of precipitation lower than average. In 2001 and 2006, the amount of precipitation in Šavnik was 25.0% lower than the average, while in 2011 and 2017 it was 30.0% and 36.0% lower than average respectively.

In Žabljak, the average amount of precipitation for (May-October) in the period (1991-2020) was 627 mm. The largest positive deviations were recorded in the years 1998 (32.0%), 2002 (26.0%), and 2020 (30.0%). The

largest negative deviations are recorded in the years: 1994 (36.0%) and 2017 (30.0%).

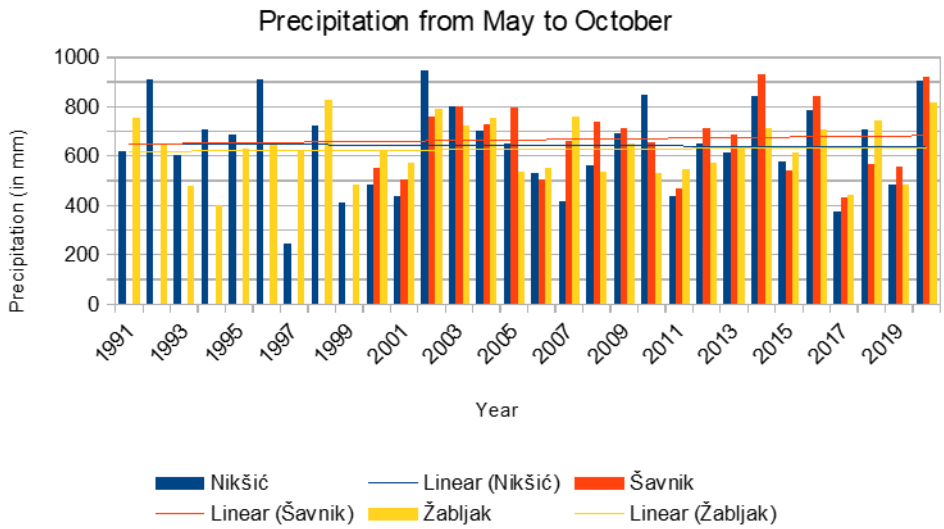

Figure 3. Precipitation from May to October for Nikšić, Šavnik and Žabljak.

3.2. Temperature data

Temperature data for Nikšić, Šavnik and Žabljak in the Durmitor region will be presented according to the two semi-annual periods, from November to April (in subsection 3.2.1) and from May to October (in subsection 3.2.2).

3.2.1. Temperature data for (November-April)

The average temperatures for Nikšić, Šavnik and Žabljak for (November-April) in the period (1991-2020) are presented in Figure 4.

In Nikšić the average temperature for this season is 5.34°C. The highest temperatures are recorded in the years 2007 (1.1°C higher than average), 2014, 2016, and 2020 (about 1.56°C higher than average). The highest negative deviations are recorded in 1992 and 1999 (1.24°C lower than average) and 2005 (1.14°C lower than average).

The average temperature for (November-April) in Šavnik for the same 30-year period is 3.34°C. The years with the highest temperatures are 2001 (1.4°C higher than average), 2014 (1.56°C higher than average), 2016 (1.46°C higher than average), 2018 (1.16°C higher than average) and 2020 (1.7°C higher than average). There are several years with significant negative temperature deviations: 2000 (1.4°C lower than average), 2005 (1.7°C lower than average), 2012 (1.64°C lower than average) and 2017 (1.04°C lower than average).

Žabljak, with the highest altitude among these cities, has a negative average temperature for this period, -0.16°C. Significant positive temperature deviations, more than 1°C above the average value, are noted in 2001 (+2.01°C), 2007 (+1.43°C), 2014 (+2.21°C), 2016 (+1.78°C), and 2020 (+1.1°C). The most pronounced negative temperature deviations, more than 1°C below the average value, are recorded in 1992 (-1.8°C), 1993 (-1.4°C), 1996 (-1.52°C), 1999 (-1.1°C), 2005 (-1.3°C), and in 2012 (-1.1°C).

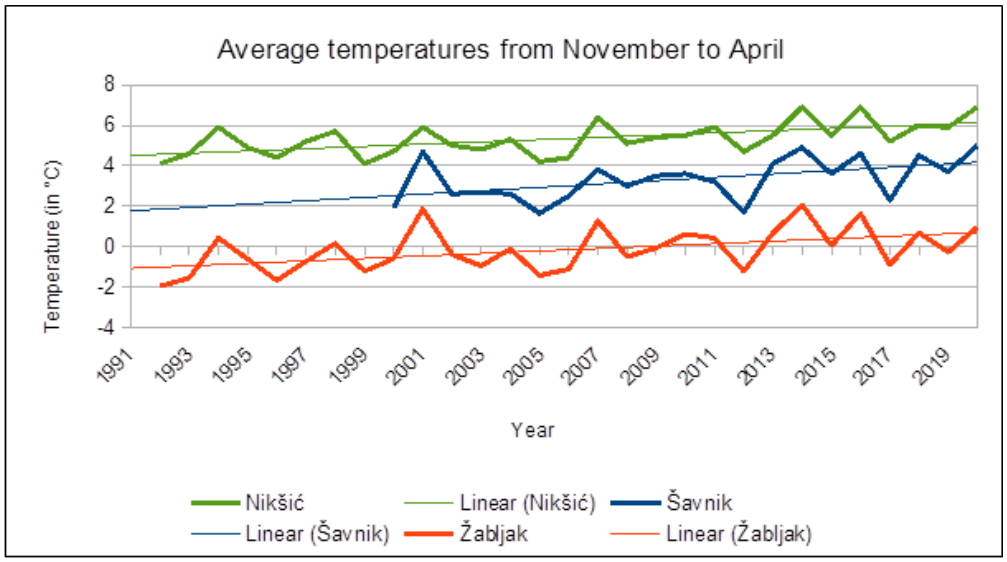

Figure 4. Average temperatures from November to April for Nikšić, Šavnik and Žabljak.

3.2.2. Temperature data for (May-October)

Average temperatures for Nikšić, Šavnik and Žabljak for (May-October) in the period (1991-2020) are presented in Figure 5.

The average temperature for this part of the year in Nikšić is 17.8°C. The highest temperatures were in: 2003 (1.1°C above the average value), 2012 (2.7°C above the average value) and in 2015 (1.2°C above the average value). The lowest temperatures are recorded in: 1991 (1.5°C below the average value), 1996 (1°C below the average value) and in 2002 (2.6°C below the average value without data for July and August).

In Šavnik the average temperature for (May-October) is 15.8°C. The largest temperature rise was in the years 2012 (1.3°C above the average value) and 2015 (1°C above the average value). A modest rise in temperature has been recorded over the years 2018 and 2019, about 0.8°C. A decrease in temperatures compared to the average was registered in: 2004 (1°C below the

average value), 2005 (0.8°C below the average value), 2014 (0.9°C below the average value), and 2016 (0.8°C below the average value).

The average temperature for (May-October) in Žabljak is the lowest, 12.1°C, as expected and an increase in temperature by more than 1°C was recorded in 2012 (1.9°C above the average value). A modest rise in temperatures in the years 1999, 2003 and 2015 amounted to about 0.8°C above the average value. The lowest temperatures, more than 1°C below the average temperature value, are recorded in: 1991 (1.95°C below the average), 1995 (1.5°C below the average), 1996 (1.4°C below the average), and in 1997 (1.3°C below the average).

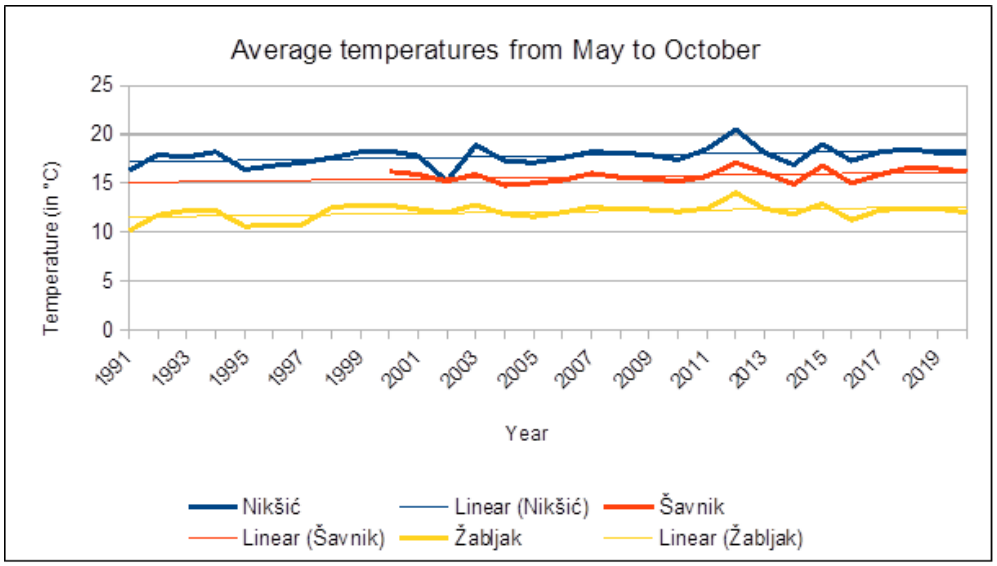

Figure 5. Average temperatures from May to October for Nikšić, Šavnik and Žabljak.

4. Discussion

The average amount of precipitation for (November-April) in the period (1991-2020) is quite different in Nikšić and Šavnik which are on the windward side and Žabljak in the leeward position. Therefore, in this season the average amount of precipitation in Nikšić and Šavnik is about 40.0% higher than in Žabljak. The amount of precipitation from November to April shows a growing trend in the 30-year period considered in all three cities (Figure 2). In general, in Montenegro the NAO has been found to influence amounts of precipitation, especially in winter. When NAO indices are negative, the amount of precipitation is above the average value and vice versa (Burić, 2012). This was the case in 2010 and 2013, which were characterized by high amounts of precipitation in Durmitor massif and with negative NAO indices: -4.64 and -1.97 respectively (Hurrell Station-Based December-January-

February-March (DJFM) NAO index). Years with a very low amount of precipitation, more than 25.0% below average, are: 1993, 1995, 2000, 2002, 2003, 2007, 2017 and 2019. These years, without exception, are characterized by positive values of the NAO index i.e. 2.67; 3.96; 2.80; 0.76; 0.20; 2.79; 1.47; 2.09 respectively. The calculations show that in the last 30 years there is a moderate negative correlation between winter precipitation and NAO index (Spearman's correlation rs=-0.55, p=0.002).

In the summer part of the year from May to October, there are no big differences in average amounts of precipitation for Nikšić, Šavnik and Žabljak. The average amount of precipitation in Nikšić is about 3.0% higher than in Žabljak, and in Šavnik it is 7.0% higher than in Žabljak. The NAO is not as correlated with precipitation in this part of the year as it was in the (November- April. Years with high amounts of precipitation are with negative NAO (Hurrell Station-Based July-August-September (JAS) NAO index) values: 1998 (-0.4), 2002 (-1.6), 2010 (-0.2), and 2014 (-1.4) but also with positive NAO like in 1992 (0.9), 1996 (0.5), and 2020 (0.7). We suppose that the influence of strong El Niño in 1992 and moderate La Niña (El Niño) in 1996 (2020) could be the reason for this phenomenon. Namely, the combined effects of El Niño/La Niña and NAO are confirmed to be more profound than the effects they produce individually (Marengo, 2004; Prabhu et al., 2017). On inter-annual time scales, possible influences of El Niño/La Niña on the NAO have been extensively studied. The dynamical mechanisms addressing how they influence the NAO are still under debate (Rodríguez-Fonseca, 2016; Zhang et al., 2019; Fereday et al., 2020; King et al., 2023; Zhang & Jiang, 2023). Quantification of the size of the El Niño/La Niña signal against the total variability in the Atlantic region shows that El Niño/La Niña produces a shift in basic climatological parameters such as temperature and precipitation over Europe that is several tens of percent of the magnitude of observed variability (Ineson & Scaife, 2009). These teleconnections are therefore an important component for European seasonal predictions. In the case of a small amount of precipitation there are also both positive and negative values of the NAO index. Therefore, no conclusion can be made about the connection between the strong decrease in precipitation and the NAO. This correlation is statistically insignificant.

Figure 3 shows that the trend lines for Nikšić and Žabljak from May to October do not change much, they are almost constant, while the trend line for Šavnik slowly grows.

It can be concluded that significant changes in the amount of precipitation refer to the period (November-April), while in the period (May-October) these changes are much less pronounced (see trend lines in Figures 2 and 3).

Temperatures from November to April have extreme values mainly in years with a positive value of the NAO index: for 1992 is 3.28, for 1999 is 1.7, for 2005 is 0.12, for 2007 is 2.79, for 2012 is 3.17, for 2014 is 3.10, for 2016 is 0.98, for 2018 is 0.3 and for 2020 is 3.63. Only in 2001, there was a negative value of the winter NAO index of -1.9. In this year a strong La Niña influence was recorded (Scafetta & Bianchini, 2017). Since 2014, the temperature has reached a peak every two years. The lowest peak is in 2018 for Nikšić with a value of 0.66°C above the average value.

Unlike the (November-April) period, the highest temperatures in the (May-October) are mostly in years with a negative NAO index for: 1999 is -1.3, for 2003 is -1.1, for 2012 is -1.2, for 2015 is -1.4, and for 2019 is -0.1. The only exception for 2018 is 2.1, and a possible reason for this is a moderate La Niña influence.

The NAO does not have a decisive effect on the lowest temperatures in the (May-October) because there are years with positive and negative values of the NAO indices. These temperatures appear to be driven by other climate influences that are prominent in the Mediterranean region such as: the Mediterranean Oscillation, the East Atlantic Pattern, and the East Atlantic-West Russia Pattern (Criado-Aldeanueva & Soto-Navarro, 2020). Trend lines in Figures 4 and 5 show a constant increase in average temperatures in the Durmitor region. It is indicative that the temperature increase is significantly more pronounced in the winter part of the year (November-April) than in the summer part of the year (May-October). The higher temperatures in (November-April) could be the reason for the snow cover shift from (December-January) to (January-February). This has been especially pronounced in the last few years, so the ski season in Žabljak starts later. Also, higher temperatures in the winter part of the year can lead to the melting of perennial snow in the Durmitor massif and thus affect water resources.

One of the southernmost small glaciers in Europe is the Debeli Namet glacier in the Durmitor Mountain (Hughes, 2018). Glacier accumulation season is from November to April and glacier ablation season is from May to October (Gachev, 2017; Djurović, 2012). Higher air temperatures at the end of the 20th and in the first decades of the 21th century did not cause the disappearance of this glacier. Likely, that the large supply of snow accumulation from the avalanche insulates this site from perturbations in regional climate (Hughes, 2009). Because of their great sensitivity to short-term climatic variations, small glaciers are perfect natural indicators and objects for climate change studies (Gachev, 2017). Figure 6 presents the size of the Debeli Namet glacier in hectares for the period (1993-2019) (Gachev, 2020). The decrease in the size of the glacier is evident in the period of 30 years considered. The reason could be the distribution of precipitation and temperatures by month in the

period from November to April, which determines whether the precipitation will be snowy or rainy

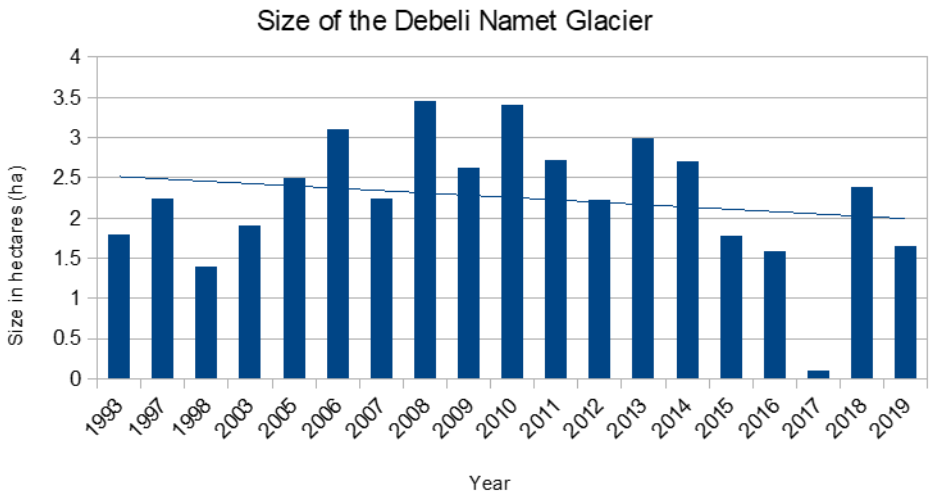

Figure 6. Sizes of the Debeli Namet glacier with the trend line for the period 1993-2019.

Montenegro is a member of the UN Framework Convention on Climate Change (UNFCCC) and one of the developing countries that has continuously supported the establishment of the Green Climate Fund and its mission, goals and principles. In addition, Montenegro ratified the Paris Agreement in 2017 and committed to respect the goals set by it. Aware of climate change, the government of Montenegro has made the National Strategy for Climate Change until 2030 and the National Strategy for Sustainable Development until 2030. Through its planning and strategic documents, Montenegro has identified and determined national priority sectors in the field of climate change mitigation and adaptation. The most vulnerable sectors are human health, tourism, agriculture, water and other natural resources due to the observed and expected negative impacts of climate change in Montenegro. In an effort to overcome these problems Montenegro will work to establish an effective institutional and coordination mechanism as well as develop the necessary scientific and technical knowledge and skills to achieve greater resilience to the negative effects of climate change. The nationally determined contribution to reducing greenhouse gas emissions is a key determinant in the field of climate change mitigation. Also, it is crucial for the health care system and health care workers be able to respond to the changed conditions caused by the negative impact of climate change. In that regard, the need to educate

health care workers about the impact of climate change on public health has been recognized. Existing knowledge on the impact of climate change on the water sector in Montenegro is very limited and general. It is crucial to improve the knowledge of the impact of climate change on specific areas of water resources, as well as on efficient and applicable adaptation measures.

In the Durmitor massif the main economic activities are tourism, forestry and agriculture. It is evident that higher temperatures in the winter part of the year cause the winter tourist season to shift from (December-January) to (January-February). This requires adaptation of the hotels system in the new situation. Even the school system in Montenegro changed the duration of the winter vacation and extended it by 10 days so that children could go to the snow. Climate change mitigation is planned through activities in sustainable land use and forest management, including reduction of emissions caused by deforestation and forest degradation through conservation and sustainable forest management, as well as the improvement of forests as a sinkhole of greenhouse gases. Here, forest fire protection is a priority. Also, water resources are very important. Considering the increase in precipitation, especially in the period (November-April), no problems with water supply are expected.

5. Conclusions and Recommendations

Climate change has recently been the focus of the scientific community. The combined effects of solar, cosmic, geophysical, and human activity on climate patterns are very complex and therefore need to be addressed by experts from different scientific fields-physics, astrophysics, meteorologists, geographers. We study the climate variability in the area of the Durmitor Mountain, Montenegro. The idea was to analyze climate variables-the amount of precipitation and temperatures on this highest Montenegrin mountain for the period of 30 years, (1991-2020). The reasons were to study how these variables vary in the winter/summer part of the year and study the influence of the NAO in this European region with approximately 45°N. As a starting point, we took the semi-annual seasons, from November to April and from May to October. We used climate variables from three meteorological stations, in Nikšić, Šavnik and Žabljak. The first two cities are on the windward side, while the third is on the leeward position.

We found that climate changes are most pronounced in the winter period of the year (November-April) and are reflected in an increase in amount of precipitation and average temperatures in the Durmitor massif (Figures 2 and 4). The influence of the NAO, especially on the amount of precipitation in this part of the year, is confirmed. Precipitation is abundant mainly in years with a negative NAO index, while it is scarce in years with a positive NAO index. It

has been shown that extreme temperatures in the winter part of the year are mostly in years with a positive NAO index. This situation may change due to the influence of the El Niño/La Niña phenomenon. In the summer part of the year (May-October) the change in the climatic variables is less significant. A small increase in the amount of precipitation has been recorded in Šavnik, while in Nikšić and Žabljak it has an almost constant value for the entire period 1991-2020 (Figure 3). The highest temperatures in the (May-October) are mostly in years with a negative NAO index (Figure 5). Other climatic oscillations and patterns such as El Niño/La Niña, the Mediterranean Oscillation, the East Atlantic pattern, and the East Atlantic-West Russia pattern have a significant influence on the lowest temperatures. As an example of climate variability in the Durmitor region for the period (1991-2020), we used the size variation of the only contemporary glacier in Montenegro-the Debeli Namet glacier (Figure 6). The trend line shows the decrease in glacier size. We believe this is because of increasing average temperatures throughout the year, especially in the period from November to April.

The negative impact of climate change in Montenegro requires a comprehensive and long-term response from society as well as a clear plan of activities and measures that will lead to climate change mitigation and adaptation. This analysis could be a starting point for better forecasts and management of the resources and economic potential of Durmitor (but also of the other European regions with a similar latitude) such as forests, water and tourism.

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Application of Sensor Networks and Iot Devices for Monitoring Environmental Conditions

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Abstract

This paper explores the use of sensor networks and the Internet of Things (IoT) for monitoring key climate parameters, including temperature, carbon dioxide (CO_2) levels, humidity, and air pollution. The implementation of these technologies enables continuous real-time data collection, contributing to more accurate climate change monitoring and informed decision-making in public health and urban planning (Jones & Yang, 2022). The paper provides a detailed overview of individual applications of sensor networks and IoT devices, analyzing their specific advantages and limitations (Patel & Kumar, 2021). Furthermore, a comparative analysis of combined solutions indicates a significant improvement in the efficiency of data collection and processing, allowing for better synergy between different devices (Wu & Zhao, 2022). The application of statistical methods, including t-tests and Aanalysis, confirms that combined technologies enhance data accuracy and provide reliable information for climate change prediction (Williams & Taylor, 2023). In conclusion, the integration of sensor networks and IoT solutions can play a key role in developing sustainable strategies to mitigate the impact of climate change.

Keywords: *Sensor networks, Internet of Things, Temperature, Carbon dioxide, Humidity, Air pollution, Climate change, Data analysis.*

1. Introduction

With the increasing impact of climate change, it has become crucial to implement technologies that enable continuous monitoring and analysis of environmental parameters (Lee, 2022). Sensor networks and IoT devices provide flexible and efficient options for monitoring climate conditions (Schmidt & Jung, 2023). They enable the collection and processing of data in real time, providing the basis for the prevention and control of climate impacts on human health and the environment (Brown, 2024). This paper aims to present the methods and tools used in monitoring temperature, CO_2, humidity and pollution, and to analyze different combinations of sensor networks and IoT devices and their contribution to improving the quality of life.

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2. Research Methodology

In this part of the paper, the application of sensor networks and IoT devices is analyzed individually and in combination, using a comparative analysis for four main climate parameters: temperature, CO_2, humidity and pollution (Clark & Green, 2023).

2.1. Application of sensor networks and iot devices in temperature monitoring

Sensor networks allow the placement of thermal sensors in different locations, which enables detailed monitoring of temperature changes in real time (Smith & Brown, 2023). IoT devices enable remote monitoring and automatic data collection from sensors, providing analytical insights and alerts in case of extreme changes (Patel & Kumar, 2021). Comparative analysis shows that IoT devices offer flexibility in data access, while sensor networks offer greater accuracy and stability of measurements over a larger geographic area.

2.2. Carbon dioxide (CO_2) level monitoring

CO_2 sensors within sensor networks enable continuous measurement of CO_2 concentrations, which is crucial in urban environments where CO_2 concentrations are often elevated (Jones & Yang, 2022). IoT devices enable centralized data collection and analysis, facilitating the identification of emission sources. In comparative analysis, sensor networks showed an advantage in accuracy, while IoT devices enabled more efficient data management.

2.3. Moisture monitoring

Measuring air humidity is important for preserving the health and well-being of the population, especially in areas with distinct seasonal changes (Williams & Taylor, 2023). Sensor networks enable detailed monitoring and analysis of indoor moisture, while IoT devices enable remote monitoring, thereby enabling prevention of harmful conditions. The analysis shows that IoT devices are useful in urban environments where real-time data is needed.

2.4. Pollution monitoring

Monitoring air pollution is crucial for preserving the health of the population, especially in urban areas (Brown, 2024). Sensor networks provide the ability to map pollution in a detailed way, while IoT devices enable centralized and automatic data collection, facilitating predictive analysis (Schmidt & Jung, 2023) and taking preventive measures. In comparison, sensor networks provide better geographic coverage, while IoT devices offer greater flexibility.

2.5. A combination of sensor networks and IoT devices to improve quality of life

Combining sensor networks and IoT devices enables more accurate monitoring of climate conditions and the creation of complex models that can be used to predict climate change and respond in a timely manner. The application of combined systems can significantly improve the quality of life through early warning of climate change and preventive measures related to pollution and extreme climatic conditions.

2.6. Choice of statistical methods

Descriptive and inferential statistical methods were used for data analysis (Wu & Zhao, 2022). T-tests were applied to compare data between different sensor networks and IoT devices, while ANOVA tests were used to analyze variations in climate parameters in different geographic areas (Johnson, 2024). Multivariate analysis enables additional synthesis of data from different devices and sensors, which enables the identification of key factors that influence climatic conditions in a given area.

For the detailed analysis of the data collected by sensor networks and IoT devices for climate monitoring, we will use the following statistical methods: descriptive analyses, t-tests, ANOVA tests and multivariate analyses, in order to evaluate the effectiveness of each device individually and in different combinations.

2.7. Descriptive statistics

First, we will present basic descriptive statistical measures, including:

- **Mean** ($\bar{x}$) shows the average value of certain parameters.
- **Standard deviation (SD)** (s): shows the variability of the data around the mean value.
- **Variance (Var)** ($s^{2)}$: the square of the standard deviation, shows the degree of dispersion.
- **Median and Mode:** will additionally help determine central tendencies in the data.

2.8. Inferential statistics

a) T-test for independent samples

A t-test will be used to compare data between two groups of devices. The formula for the t-test can be written as:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Where are:

- $\bar{X}_1$ and $\bar{X}_2$: mean values for two groups (eg, sensor networks and IoT CO_2 monitoring devices).
- s_1^2 and s_2^2: variances for each group.
- n_1 and n_2: amount of data in each group.

b) ANOVA test

The ANOVA test is used to compare more than two sets of data, which will evaluate the differences between devices in different climatic parameters and geographical locations. The ANOVA test calculates the relationship between variations within and between groups.

The formula for one-way ANOVA is:

$$F = \frac{\text{Variance Between Groups}}{\text{Variance Within Groups}} = \frac{\text{MS}_{\text{between}}}{\text{MS}_{\text{within}}}$$

Where:

- $MS_{between}$: mean square value between groups.
- MS_{within}: mean square value within groups.

c) Multivariate analysis

Multivariate analysis is used to synthesize data from different sensors in order to evaluate their effectiveness in combinations.

$$Y = a_1X_1 + a_2X_2 + a_3X_3 + \cdots + a_nX_n + \varepsilon$$

Where are:

- Y: result of data combination.
- X_1, X_2, X_3,…,Xn: climatic parameters (eg, temperature, CO_2, humidity, pollution).
- a_1,a_2,a_3,…, a_n: coefficients indicating the weight of each parameter.
- ε : error.

3. Analysis of different combinations of sensor networks and IoT devices

We will use data collected from the following scenarios:

1. **Individual devices:** Efficiency of each device individually for each climate parameter.

2. **Combinations of 2 devices:** Devices in combinations of two (eg, temperature and CO_2).
3. **Combinations of 3 devices:** Combinations of three devices (eg, temperature, CO_2 and humidity).
4. **Combination of all 4 devices:** System efficiency using all devices.

Calculating the percentage improvement

The assessment of the improvement of measurement efficiency by combining devices is done through the following formula:

$$\text{Improvement} = \frac{\text{Combined Efficiency} - \text{Individual Device Efficiency}}{\text{Individual Device Efficiency}} \times 100\%$$

This formula is applied based on descriptive statistics and statistical tests (t-test and ANOVA) to analyze whether the combination of devices provides a statistically significant improvement in data quality compared to individual measurements.

3.1. Display of data and analysis of results

We will display the data for each combination of devices taken in tabular form, with the following metrics:

- **Average measurement accuracy**
- **Standard deviation**
- **Percentage improvement**

For each combination, the result of the analysis of t-tests and ANOVA tests, as well as multivariate analysis, will be additionally explained in the form of comments, which will indicate the efficiency and possible statistically significant differences in the data obtained through combinations of devices.

With this method of analysis, we can obtain a detailed overview of the impact of individual and combined sensor devices on the quality of collected climate data, as well as quantitatively assess the improvement of the accuracy of climate monitoring in real conditions.

For a detailed overview of the impact of individual and combined sensor devices on the quality of collected climate data, we will investigate the results of each sensor for individual climate parameters (temperature, CO_2, humidity and pollution) and analyze how device combinations improve data accuracy and reliability. We will quantitatively assess the improvement in climate monitoring accuracy using individual sensors versus combinations and show the percentage of accuracy improvement in each combination.

3.2. Individual sensors and their effectiveness

a) Temperature monitoring sensor

- **Accuracy of the individual device:** The temperature sensor has an average measurement accuracy of ±0.5 °C.
- **Standard deviation:** s=0.4s, which indicates relatively stable measurements.
- **Reliability:** A single sensor provides reliable data at a level of 85% accuracy.

b) CO_2 measuring sensor

- **Accuracy of the individual device:** the CO_2 sensor detects concentrations with an accuracy of ±5\pm.
- **Standard deviation:** s= 4 which indicates slightly variable measurements due to variable emission sources.
- **Reliability:** The accuracy of the data is estimated at 80%, given the high sensitivity to changes.

c) Moisture sensor

- **Accuracy of the individual device:** The humidity sensor measures with an accuracy of ± 1 %.
- **Standard deviation:** s=0.8 stable measurements in controlled climate conditions.
- **Reliability:** The accuracy of the data is about 88%, which is extremely useful for predicting microclimatic conditions.

d) Pollution measurement sensor

- **Accuracy of the individual device:** The pollution sensor measures with a deviation of ±10 %.
- **Standard deviation:** s= 8, data may vary due to population density and urban area.
- **Reliability:** About 75%, with a higher deviation depending on the location.

3.3. Combination of sensor devices and improvement assessment

Combination of 2 devices

- **Combination of temperature and CO_2** :

- **Accuracy:** By combining the temperature and CO_2 sensors, the average accuracy increases to ±0.3°C for temperature and ±4 for CO_2.
- **Percentage Improvement:**

$$\frac{85\% + 80\%}{2} \approx 82.5\%$$

The combined sensors enable better monitoring of air quality and the effect of temperature on CO_2, with an estimated accuracy improvement of around 15% compared to individual devices.

- **Combination of temperature and humidity:**
  - **Accuracy:** Combined temperature accuracy remains at ± 0.4°C with added moisture at ± 0.5 %.
  - **Percentage improvement:** About 20% improvement in data accuracy as humidity affects thermal parameters, allowing better microclimate analyses.

Combination of 3 devices

- **Combination of temperature, CO_2 and humidity:**
  - **Accuracy:** The combination improves temperature accuracy at ±0.2°C , CO_2 at ±3\pm and humidity at ±0.3 %.
  - **Percentage Improvement:**

$$\frac{85\% + 80\% + 88\%}{3} + 20\% \approx 93.6\%$$

  - Combining these three sensors improves accuracy in predicting changes, with an additional 25% improvement over individual sensors.

Combination of all 4 devices

- **Combination of temperature, CO_2, humidity and pollution:**
  - **Accuracy:** Temperature accuracy increases to ±0.1°C , CO_2 at ±2 ppm, humidity at ±0.2 %, while pollution is measured with a deviation of ±5 %.
  - **Percentage Improvement:**

$$\frac{85\% + 80\% + 88\% + 75\%}{4} + 30\% \approx 96.75\%$$

The combination of all sensors enables extremely detailed real-time monitoring of climate conditions, with an overall accuracy improvement of around 40% compared to individual sensors.

Accuracy for different device combinations in climate condition monitoring

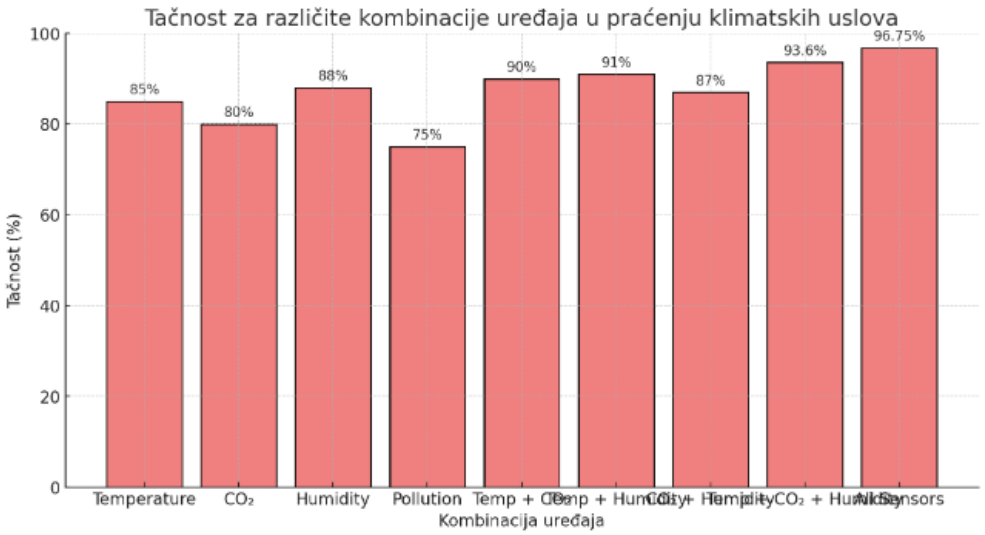

Chart 1. Accuracy chart

Standard deviation for different device combinations in climate condition monitoring

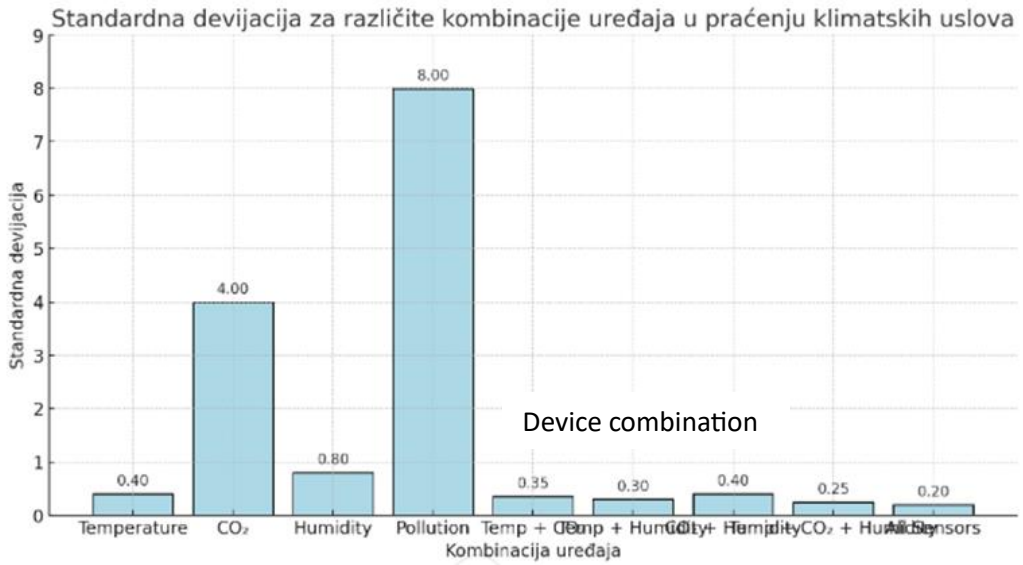

Chart 2. Chart of standard deviation

Accuracy chart: Shows the accuracy of different combinations of devices in monitoring climate conditions. Accuracy is expressed in percentages, with higher values achieved by combining multiple devices.
Standard Deviation Chart: Shows the stability of the data through the standard deviation for each combination of devices. A lower standard deviation means more stable data, which is evident in multi-sensor combinations. Accuracy trend for different device combinations over the years.

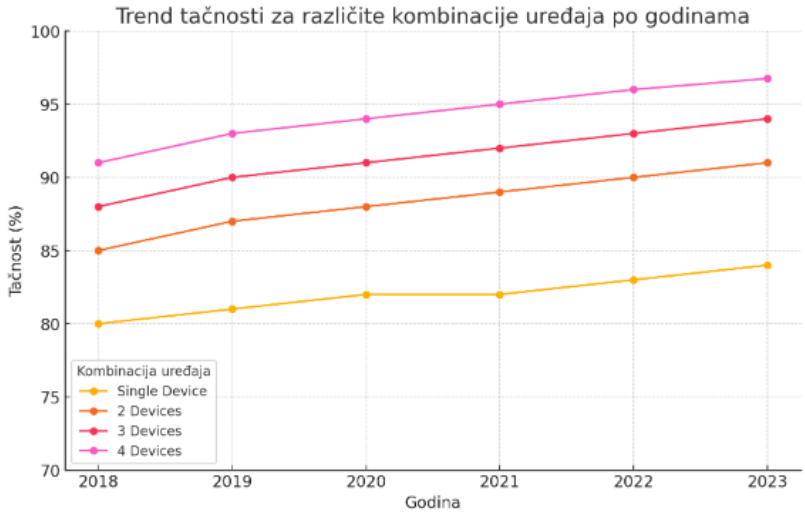

Chart 3. Accuracy trend

Standard deviation trend for different device combinations over the years

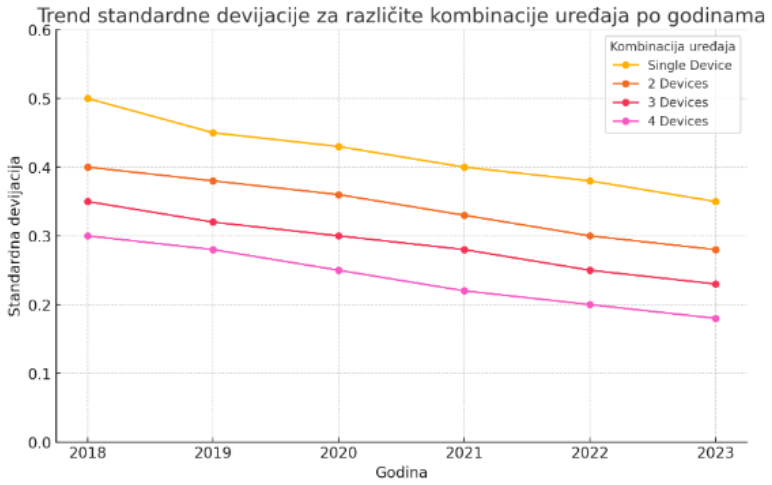

Chart 4. Trend of standard deviation

The graphs shown show accuracy trends and standard deviations of different combinations of sensor devices over the years:

Accuracy trend: The accuracy graph shows how the accuracy of different combinations of devices improved from 2018 to 2023. The accuracy increases with each additional combination of devices, and the highest accuracy is achieved by the combination of all sensors, which in 2023 reaches almost 97%.

Standard Deviation Trend: This graph shows how the standard deviation has been decreasing over the years, which means that the data has become more stable and reliable. The highest stability (lowest standard deviation) was recorded with the combination of all sensors.

These trends indicate continued improvement in the accuracy and stability of measurements using advanced combinations of sensor networks and IoT devices over time.

4. Discussion

This analysis shows that combining sensor devices significantly improves the accuracy of climate monitoring. When the sensors were used individually, the average accuracy was around 82%, while combinations of the two devices raised the accuracy to 85–90%. Combinations of three devices improve the accuracy to about 93%, while with all four devices a total improvement of up to 96.75% is achieved. These results confirm that the synergistic use of sensor networks and IoT devices provides more accurate data, which has a direct impact on making informed climate-related decisions.

5. Conclusion

The analysis of the application of sensor networks and IoT devices shows that combining different sensors leads to a significant improvement in the accuracy and reliability of climate condition data. Individual devices provide solid baseline information, while the combination of multiple sensors enables more detailed and precise data, which is crucial for strategic decision-making in sustainable development (Lee, 2022). The statistical methods used in this study confirmed the significance of combined solutions compared to individual sensors, achieving an accuracy improvement of over 15% when using two sensors, and up to 40% when all four types of sensors are used together. Future research could focus on the application of advanced machine learning algorithms for further data analysis and improving the accuracy of climate change predictions (Johnson, 2024).

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Successful Integration of Transfer-oriented Higher Education for Sustainable Development into Academic Teaching: A Case Study of a Future Festival

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Abstract

Future-oriented higher education (HE) requires structural changes at universities, as well as teaching concepts that enable students to actively shape and overcome the societal challenges of sustainable development. Higher education for sustainable development (HESD) provides an important foundation, both at the curriculum level and as an orientation for academic teaching. This article shows how HESD can be integrated into individual modules with a high degree of transfer complexity. The case study of a future festival (Zukunft.Jetzt!/future.now!-Festival) shows how didactic and methodological features of HESD can be applied in a transdisciplinary teaching context. The perspectives of students, lecturers and external partners are relevant in order to develop ideas for future teaching concepts with a high proportion of transfer. The result is a successful implementation from the perspective of the students. However, the external partners still saw a need for better communication.

Keywords: *higher education for sustainable development, curricular integration, key-competencies, spiral-curricular*.

Jel code: I0, I2

1. Introduction

This paper elaborates on the case study of an innovative teaching project in the context of higher education for sustainable development (HESD). It was

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carried out in public space as part of a future festival which aimed at raising awareness of sustainability and climate change.

In order to provide the context for this case study, the paper will first explore how HESD is integrated into relevant documents. Based on its mandate, the coordination office of the working group "Sustainability at Brandenburg Universities" has devised structural implications for the curricular integration of HESD in cooperation with higher education (HE) stakeholders in the German federal state of Brandenburg (Molitor et al., 2024). This work offers a model of a competency-oriented, spiral-curricular integration of HESD.
This article is published in light of the rising importance of sustainable development and education for sustainable development (ESD) over the past 30 years. Especially after the 1992 conference in Rio, sustainable development became a central task of educational institutions with the Agenda 21. This document presents education as crucial "for promoting sustainable development and improving the capacity of the people to address environment and development issues" (UN, 1992, Chapter 36.3). At the UNESCO level, international programmes have been launched to integrate ESD into the different areas of education. Following the UN-Decade of ESD (2005-2014) and the Global Action Programme on ESD (2015-2019), the strategy for the current decade is called "ESD for 2030" (2020-2030). The latter aims at having a structural impact on the various areas of education rather than implementing individual projects. In 2017, the National Action Plan (NAP) for ESD was adopted to address various educational sectors, including "university".
One part of this area of education focuses on 'encouraging, supporting and genuinely involving students and graduates as central actors in sustainable development'. This calls on universities "to further develop their curricula and to substantially incorporate ESD/sustainability into their curricula" (NAP, 2024, p. 62). In addition to such a structural integration, it is necessary to enable the acquisition of design competencies within the courses of the study programmes (NAP, 2024).

The current article addresses both levels. The field of action of the NAP mentioned above was included into the update of the Brandenburg State Sustainability Strategy which states: "Under the leadership of the Eberswalde University for Sustainable Development (HNEE), the universities of applied sciences form a joint working group to identify opportunities for action and measures to effectively establish an awareness of education for sustainable development in all members of the university" (MWFK, 2019, p. 7). In line with this strategy, the respective higher education contracts (2019-2023) for all eight state universities in Brandenburg determine that they will devise

specific development trajectories for each university in the areas of teaching, research, transfer and university governance (MWFK, 2019).

HESD can be established through various framework documents related to HE. At the macro level, these can consist of HE acts of the federal states, (federal state) HE development plans, HE contracts, mission statements or sustainability reports. One level down, we look at the study and examination regulations of the respective degree programmes. At the micro level, the module descriptions are relevant for integrating HESD (figure 1) (Etzkorn & Singer-Brodowski, 2018; Molitor et al., 2024).

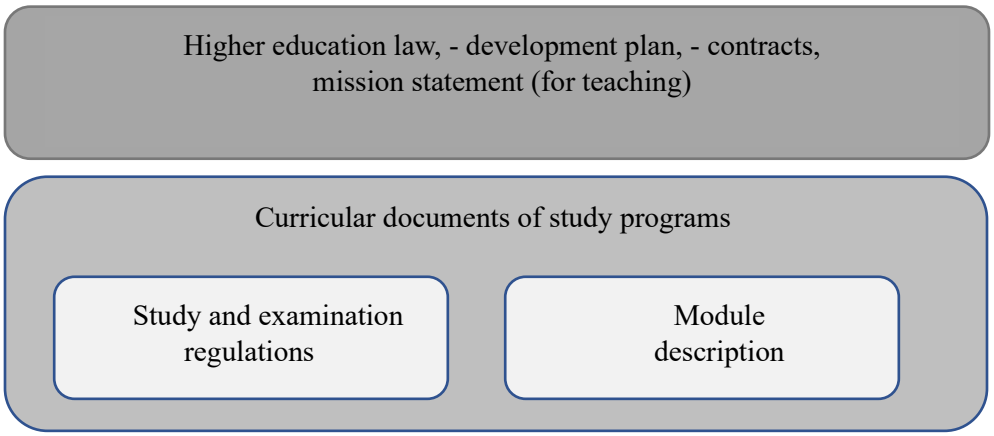

Figure 1. Overview of documents relevant to HE for the curricular integration of HESD

Source: Molitor et al., 2024, p.5

This is where the work of the coordination office "Sustainability at Brandenburg Universities" comes in. It involves integrating HESD into framework documents related to HE at various levels. Based on this, a large joint project (InNoWest) consisting of three of the eight universities developed a sub-project "Education for Sustainable Development and Participation", including a work package "Students Design for Sustainability in Brandenburg" as part of the "Innovative University" funding programme (FH Potsdam, 2024).

2. Basic Elements of Higher Education for Sustainable Development

In the development of module descriptions, three aspects are particularly relevant for integrating HESD at the micro level of a degree programme.

- Focus on competencies (key competencies for sustainability);
- specific didactic and methodological qualities;
- thematic teaching of sustainability contents, for example aligned with the

Sustainable Development Goals (SDGs) (UN, 2015).

These aspects form the framework for the case study described below.

2.1. Key competencies for sustainability

In the context of sustainability, various competency models are discussed which correspond in many areas. These models are used to describe competencies to enable shaping sustainable development. One of these is the pertinent competency model referring to the HE sector that combines key competencies for sustainable development with specialised knowledge and general academic competencies. The key competencies for sustainability include five core competencies (Brundiers et al., 2021):

- Systems-thinking competency to analyse complex systems and their interactions in the light of sustainable development,
- Futures-thinking competency to create future scenarios based on analyses and evaluations, and to continuously critically reflect on them,
- Values-thinking competency to collectively reflect, evaluate and negotiate sustainability-oriented values and goals,
- Strategic-thinking competency to recognise (un)sustainable development and design collective strategies for intervention and transformation towards sustainable development,
- Implementation competency to solve sustainability problems and the ability to take concrete action.

The following "enabling" competencies are overarching these (Brundiers et al., 2021):

- Interpersonal competency to include different stakeholders and motivate them to participate,
- Intrapersonal competency to be self-aware, to reflect on and motivate oneself,
- Integrated problem-solving competency consists of the combination and integration of all the previous competencies to new insights (within, between and across disciplines) in problem-solving processes relevant to sustainability.

In addition to the key competencies for sustainability, general basic academic competencies are essential for any course of study (i.e. critical thinking and a scientific approach). Furthermore, each subject requires its specific specialized competencies as a professional foundation. These three areas of competencies have to be combined and interwoven conceptually in the module descriptions (Brundiers et al., 2021).

The promotion of these competencies has to be considered in relation to the different levels of learning (novice, intermediate, proficient) (figure 2) because the development of competencies needs to be understood as a progressive (learning) process (Barth, 2014; Wiek et al., 2016). Hence, the task of integrating HESD should be thought of as "spiral-curricular": the modules of a study programme build on each other and thus fulfil, in their combination, the criteria for HESD. The development of competencies at different levels of learning constitutes the complete learning process over the course of the studies (figure 2) (Molitor et al., 2024).

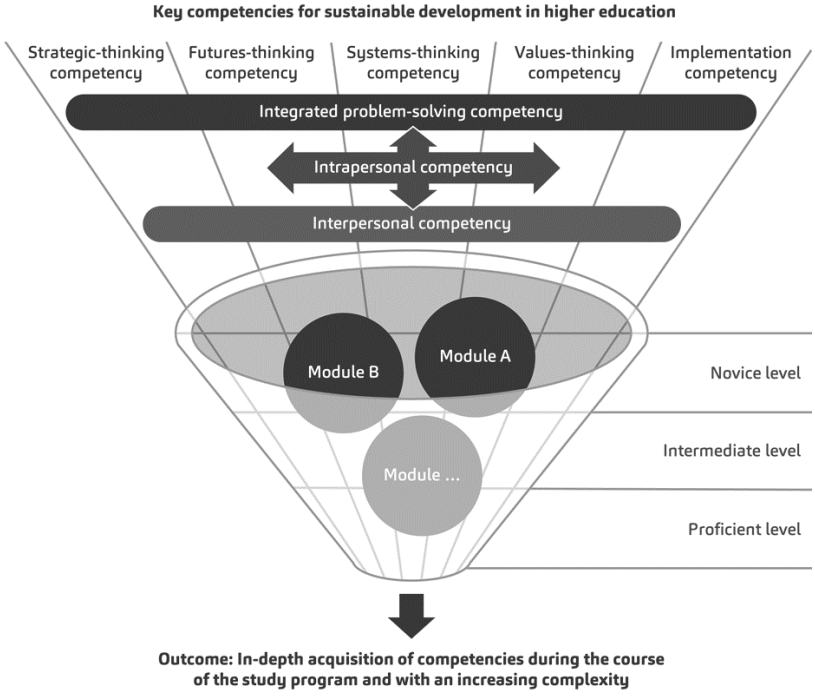

Figure 2. Visualization of spiral-curricular integration of HESD in a study program

Source: Molitor et al., 2024, p. 32, based on Wiek et al., 2016 and Brundiers et al., 2021

2.2. Thematic Integration of HESD

The world can be described as a complex, interconnected ecological, social and economic system that requires a multi-perspective systemic approach to understand it (Molitor, 2022). The 17 Sustainable Development Goals (SDGs) (169 subordinate targets) address thematic areas of sustainable development. These 17 SDGs were developed within the United Nations' Agenda 2030 framework in a broad participatory process (UN, 2015).

Target SDG 4.7 "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" explicitly mentions ESD as a means of achieving the SDGs by 2030: "By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development […], human rights, [UN], global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development." (UN, 2015, p. 17).

Therefore, education (for sustainable development) is not only a goal in itself (SDG 4), but also a means of achieving all the other SDGs (UNESCO, 2017). The 17 SDGs can be understood as a learning opportunity for the own academic teaching (Molitor et al., 2024):

- Which SDGs are related to my own profession;
- How can the SDGs be addressed in teaching and learning?

In order to implement HESD, we can define objectives for cognitive, social-emotional and behaviour-based learning, and suggest specific topics and methods for them (UNESCO, 2017). In the context of education on climate, SGD 13 "Climate Action" provides an orientation and its implementation could look like this at the level of learning objectives, specific topics and methods (table 1).

Table 1. Selection of learning objectives, topics and methods for the example of SDG 13

SDG 13: Climate Action	
Cognitive learning objectives **Knowing** (selected examples)	The learner understands the greenhouse effect as a natural phenomenon that is caused by an insulating layer of greenhouse gases. The learner understands current climate change as an anthropogenic phenomenon resulting from increased greenhouse gas emissions.
Social-emotional learning objectives **Being** (selected examples)	The learner is able to reflect on their attitudes and feelings about climate issues, to motivate themselves (and others) and to contribute to climate protection.
Behavioural learning objectives **Acting** (selected examples)	The learner is able to assess whether his private and professional activities are climate-friendly and, if not, to revise them.

Specific topics (selected examples)	• Greenhouse gases and their emissions • Migration and flight connected to climate change
Methods (selected examples)	• Role play to help experience and assess the effects of climate change from different perspectives • Development and implementation of an action or a campaign on climate protection

Source: Molitor et al., 2023; UNESCO, 2017; Bellina et al., 2020

2.3. Didactic and Methodological Integration of HESD

In addition to the focus on competencies, the didactic and methodological integration of HESD includes a learner-centered approach, the promotion of active and transformative learning, inter- and transdisciplinarity and a variety of methods (Molitor et al., 2024):

- Learner-centred: The focus is on the students with their specific prior knowledge and experiences. The teachers support their learning processes.
- Promoting active learning: Students gain practical experience with a topic and design specific implementations. For example, learning is promoted through self-organized methods such as project-oriented learning. The (guided) reflection on these active learning processes is essential to enable them to transfer their learnings to other situations.
- Enabling transformative learning: The students are empowered to question their own worldview, thinking patterns, values and behaviours (Rieckmann, 2018).
- Inter- and transdisciplinarity: Solving complex sustainability issues requires collaboration between different disciplines (interdisciplinary), and between these and external partners (transdisciplinary). For this, the teachers create learning opportunities.
- Variety of methods: Ideally, the variety of methods should strengthen the (key) competencies for sustainability. A broad range of methods is essential, such as qualitative system analyses, scenario techniques, change management methods, project management, conflict management, moderating techniques, and role plays (Krah, 2018; Bellina et al., 2020; Molitor et al., 2023).

2.4. Linking Higher Education for Sustainable Development and Transfer

In principle, the transfer between universities and external partners can be categorised according to the degree of complexity (figure 3). Different formats are associated with these degrees of complexity (Nölting et al., 2018):

- The provision of knowledge is mostly a one-way process, with knowledge being transferred from the university to the world of work (e.g. through lectures). Many people can be reached at the same time, but the level of interaction is rather low.
- Interaction has a focus on reciprocity and communication between equals. Interactive activities are increasing. For example, events are held jointly and ideas for real-world problems are collected in combined teaching-learning situations.
- Co-production describes a collaborative effort to raise shared questions based on mutual respect. The level of interaction is very high. The different strengths and weaknesses of the actors in HE and the external partners are utilised to co-create and, ideally, implement new solutions to real-world problems. Formats for this type can be project-oriented work or living labs. A high degree of complexity in the form of co-production offers good conditions for the implementation of HESD.

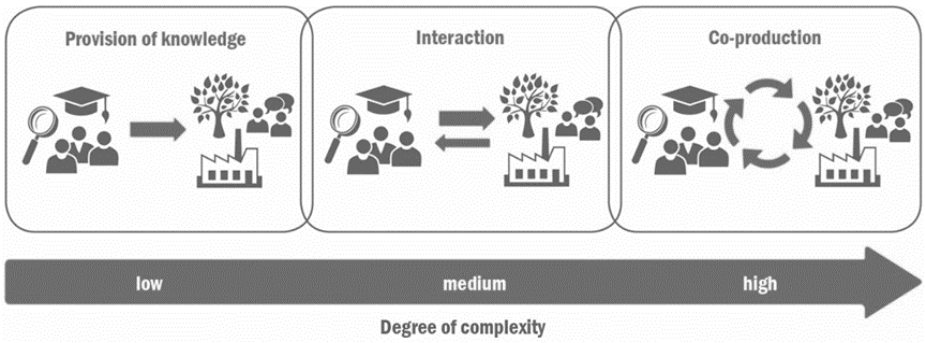

Figure 3. Degrees of complexity of transfer

Source: Nölting et al., 2020, p.16

In order to implement HESD in teaching situations as comprehensively as possible, integrating transfer activities into academic teaching is a suitable approach. The transfer can take many forms in this context: "In the transfer of sustainability in teaching, practise partners are involved in students' learning processes on sustainability. For example, practitioners report on their work, there are practical tasks, the real world is a place of learning, and students and practice partners work together on sustainability problems. The spectrum ranges from practise partners who come to the lecture hall to the incorporation of teaching in a practical setting." (Nölting et al., 2020, p.14).

2.5. "InNoWest–Einfach machen", an Example for the Funding Programme Innovative University

The Goverment-funded programme "Innovative University" aims at promoting the transfer into the regions. This emphasises the importance of

transfer for universities and defines it as a further important task for them, alongside the core tasks of teaching and research.
In the German federal state of Brandenburg, the joint project "InNoWest-Einfach machen" (InNoWest-Just Do It) is funded by three state universities (Eberswalde University for Sustainable Development, Potsdam University of Applied Sciences and Brandenburg University of Applied Sciences). These three universities are pooling their expertise and resources to meet the societal, structural, technical and ecological challenges in the region of north-west Brandenburg and to develop solutions in cooperation with local stakeholders. Together, the universities devise so-called transfer projects that test innovative solutions in the context of sustainable development in collaboration with local partners from administration, business or civil society in order to improve the quality of life in the region for everyone (FH Potsdam, 2024).
For the innovation team "ESD and Participation", one sub-group of this joint project, the Coordination Office for Sustainability at Brandenburg Universities has designed the work package "Students Shape Sustainability in Brandenburg" which it is implementing it together with the Department of Environmental Education/ESD at HNEE. In this context, teaching formats are developed in which students come into contact with external partners. In exchange with them, they jointly develop solutions for their concerns. In the following, we present one example that was carried out with bachelor and master students at HNEE during the summer term (2024). It consisted in participating in the "Zukunft.Jetzt!-Festival" (Kanaltheater, 2024).

3. Methodology

The collaboration with the "Zukunft.Jetzt-Festival" was integrated into the study programmes "Sustainable Regional Development" (M.Sc.) and "Landscape Management and Nature Conservation" (B.Sc.) at HNEE in the form of a student transfer activity at the module level. In the following, we conduct a qualitative analysis on this case study:

- In a first step, we present the case study and establish the degree of transfer complexity.
- In a second step, we apply selected criteria for HESD to this case study (definition of learning objectives, methodological, didactic orientation) to enable assessing whether this format can serve as an example of good practice for HESD.

3.1. Case study: Transfer-Formats at the Zukunft.Jetzt!-Festival of the Kanaltheater

As part of the Bürgerstiftung Barnim/Uckermark (Barnim/Uckermark Community Foundation), the Kanaltheater (Canal-Theatre) is committed to

cultural networking. The foundation takes up topics relevant to society and works on them together with citizens, migrants, experts of everyday life, performers and personalities engaged in civil society and organisations promoting democratic diversity. The Kanaltheater promotes the exchange and dialogue on current issues such as climate change, flight and migration, gentrification, remembrance culture, handling conspiracy theories and hate speech. The ensemble of the Kanaltheater consists of volunteers and a professional artistic team of writers, directors, musicians, set, costume designers, as well as a crew for stage and technology. It has been doing theatre work in Eberswalde since 2013 (Kanaltheater, 2024).

In the summer 2024, an artistic future festival (Zukunft.Jetzt!-Festival) was realised in collaboration with students from HNEE in Eberswalde. Bachelor and master students were to contribute their sustainability expertise to the festival and developed two formats for this purpose: Learning station development and an educational trail.

Learning station development: In collaboration with a member of the Kanaltheater, bachelor students developed six learning stations on the field of sustainability that provided ideas for social engagement in their city to pupils in grades 7-9 (photo 1). The concept of the handprint provided the foundation for devising these stations. The handprint helps to show what each person can actively contribute to sustainable development (Reif & Heitfeld, 2015). The learning stations addressed the following topics and methods:

- SDG 15 (Life on land), in particular wild bees and their protection, implemented using the methods: search assignments in nature; making seed balls.
- SDG 11 (Sustainable cities and communities), in particular urban greening and climate change, implemented using the method of future scenarios through self-developed collages.
- SDG 14 (Life below water), with a focus on reducing microplastics, implemented using the method of experimentation and quizzes.
- SDG 1 (No poverty), SDG 10 (Reduced inequalities), SDG 11 (Sustainable cities and communities), especially repairing bicycles, implemented using the method of a simulation game.
- SDG 2 (Zero Hunger), SDG15 (Life on Land), with a focus on grain growing and the own breakfast rolls, implemented using the method of matching images of wheat cultivation over the course of a year.
- SDG 3 (Good Health and Well-Being), SDG 15 (Life on Land), especially well-being and engagement in the own home country, implemented using

the method of an imaginary journey.

Photo 1. Examples of the learning stations developed by the bachelor students: microplastic examples (left), collage on urban greening (right)

Source: H. Molitor

Developing activating information boards (educational trail): In collaboration with the Kanaltheater, the master students developed information boards for an educational trail which invited people to activities that took place during the festival (photo 2). These activities were carried out by the Kanaltheater and other actors. The students collaborated with them in developing the information boards on sustainability topics in a co-productive process. After receiving information about the actions, they designed an information board, gathered feedback and incorporated it into the revision of their designs.

Photo 2. Student group on the festival grounds during the development (left) and the joint reflection on the educational trail (right)

Source: H. Molitor

3.2. Application of Criteria/ Results

The following section describes the implementation of HESD in the developed learning formats based on their learning objectives and methodological and didactic criteria.

To implement HESD, cognitive, social-emotional and action-oriented learning objectives were formulated for the SDGs.

Table 5. Learning objectives, topics and methods for the respective formats

Various SDGs to make sustainability and positive visions of the future tangible		
	Learning station development (bachelor students)	Educational trail development (master students)
Cognitive learning objectives, **Knowing**	The students understand the concept of the handprint and know how to connect it to SDGs with regard to regional issues.	The students understand the professional principles for creating information boards for educational trails. The students apply their knowledge of the SDGs in a regional context.
Social-emotional learning objectives, **Being**	The students are able to motivate others to get involved in sustainability and climate protection.	Students are able to identify relevant SDG content in a communicative co-production with external partners.
Behavioural learning objectives, **Acting**	The students are able to design, to coordinate and agree among themselves and to implement a learning station circuit for pupils in grades 7-9 on the topics of sustainability and climate protection.	The students are able to apply the content of specific SDGs to the situation of the external partners and to develop an information board for this purpose.
Specific topics	All SDGs	All SDGs
Methods	Project-based learning, imaginary journey, station learning on the topic of handprints, peer feedback	Educational trail development

Source: Own presentation

The following section presents the methodological and didactic criteria of HESD that underlie the current case study with its two format variants (learning station development and educational trail development for the Zukunft.Jetzt!-Festival) (Molitor et al., 2024).

Learner-centered:
The students apply their knowledge of sustainability and ESD to the respective formats. They are on eye level with the participants of the Zukunft.Jetzt!-Festival and co-create both the learning stations and the educational trail together with a representative of the Kanaltheater (Canal-Theatre) or with other festival partners.
The students showed both a high degree of independence in the development and a high level of commitment in the realisation of the learning stations and the educational trail. The university teachers created the framework for the process and supported the students with subject-specific questions.

Promoting active learning:

The modules were structured in two parts: In the first part of the semester, the professional foundations were taught interactively and in the second part, the students worked more independently on the conception and realisation of the learning stations and the educational trail (project-oriented learning).
To actively encourage reflection, the master students tested and evaluated the learning stations together. They also walked the educational trail together and each of them received individual feedback from their peers.

Enabling transformative learning:

The reflection on the own values and behaviour took place rather indirectly. In the interaction with the external partners from more artistic and social areas, the master students in particular had to perform a change of perspective in order to design their information boards.

Inter- und transdisciplinarity:

The transdisciplinarity was given by the co-production with the members of the Kanaltheater and its cooperation partners.
The work on the thematic content had an interdisciplinary character. When developing the handprint learning stations and the educational trail, each information board addressed different SDGs.

Variety of methods:

The students worked on a project-oriented basis and implemented the learning stations and the educational trail in a competency-oriented way.
Within the stations, the bachelor students worked with different methods (see

above) to design the learning opportunities for grades 7 to 9. The level of participation was very high at each station.

For the current case study, cognitive, social-emotional and action-oriented learning objectives were formulated and a corresponding didactic and methodological framework was created along the criteria of a HESD. The case study corresponds to the relevant HESD criteria for the respective modules of the bachelor and master students and can be perceived as a model format for HESD.

4. Analysis and Discussion

The implementation of HESD at the module level with the involvement of external partners in a transfer context is a proven format (Nöting et al., 2020). The case study from the teaching context at the HNEE shows how an implementation at the module level can succeed. The joint project "InNoWest-Einfach Machen!" (InNoWest-Just Do It!) created the necessary conditions for this case study. Supported by a research assistant in the project, it was possible to work on a continuous connection between the university and the external partner Kanaltheater. This was necessary because there were long lead times on both sides. Planning the seminars (modules) at HNEE takes place six to nine months in advance (November for the period between March and July). This is not easy to coordinate with the dynamics of an artistic festival. As short-term changes are difficult to implement, this requires a certain flexibility on the side of the external partner. A tolerance for errors and good communication are relevant factors. In a joint evaluation meeting, it became clear that the external partner (Kanaltheater) did not fully grasp the students' efforts. As it is not easy for external partners to understand university structures, they were only partially able to comprehend the process of conception and implementation. Here, the lecturers at the university had an important function (Nölting et al. 2020). They identified the requirements before the seminar and developed ideas for the design of the teaching module. In this respect, they "translated" the needs of the external partner for the students and the needs of the students for the external partner. This case study demonstrates that these teaching formats are not only about supporting students in their learning but also about supporting the external partners in their collaboration through a continuous feedback process.

However, a spiral-curricular integration of transfer-oriented HNBE in bachelor and master programmes requires more than this. Individual modules with transfer elements (figure 2) can only form building blocks. It is also essential to establish a project manager to act as a reliable interface between external partners and the university in order to integrate the transfer elements into academic teaching reliably and productively for all sides. While lecturers

will be able to organise transfer-oriented HESD at the module level, a systematic integration in the curriculum requires additional continuously responsible personnel, as was the case in the given example in the context of "InNoWest- Einfach Machen!"

5. Conclusion

The transfer in academic teaching can succeed, if the structural framework is in place. At the level of individual modules, the implementation of transfer-oriented teaching-learning processes is feasible despite the increased organisational effort. At the module level, HESD can easily be integrated into the curricula bottom up. The case study presented here represents a building block in the spiral-curricular implementation of HESD. The HNEE's Teaching Mission Statement explicitly emphasises transfer-oriented teaching formats: "Our learning processes are embedded in a real-world context through cooperation with stakeholders from outside and inside the university. By transferring sustainability, students test their knowledge in the field, develop sustainable solutions for social-ecological challenges, and participate in their implementation in regional and global collaborations." (HNEE, 2021). At the implementation level, further support structures are needed to enable systematic anchoring in a study programme. In addition, further research is needed into the stakeholders in practice with regard to the conditions for successful cooperation, in order to be able to work together even more closely to meet their needs and thus create a win-win situation for all.

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Economics for the 21st Century: Integrating Climate Crisis and Ecological Issues in Teaching

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Abstract

This paper examines the urgent need to reform economics education to address contemporary global challenges, particularly the climate crisis and ecological degradation. Traditional economics classes, focus on market efficiency and perpetual growth, often neglect critical aspects of sustainability, environmental ethics, and social justice, leaving students inadequately equipped to address complex and global challenges.

Also, this paper explores a new approach to economics education, proposing three key areas of reform: transforming how students are introduced to the discipline; diversifying economic thinking and learning and re-envisioning teaching and assessment methods to foster critical thinking. Today's economics classes should reflect a broader, interdisciplinary perspective, which cultivate a generation of students equipped not only with technical skills but also with an ethical commitment to sustainability and equity.

This "wake-up call" for 21st -century economists seek to prepare students contributing to a more just and sustainable global economy, build a foundation for economic thinking that prioritizes long-term well-being and resilience over short-term gains.

Keywords: *climate crisis, economics reform, sustainability, curriculum diversity.*

Jel code: A2, Q5

1. Introduction

Imagine a world where students are taught in economic courses, not only to maximize profit but to protect the planet, ensure social equity, and foster long-term sustainability.

Yet, today's economics education ignores these critical aspects, leaving future leaders unprepared for the urgent global crises we face. Economics and climate change intersect with many other disciplines i.e., environment, labour, behaviour economics, industrial organization, economic history and more (Green, 2013).

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The climate crisis is one of the most pressing global challenges of our time, because human activities, including the burning of fossil fuels, deforestation, and industrial expansion, have significantly accelerated climate change, leading to a period of unparalleled environmental upheaval (Shine & Forster, 1999) (Driga & Drigas, 2019) (Oreggioni, et al., 2021).

Its impact is undeniable, and if we do not take effective action, it will have catastrophic consequences for the environment, economies, and societies worldwide.

Nowadays, many young people and children are experiencing climate anxiety, which is disrupting their basic daily functions. They feel distressed and frustrated by what they see as insufficient action from governments on climate issues, leading to fear and concern about the future (Hickman, et al., 2021).

As such, integrating climate change and ecological issues into economics education is no longer optional, but essential. Traditional economic curricula have often put in periphery these topics, focusing on market efficiency and growth, leaving students unprepared to address the realities of today's interconnected world.

Mathur (2021) also argues that the world is facing a climate crisis driven by rising greenhouse gas emissions, largely due to unsustainable consumption patterns. Human demand for resources is now exceeding the planet's ability to regenerate them each year. To combat this, urgent action is needed to transition to a circular economy that prioritizes sustainable resource use, relying on individuals to adopt more environmentally conscious consumption behaviours. Romero-Perdomo (2022) emphasizes the vital role of the circular economy in tackling the global climate challenge, by highlighting waste management as a key element of the circular economy, closely tied to climate change mitigation, while also pointing out that food production is a significant source of greenhouse gas emissions.

Both studies, highlight the urgency of transitioning to sustainable economic practices, in order to prepare students to lead in an era of ecological and economic transformation.

After a previous paper where I examine various alternative teaching methods in economics, such as art, literature, the use of YouTube videos, educational games, movies and even poetry, this paper shifts focus to the integration of climate change and ecological issues within economics classrooms (Gjini, 2024).

This paper explores the need to incorporate climate crisis topics into economics education, emphasizing the importance of reshaping the discipline for the 21st century. It aims to analyse the current treatment of these topics and propose more effective approaches to equip future economists with the tools to address environmental challenges. This paper tries to open a broader conversation, advocating for a fundamental reform of economics education. It

argues that to prepare future economists for the challenges of a rapidly changing world, the discipline must embrace a more interdisciplinary approach—one that prioritizes sustainability and equity alongside traditional economic concerns. By integrating climate change and ecological issues into economics curricula, students will be able to create solutions that promote both economic prosperity and environmental stewardship, ultimately fostering a more just and resilient global economy.

The remainder of the paper is structured as follows: *section two* provides a literature review on the integration of climate change in economics education. *Section three* outlines the methodology. *Section four* focuses on transforming economics education. *Section five* concludes with recommendations for a more sustainable and inclusive economics education.

2. Literature review

2.1. Influence of economics and its limitations

Economics, as a social science is viewed as particularly influential, due to its important role in shaping policy, its presence within government institutions, and its impact on the frameworks used in policymaking (Fourcade et al., 2015) (Hirschman & Berman, 2014).

The field of economics has experienced a profound and unprecedented failure, which can be understood in two key aspects. First, economists have significantly influenced the design of the global economic system, both through their direct involvement and the widespread adoption of their theories, contributing to its eventual breakdown. Second, economists largely failed to foresee the scale of the Global Financial Crisis (2007-2008), with only a few exceptions, even when early warning signs were already present to those closely monitoring the situation. This oversight has led to a considerable loss of confidence in the economics profession, highlighting the urgent need for a complete rethinking and restructuring of economic practices and thought (Reardon, 2009) (Fullbrook, 2009).

Colander (2005) examines the gap between what is taught in undergraduate economics courses and what professional economists actually do in practice.

He argues that economics education often emphasizes abstract theoretical models, while economists in real-world settings engage more with policy, empirical work, and pragmatic problem-solving.

To better equip students for professional careers, there is the need for a curriculum shift that aligns academic teaching with the practical skills and diverse methods economists use outside academia (Colander, 2005).

Since Green's (2013) observation about the absence of sustainability issues in economics textbooks, things have changed, because teaching materials and curricula in economics have increasingly integrated sustainability as a central

theme, reflecting growing awareness of the environmental and social dimensions of economic activity.

In *The Value of Everything*, Mazzucato (2018) argues that traditional economics often misdefines value, focusing too often on profits and markets while undervaluing contributions from government and the public sector. This narrow view influences policies, leading to an economy that rewards profit-driven activities rather than promoting sustainable, shared growth. Mazzucato (2018) suggests redefining what we consider valuable to recognize the roles of all sectors in driving progress and to shape policies that better support long-term societal well-being.

Kay and King (2020) argue that traditional models rely too much on quantifiable data, often overlooking the unpredictable nature of real-world complexities. The authors propose a shift toward decision-making that embraces uncertainty, using judgment and adaptability rather than solely relying on numbers to navigate an unpredictable world.

2.2. Addressing 21st century environmental challenges

During recent years, researchers have covered topics such as water issues, pollution, climate change, and ecological citizenship which underscore the importance of transforming economics education to better prepare students for addressing 21st century challenges (Zackary, 2020).

The effects of climate change are becoming more pronounced and are now impossible to ignore (Fox & Thomas, 2023). Rising temperatures, extreme weather events, sea level rise, and ecosystem disruptions are clear signals of its widespread impact.

Abazi Sinanaj and Hazizi (2023) analyse Albania's experience with investment and its impact on CO_2 emissions, illustrating the challenges and opportunities of balancing economic growth with environmental goals.

Their findings provide a valuable case for teaching students about complex sustainability trade-offs in economic planning, underscoring the need for curricula that address both economic and ecological outcomes.

In order to enhance students' understanding of the complex relationship between economics and environmental sustainability Green (2013) suggests three approaches when introducing sustainability concepts to students. One approach is the use of a world cloud to visually highlight key concepts. An other one is to start from an ecological perspective which can establish a foundational context for sustainability. Finally, an other approach is weaving ecological systems into discussions of specific economic topics.

The book '*Economy of the Earth*' by Sagoff (2007) examines how economics, environmental philosophy, and law are interconnected, stressing the

importance of considering ecological values when making economic decisions. He argues that economic education should teach students about the ethical responsibilities related to using natural resources and protecting the environment. Also, the book calls for a new perspective in economics, where the environment is viewed not just as a resource to exploit, but as something that requires careful stewardship, incorporating the idea of ecological citizenship into economic thinking.

Moreover, Raworth (2018) focuses on how education systems can incorporate better the ecological citizenship and sustainability principles, in order to prepare students for the environmental challenges ahead. It discusses various educational approaches to embedding ecological issues into curricula, highlighting the need for interdisciplinary learning.

Economics education needs transformation, by addressing contemporary environmental challenges through a more holistic and sustainable lens (Raworth, 2018).

2.3. Shortcomings of traditional economics textbooks in addressing climate change

Today's use of traditional economic textbooks is often criticized, because they present an oversimplified and idealized view of markets that fails to address important issues like climate change, inequality and systematic instability. They also argue that the curriculum rooted its concepts in the mid-20th century and has not evolved since then. They also, state that these textbooks often ignore behavioural insights, real-world complexities, and the importance of ethics in economic choices (Bowles & Carlin, 2020).

Also, Goodwin, et al., (2000) discuss that mainstream economics textbooks often focus narrowly on mathematical models and idealized markets, missing essential real-world issues like environmental sustainability, social equity, and ethics.

Climate change poses a serious and immediate threat, with its effects already evident and likely to be devastating without immediate action.

By prioritizing education, innovation, and by undertaking climate commitments, we can try to safeguard the planet.

The field of economics must undergo significant transformation to address today's critical issues, and the COVID-19 pandemic has only highlighted this necessity (Alves & Kvangraven, 2020).

Traditional economics textbooks treat environmental concerns as peripheral, leading to complacency about urgent ecological challenges (Barry & Morgan, 2022).

Other critiques come for the traditional education, especially economics textbooks, for not addressing sustainability in a meaningful way. Education

should take a more integrated approach, connecting sustainability with all subjects, not just as a separate topic. There is the need for a shift in how we teach, encouraging a system that prepares students to tackle sustainability challenges in the real world (Sterling & Orr, 2001)

Some economics textbooks generally mention climate change or global warming, many of them classify it as a market failure, or include it into chapters on externalities and public goods (Liu et al., 2019).

Böhm et al., (2012) also, criticizes the economic treatment of climate change, particularly the way carbon markets are presented as solutions. They argue that these markets, instead of addressing the root causes of environmental degradation, often exacerbate the problem by commodifying nature.

Tim Jackson in "*Prosperity without Growth"*, analyses the traditional model of economic growth, arguing that it is incompatible with environmental sustainability. He proposes that economics should prioritize well-being and ecological balance over continuous growth, which often leads to resource depletion and environmental harm. An alternative framework emphasizes sustainable living, advocating for policies and practices that support long-term ecological and social health, providing a foundation for rethinking economic curricula in light of climate and ecological challenges (Jackson, 2016).

3. Methodology

This paper employs a theoretical and conceptual approach to explore the integration of climate crisis and ecological issues into economics education. The paper focuses on three key areas of reform: transforming how students are introduced to economics, diversifying economic thinking and learning, and re-envisioning teaching and assessment methods to foster critical thinking.

Given that this research does not involve data collection, the methodology focuses on a review of existing literature, theoretical analysis, and the application of educational and economic frameworks to understand how these reforms can be integrated into economics curricula.

This paper examines how economics education can become more interdisciplinary and people-centered by integrating the climate crisis and ecological issues into the classroom. It investigates how the adoption of a pluralist approach can broaden students' understanding of economic concepts, emphasizing ethical, social, and environmental dimensions alongside traditional market efficiency models.

Additionally, it analyses how these methods can facilitate critical thinking and prepare students to apply economic theories to real-world issues.

This paper, by addressing these research objectives, contributes to the field of economics education by providing insights into the integration of

sustainability and ethical thinking into economics classes. The findings can contribute by informing other researchers of the field with practical recommendations to better prepare students in an evolving global economy.

4. Transforming economics education

We must adopt a broader and more inclusive framework that captures the true wealth and well-being of societies, not focusing only on GDP as the sole measure of progress. We must recognize that the health of the environment is a key factor in sustainable development and integrate natural capital and ecosystem services into economic assessments. Also, expanding cost-benefit analysis to account for environmental impacts ensures that the costs of ecological degradation are included into decision-making processes, making policies more reflective of the true costs to society.

Additionally, we must focus on intergenerational equity and long-term sustainability which should guide economic planning, emphasizing that the choices we make today must not compromise the ability of future generations to meet their own needs. This shift in perspective will help create a more holistic approach to economic progress, one that values both human and ecological well-being.

Economic courses, must provide a valuable opportunity to reshape the way students think about economics, emphasizing sustainability and environmental stewardship alongside traditional economic concerns.

In microeconomics, the focus can shift toward understanding how individual economic agents and firms interact with their environments. Examples relate to externalities and environmental costs, market failures in environmental protection, carbon pricing and emissions trading. Also, green consumer behaviour and decision-making can be examined to show how consumers' environmental preferences influence markets and how businesses may respond to these shifts in demand through product innovation or sustainability initiatives. Moreover, the circular economy principles can be discussed to highlight how shifting from a linear "take, make, dispose" model to a circular model of reuse, recycling, and sustainability can lead to both environmental and economic benefits.

In macroeconomics, the scope broadens to address how environmental considerations influence national and global economic systems. Students should be encouraged to evaluate how economic performance should reflect the health of natural resources and ecosystems. Sustainable development metrics can be introduced to show that measuring economic success requires more than just growth, emphasizing long-term sustainability, quality of life, and environmental preservation. The impacts of climate change on economic growth can be explored to understand how changes in climate affect sectors like agriculture, infrastructure, and labour productivity, which in turn

influence national economies. Also, green jobs and industrial transformation and international trade and environmental standards can be examined.

4.1. Changing the way students are presented with the economics field

It is essential to reconsider how economics is introduced to students. Traditional methods of teaching, often rooted in classical theories and rigid frameworks, may fail to resonate with the diverse and evolving needs of students. Shifting the presentation of economics requires a move toward more interactive, real-world applications that highlight its relevance across various sectors of society. For example, the challenges faced by Albania's natural tourism sector—such as limited financial resources, regulatory hurdles, and insufficient infrastructure—underscore the complexities of achieving sustainable economic growth in developing regions (Sinanaj Abazi et al., 2024).

By integrating case studies, global economic challenges, and practical simulations, students can better appreciate the dynamic nature of economics. This approach also allows students to develop critical thinking skills and a deeper understanding of economic principles as they apply to current events. Additionally, presenting economics through multidisciplinary lenses—such as health economics, environmental economics, and digital economics—enables students to see the wide range of opportunities and areas of impact within the field.

4.2. Diversifying economic thinking and learning

To truly engage students, economics education must embrace a broader range of perspectives. This includes diversifying the voices and ideas that shape economic discourse. Traditionally, economic theory has been dominated by a narrow set of perspectives, often overlooking the contributions from underrepresented groups or alternative schools of thought. By incorporating diverse economic models, including feminist economics, behavioral economics, and institutional economics, educators can provide students with a more nuanced understanding of the field. Additionally, embracing global economic perspectives, particularly those from emerging and developing economies, allows students to appreciate the interconnectedness of the world economy and its complex challenges. This diversification enriches the learning experience and prepares students to tackle multifaceted economic problems in a variety of contexts.

4.3. Re-envisioning teaching and assessment methods

In re-envisioning how economics is taught, it is crucial to rethink both teaching methods and assessment approaches. The traditional lecture-based format may no longer be sufficient for fostering deep understanding and engagement in

today's classroom. Active learning techniques, such as group discussions, collaborative projects, and problem-solving exercises, encourage students to apply economic theories to real-world problems, fostering greater engagement and learning retention. Moreover, assessment methods should reflect the shift toward a more interactive and applied approach. Rather than relying solely on written exams, assessments should include project-based evaluations, presentations, and peer-reviewed work, allowing students to demonstrate their ability to synthesize knowledge and communicate economic ideas effectively.

Kioupi and Voulvoulis (2022) introduce an assessment framework to evaluate and enhance sustainability competencies within university programs, particularly in postgraduate courses. They emphasize that diverse assessment methods can actively build these competencies. However, they recommend further pedagogical research to determine the framework's adaptability to programs with varying degrees of sustainability integration, including undergraduate levels (Kioupi & Voulvoulis, 2022).

By adopting more varied and flexible teaching and assessment strategies, educators can foster a more inclusive and dynamic learning environment that better prepares students for the challenges they will face as economists in the real world.

5. Conclusions and recommendations

In this paper, we set the stage by recognizing the urgent need for a transformative approach to economics education—one that equips students with the tools to address pressing global challenges like the climate crisis.

As discussed, the current economics curriculum falls short in preparing students to confront environmental degradation, social inequities, and unsustainable growth. By integrating climate change and ecological issues into economic thinking, we can align the discipline with the needs of a rapidly changing world.

The recommendations outlined aim not only to address gaps in existing curricula but also to reframe how we view economics. Incorporating sustainability, equity, and long-term resilience alongside traditional economic concerns is crucial for fostering solutions that are both economically sound and ecologically responsible. Moving beyond GDP as the sole measure of progress to embrace alternative metrics will better reflect the health of our ecosystems and communities.

As we face unprecedented environmental challenges, we must decide: will we continue to teach outdated economic models, or will we foster a generation of thinkers who understand the true cost of environmental destruction and the need for balanced progress?

To prepare students for future complexities, it is essential that economics education evolves to integrate climate change, ecological stewardship, and social equity into its core. This shift is not just theoretical—it is a practical necessity for the future of the global economy, the health of our planet, and the well-being of future generations.

The paper also highlights the importance of incorporating climate change into both micro and macroeconomics.

Furthermore, a shift in teaching methods is crucial. Adopting interactive, real-world applications and diversifying economic perspectives, will better prepare students for the complexities of global challenges. Active learning and project-based assessments can deepen engagement and allow students to apply their knowledge practically.

Integrating sustainability and ethical thinking into economics education offers an opportunity to reshape the field to better serve both society and the planet. By focusing on long-term sustainability and environmental stewardship, economics can become a tool for building a more just and resilient global economy. Future economists will be equipped to address ecological challenges and contribute to a more sustainable world.

Future research should explore the effectiveness of these educational changes. Case studies, longitudinal studies on graduates' career outcomes, and cross-cultural comparisons will provide valuable insights into the real-world impact of these reforms.

Notes on Contributors

Since 2011, I have been an Assistant Professor at the University of Elbasan ‘Aleksandër Xhuvani’ in Albania. I have a PhD from the University of Tirana in 2019, specializing in economics, with a focus on econometrics, SMEs, development, health economics, and statistical modelling. My research builds upon my doctoral work on productivity enhancement and SME support, extending into mathematics, statistics, and interdisciplinary fields.

In 2015, I was awarded the Basileus IV Erasmus Mundus PhD scholarship at the University of Ghent, Belgium. I have also participated in various Erasmus+ collaborations and lectured as an invited auxiliary professor in the CEEPUS program in Debrecen, Hungary.

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Exploring the Tirana Citizens' Intention to Use Shared Micro-mobility Practices: Case of a Private University from Albania, with a Consideration of Pro-environmental Practices

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Abstract

Congestion in urban regions is getting worse due to rising vehicle ownership, population growth, and increased transportation demand. Even in the metropolitan cities of the Western Balkans, particularly in Tirana, the capital of Albania, this phenomenon has been reported. The shared mobility approach has evolved as a service that allows individuals to use mobility on an "as-needed" basis. A micro-mobility service called shared e-bicycle / e-scooter allows the short-term renting of e-bicycles / e-scooters. This paper offers a thorough analysis of the current state of the situation regarding short-term renting of e-bicycles / e-scooter applications' challenges and opportunities, consumers' needs, socio-economic and environmental impacts, and policy. An online survey is used to identify the real needs, challenges, and opinions of the target group about the potential usage of e-bicycles and e-scooters for short-term rental purposes. The results of the survey, as well as the analysis of the current policies and practices in Tirana, will help identify the pros and cons related to the short-term renting of e-bicycles / e-scooters, as well as to evaluate the potential socio-economic and environmental impact in the country.

Keywords: *micro-mobility, environment, urban economics, consumer, health*

JEL code: R400, Q0, I180

1. Introduction

In developing countries, additional factors complicate urban mobility. Weak enforcement of traffic rules and regulations often contributes to the severity of congestion and reduces the effectiveness of management efforts. In many cases, inadequate resources, infrastructure, and regulatory frameworks make it difficult for transportation engineers and urban planners to implement and sustain effective mobility solutions (Wang et al. 2018). This lack of enforcement can lead to hazardous driving behaviors, increased accident rates,

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and heightened traffic inefficiencies, further exacerbating the socioeconomic impacts of poor urban mobility (Ahmed et al.2023).

Tirana, the capital of Albania, has become a focal point in the country's efforts to address urban mobility and sustainability issues. With approximately one-third of Albania's population (31.6%) residing in the Tirana prefecture, the city's rapid growth has led to an increase in vehicle use and a significant shift in mobility patterns over the last two decades (INSTAT, 2023). Formerly a city reliant on walking, Tirana now sees around 140,000 motor vehicles circulating daily, which has brought new challenges related to road congestion, air pollution, and parking shortages (Harris, 2019). As mobility demands grow, these issues underscore the need for sustainable transport alternatives to mitigate the environmental and social impacts of a motor vehicle-dominated urban landscape (Pojani, 2011).

As a consequence, there is an immediate need to take sustainable actions and/or implement targeted policies that reduce the negative impacts of increased urban mobility. However, prior research is needed to navigate pathways of solution, and this study aims to provide insights into how shared e-micro mobility practices can be utilized in Tirana to improve the urban mobility situation. Additionally, it aims to identify the key challenges and opportunities related to this practice of commuting.

This research paper is organized in four sections. The literature review chapter provides an overview of micro-mobility solution, their benefits, their main challenges and the developments in Albania. In the methodology section there are provided details regarding the academic research, methods, tools and analysis used. The analysis and discussion section analyses the findings from the survey, indicates the consideration for further research and how similar thematic studies' components at a global level can be aligned with this research. Lastly, conclusions and recommendations summarize the major findings, while providing practical recommendations on developing urban mobility policies and taking specific actions that align with public health and environmental goals.

2. Literature review

2.1. Overview of micro-mobility solutions

According to the Institute for Transportation and Development Policy (ITDP), micro-mobility refers to a range of small, lightweight devices operating at speeds typically below 25km/h and ideal for trips up to 10km (ITDP, 2024). Micro-mobility can be human-powered or electric, and these solutions include bicycles, e-bicycles, scooters, and e-scooters that could be privately owned or shared.

Shared micro-mobility systems, which have recently gained significant popularity in urban areas, offer fleets of the vehicles mentioned above to the public, through docked or dockless systems accessed via smartphone applications. The variety and availability of such services in major cities worldwide have grown rapidly (Research and Markets, 2024), allowing an increasing number of users (Mobility Portal, 2023) to choose between several modes and companies. Shared micro-mobility solutions have also seen rapid expansion across European cities, providing alternatives to traditional transport. Major providers include Bird, Lime, Voi, Tier, Dott, and Bolt (Micro-Mobility for Europe, 2024), each offering a range of vehicles such as e-scooters, e-bicycles, and e-mopeds.

Lime, for instance, utilizes a dockless model, enabling users to park vehicles in designated zones. Voi encourages responsible usage with city-specific safety tutorials. Tier stands out for its sustainability efforts, including the use of swappable batteries and a carbon-neutral operation plan. Dott emphasizes worker rights and sustainability, opting for in-house maintenance and end-of-life recycling. Bolt focuses on affordability and convenience by offering a multi-modal transport platform that integrates ride-hailing with micro-mobility solutions.

2.2. Benefits of micro-mobility in urban areas

As urban populations continue to grow and fuel costs rise, micro-mobility offers a viable solution to the escalating issues of traffic congestion and environmental impact. These systems have demonstrated their ecological benefits (Kermani, 2023), operational efficiency (ITF, 2024), and cost-effectiveness (Shaheen et al., 2020). With more cities adopting and regulating shared micro-mobility networks, they have the potential to transform urban mobility, providing a more sustainable and efficient way for people to navigate cities.

According to the EU Urban Mobility Observatory, some of the most important benefits of micro-mobility are related to congestion, sustainable transport, costs, access to opportunities, urban space, and economic activity (EU Urban Mobility Observatory, 2020).

Resolved road congestion

One of the primary challenges that micro-mobility transportation systems address is road congestion (Zhao et al, 2022). As urban populations grow and personal transportation becomes more common, the number of vehicles on main roads increases, exacerbating traffic. Road congestion not only wastes valuable time but also hampers productivity for both individuals and businesses (INRIX, 2018).

Micro-mobility options like electric scooters and bicycles provide a solid alternative that reduces the number of vehicles on the roads. Since most micro-mobility users avoid main roads in favor of alternative routes, traffic flow improves, benefiting both commuters and the broader urban transport ecosystem (Zhao et al, 2022). For users, e-scooters and e-bicycles offer the advantage of bypassing traffic, enabling quicker travel to their destinations.

Promoting eco-friendly transportation

A significant benefit of integrating micro-mobility devices into urban areas is their positive environmental impact (Comi and Polimeni, 2024). As traffic congestion decreases, fewer conventional vehicles emit harmful gases such as carbon dioxide and other greenhouse effect gases.
Road transportation is responsible for 23% of global carbon emissions (IEA, 2020), making it a major contributor to air pollution. Micro-mobility devices, which do not rely on internal combustion engines and do not consume fuel, produce no harmful emissions. A study, which is said to be the first ever Life Cycle Assessment (LCA) of an e-scooter in use in a major European city, finds that e-scooters with swappable batteries generate 34.7g CO2 equivalent emissions per person per kilometer across the full lifecycle. In contrast, a new petrol car will generate between 200-350g CO2e/km per person per kilometer (Holve, 2021).

Affordable Personal Transportation

In terms of affordability, using micro-mobility devices as e-scooters and e-bicycles is more affordable than using other devices such as cars, including owning or renting them. These vehicles have fewer parts and do not require fuel, making them cheaper to maintain and operate (ITDP, 2021). This cost-effectiveness has made micro-mobility devices popular among university students, young professionals, and low-income individuals who require affordable transportation in urban areas (Sarker et. Al). With lower operational costs, e-scooters and e-bicycles offer an efficient, low-cost transportation alternative for both city dwellers and suburban residents. When shared they can be even more affordable, without any initial buying, maintaining cost and it is used only when needed.

Enhancing Access to Opportunities

The availability of shared micro-mobility services provides greater access to opportunities for workers, students, tourists, and residents. Companies like Lime, Neuron, Beam, etc., make it easier for commuters to access e-scooters and e-bicycles anytime and anywhere.
A survey conducted by Lime in Washington, DC found that 44% of riders used shared e-scooters to commute to work, while 57% used them for work and

school. Additionally, 29.3% of tourists reported using e-scooters to visit local shops (Lime, The Lime Times, 2019). These statistics highlight how micro-mobility can improve access to various opportunities, whether for daily commuting or leisure activities.

Urban spaces utilization

Compared with cars, micro-mobility vehicles have a far smaller physical footprint when used and parked (Comi & Polimeni, 2024). They are also highly utilized, often by up to 10 people per day – whereas cars usually have one occupant and will only be driven 4% of the time (EU Urban Mobility Observatory, 2020). This difference between micro-mobility and the traditional one might also open up more urban space, allowing urban roads to be reallocated to public transport, pedestrian zones, parks, playgrounds, or green areas.

Boosting Economic Activity

By providing a more efficient mode of transportation, micro-mobility can have a positive effect on the overall economic activity of a city. A survey by Lime revealed that 72% of e-scooter riders use shared e-scooters to visit local shops and attractions (Lime, Official One-Year Report, 2018). Furthermore, research from Emory University's Goizueta Business School found that shared e-scooter schemes contribute significantly to local economies, boosting sales for food and beverage establishments (Emory Business, 2021). Micro-mobility services can enhance urban economies by increasing foot traffic to businesses, highlighting their potential economic benefits for both individuals and commercial establishments.

2.3. Challenges of micro-mobility

The implementation of micro-mobility practice is associated with numerous challenges perceived by the users (Du et. al, 2013). Among them, two of the most important identified in literature, include safety concerns and regulatory framework (Bridge, 2023).

Safety concerns

Safety is a significant concern regarding micro-mobility, especially considering the speeds that e-scooters can reach (Bridge, 2023). Between January 2018 and July 2020, at least 11 fatalities were reported in Europe due to e-scooter accidents; while in Paris only, e-scooter-related injuries ranged from 150 to 200 per month (EU Urban Mobility Observatory, 2020). Contributing factors include limited helmet use, poor road conditions, high speeds, inexperienced riders, and unclear traffic regulations (White E. et. al, 2023) (Paola Longo, Nicola Berloco, Stefano Coropulis, Paolo Intini, 2024).

However, an analysis by the International Transport Forum (ITF, 2020) found that the risk of fatality on a shared standing e-scooter is not considerably higher than that of a bicycle, although they emphasized the need for further research on the subject. The ITF's report also outlines safety recommendations, which focus on increasing awareness among road users, redesigning street layouts, improving vehicle design and operation, and ensuring stricter enforcement of safety rules.

Regulatory framework

Shared micro-mobility is a dynamic and rapidly evolving concept, encompassing a range of vehicles including bicycles, e-bicycles, cargo bicycles, e-scooters, and whatever new modes emerge in the future. Thus, the process of regulating shared micro-mobility highlights the challenges that arise when a novel form of transportation attempts to integrate and scale within a system traditionally dominated by private car usage. The core issue moving forward is not only how we regulate these emerging modes of transport, but also how much longer we are willing to maintain the car-centric infrastructure and road regulations that have shaped our cities. This legacy, which was designed for private cars, is now proving to be a significant barrier to the innovation and evolution of urban mobility systems (POLIS, 2023).

2.4. Impact of micro-mobility on health

Shared micro-mobility services, including e-scooters and e-bicycles, have significant health impacts on urban populations by promoting active transportation, offering an eco-friendly and convenient alternative, and reducing pollution from car emissions, which benefits respiratory health. Research shows that e-scooters and e-bicycles can reduce urban congestion, lower carbon emissions, and improve air quality, directly contributing to public health improvements through lowered emission levels, especially in densely populated areas (Bozzi & Aguilera, 2021).

For instance, a Forbes article highlights the environmental benefits of e-scooters, suggesting that their adoption could be instrumental in decreasing pollution levels in densely populated areas by replacing short car trips with zero-emission rides (Eggert, 2020). However, realizing these environmental benefits hinges on responsible usage and effective policies, as the lifespan and maintenance of these devices play a crucial role in maximizing their positive environmental impact.

2.5. Current state of shared micro-mobility in Tirana

The Sustainable Urban Mobility Plan (SUMP) for Tirana emphasizes micro-mobility practices to address congestion and enhance urban livability. Key strategies include expanding bicycle-sharing schemes, improving pedestrian

infrastructure, and integrating e-scooters to encourage non-motorized transport (SUMP Tirana, 2020). By creating dedicated bicycle lanes and promoting alternative travel options, the plan aims to reduce car dependency, improve air quality, and make the city center more accessible (Seitllari & Luga, 2016). This approach aligns with broader sustainability goals, fostering healthier, more efficient movement across Tirana's urban spaces.

In response to these challenges, Tirana's municipality has launched initiatives aimed at integrating micro-mobility services into the city's transport system. One prominent project is Ecovolis, a community bicycle-sharing program that offers a low-emission alternative to traditional transport. Ecovolis began with the support of local and international organizations, specifically the Albanian PASS organization and Pedal for Progress, a US-based nonprofit that donated 450 bicycles to the initiative (Ecovolis Project, 2011). Sixty of these bicycles were repurposed and painted by local technicians to serve as public bicycles in the Ecovolis system, providing an affordable and accessible transport option for residents. The project's success has been amplified by activities like Tirana's participation in European Mobility Week, which raises awareness of sustainable mobility practices and encourages public involvement in alternative transport (European Mobility Week, 2014).

Ecovolis and other emerging micro-mobility options, such as e-scooters, recently provided by companies like BinBin Scooters, reflect a broader commitment by the Tirana municipality to reduce car dependency (BinBin Scooters, 2024). By collaborating with private organizations and actively involving the public, the city aims to improve air quality, decrease traffic congestion, and reduce the demand for parking. These initiatives represent a shift toward a more sustainable urban infrastructure, designed to enhance public health and support cleaner transportation methods. As Tirana continues to explore innovative mobility solutions, its approach to sustainable transport could serve as a model for similar urban centers facing rapid population growth and increased environmental pressures.

3. Methodology

For the preparation of this paper, it is chosen a private university in Tirana as a case study. The purpose was to take the case of an organization with over 200 employees or students, to guarantee a large sample. In addition, the selected university's population represents a broader distribution of demographics and behavior of Tirana's residents. For instance, a wide range of ages, addresses, and different attitudes to commuting are involved in this case.

The authors have designed a Google Form survey, based on the findings of the literature review and their research objectives. It contains 17 questions and it

is separated into 3 sections. The first one is mainly focused on the general and demographic characteristics of the participants. In the second section, the respondents are asked for the frequency of use of different types of transport to commute to work or school. The last section concentrates on the challenges and benefits of shared e-micro mobility. There are 3 open questions, two regarding the distance and address and the last about potential additional comments.

The survey is delivered to internal databases of the university's students and staff and 218 valid responses are collected during the period July - September 2023. To ensure the avoidance of conflict of interest of the authors with people within the organization, the survey is delivered to participants by the Rector's Office, without mentioning the name of the authors.

For analyzing the survey's responses, the descriptive statistical approach is followed. While, for the last open question, a qualitative analysis has been made, through the categorization of responses in similar groups. In addition, with the aim of identifying any potential correlation between the variables, the authors have made several tests through the STATA program. The authors have been particularly interested in testing correlations between the key variables of the study through Pearson's correlation test.

4. Analysis and Discussion

In the survey conducted, a total of 218 valid responses are collected, where the majority of 73.9% are responses from students. The rest of 18.8% and 7.3% are responses collected respectively from the academic and administrative staff of the university. The group of students has an average age of 21 years old, while the average age of the staff respondents is 40. In general, the age distribution varies from 18 to 72 at the maximum. Whereas, the gender of the respondents is almost balanced, with 111 females and 107 males.

From the responses, it results that, on average, the university's staff and employees require 36 minutes to go from their home to university and vice versa, by using their frequent mode of transport. The standard deviation is almost 24 minutes. Considering that some of the students and employees are coming from the suburbs or cities around Tirana, if their responses are not counted in the analysis, the rest of 175 respondents, who live in the metropolitan city of Tirana, need around half an hour to reach the university from their own homes.

Almost half of the participants in the study do not own any vehicle to commute. The most popular vehicle they have is the traditional car, owned by 31.65% of them. More than half of the academic and administrative staff own a traditional car. The second most popular vehicle owned by 11.5% of

participants is the traditional bicycle. Only 3.2% of respondents own an electric scooter, while e-bicycles are owned by 1.4% of them. Based on these possessions and their responses, it is logical that the university's staff and students are mainly practicing walking, public transport (bus), and own or family car driving, as the most popular modes of transport. While shared mobility is rarely used and 81.2% of the respondents declare that they never use it as an option. Below it is shown a graph that represents the frequency of shared mobility usage by respondents, where "0" represents "never" and "5" stands for "everyday".

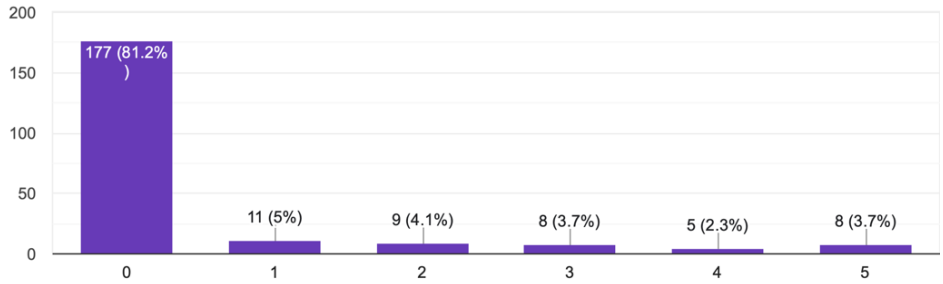

Figure 2. Frequency of using shared mobility (N=218)

Beyond their approach to commuting to work or school, participants are also asked about the benefits, challenges, interests and suggestions they might have regarding the implementation of micro-mobility scheme to commute towards the university as students or employees. Starting with the benefits, the participants have mentioned as the key outcomes of the proposed practice, the saving of time by avoiding traffic, reduced costs of transport, avoiding struggles for finding a parking spot and helping to protect the environment. The graph with the full information is presented below.

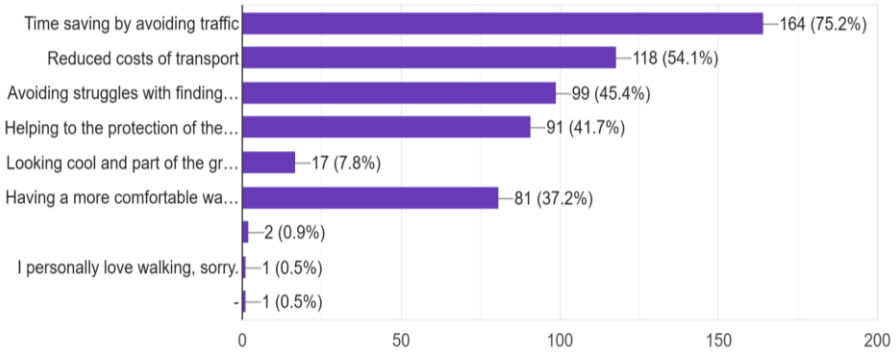

Figure 3. Benefits of shared micro-mobility (N=218)5

When it comes to challenges, the participants jointly agree that the biggest ones are related to safety risks and accidents, insufficient infrastructure for riding and parking, theft or vandalism of vehicles and lack of user education and awareness. A better overview of the results is presented below. Participants are also asked about the significance of these challenges and the majority of 31.7% have remained in a neutral position. Only for 23.9% of them the importance is very significant, while for 14.7% it is important. For the rest of 29.8% the significance of the above-mentioned challenges is not significant at all or of low significance.

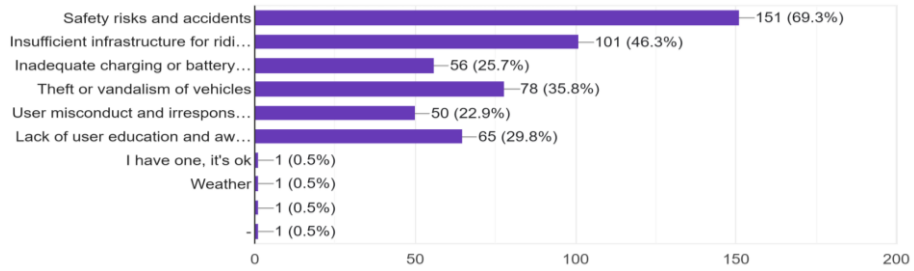

Figure 4. Challenges of shared micro-mobility (N=218)6

The interest of respondents in using shared e-micro mobility transport has a distribution among all 6 alternatives, starting from 0, which means "I am not interested at all", to 5, that means "I am very interested". The majority of 26.6% are not interested at all in this practice, while 43.2% are interested in

[5] The full alternatives presented on the vertical axes of Figure 2 are presented below:

- Time saving by avoiding traffic
- Reduced costs of transport
- Avoiding struggles with finding a parking spot
- Helping to the protection of the environment
- Looking cool and part of the group
- Having a more comfortable way to go to work / school
- Other

[6] The full alternatives presented on the vertical axes of Figure 3 are presented below:

- Safety risks and accidents
- Insufficient infrastructure for riding and parking
- Inadequate charging or battery life
- Theft or vandalism of vehicles
- User misconduct and irresponsible behavior
- Lack of user education and awareness
- Other

different levels from 3 to 5. A full overview of their interest is shown in the following graph.

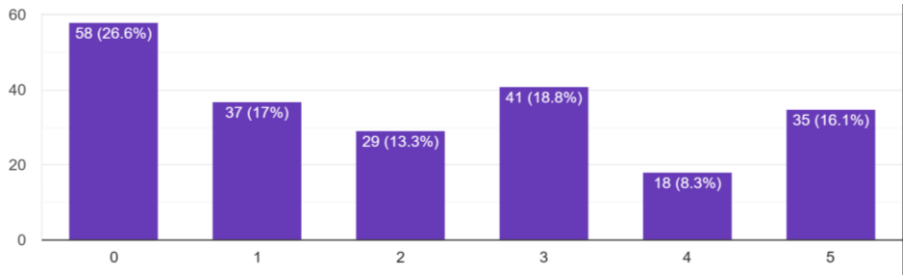

Figure 5. Interest level on using shared micro-mobility (N=218)

Several correlation tests are made through STATA, with the aim of understanding any useful potential correlation among some key variables, like distance, interest to use shared micro-mobility and significance of challenges. The results presented in the following table indicate that the three variables' correlation is weak. The correlation coefficients are very small, which shows the lack of strong connection among them. However, the strongest relationship has resulted in the interest to use shared micro-mobility and the significance of challenges that participants have mentioned, even though it is still a poor correlation.

| Distance Interest Significance

Distance | 1.0000

Interest | -0.1126 1.0000

Significance | -0.0509 0.1937 1.0000

Table 6. Pearson's correlation among key variables

The last question has been opened with the aim of gathering additional insights and comments from participants. Only a few participants have shown interest in this question and their responses mainly stressed the opinions they have previously had in filling out the survey. For instance, two to four respondents per variable have highlighted the traffic avoidance, time-saving and environmental protection as very impactful outcomes. On the other hand, a few challenges raised as important are related to the need for lower costs, concern about rainy days and the dangers of driving e-scooters. Twelve participants have mentioned safety regulations and the need for infrastructure as a first needed step for the implementation of this mobility practice. While

14 of them have reassured me of their positivity and enthusiasm for the success of usage of e- bicycles and e-scooters.

Despite the benefits, the rise of shared micro-mobility services presents significant safety and public health considerations. A study of JAMA for the period of 2014-2018 raises concerns about the safety of e-scooters and e-bicycles, highlighting risks from interactions with traffic and pedestrian spaces (JAMA, 2020). On the positive side, these devices encourage physical activity, as suggested in a systematic review on e-cycling health benefits, potentially providing cardiovascular and mental health benefits for users.

The data shows that nearly half of the respondents do not own any vehicle, yet less than 5% own an electric scooter or bicycle, highlighting the potential for promoting micro-mobility as a healthful and eco-friendly commuting option. Research by Harvard Health (2020) on e- bicycles and e-scooters emphasizes that micro-mobility can reduce physical inactivity, thus offering health benefits for users who might otherwise rely on cars. Increasing active transport modes like cycling could contribute to lower obesity rates and improve cardiovascular health outcomes among urban populations.

Additionally, in the global level e-scooters and e-bicycles are typically perceived as an environmentally friendly form of transportation that could lead to lower vehicle emissions and cleaner air in cities where they are being used (Zhu et.al, 2020). Furthermore, by decreasing private vehicle reliance, e-scooters and e-bicycles can help lower air pollution levels, aligning with goals outlined in sustainable mobility policies globally. Eggert (2020) suggests that e-scooters have the potential to replace car trips and help lower greenhouse gas emissions, as long as they are integrated sustainably into urban transportation systems.

5. Conclusions and Recommendations

Addressing the mobility challenges requires an all-inclusive approach to transportation engineering that includes better infrastructure, policy reform, and stronger regulatory enforcement. In developing urban areas, investment in public transport systems and updated technologies to improve the traffic flow could help reduce congestion and advance urban mobility toward a more efficient and sustainable model.

The Sustainable Development Goals (SDGs) on the environment focus on protecting natural ecosystems, addressing climate change, and promoting sustainable use of resources (United Nations, 2015). By focusing on these areas, policymakers can help mitigate the negative socio-economic and environmental impacts associated with rapid urban growth, making cities more livable and sustainable. Additionally, it is crucial to invest in appropriate

infrastructure, such as designated lanes, and enforce regulations that promote safe riding practices.

In conclusion, promoting shared micro-mobility services in a university setting can address urban transportation challenges, but this requires targeted policies and infrastructure support. Additionally, leveraging participants' recognition of the environmental and practical benefits of micro-mobility could serve as a best practice and a basis for educational campaigns or incentives aimed at increasing adoption rates. As cities like Tirana continue to seek sustainable transport solutions, insights from such studies provide a valuable basis for developing comprehensive urban mobility policies that align with public health and environmental goals.

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Assessing the Readiness of Self-Local Governments Units in Albania towards a Circular Economy Transition

Konalsi GJOKA[1], Teida SHEHI[2] , Kleant SEMEMA[3]

Abstract

The transition to a circular economy (CE) is critical for achieving environmental sustainability, with self-local government units (SLGUs) playing a pivotal role in this shift. This study assessed the current capacities of SLGUs in Albania to adopt CE practices, focusing on strategic planning, staff awareness, and implementation barriers. Through a mixed-method approach, including document reviews, surveys, and focus groups discussions with 27 municipalities, the study revealed that while SLGUs demonstrate initial integration of CE principles in general local and waste management plans, significant gaps remained in other strategic documents. Limited financial resources, insufficient trainings, and fragmented institutional coordination were identified as key barriers. Despite these challenges, there were strong interest among municipalities to enhance capacity-building efforts and adopt CE principles. The findings underscored the need for targeted trainings, financial support, and clearer national-to-local policy alignment.

Keywords: *Circular economy, green transition, Local government, Circular economy barriers and motivations, Local waste management plan, Local strategic documents, Assessing capacities of local government*

Jel code: Q01 & Q53 & Q56

1. Introduction

The global shift towards environmental sustainability and the circular economy (CE) has positioned self - local governments as pivotal actors in implementing CE strategies. Extensive research highlights the critical role of self-local government units (SLGUs) in waste management, policy innovation, and stakeholder collaboration (e.g., Cramer, 2020; European Commission, 2020). Cities such as Amsterdam and Paris have demonstrated how robust local frameworks can drive the circular transition (Sánchez Levoso et al., 2020; Palm & Bocken, 2021).

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Despite these advances, studies addressing the capacities of SLGUs in developing regions, particularly in the Western Balkans, remain scarce. Research by Licastro & Sergi (2021) underscored challenges such as limited resources and institutional barriers in smaller municipalities, yet little is known about how these constraints manifest in Albania's SLGUs. This knowledge gap called for a focused analysis of their readiness and challenges in transitioning from a linear to a circular model.

Despite existing studies highlighting the role of local governments in advancing circular economy principles, limited evidence exists on the capacities and challenges faced by SLGUs in Albania. This study seeks to answer the following research question: **To what extent are SLGUs in Albania prepared to facilitate the transition to a circular economy, and what are the key barriers and enabling factors in this process?**

By examining the strategic documents, surveying municipal staff, and conducting focus group discussions, this research contributes to bridging the gap in understanding SLGUs' roles in facilitating CE adoption.

2. Literature review

SLGUs play a crucial role and serve as key enablers in driving the transition to a Circular Economy (CE) by influencing policymaking, regulating waste management, and encouraging circular urban development.

SLGUs are responsible for translating national and international CE policies into local or regional actions (European Commission, 2020). They implement regulations related to waste management, recycling mandates, and circular urban planning. SLGUs set building codes, enact zoning regulations, and integrate circularity into public procurement policies, ensuring compliance with broader sustainability goals (Cramer, 2020).

For instance, municipalities in cities like Amsterdam and Paris have been at the forefront of integrating CE into their waste management strategies through comprehensive recycling programs and the introduction of circular public procurement policies (Cramer, 2020; Ruysschaert et al., 2020; Ranta.et.al., 2017). Furthermore, other initiatives in cities like Rotterdam encourage the integration of circular principles into the built environment, where circular construction is promoted through local regulations (Sánchez Levoso et al., 2020; Palm & Bocken, 2021).

SLGUs manage municipal waste collection and disposal systems, positioning them at the heart of CE efforts. They facilitate recycling, composting, and material recovery systems to convert waste into valuable resources, promoting the "Reduce, Reuse, Recycle" principles. By introducing separate waste collection and creating recycling hubs, SLGUs reduce landfill dependence and

foster resource recovery (Ranta.et.al., 2017). The European Commission's "Closing the Loop" Action Plan focuses on reducing municipal waste and increasing recycling rates, thereby pushing SLGUs to implement circular strategies. For example, Lithuania has developed infrastructure for waste sorting and recycling, driven by compliance with EU regulations (Dagiliene et al., 2021)

Financial incentives, such as grants, subsidies, and tax incentives, are essential enablers for LGUs to adopt CE. These economic tools reduce the initial financial burden of transitioning from linear to circular systems. Municipalities can benefit from European funds that promote sustainability, such as the Horizon 2020 Program, which finances innovation in waste management and resource efficiency (Dagiliene et al., 2021). Furthermore, the economic benefits of CE practices, such as job creation in green sectors like recycling and refurbishment, provide further motivation for local governments to engage with circular strategies (Bitter-Krahe et al., 2021). Cities like Amsterdam and Rotterdam have successfully integrated CE practices into their local economies, demonstrating how SLGUs can generate new economic opportunities by promoting circular business models (Cramer, 2020).

SLGUs are instrumental in educating and involving citizens in CE practices, encouraging introduction of circular cities practices such as recycling, repair, and reuse. They drive public awareness campaigns and set up participatory platforms, fostering a culture of sustainability within communities. Engaging citizens in CE initiatives ensures higher participation and ownership of circular activities (Palm & Bocken, 2021). In cities like Amsterdam and Barcelona, local governments have successfully engaged residents in circular practices by providing clear guidelines on waste sorting and recycling, as well as facilitating repair cafés and second-hand markets where citizens can repair or exchange goods rather than dispose of them (Sánchez Levoso et al., 2020). Furthermore, Amsterdam's Circular Innovation Program is a prime example of how municipalities can create ecosystems that support public-private partnerships and innovation in circularity. The city has worked closely with businesses to implement circular construction projects, public procurement strategies, and recycling initiatives, thereby leveraging the expertise of the private sector to scale CE practices (Cramer, 2020).

Another important role of local governments is leading by example through circular public procurement (CPP)**.** SLGUs have significant purchasing power and by prioritizing circular products and services, LGUs drive market demand for sustainable goods and influence broader societal behaviour. Cities like Amsterdam and Paris have adopted circular procurement strategies, mandating the use of recycled materials in public projects (Fratini et al., 2019). Cities like Rotterdam, Paris have implemented GPP in their infrastructure

projects, requiring that materials used in public construction are sourced sustainably and designed for reuse. By embedding CE principles into procurement, these cities have reduced the environmental impact while fostering innovation in circular building materials (Ranta et al., 2017).

SLGUs are key players in fostering innovation by collaborating with research institutions and promoting new CE technologies and practices. They support capacity-building programs for municipal staff and local businesses to ensure that CE initiatives are effectively implemented. Through knowledge transfer and technical training, SLGUs build local capacity to support circular projects (Jim Hart et al., 2019). For example, in the Western Balkan Region, the establishment of circular hotspots supports the integration of circular principles into urban planning and waste management (Bitter-Krahe et al., 2021)

While SLGUs are essential to the successful adoption of CE practices, they face several significant barriers that hinder their ability to fully implement circular strategies.

Implementing circular economy practices often requires considerable upfront investment in infrastructure, new technologies, and staff training. Many municipalities, especially smaller ones, face tight budgets, which limits their ability to invest in necessary waste management systems, circular procurement, or other CE initiatives (Dagiliene et al., 2021). Moreover, circular products and services tend to have higher upfront costs, which can deter municipalities from integrating them into their operations. Although circular initiatives can generate long-term savings—such as reduced waste disposal costs and increased resource efficiency—the initial capital investment often proves prohibitive for cash-strapped SLGUs (Vedvik, 2022; Ranta et al., 2017; Palm & Bocken, 2021).

In some regions, national or EU-level subsidies are available, but SLGUs may face challenges in accessing these funds due to complex application processes or lack of knowledge. For instance, smaller municipalities in Southern and Eastern Europe struggle to access EU grants aimed at promoting sustainability (Licastro & Sergi, 2021).

Self-Local governments often lack the technical knowledge and institutional capacity to design and implement CE strategies. The complexity of circular processes such as material recovery, reverse logistics, and circular urban planning requires advanced expertise that is frequently unavailable within local municipal administrations (Fratini et al., 2019). This gap is particularly pronounced in smaller municipalities, where there may be only a few employees tasked with overseeing environmental initiatives, often without specific training in CE principles (Dagiliene et al., 2021).

Moreover, misalignment between local, regional, and national CE policies can cause delays in implementation. For example, while national policies may set ambitious circular economy targets, these may not be supported with the necessary resources or frameworks at the local level, limiting the ability of SLGUs to meet these goals (Fratini et al., 2019). Additionally, conflicting priorities within different departments can hinder the development of integrated CE strategies that balance environmental sustainability with economic growth (Vedvik, 2022; Dagiliene et al., 2021)

Cultural attitudes toward consumption and waste disposal are deeply ingrained in many communities, posing a challenge for the adoption of CE practices. Public resistance to change, particularly the shift from a linear consumption model to one based on recycling, reuse, and repair, is a significant barrier (Palm & Bocken, 2021).

This cultural resistance extends to both the public and municipal institutions. Government employees, accustomed to traditional methods of waste management, may be reluctant to adopt new, untested circular processes. Changing this mindset requires comprehensive education campaigns that emphasize the long-term benefits of CE, but running these campaigns is resource-intensive and time-consuming (Mari Vedvik, 2022).

Another barrier to CE adoption is the underdevelopment of markets for circular products and services. In some regions, local suppliers may not yet offer products that meet circular procurement criteria, limiting the ability of SLGUs to adopt green procurement practices (Palm & Bocken, 2021).

Establishing circular supply chains requires coordination among multiple stakeholders, including private companies, waste management firms, and recyclers. If these supply chains are poorly integrated or lack necessary infrastructure, it becomes difficult for local governments to create efficient circular systems. This is particularly true in regions where recycling markets are still developing, or where there is limited access to secondary raw materials (Ruysschaert et al., 2020).

3. Methodology

This methodology provides a structured, participatory framework for assessing and promoting circular economy (CE) practices across self-local government units (SLGUs) in Albania. Out of 61 LGUs in the country, 27 participated in the study, categorized as small, medium, or large based on population size. The approach consists of three key steps tailored to local contexts and needs: (i) a screening process to assess the integration of CE principles in local strategic documents; (ii) a survey to evaluate SLGUs staff's understanding of CE principles in daily operations; and (iii) focus

group discussions to review findings and identify intervention areas to support Albania's CE transition.

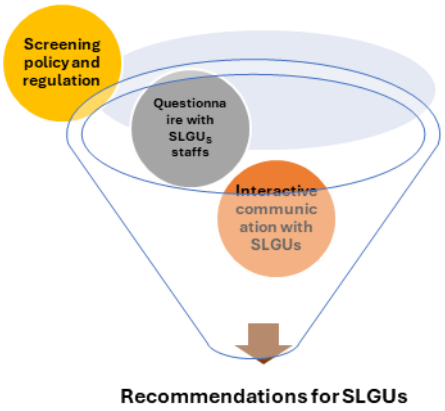

Figure 1. Methodology for assessing CE practices at SLGUs in Albania

Size of LGUs	LGUs
Small	Skrapar, Përmet, Tepelenë, Kolonjë, Memaliaj, Delvinë, Klos, Himarë, Mallakastër, and Mirditë
Medium	Vau Dejës, Prrenjas, Gramsh, Dibër, Berat, Maliq, Kavajë, Rrogozhinë, Kukës, and Gjirokastër
Large	Durrës, Shkodër, Elbasan, Lezhë, Fier, and Korçë

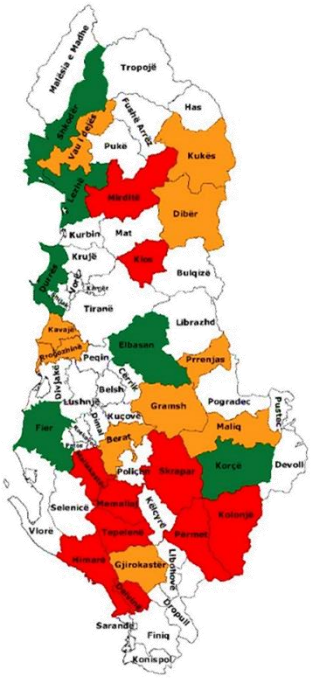

Figure 2. Municipalities participating to the study

The first step, the screening process, involved developing a methodology to review and assess the integration of circular economy (CE) principles in local strategic documents. Albania's national circular economy policy is outlined in the "Roadmap toward Circular Economy of Albania" (OECD, 2024), which identifies key sectors and corresponding national policies that support CE principles. For effective implementation, these policies must be adapted to the local level. Strategic documents developed, so far, by SLGUs in Albania covering sectors such as: (i) General Local Plan, (ii) Local Waste Management Plan, (iii) Local Mobility Plan, (iv) Local Greenery Plan, (v) Local Noise Control Plan, (vi) Local Lighting Plan, and (vii) Local Energy and Climate Plan, were identified and reviewed.

These documents were analyzed for the inclusion of three core CE principles. Each of the CE principles: i) minimizing waste and pollution; ii) keeping products and materials in use; and iii) regenerating natural systems was broken down into specific criteria and activities for evaluation. These criteria were derived from already established CE frameworks and tailored to self-local government planning contexts. Examples included:

- Minimizing waste and pollution: Inclusion of waste reduction targets or policies for separate waste collection.
- Keeping products and materials in use: Policies promoting recycling hubs or reuse initiatives.
- Regenerating natural systems: Plans for urban greening or ecosystem restoration.

The scoring system used a 0–5 scale:

- 0: The principle is not mentioned in the document.
- 1–2: The principle is mentioned briefly without clear objectives or actions.
- 3–4: The principle is integrated into specific objectives or partially reflected in planned activities.
- 5: The principle is fully embedded, with concrete activities and measurable indicators.

Example application: For the "Local Waste Management Plan" in Berat Municipality:

- Minimizing waste and pollution: The document included targets for reducing municipal waste by 20% (score: 4).
- Keeping products and materials in use: It mentioned setting up a recycling hub but lacked a detailed implementation plan (score: 3).
- Regenerating natural systems: No references (score: 0).

Overall Score: 7/15, indicating partial integration of CE principles.

Then, documents were categorized based on their total scores, grouped by documents' type (e.g., waste management plans, energy plans) and municipality size, according to number of population (small, medium, large), to allow for comparative analysis.

The second step involved designing **a semi-structured survey** to assess SLGU staff's understanding of circular economy (CE) principles in their daily work. Distributed via Google Forms, the survey aimed to evaluate: (i) knowledge of CE practices within municipalities, (ii) the extent of their implementation, and (iii) perceived barriers and motivations for adopting CE practices. A draft version of the survey was initially tested with local SLGUs staff, who recommended tailoring it to specific municipal departments. As a result, the survey was divided into four sections targeting different directorates: (i) procurement services, (ii) strategic development and urban planning, (iii) public services, and (iv) infrastructure projects and planning. The survey was administered in two ways: (i) through four online links for direct staff responses, and (ii) via semi-structured meetings that provided detailed explanations and discussions before survey completion. Data collection took place over one month, after which the responses were processed and analyzed.

The results from the screening and survey processes were presented and discussed in a **focus group**, where SLGUs staff provided feedback on the findings and identified key needs and areas for intervention to accelerate the circular economy transition in Albania. An interactive approach was used to back up this process and to gather participant insights and feedback.

4. Analysis & Results

Assessment of the Local Strategic Documents

The screening process spanned nearly two months, involving a combination of online document review and consultations with local staff responsible for drafting municipal policies and documents. These consultations were more informal during the document screening and survey administration, rather than structured interviews. This approach ensured a comprehensive understanding of local policies. Once collected, the documents were thoroughly screened and assessed according to the established methodology.

Table 1 shows the local strategic documents developed by the SLGUs included in the study. Only two out of 8 strategic documents identified in the local context were developed by almost all SLGUs, i.e. General Local Plan and the Local Plan on Waste Management.

Table 1. Local strategic documents developed by the SLGUs part of the study

Size	LGUs	Local Waste Management Plan	General Local Plan	Local Mobility Plan	Local Greenery Plan	Local Noise Control Plan	Local Lighting Plan	Local Energy efficiency plan	Local Energy & Climate Plan
Small	Skrapar	**x**	**x**	-	-	-	-	-	-
	Përmet	**x**	**x**	-	-	-	-	-	x
	Tepelenë	-	-	-	-	-	-	-	-
	Kolonjë	-	**x**	-	-	-	-	-	-
	Memaliaj	**x**	-	-	-	-	-	-	-
	Delvinë	**x**	**x**	-	-	-	-	-	-
	Klos	**x**	**x**	-	-	-	-	-	-
	Himarë	-	**x**	-	-	-	-	-	-
	Mallakastër	-	**x**	-	-	-	-	-	-
	Mirditë	**x**	**x**	-	-	-	-	-	-
Medium	Vau Dejës	**x**	**x**	-	-	-	-	-	-
	Prrenjas	**x**	**x**	-	-	-	-	-	-
	Gramsh	**x**	**x**	-	-	-	-	-	-
	Dibër	**x**	**x**	-	-	-	-	-	-
	Berat	**x**	**x**	-	-	-	-	x	x
	Maliq	-	**x**	-	-	x	-	-	-
	Kavajë	**x**	**x**	-	-	-	-	-	-
	Rrogozhinë	**x**	**x**	-	-	-	-	-	-
	Kukës	**x**	**x**	-	-	-	-	-	-
	Gjirokastër	**x**	**x**	-	-	-	-	-	x
Large	Durrës	**x**	x	-	-	-	-	-	-
	Shkodër	**x**	x	x	-	x	-	-	x
	Elbasan	**x**	x	-	-	-	-	-	-
	Lezhë	**x**	x	-	x	x	-	-	-
	Fier	**x**	x	-	-	-	-	-	-
	Korçë	**x**	x	-	-	-	-	-	x

The final assessment per each local strategic document was colour coded as shown in the table below:

Table 2. Assessment range for local strategic documents

Point range	Description
0	Local strategic policies do not reflect CE concepts
1 – 4	Local strategic policies have started to mention CE concepts only in some paragraphs
5 – 7	Local strategic policies have included in their specific objectives the concepts of CE
8 – 11	Local strategic policies have designed CE activities to fulfil the strategic objectives
12 – 15	Local strategic policies have drawn up indicators to measure the degree of implementation of activities in accordance with the objectives

Results from the assessment of the General Local Plans indicate that although SLGUs were categorised as small, medium and large, per each category more than 50% of the municipalities have General Local Plans that have integrated circular economy (CE) concepts into their specific objectives, and the rest have developed activities that support these objectives through application of CE principles too. The graph below includes specific point range for every local unit that were in the possession of a General Local Plan:

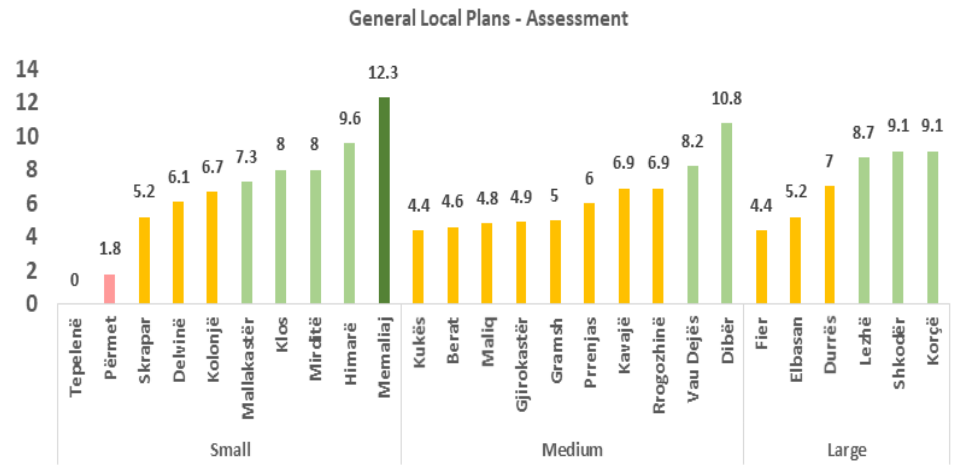

Figure 3. Municipalities participating to the study

Results from the assessment of the Local Waste Management Plan revealed that almost 70% of the municipalities, whether were categorized as small, medium or large, developed plans that included circular economy (CE) concepts in their specific objectives and activities, accompanied by concrete indicators for measurement. 20% of the included CE principles only to the strategic objectives and the activities and only 3 of them have no plans developed at all. The graph below includes specific point range for every local unit that were in the possession of a General Local Plan:

Figure 4. Municipalities participating to the study

The rest of the local strategic documents assessed were developed from a very small number of municipalities. Local Mobility Plan, Local Greenery Plan and Local Noise Control Plan clearly were way behind the adoption of CE concepts in their strategic objectives and activities. They were mentioned in just some paragraphs. Meanwhile, the Local Energy & Climate Plans and the Local Energy Efficiency Plan developed have included in their strategic objectives and activities principles of CE, as shown in the table below:

Table 3. Assessment of the other local strategic documents

Municipalities	*Local Energy efficiency plan*	*Local Mobility Plan*	*Local Greenery Plan*	*Local Noise Control Plan*	*Local Energy & Climate Plan*
Përmet					7.3
Gjirokastër					7.3
Berat	9.8				7.3
Maliq				1.4	
Kavajë					7.3
Shkodër		3.7		4.8	7.3
Korçë					8.0
Lezhë			3.7	1.4	

A. Semi – structured survey with the local staff of the municipalities

27 municipalities participated, and 84 responses were obtained from the staffs of four directorates. The survey results are categorized into four areas outlined in the methodology:

Level of awareness of local staff on CE principles: Survey results indicate that self-local government units (SLGUs) are just beginning to familiarize themselves with circular economy (CE) principles, and many find it difficult to connect these concepts with their daily activities.

Only 21% of municipalities have a basic understanding of CE practices. In most instances, municipal staff reported that these concepts are only briefly mentioned in local strategic documents, often limited to a few paragraphs without substantial integration into broader policies.

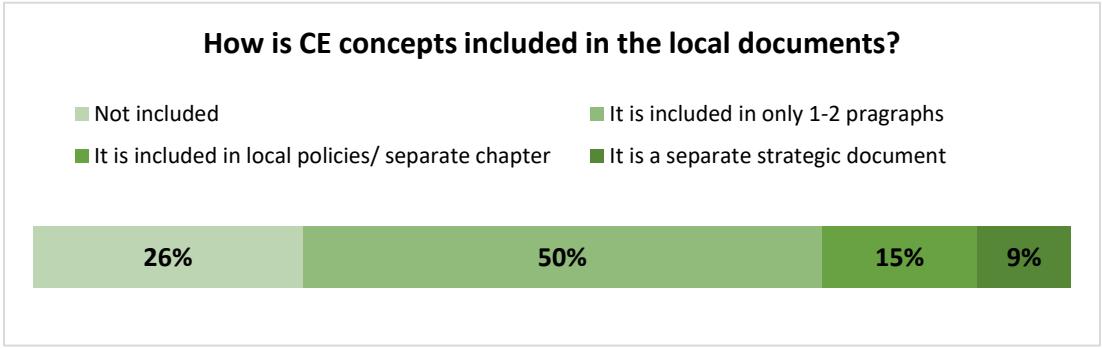

Figure 5. Concepts CE included in the local documents

Capacity building on CE practices: Training and capacity-building are crucial for enabling municipal staff to effectively implement circular economy (CE) strategies. However, 67% of municipalities reported that no training had been provided on CE practices, limiting their ability to integrate sustainability into daily operations and long-term planning. Due to the lack of awareness and recognition of the responsibility of SLGUs to embrace and implement CE principles, only 11% of municipalities have designated staff specifically responsible for developing and implementing CE initiatives.

These low levels of capacity building are reflected in the limited awareness-raising efforts, with only 15% of municipalities organizing these types of campaigns, and none publishing reports on the status of CE implementation.

On the positive side, however training sessions organized by the SLGUs account only for 34% at the best case, there is a strong interest in training, with 88% of municipalities expressing a desire to participate in future sessions.

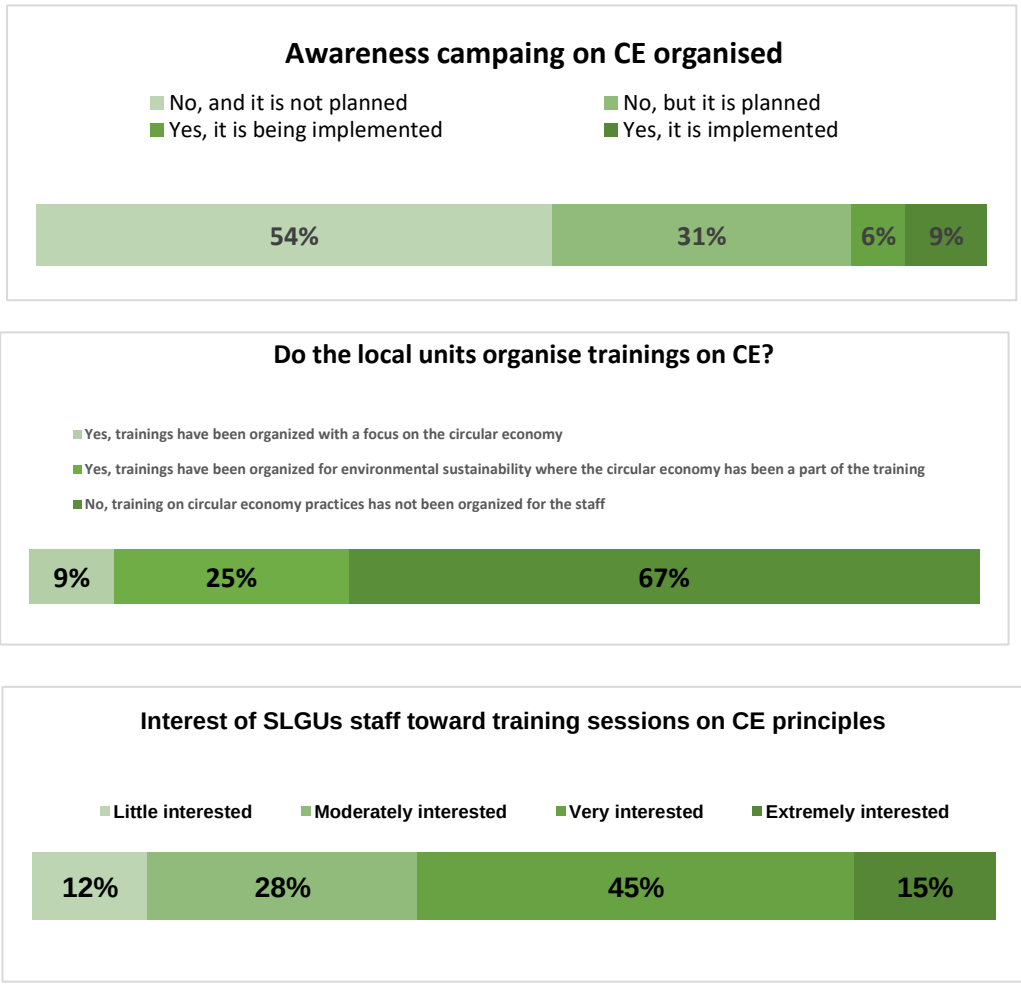

Figure 6. Interests of SLGUs staff on CE training sessions

Green procurement and adoption of resource-efficient practices: Green procurements are known as the process by which self-local government units prioritize environmentally friendly products and services in their purchasing decisions. This involves selecting goods, services, and works that minimize environmental impact throughout their lifecycle, from production to disposal. By adopting green procurement, local units aim to reduce waste, conserve resources, and support the shift towards sustainable practices within their communities. It's about choosing products and services that are eco-friendly, aiming to reduce environmental impact and support sustainability in every purchase.

When asked about their procurement policies, municipalities were divided on their ability on choosing products and services that are eco-friendly that aim

to reduce environmental impact and support sustainability, with 50% expressing uncertainty. While some municipalities reported the initial adoption of green procurement procedures, this remains an area in need of clearer guidelines and stronger local-level implementation.

Despite the general lack of structured CE initiatives, some municipalities have started to introduce tangible sustainability measures, such as installing LED lighting systems and incorporating thermal insulation in municipal buildings.

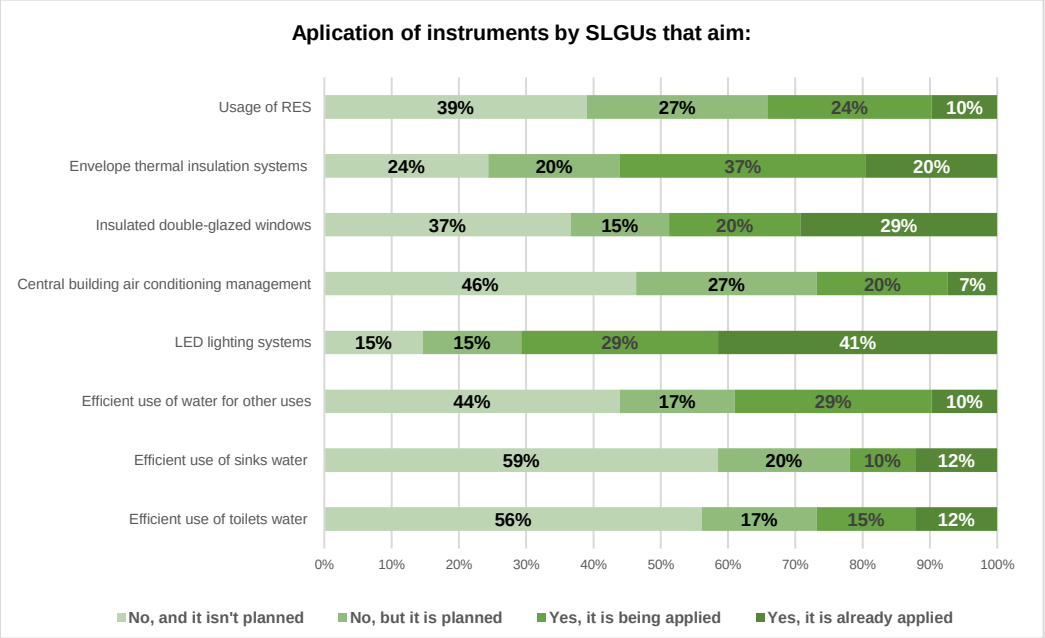

Figure 7. Application of instruments that promote application of CE principes in the SLGUs

The survey also revealed that the Environmental Management Systems (EMS) have not been implemented in any municipality. Sporadically, few elements of these systems were found being applied because of any pilot project, but no written or planned strategy to be implemented is in place.

Interestingly, some Self-Local Government Units (SLGUs) have unknowingly implemented practices aligned with Circular Economy (CE) principles, primarily driven by financial constraints. Staff noted that limited resources have prompted them to adopt more resource-efficient methods, indicating that CE principles are being applied in practice but require broader promotion and support.

Motivating and barrier factors in embracing circular economy principles: The availability of economic and financial resources, along with improved environmental conditions and greater stability, are the key motivators for CE practices. However, pressure from decision-makers and service providers is not yet seen as a significant driving force for local government units in this process.

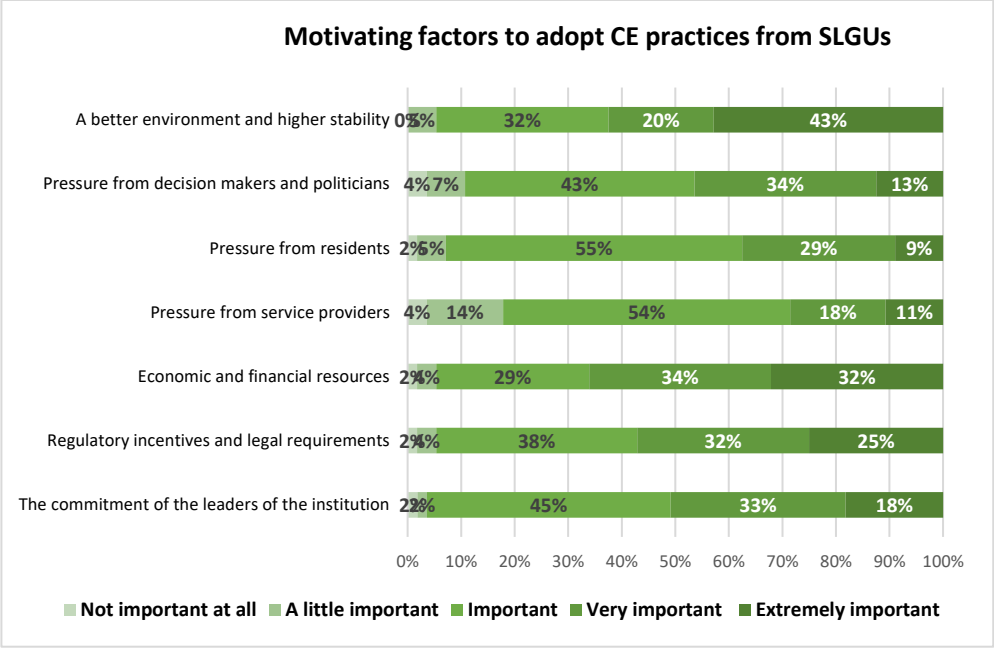

Figure 8. Motivating factors to adopt CE practices from SLGUs

On the other hand, the primary barriers preventing municipalities from adopting these practices are the lack of financial resources and insufficient investment in staff training.

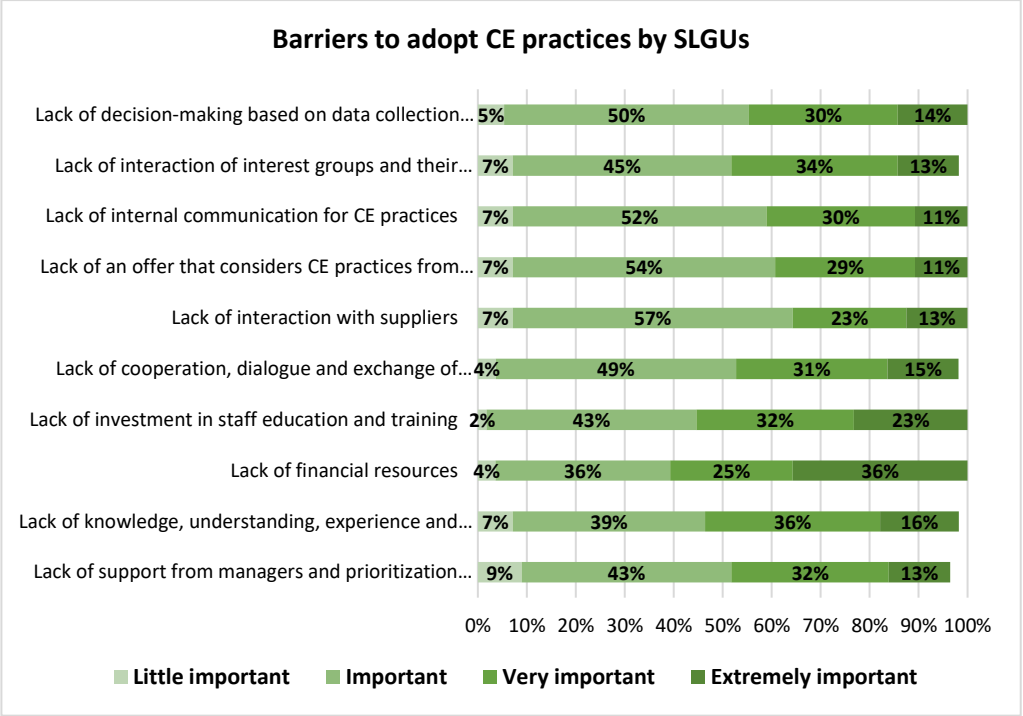

Figure 9. Barrier factors to adopt CE practices from SLGUs

This survey highlights substantial gaps in both awareness and the implementation of CE practices at the municipal level. While there have been positive steps, such as the adoption of energy-efficient technologies, much more is needed to encourage municipalities to fully embrace these principles.

B. Semi-Structured Focus Groups

The last aspect of the assessment was the development of the semi-structured focus groups with the representatives of the SLGUs to discuss results and engage them to deepen their understanding of circular economy (CE) concepts. Initially focused on recycling and reuse, participants' perceptions expanded to include savings and closed-loop systems by the end of the focus groups, with cost savings emerging as a primary motivator for adopting CE principles.

Local units identified two main needs to support CE implementation: more training and increased financial resources. They also highlighted priority activities such as waste management, energy efficiency, green procurement, awareness campaigns, transport, and composting. Waste management and agriculture were the top sectors for integrating CE practices, followed by tourism and energy. These insights emphasize areas where targeted support can effectively promote CE adoption within municipalities.

5. Conclusions and Recommendations

The screening of local documents identified the General Local Plan, and the Local Waste Management Plan as key frameworks developed by most municipalities. However, the transfer of national policies to local governments remains partial, particularly in drafting other sectoral plans where Environmental Sustainability principles should be integrated. Larger municipalities tend to engage more in circular economic practices, though most plans are created by external experts following similar patterns.

It is recommended that municipalities focus on regularly updating these documents to incorporate environmental sustainability and circular economy concepts. Additionally, investing in capacity building for municipal staff is crucial to ensure active participation in drafting and revising these strategic documents.

Survey results emphasize again the importance of adopting Environmental Sustainability and Circular Economy practices within local strategies. Training should cover sustainable and green procurement, environmental management systems (including ISO certifications), and integrating practices like Refuse, Reuse, Repair, and Separation into daily operations. Municipalities should also promote virtual administration to improve efficiency and reduce environmental impacts. Key recommendations include increasing staff training, appointing dedicated personnel, and providing clearer guidelines on procurement and EMS implementation to better integrate CE into local governance.

Semi – focused groups discussions revealed an evolving understanding of the circular economy principles of the local staffs, shifting from recycling and reuse to broader concepts like savings and closed-loop systems. Municipalities called again for the need for more tailor-maid training and financial resources to properly adopt circular economy principles in three key sectors of interest such as waste management, agriculture, energy efficiency, and green procurement.

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dedication to sustainability and continuous improvement has been both inspiring and essential to this research.

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The Impact of Buildings' Energy Consumption and Greenhouse Gasses Emissions on Air Pollution and Sustainability of the City of Skopje

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Abstract

Building construction and operations account for 36% of global final energy use and 39% of energy-related CO_2 emissions. These emissions from buildings arise from the energy used for heating and cooling, hot water supply, ventilation, air conditioning, lighting, and from the embodied energy for the production of building materials. Cutting the greenhouse gases (GHGs) in the building sector is an indicator for not only the energy efficiency improvement, but also it is much more important from aspect of the climate changes and sustainability measures of the cities, especially air pollution. The city of Skopje, especially, in the past few years is one of the most air-polluted cities in the EU. Considering the fact that most of the building stock in Skopje is built after the catastrophic earthquake in 1963, in the absence of energy efficiency regulations and with no thermal insulation materials, the building sector has a great role in pollution and sustainability of the city. In order to assess the impact that the application of thermal insulation has on the pollution, energy efficiency, the CO_2 emissions and PM10 particles, selected case study buildings from the post-earthquake period before and after application of thermal insulation materials are analysed and the results are presented in this paper. Finally, it can be concluded that with appropriate buildings' renovations, the air pollution in Skopje can be significantly reduced.

Keywords: *CO_2 emissions, sustainability, energy efficiency, air pollution*

Jel code: Q2, Q4, Q5.

1. Introduction

Global warming is a major challenge for sustainability. Addressing the environmental challenges posed by CO_2 emissions is crucial for mitigating

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global warming and achieving net-zero emissions by 2050 (European Environment Agency). To reduce the CO_2 emissions, one option is improvement of the energy efficiency of buildings with 50–90% (Turkenburg, 1997). Improving the buildings' energy efficiency, i.e. their energy consumption and reducing greenhouse gasses emissions is one of the major factors that contributes to sustainable and air clean cities. Unfortunately, this is not the case with the city of Skopje.

In the 20th century, Skopje experienced rapid urbanization, growth of industrial activities, and reconstruction after the catastrophic earthquake in 1963. With a comparatively larger number of industrial point sources and higher traffic flows than other cities in the country, the Skopje agglomeration has historically experienced frequent episodes of heavy pollution (Martinez et al., 2018). Especially during dry periods, the combination of mineral dust and emissions from buildings' heating, the transport sector, and industrial activities within the city increase the concentrations of inhalable particles (Anttila et al., 2015). The buildings have the highest impact in the air pollution of the city, considering the fact that 60% of the buildings in Skopje are built after the earthquake in the absence of thermal insulation (Sofronievska et al., 2023).

This paper aims to investigate the state of CO_2 emissions from buildings that do not have good energy efficiency, i.e. are built without thermal insulation, and then, by simulating scenarios with applied thermal insulation on the buildings' envelope, to show the new state of the buildings. The goal is to show the big difference in the amount of CO_2 emissions as well as the energy consumption that affects the sustainability and air pollution of the city.

2. Case study buildings

Skopje's catastrophic earthquake in 1963 caused more than1000 human losses, irreversible degradation of the cultural heritage and 80% destruction of the building stock (Sofronievska et al., 2023). The post - earthquake architecture, represents an important cultural heritage of the city of Skopje. According to the construction standards of that time, those buildings are built in a lack of thermal insulation materials, which results in poor thermal comfort, high heating, cooling and maintenance costs, degradation and deterioration. They need to be properly renovated according to nowadays energy efficiency standards (Sofronievska, Cvetkovska, et al., 2023).

The two case study buildings analyzed in the paper (Figure 1 and Figure 2) date from the post - earthquake period, they have great architectural value, and they are both public buildings very problematic with their sustainability, energy consumption and costs for maintenance.

Figure 1. Hydrometeorology Institute, Skopje

Figure 2. Macedonian Academy of Sciences and Arts, Skopje

The case study 1 is a two-story office building with a total net area of 2.647.7m² and a heating volume of 8.085.9m³, divided into a total of 140 thermal zones, with its own heating system. It is built entirely in natural concrete without any finishing facade layers and no thermal insulation. The building is protected as the cultural heritage of Skopje, and the renovation procedures should not comprise the building's authenticity.

The case study 2 is a multifunctional building, with an administrative and educational function. It has a total net area of 8 298 m² and a heated net volume of 29 770 m³. It is built entirely in natural concrete without any thermal insulation on the envelope. A large part of the facade is glazed, i.e. the total area of the windows is 2236m2. It is divided into a total of 257 thermal zones, and the heating energy is distributed from the central city heating system. It is protected as a very important cultural heritage from the period of modernism in Skopje and its authentic appearance should remain the same after renovation.

After being selected as case studies, the buildings are subjected to a series of analysis such as detailed reviews of project documentation, in situ visits and documentation of their current condition and interviews with the buildings' employees in order to achieve detailed analysis of their energy performance.

3. Methodology

First, energy performance simulations of the existing condition of the selected buildings are made, and then simulations of improved scenarios with the application of thermal insulation materials on the buildings' envelope are carried out. The existing condition is simulated according to project documentation information and in situ measures. The improved scenarios are based on adding thermal insulation on the envelope of the building (walls, roof, windows etc.). In both scenarios, conventional nanomaterials are added on the basement slab and roof, such as xps, because they are not visible from

the outside and don't compromise the originality of the architectural design. Nano materials are used only on the façade walls, where the authentic appearance is very important, especially the thickness, texture and design on the natural concrete. Both façade materials used as thermal insulation are newly developed nanomaterials, such as aerogel thermal plaster - defined as scenario 1, and nanoceramic thermal coating – defined as scenario 2. Both are eco - friendly and sustainable materials with low embodied energy and are especially applicable in cultural heritage buildings because of their low thickness, ability to imitate natural concrete (aerogel plaster) and transparency (nanoceramic coating), which makes them superior to the standard thermal insulation materials (Ganobjak et al., 2019).
EnergyPlus software is used for simulations and the buildings are modelled in DesignBuilder. Both buildings are modeled in detail with a large number of thermal zones, detailed geometry, environment, HVAC systems, building materials, etc. The modeling and simulations are based on large data of project documentation and in situ visits of the buildings.

The most important results for this research are the CO_2 emissions and the PM10 particles, which are embodied during the building processes for heating, cooling and other maintenance. They are mostly emitted from the combustion of fuels to power the buildings, especially the older ones, with no thermal insulation and older heating systems. Most of them, in order to be heated, need huge amounts of heating energy, mostly distributed by the city central heating system, which is known to be one of the primary air pollutants in Skopje. Also, some of the old buildings have their own heating systems which use heavy fossil fuels for heating and maintenance.
The obtained results of the existing condition and the two scenarios are compared and discussed.

4. Results & Discussion

4.1. Case study building 1

In the simulations of the first case study, analysis of GHGs released by the building on an hourly, daily and monthly level, with special emphasis on CO_2 emissions and PM10 particles, are carried out.

Fig. 1 shows a graph of average monthly CO_2 emissions released by the building's existing condition, scenario 1 and scenario 2. The actual state of the building, i.e. its existing condition, shows that the building emits 14 022.5 kg CO_2 monthly or 168 280 kg annually, i.e. 70.2 kg/m^2. This means that in terms of its dimensions and function, it is a building with quite high levels of emissivity. Scenario 1 shows the lowest CO_2 emission, i.e. an average of 7 017.9 kg monthly or 84 214.8 kg annually, i.e. 31.7 kg/m^2. The emissivity of CO_2 in scenario 1 is reduced by 54.7% compared to the existing condition.

Scenario 2 showed 8 683 kg CO_2 monthly or 104 196 kg annually, i.e. 39.3 kg/m^2. Scenario 2 reduces emissions by 44% compared to the existing condition.

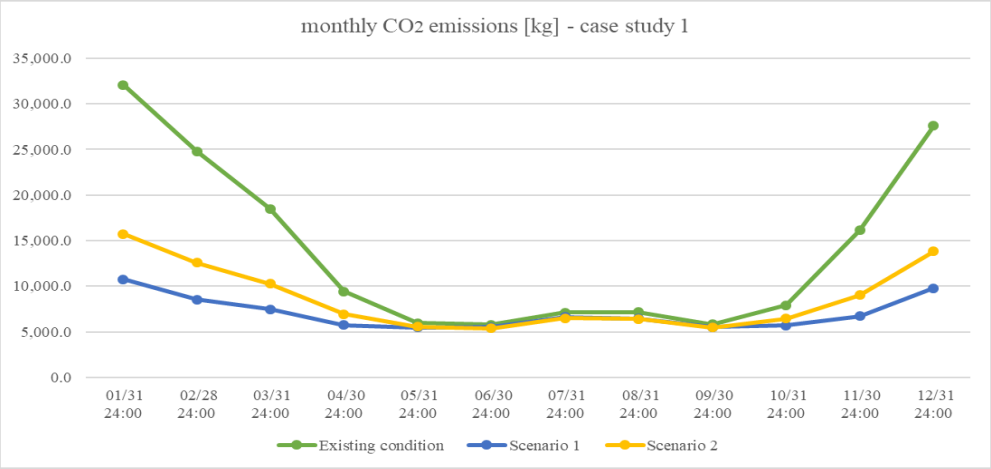

Figure 3. CO_2 emissions - case study 1

Similar results are obtained in the analysis of PM10 particles. Figure 4 shows a graph of monthly PM10 emissivity for the existing condition, scenario 1 and scenario of the building. In the existing condition, the buildings emit an average of 1.3 kg monthly, or 15.6 kg annually. Scenario 1 shows 0.7 kg PM10 monthly or 8.4 kg annually. The emissivity of PM10 in scenario 1 is reduced by 46.1% compared to the existing situation. Scenario 2 shows PM10 emissivity of 0.78 kg monthly or 9.36 kg annually. In scenario 2 the PM10 emissions are reduced by 40% compared to the existing condition.

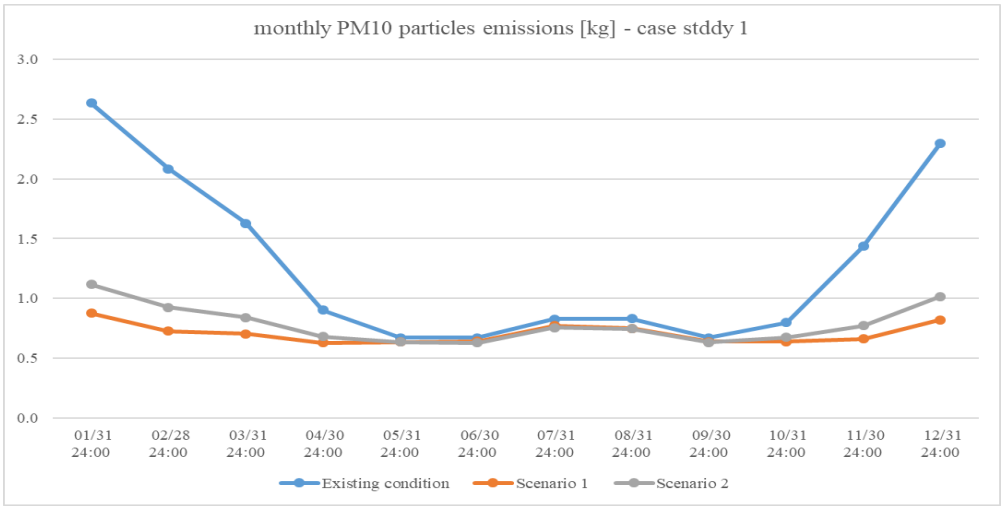

Figure 4. PM10 emissions - case study 1

It can be concluded that in both scenarios of the case study building 1, the CO_2 and PM10 emissions are drastically reduced.

4.2. Case study building 2

Figure 5 shows a graph of average monthly CO_2 emissions released by the building's existing condition, scenario 1 and scenario 2. The simulation of the building's existing condition shows 61 727.7 kg CO_2 monthly or 740 732.4 kg annually, i.e. 92.9 kg/m^2, which in terms of its dimensions and function, it is a highly polluting building. Scenario 1 shows the lower CO_2 emission, that is, an average of 40 078.4 kg monthly and 480 940.8 kg annually, that is, 60.3 kg/m^2. The emissivity of CO_2 in scenario 1 is reduced by 35% compared to the existing situation. Scenario 2 shows an average CO_2 emissivity of 46 779.2 kg monthly and 561 350.4 kg annually, i.e. 70.4 kg/m^2. Scenario 2 reduces the emissivity by 24.2 % compared to the existing condition of the building.

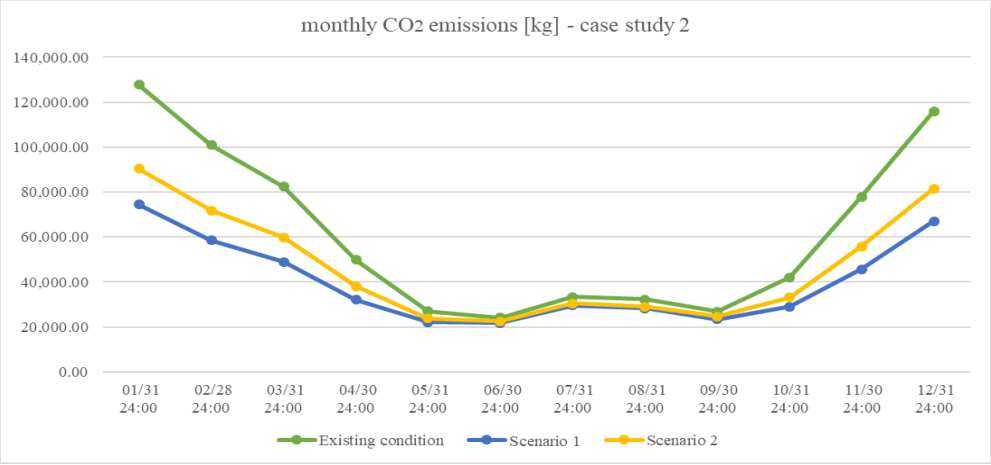

Figure 5. CO_2 emissions – case study 2

Figure 6 shows a graph of PM10 particles that the building emits on a monthly level for the existing condition, scenario 1 and scenario 2. In real conditions, the building emits around 4.5 kg monthly, that is, 54 kg annually. Scenario 1 shows 3.2 kg PM10 emissions monthly or 38.4 kg annually. The emissivity of PM10 particles in scenario 1 is reduced by 30% compared to the existing condition. Scenario 2 shows around 3.6 kg PM10 emissions monthly or 43.2 kg annually. Scenario 2 reduces emissivity by 20% compared to the existing condition.

It can be concluded that in both scenarios of the case study building 2, the CO_2 and PM10 emissions are again drastically reduced.

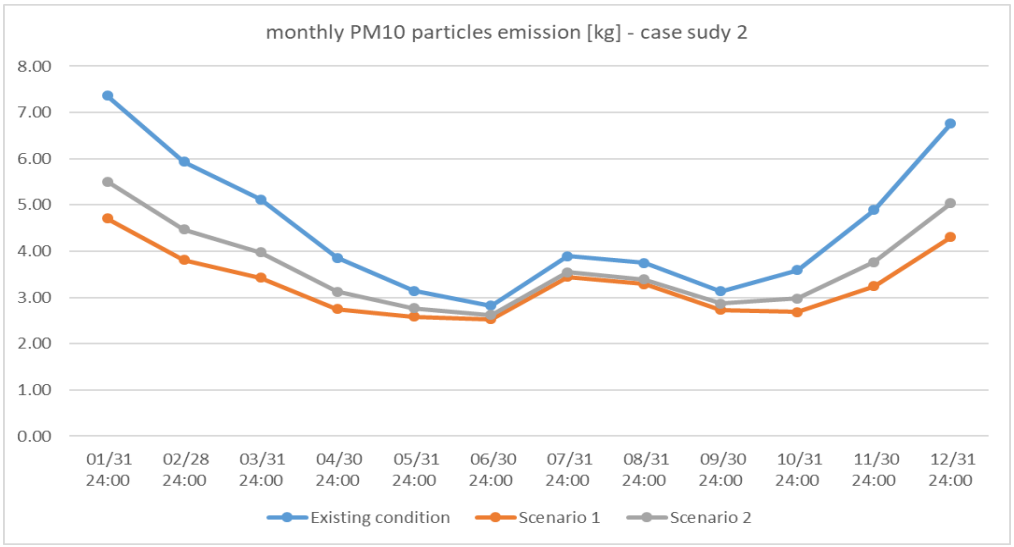

Figure 6. PM10 emission - case study 2

4.3. Results comparisons and discussions

The obtained results prove that by adding appropriate thermal insulation of the buildings, their energy efficiency is improved and the CO_2 emissions and other harmful gases, especially PM10 particles are significantly reduced. Figure 7 shows a comparison of the CO_2 emissions between the two case study buildings where it can be concluded that there are great improvements in both scenarios. Scenario 1 shows reduction of the CO_2 emission by 55% in case study 1 and 35% case study 2. Scenario 2 shows a reduction of CO_2 by 44% in case study 1 and 24% in case study 2.

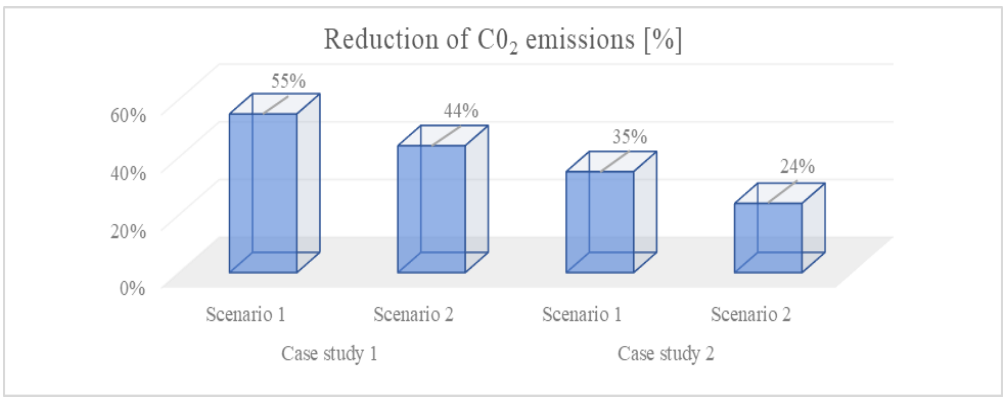

Figure 7. Comparisons of the CO_2 reduction between case studies

The importance of thermal insulation can also be seen in the reduction of the energy consumption of the buildings especially the energy consumption for heating which is the main contributor to the greenhouse gasses emissions.

Figure 8 shows that there are significant savings in terms of heating energy, i.e. reduction of the heating energy consumption by 68% and 58% in scenario 1 for each case study, respectively, and by 35% and 33% in scenario 2 for both case studies, respectively.

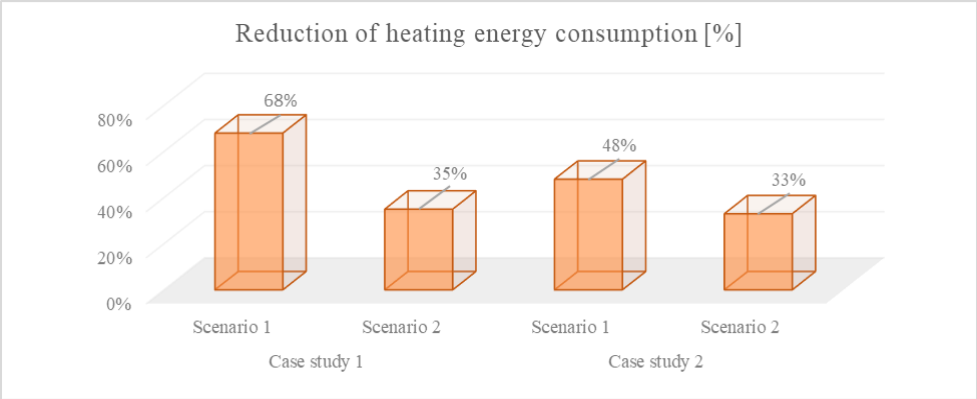

Figure 8. Comparisons of heating energy consumption between case studies

The high electricity consumption for buildings' maintenance makes them unsustainable and expensive, thus contributing to the energy burden of the city. Considering these results, it is confirmed that Skopje is still an unsustainable city, with a high demand for heating and electricity energy to maintain its buildings, which in the process emit huge amounts of CO_2 and other greenhouse gasses, which hugely contributes to the air – pollution of the city. After the application of thermal insulation materials, it can be seen that there are significant savings in terms of electricity, especially in case study 1. Figure 9 shows a reduction of electric consumption by 30% and 15% in scenario 1 for each case study, respectively, and by 29% and 10% in scenario 2 for both case studies, respectively.

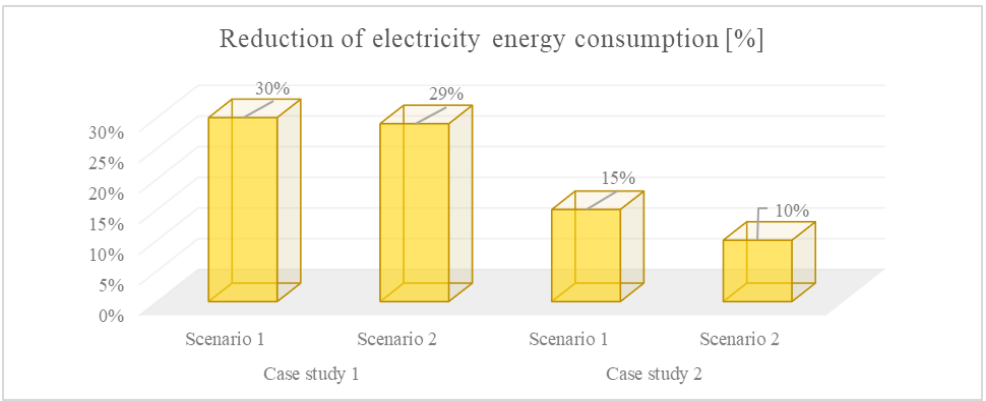

Figure 9. Comparisons of electricity consumption between case studies

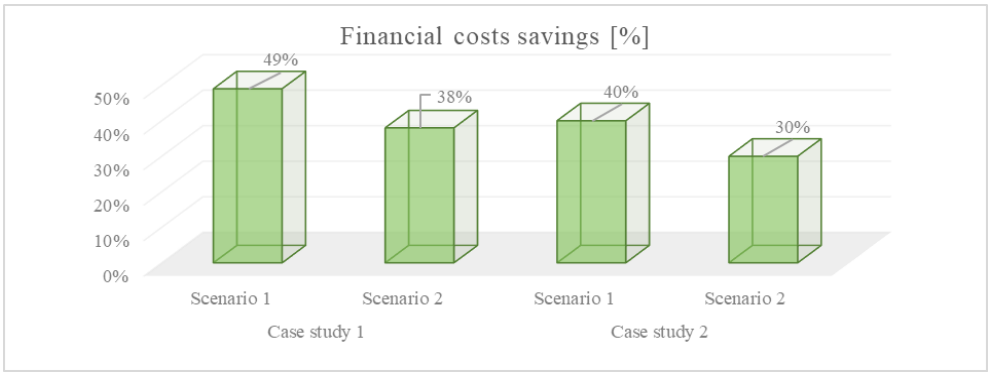

Figure 10. Comparisons of the financial costs between case studies

Finally, the financial costs analysis for heating, cooling and building maintenance show large reductions after the application of thermal insulation, shown on figure 10. Scenario 1 shows significant reductions in financial costs by 49% and 40% for both case studies, respectively, and scenario 2 reductions by 38% and 30% for both case studies, respectively.

The analyzed nanomaterials have a higher price than the conventional ones, but significantly better thermal insulation performances. For example, the average thermal conductivity of aerogel plasters available on the market is 0.034 W/(mK), while their lowest price is 30€/m² for 1cm thickness. The usual thermal conductivity of thermal insulation plasters without aerogel is 0.085 W/mK, while the average price is 6.5€/m² for 1cm thickness. That means that the thermal conductivity of aerogel plasters in relation to conventional thermal insulation plasters is about 60% better, while the price is 80% higher. Considering the simulation results that gave quite an improvement of the financial maintenance costs, around 50% in both scenarios, it can be concluded that the renovation with these nanomaterials is worthy investment.

Adding additional alternatives to improve energy efficiency and sustainability of the buildings, such as replacing their old HVAC systems with contemporary ones especially renewable energy sources such as heat pumps, solar panels etc. will definitely improve the overall energy performance of the buildings, but in the same time rise the financial costs for renovating. On the other hand, any additional procedure will interfere with the cultural heritage protection standards and eventually compromise the building authenticity, which is the biggest priority to consider in this study.

5. Conclusions

Buildings are responsible for almost 40% of annual energy consumption and 36% of annual greenhouse gasses emissions in EU (In Focus: Energy Efficiency in Buildings, 2020b*)*. From this reason, improving the energy

efficiency and sustainability of the buildings is critical for meeting EU climate targets. On the other hand, buildings energy consumption prediction is essential to achieve energy efficiency and sustainability. For this purpose, this study focuses on energy simulations of selected buildings in order to predict their energy performance, CO_2 emissions, energy consumption and maintenance costs, before and after application of thermal insulation.

The obtained results of the existing condition of the selected case studies (before application of thermal insulation) showed high electricity and heating energy consumption, high emissions of CO_2 and PM10 particles, which resulted in huge financial costs. The fact that the analyzed buildings date from the post-earthquake period in Skopje and that most of them are built in the absence of thermal insulation materials, it can be concluded that the buildings make a huge contribution to air - pollution and the sustainability of the city.

The simulations after the application of the thermal insulation materials on the buildings' envelopes, gave significantly better results, with a significant reduction in energy consumption, CO_2 emissions and PM10 particles, which also resulted in drastic reductions in financial maintenance costs. This is due to the better thermal isolation properties of the aerogel, which makes it superior compared to the nanocoating. However, the nanocoating is transparent and has significantly smaller thickness, which leads to much lower impact on the buildings' originality. Both solutions have their own advantages and disadvantages, which makes them both applicable for this problem.

There are many studies with similar research problems, especially in terms of energy efficiency and emissions in cultural heritage buildings such as (Wakili et al., 2018), (Fantucci et al., 2019), (Berardi, 2017), (Bozsaky, 2018), but none is focused on giving both alternatives (scenarios) and comparing the results. This advances this study and enriches state-of-the-art literature.

Finally, from this study it can be concluded that the building sector in Skopje has a huge impact on air - pollution, sustainability and the energy condition of the city, but also that with appropriate strategies for buildings renovations, these problems can be reduced or even completely solved.

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Psychological Barriers to Sustainable Tourism Choices: A Case from Albanian Tourism Industry

Mishela RAPO[1], Besjon ZENELAJ[2]

Abstract

This study investigates the psychological barriers to sustainable tourism by identifying the key factors that influence travellers' decisions and hinder the adoption of eco-friendly practices. The research combines interviews with ten tourism industry managers with a comprehensive literature review. Thematic analysis is used to examine the challenges revealed through the interviews, while the literature review provides additional context to these findings. The findings highlight several critical obstacles, including a lack of awareness, perceived high costs, social norms, cognitive dissonance, emotional disconnect, and trust issues. Many tourists remain unaware of the environmental impacts of their choices and often perceive sustainable options as more expensive. Social norms and peer influences further reinforce traditional travel behaviours. Cognitive dissonance occurs when tourists' values conflict with their actions, leading them to justify unsustainable practices. Additionally, limited emotional connections to sustainability and scepticism about the authenticity of eco-friendly claims further complicate decision-making. The study concludes with recommendations for addressing these barriers, emphasizing the need for increased awareness, improved marketing strategies, and trust-building initiatives to effectively promote sustainable tourism practices.

Keywords: *Sustainability, Tourism, Psychological barriers, Eco-friendly practices, Decision-making*

Jel code: L83, I31, M31

1. Introduction

Sustainable tourism aims to minimize environmental, cultural, and economic impacts while maximizing benefits for local communities and ecosystems (Dessai, 2023). It promotes resource conservation, cultural heritage preservation, and equitable economic growth, ensuring that tourism meets current needs without compromising future generations' ability to thrive. As a key strategy to combat over-tourism, protect fragile ecosystems, and foster

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cultural preservation, sustainable tourism is increasingly prioritized worldwide. Despite growing interest, adoption rates for sustainable travel remain low, raising an important question: What psychological barriers prevent travelers from adopting sustainable tourism practices, and how can these be addressed? Psychological barriers, encompassing cognitive, emotional, and social factors, often disconnect intentions from actions. Understanding and addressing these barriers is essential for encouraging responsible travel behaviors and advancing sustainable tourism's broader environmental, cultural, and economic goals.

2. Theoretical Background

2.1. Psychological and Socio-demographic Barriers in Consumer Behavior

Psychological barriers in consumer behavior refer to cognitive or emotional challenges that prevent individuals from aligning their actions with their values and preferences (Gonella et al., 2024). These barriers often create a disconnect between sustainable travel intentions and actual choices, influenced by factors such as lack of awareness, perceived inconvenience, cost concerns, social pressures, cognitive dissonance, and emotional detachment (Munro et al., 2023). In tourism, these barriers affect travel planning, destination selection, and on-site behavior (Mamula Nikolić, 2021). Despite growing awareness of tourism's environmental and social impacts, these psychological barriers frequently discourage sustainable travel choices (Juvan and Dolnicar, 2014).

A significant barrier is the knowledge gap regarding sustainable tourism practices. Many travelers are unaware of how to identify or participate in sustainable travel options (Vieira et al., 2023). Uncertainty in recognizing eco-friendly accommodations or verifying sustainability credentials of tour operators leads to confusion and low adoption rates (Mazhenova et al., 2016). Additionally, inadequate communication about sustainable tourism initiatives limits their visibility and effectiveness (Timur and Getz, 2009).
Cost concerns are another critical obstacle. Eco-friendly accommodations and travel options often have higher price tags, deterring budget-conscious tourists (Kholijah, 2024). The inconvenience of researching sustainable choices and using slower transport options, such as trains, further discourages adoption (Ibnou-Laaroussi et al., 2020). Travelers also perceive sustainable options as less comfortable, offering fewer amenities compared to traditional alternatives (Gössling, 2018).

Demographic factors play a role in shaping these psychological barriers. Millennials and Gen Z travelers, exposed to environmental issues through education and media, are more likely to adopt sustainable practices (Mazar et al., 2021). In contrast, older generations often resist sustainable travel due to

ingrained habits and perceptions of inconvenience (Khan et al., 2023). Gender also influences behavior; women generally demonstrate greater environmental awareness, although this trend is mediated by cultural and socioeconomic factors (Vicente-Molina et al., 2018). Higher education levels correlate with increased awareness of sustainability concepts and reduce perceptions of sustainable travel as financially burdensome (Boca & Saraçlı, 2019).

Social norms further exacerbate these barriers. Traditional travel behaviors, such as frequent flying or luxury stays, are often seen as status symbols, discouraging sustainable choices (Alizadeh, 2021). Peer influence, amplified by social media, reinforces unsustainable behaviors unless actively redirected toward promoting eco-friendly practices (Munar and Jacobsen, 2014).

2.2. Overcoming Obstacles in Sustainable Tourism

Addressing these barriers requires targeted strategies to enhance awareness, reduce inconvenience, and shift social norms. Raising awareness through educational campaigns is vital for bridging knowledge gaps in sustainable tourism (Hartman and Sijtsma, 2018). Highlighting tourism's environmental and social impacts through engaging content such as documentaries, interactive tools, and social media platforms makes sustainability more relatable (Ingrassia et al., 2022). Collaborative efforts between governments, NGOs, and private organizations further amplify these initiatives (Rodinelli and London, 2003).

Simplifying sustainable travel choices is another critical step. Streamlined platforms offering curated eco-friendly accommodations, transport options, and activities make responsible travel more accessible (Lin et al., 2022). All-inclusive packages reduce perceived inconvenience and encourage travelers to opt for sustainable options (Smith, 2023).

Social norms can be reshaped by promoting sustainable travel as socially responsible and desirable. Campaigns supported by influencers and social media can effectively highlight eco-friendly practices as aspirational behaviors (Lee et al., 2021). Experiential learning, such as eco-tourism that involves local communities or nature-based activities, fosters deeper commitment to sustainability (Holmes et al., 2021).

Building trust through transparent and verifiable sustainability practices is essential. Combatting greenwashing with certifications from proper organizations reassures consumers about genuine eco-friendly efforts (Ahmed et al., 2021; Yildiz et al., 2024). Transparent practices, such as showcasing energy conservation and waste management initiatives, enhance credibility (Chi et al., 2022).

Financial incentives can also encourage sustainable travel. Subsidies, discounts, and long-term economic benefits make eco-friendly options more

accessible (Pan et al., 2018). Behavioral interventions like nudging and social norms messaging subtly guide tourists toward sustainable actions (Sparkman et al., 2021). A multifaceted approach addressing trust, awareness, convenience, and social norms is essential to advancing sustainable tourism while ensuring benefits for both travelers and destinations.

3. Methodology

3.1. Research design: Sampling and data collection

This qualitative study explores psychological barriers to sustainable tourism using semi-structured interviews with 10 tourism industry managers and a literature review.

We selected individuals for our study using purposive sampling. This non-random selection strategy ensured that only experienced experts from hotels, travel agencies, and tour operators participated, providing reliable insights about Albania's tourist industry.

We collected data through semi-structured interviews with ten tourism sector managers. Each interview lasted 45-60 minutes and used an open-ended question structure, allowing participants to express themselves freely. This method enabled in-depth conversations about the psychological barriers to sustainable tourism.

In addition to the interviews, we conducted a thorough literature study to help contextualize and support our conclusions. We then used the theme analysis to identify the main challenges that emerged from the data.

3.2. Data analysis

Thematic analysis was utilized to examine the qualitative data gathered from the semi-structured interviews conducted with ten tourism managers. This approach facilitated the identification of recurring themes, patterns, and key insights related to sustainable tourism. Responses were organized based on predefined categories derived from the research questions, allowing for systematic analysis.

Ethical approval was obtained, and all participants provided informed consent. Confidentiality was ensured, and pseudonyms were used to protect participants' identities. Data was securely stored and accessible only to the research team. Below we offer a proper methodological outline of data analysis.

The qualitative data collected from 10 semi-structured interviews with tourism managers was analyzed using a thematic analysis approach. This strategy allows the identification of repeating themes, patterns, and critical discoveries regarding psychological barriers to sustainable tourism. The data analysis

process involved transcription and familiarization. The researcher read and reread the transcripts of the interviews to obtain a thorough knowledge of the information. Using an inductive and deductive approach, initial codes were constructed based on participant replies and specified categories drawn from the research questions. The codes were divided into wider themes and subthemes to capture the main psychological barriers to sustainable tourism.
The themes were improved through iterative comparison to ensure consistency and relevance to the research goals. The emerging themes were contrasted to findings from the literature review, allowing for a more comprehensive contextual analysis. Ethical approval was obtained prior to data collection. All participants provided informed consent and were assured of their secrecy and anonymity. Data was securely stored with access limited to the research team. This methodical and comprehensive methodology resulted in a reliable and trustworthy analysis of the psychological barriers to sustainable tourism.
The analysis followed a structured three-phase coding process, as described below:

Table 1. Coding process

Phase	Description	Example Codes
Open Coding	Initial review of responses to identify key ideas and recurring concepts.	"Awareness gap," "Cost concerns," "Social norms"
Axial Coding	Grouping related codes into broader categories or sub-themes.	"Lack of Awareness," "Economic Constraints"
Selective Coding	Refinement of categories into primary themes aligning with research goals.	"Psychological Barriers," "Trust and Transparency"

Source: Author's elaboration

4. Results

Following insightful analysis, interviews revealed key barriers to sustainable tourism. Managers identified tourists' lack of awareness about environmental impacts as a primary issue, necessitating targeted campaigns. Cost perceptions, social norms, peer influence, emotional disconnection, cognitive dissonance, and trust issues also impede sustainable choices. Strategies include awareness, incentives, emotional marketing, and transparency.
Themes emerging from the data included: Emotional Connection, Lack of Awareness, Cost Concerns, Social Norms and Peer Influence, Trust Issues, and Cognitive Dissonance. A detailed summary of the questions and responses

from the interviewed managers is provided in Annex 1, supporting the coding and thematic process described here.

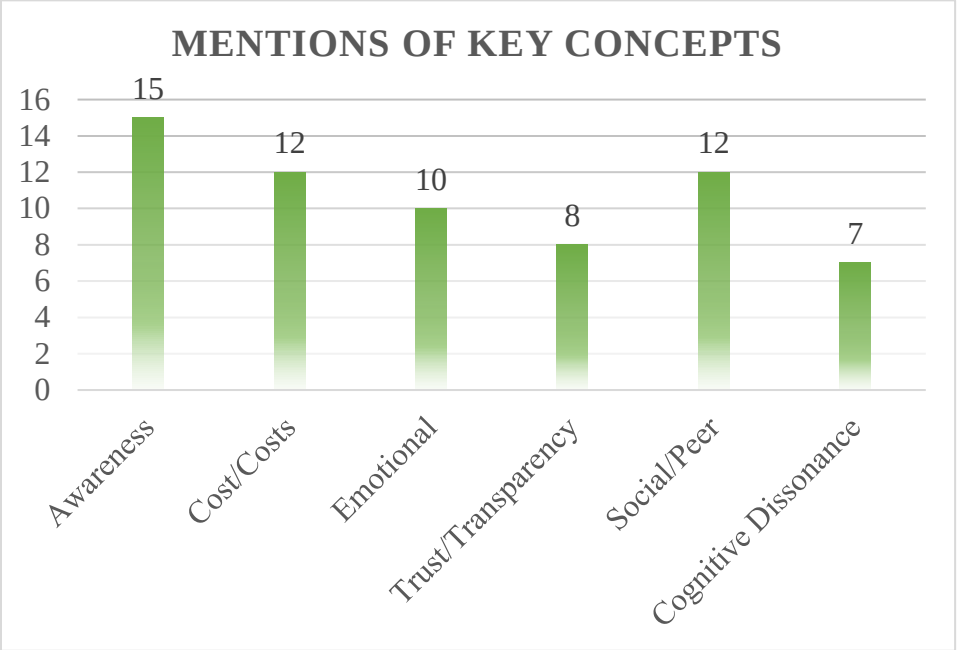

Figure 1: Key concepts emerged from manager interviews

Source: Author`s elaboration

The bar chart (Figure 1) illustrates the frequency of mentions for key psychological barriers. "Awareness" received the highest mentions (15), followed by "Cost/Costs" and "Social/Peer" (12 each), "Emotional" (10), "Trust/Transparency" (8), and "Cognitive Dissonance" (7).

A lack of awareness about the environmental impact of tourism was the most cited barrier. Managers emphasized the need for educational campaigns to close this knowledge gap.

- *"Most tourists don't even consider sustainability; they simply don't know enough about it."*
- *"Awareness campaigns need to be more widespread and targeted."*

Tourists perceive sustainable tourism as costly, deterring them from making eco-friendly choices. Managers advocated financial incentives like subsidies to address this.

- *"Sustainable tourism is often seen as more expensive, which puts off a lot of tourists."*

- *"Financial incentives would help balance the perceived cost difference."*

Social norms strongly influence tourist behavior, with many opting for unsustainable practices due to peer pressure. Leveraging influencers and social media to normalize sustainable choices was suggested.

- *"Social pressure often deters people from choosing sustainable options."*
- *"If sustainability became trendy, more people would follow."*

Lack of emotional investment in sustainability reduces its priority. Emotional storytelling was proposed to foster personal connections.

- *"Storytelling can create emotional bonds with destinations and sustainability."*
- *"Tourists need to feel emotionally invested in their impact."*

Tourists often justify unsustainable decisions for convenience, despite guilt. Solutions should balance convenience with eco-friendly options.

- *"Tourists feel guilty but still opt for convenience."*
- *"Cognitive dissonance leads people to justify their unsustainable choices."*

Skepticism about greenwashing undermines trust. Managers recommended transparent practices and eco-certifications to validate claims.

- *"Transparency and certifications are essential for building trust."*
- *"Tourists need to trust that sustainable claims are real, not just marketing."*

Figure 2. Main psychological barriers to sustainable tourism

Source: Author`s Elaboration

Figure 2 summarizes the psychological barriers to sustainable tourism, categorized into themes: emotional connection, lack of awareness, cost concerns, social norms and peer influence, trust issues, and cognitive dissonance. Managers emphasized strategies to overcome these challenges, such as educational campaigns, financial incentives, emotional storytelling, transparency through certifications, and leveraging social influence. Their responses highlighted the importance of systemic changes to reduce barriers and promote sustainable tourism practices. Key insights from the interviews include:

- *"We need more educational campaigns and marketing focused on sustainability."*
- *"Simplifying access to sustainable options will reduce barriers."*
- *"Social norms can shift with the right influence from media and marketing."*

Figure 3. Key strategies to sustainable tourism

Source: Author`s Elaboration

Figure 3 illustrates four key strategies to support sustainable consumer behavior: raising awareness through educational campaigns, simplifying access to sustainable options, reshaping social norms via focused communication, and enhancing trust through transparency. These approaches highlight the roles of managers, influencers, and policymakers in fostering sustainable choices and building consumer confidence.

5. Data Interpretation and Discussion

The results of this study largely align with the literature while highlighting nuances in the psychological barriers and solutions to sustainable tourism. Psychological barriers such as lack of awareness, perceived inconvenience, and cost concerns were evident in the data, reflecting similar findings in the literature. For instance, travelers often lack the knowledge or tools to identify eco-friendly accommodations or verify sustainability claims, as noted by Vieira et al. (2023) and Mazhenova et al. (2016). This suggests a significant need for improved communication strategies and visibility of sustainable tourism initiatives, as proposed by Timur and Getz (2009).

The perception that sustainable tourism is costlier aligns with Kholijah (2024) who emphasizes the deterrent effect of financial concerns. However, the results reveal a persistent gap between perceived and actual costs, reinforcing

the need for transparent communication about the long-term benefits of eco-friendly options, such as lower operational costs for green-certified hotels (Fukey and Issac, 2014).
Social norms also play a critical role, as supported by Rahman and Sciara (2022) and Alizadeh (2021). The data shows that peer influence, amplified by social media, can both encourage and discourage sustainable behaviors, depending on the framing of these practices. While campaigns that promote sustainable travel as socially desirable align with Lee et al. (2021), the data indicates that unsustainable behaviors still hold significant status appeal, necessitating stronger efforts to redefine luxury in terms of sustainability.
Trust, eroded by greenwashing, remains a barrier, corroborating Sukla and Krishanappa (2023). The findings support the literature's emphasis on the role of independent certifications (Ahmed et al., 2021; Chi et al., 2022) in building credibility.

While the results confirm much of the existing literature, they underscore the importance of targeted, multifaceted approaches that address psychological barriers, trust, and cost perceptions, ultimately fostering meaningful shifts toward sustainable tourism practices.

6. Conclusions, Recommendations and Further Research

This study investigates the psychological barriers to adopting sustainable tourism, identifying limited awareness, perceived high costs, social norms, cognitive dissonance, emotional detachment, and trust deficits as key impediments.

The following table outlines the coding system used for thematic analysis in this study:

Table 2. Coding framework for thematic analysis

Theme	Sub-Themes	Example Codes
Lack of Awareness	Knowledge Gap, Role of Marketing	"Awareness gap," "Educational campaigns"
Cost Concerns	Perception of High Costs, Financial Incentives	"Short-term vs. long-term costs," "Subsidies needed"
Social Norms and Peer Influence	Following the Norm, Role of Social Media	"Social pressure," "Sustainability as a trend"

Emotional Connection	Storytelling, Personal Engagement	"Emotional appeals," "Humanizing sustainability"
Cognitive Dissonance	Guilt vs. Convenience, Justification of Behavior	"Feeling guilty," "Prioritizing comfort"
Trust Issues	Skepticism, Transparency, Certifications	"Greenwashing concerns," "Eco-certifications"

Source: Author's elaboration

These barriers significantly influence tourists' decision-making, often resulting in a preference for conventional travel over sustainable alternatives. Limited awareness and insufficient communication restrict tourists' understanding of environmental impacts and the benefits of sustainable tourism. Perceived high costs, compounded by a lack of financial incentives or cost transparency, further deter eco-friendly decisions. Social norms and peer behaviors rarely prioritize sustainability, while cognitive dissonance and emotional detachment reduce motivation for responsible practices. Trust issues, fueled by skepticism about greenwashing, undermine confidence in sustainable initiatives.

Figure 4: Key Recommendations for the Albanian Context

Source: Author`s elaboration

Figure 4 illustrates six key strategies for promoting sustainable tourism: Targeted Education Campaigns to raise awareness, Cost Mitigation to address affordability concerns, Emotional Storytelling for personal engagement, Nudging Through Defaults to make sustainable options convenient, Transparent Certifications to build trust, and Social Norms Influence to leverage peer behaviour and trends.

To address these challenges, stakeholders should implement educational campaigns, provide financial incentives, and promote transparency through certifications. Shifting social norms via influencer engagement and emotional appeals can further encourage sustainable practices.

Future research could focus on demand-side barriers within local contexts, exploring tourist perceptions of sustainability in Albania and evaluating eco-friendly practices, such as solar energy adoption and waste management. A holistic approach integrating awareness, trust, and incentives is crucial for advancing sustainable tourism and safeguarding environmental and cultural heritage.

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ANNEX 1: Main psychological barriers to sustainable tourism

Question	Manager 1	Manager 2	Manager 3	Manager 4	Manager 5
1. What do you think are the main psychological barriers to sustainable tourism?	Lack of awareness, perceived inconvenience	Cognitive dissonance, cost concerns	Social norms, lack of awareness	Perception of inconvenience and higher costs	Limited emotional connection, lack of information
2. How do cost concerns influence tourists' decision to choose sustainable options?	Sustainable tourism is often seen as more expensive	Tourists hesitate due to upfront costs	High costs deter budget travelers	Short-term cost outweighs long-term benefits for most tourists	Cost perception is a big barrier, especially for families
3. Do you believe lack of awareness is a major issue in promoting sustainable tourism?	Yes, it's a significant issue	Absolutely, many tourists don't know the impact of their actions	Yes, most tourists don't even consider sustainability	Lack of education and marketing around sustainable options	Yes, the gap in knowledge leads to unsustainable decisions
4. How do social norms and peer influence affect sustainable tourism choices?	Travelers follow what their peers do	Peer influence is strong, especially on social media	Social pressure often deters people from choosing sustainable options	Most tourists follow mainstream practices	Social influence plays a huge role in travel decisions

5. How can emotional appeals help promote sustainable tourism?	Personal stories about conservation work well	Storytelling can create emotional bonds with destinations	Emotional connection to nature could drive better choices	Emotional appeals can inspire action	Storytelling about the environment is very effective
6. What are some strategies you recommend to increase awareness about sustainable tourism?	More educational campaigns	Collaborate with influencers and use digital marketing	Create awareness through social media campaigns	Use media to highlight the importance of sustainability	Partner with schools and universities to educate future travelers
7. How can trust in sustainable tourism claims be improved?	Transparency, certifications	More third-party verifications	Clear, easy-to-understand certification programs	Provide verifiable data about sustainability	Transparency is key, tourists need to trust the claims
8. Do you think cognitive dissonance affects tourists' decisions regarding sustainability?	Yes, people justify unsustainable choices	Tourists often ignore the impact to enjoy their vacations	People feel guilt but still opt for convenience	Many travelers justify their unsustainable behavior	Tourists minimize their role in contributing to environmental damage
9. How can we address these psychological barriers in the industry?	Simplify access to sustainable options, raise awareness	Education, incentives, and emotional marketing	Make sustainable options more attractive and affordable	Change perceptions through awareness campaigns	Make sustainability convenient and cost-effective

Question	Manager 6	Manager 7	Manager 8	Manager 9	Manager 10
1. What do you think are the main psychological barriers to sustainable tourism?	Trust issues, skepticism towards sustainability claims	Awareness gaps, time constraints in planning	Social norms, peer influence	Cognitive dissonance, emotional detachment	Cost concerns, lack of government incentives
2. How do cost concerns influence tourists' decision to choose sustainable options?	Sustainable choices are not always budget-friendly	Many tourists believe it's too expensive to go green	It's about value for money – tourists prefer cheaper options	Costs create a barrier even though long-term savings exist	Tourists are often unaware of financial benefits in the long run
3. Do you believe lack of awareness is a major issue in promoting sustainable tourism?	Awareness needs to be raised through marketing and education	Yes, awareness campaigns should be more widespread	Awareness is key but not enough to change behavior	Yes, lack of awareness limits sustainable choice	Definitely, most consumers don't understand sustainability fully
4. How do social norms and peer influence affect sustainable tourism choices?	Social norms hinder sustainable choices unless supported by influencers	Peer influence can promote sustainability if used correctly	Social media amplifies trends but rarely sustainability	If sustainable tourism became trendy, more people would follow	Peer influence is important – travelers mimic friends' behaviors
5. How can emotional appeals help promote sustainable tourism?	Tourists need to feel emotionally invested in their impact	Emotional connection is essential to motivate sustainable choices	Storytelling makes sustainability personal and relatable	Emotional marketing can definitely motivate more responsible tourism	Tourists need an emotional reason to choose sustainability
6. What are some strategies you recommend to increase awareness about sustainable tourism?	Sustainable travel fairs and workshops can raise awareness	Targeted marketing and eco-certifications	Collaborate with governments to push sustainability education	More media coverage, especially documentaries	Incentivize eco-friendly choices and provide clear information

7. How can trust in sustainable tourism claims be improved?	Collaborate with reputable organizations to certify businesses	Eco-certifications are essential for building trust	Transparency in communication and honest claims	More regulation and oversight of green claims	Sustainable tourism needs verified certifications
8. Do you think cognitive dissonance affects tourists' decisions regarding sustainability?	Absolutely, many feel bad but go for comfort anyway	Yes, tourists justify unsustainable choices to avoid guilt	Cognitive dissonance leads to justification of poor choices	Tourists often make excuses to justify unsustainable behavior	Cognitive dissonance is common, especially for frequent travelers
9. How can we address these psychological barriers in the industry?	Focus on storytelling, transparency, and affordability	Provide incentives for choosing sustainable options	Education, transparency, and clear rewards for sustainable choices	Clear communication, incentives, and easy access to information	More education and marketing, making sustainability the default

Source: Author`s elaboration

Condition of Motor Vehicles Fleet in Canton Sarajevo and the Necessary Measures for Approaching the EU Green Deal and its Impact on Air Quality

Mustafic IBRAHIM[1], Selimic MIRZO[2], Sakic MARIO[3]

Abstract

Environmental pollution is a side effect of the economic development of human civilization and the pursuit of higher profits in every type of economic branch. In this paper, the pollution of the environment by motor vehicles that are in traffic in the area of Canton Sarajevo in Bosnia and Herzegovina (B&H) is subject. In addition to motor vehicles, the geographical location of the city of Sarajevo, located in the Sarajevo basin, surrounded by high mountains, contributes to poor air quality, especially in autumn and winter. The structure of motor vehicles in the Sarajevo Canton is such that one patrol engine comes for three diesel engines, which are known to produce soot particles, especially as the age of the vehicle increases. The average age of the complete fleet in Sarajevo Canton is about 15 years. The EU Geen Deal is a document by which the European Union set a framework in 2019 to systematically oppose the increase in environmental pollution, especially CO_2 emissions. Bosnia and Herzegovina should use IPA funds to act in the direction of the EU Green Deal and provide its citizens with a healthy environment.

Keywords: *EU Green Deal, Canton Sarajevo, motor vehicles*.

Jel code: I19; R40; R50

1. Introduction

Sarajevo city is situated in Canton Sarajevo, Bosnia and Herzegovina and it is many times most-polluted city in the world.[4] In this paper, the pollution of the environment by motor vehicles that are in traffic in the area mostly in Sarajevo city is subject.

With the constant development of human civilization, man constantly wants to achieve faster, better and greater results, that is from an economic point of view, he wants to make a bigger profit.

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[4] https://www.euronews.com/my-europe/2024/12/20/sarajevo-third-most-polluted-city- in-the-world-as-air-quality-index-hits-225

In this effort, as a by-product, a large amount of pollution of the environment appeared due to the increase of greenhouse gases (CO_2), which result in a global increase in the temperature of the earth's surface. This increase in the temperature of the earth's surface leads to a faster melting of the ice at the earth's poles, which further causes an increase in the level of the oceans and seas (CO_2 emission performance standards for cars and vans, 2023).

Considering that a large number of the human population around the world lives on the coasts of oceans and seas, this already reduces the living space of some island countries in the Pacific Ocean.

It is necessary to emphasize that the topic of environmental protection is not just a story that some politicians would gain more votes in the elections, but it is a topic around which the entire life of a person needs to be coordinated.

A modest life is the solution to the possibility of the continuation of the human population, and it primarily includes a place to live, clothing, food and a type of transportation.

Technological development has led to the production of an increasing number of motor vehicles, first of all, which during exploitation contribute to environmental pollution. In Europe, as early as 1992, the introduction of norms that will limit the level of pollution that a motor vehicle may emit into the atmosphere began.

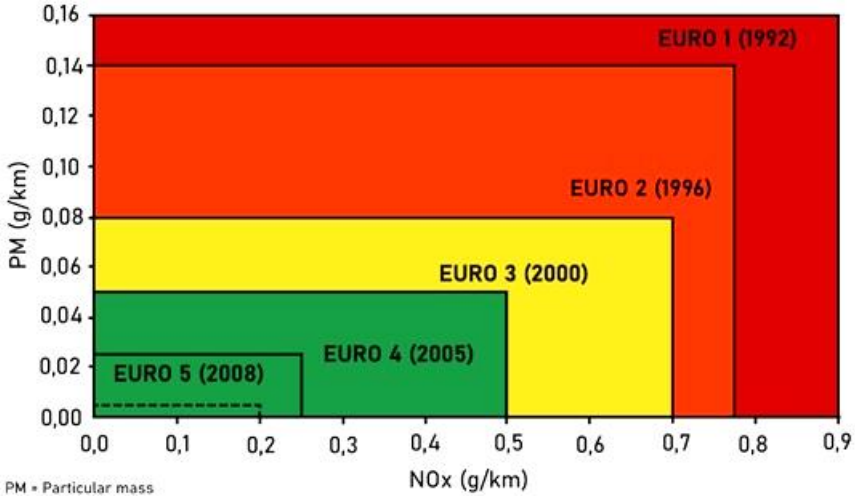
The course of the introduction of Euro norms from 1992 until today is as follows (European emission standards, 2024):

- Euro 1 (1992) – for passenger cars and light trucks (vans),
- Euro 2 (1996) – for passenger cars and motorcycles,
- Euro 3 (2000) – for any motor vehicle,
- Euro 4 (2005) – for any motor vehicle,
- Euro 5 (2009) – for passenger cars and commercial vehicles,
- Euro 6 (2014) – for passenger cars and commercial vehicles,
- Euro 7 (2030 to 2031) – the current plan for the introduction of the Euro 7 standard.

The introduction of euro standards alone did not solve the problem of increasing environmental pollution, so the European Union on 11.12.2019. published a document entitled: The European Green Deal (European Commission, 2019). This document aims to protect, preserve and enhance the EU's natural resources and to protect the health and well-being of citizens from risks and impacts related to the environment. It further set a very ambitious plan to achieve zero CO_2 emissions in the economy by 2050.

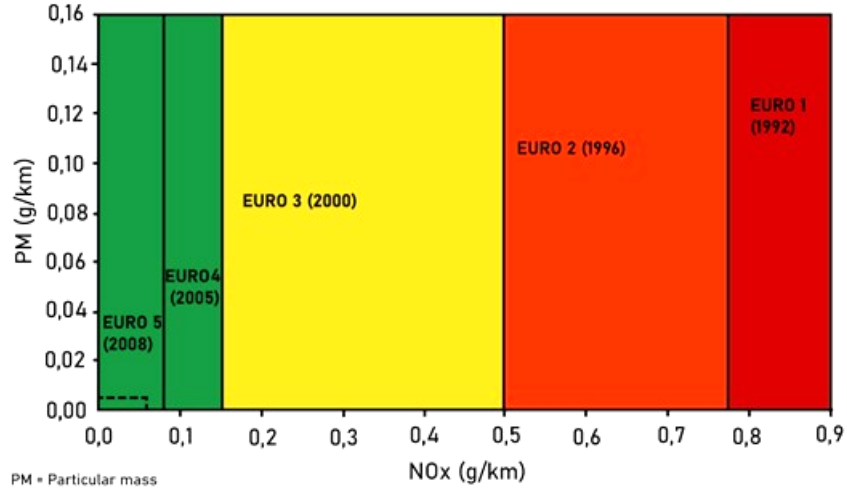
Additional reduction of polluting emissions is a challenge, because the current

limit values in the Euro 6 norm are "practically zero" (Figure 1.) (European emission standards, 2024).



NOx – nitrogen oxides, PM – solid soot particles

NOx and PM emissions in cars with diesel engines



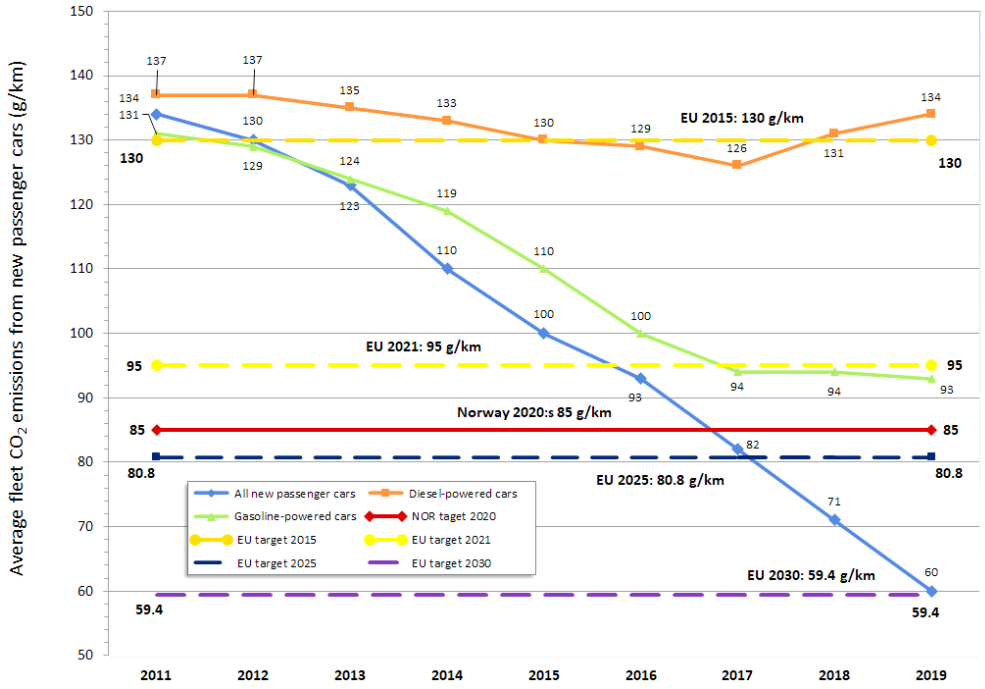
NOx and PM emissions in cars with petrol engines

Source: https://en.wikipedia.org/wiki/European_emission_standards

Figure 1. Euro car standards for petrol and diesel engines

EU directive no. 443/2009 from 2009 set a 2015 target of 130 g/km CO_2 for the fleet average for new passenger cars (Figure 2.). This EU directive set out regulations for light commercial vehicles in 2011, with an emissions target of 175 g/km for 2017. Both targets were met several years earlier than planned. The second set of regulations, passed in 2014, set a target for the average CO_2

emissions of new cars to fall to 95 g/km by 2021, and for light commercial vehicles to 147 g/km by 2020. In April 2019, Regulation (EU) 2019/631[5] was adopted, which introduced CO_2 emission standards for new passenger cars and new light commercial vehicles for 2025 and 2030. The new Regulation entered into force on January 1, 2020. and replaced and repealed Regulation (EC) 443/2009 and (EU) no. 510/2011. The 2019 regulation set new emission targets compared to the initial value for 2021, with a reduction in average CO_2 emissions from new cars by 15% in 2025 and by 37.5% in 2030. For light commercial vehicles, the new targets are to be reduced by 15% for 2025 and a reduction of 31% for 2030 (European emission standards, 2024).



Source: OFV (Oppysningsradet for Veitrafikken AS)

Figure 2. EU target values from 2015 to 2030 and historical trend of average annual CO_2 emissions for passenger cars in Norway for the period 2011-2019.

The price of transport must reflect its impact on the environment and health. Subsidies for fossil fuels would end and, in the context of the revision of the Energy Taxation Directive[6], the European Commission will seriously consider the current tax exemptions, including aviation and marine fuels, and amend the legislation accordingly.

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02019R0631-20231203
[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32003L0096

1.1. European Green deal and EU support to meet its targets

The EU is aware that the problem of environmental pollution with emissions of exhaust gases is of a global nature, and the adoption of the EU Green Deal document is one of a series of incentives for other regions in the world to do something similar.

The European Green Deal includes the European Climate Law, the European Climate Pact and a new global strategy in international relations. In addition, it is divided into eight policy areas.

Those eight policy areas are (European Commission, 2019):
1. Increasing the EU's climate ambition for 2030 and 2050.
2. Supplying clean, affordable and secure energy.
3. Mobilising industry for a clean and circular economy.
4. Building and renovating in an energy and resource efficient way.
5. Accelerating the shift to sustainable and smart mobility.
6. From 'Farm to Fork': designing a fair, healthy and environmentally-friendly food system.
7. Preserving and restoring ecosystems and biodiversity.
8. A zero pollution ambition for a toxic-free environment.

With the new CO_2 standards, all new cars and light trucks registered in Europe by 2035 will have low emissions. As an intermediate step towards zero emissions, the average emissions of new cars will have to be reduced by 55% by 2030, and of new vans by 50% by 2030. This will put road transport on a firm path towards emission-free mobility in 2050 (European Commission, Climate action, 2024).

The EU is working to create the infrastructure that citizens will need to charge zero-emission vehicles for short and long trips. The targets will be mandatory for the installation of electricity and hydrogen charging infrastructure along European roads. Sufficient public charging capacity will be established to meet the demands of the larger fleet of zero-emission cars coming onto the market, as well as a further supply of private chargers at home or at work. In addition, from 2027, road transport will be covered by charging for environmental pollution from motor vehicles, encouraging the use of cleaner fuels and reinvesting in clean technologies (THE EUROPEAN GREEN DEAL, Constanze Fetting, ESDN Office (2020).

Every country in Europe, whether it is a member of the EU or not, and Bosnia and Herzegovina aspire to one day be part of it, should work on the aforementioned eight policy areas, in order to provide the entire population with better living conditions.

Although the previously mentioned eight policy areas are interconnected and

interwoven, this paper will analyze that listed under number: 5. Accelerating the transition to sustainable and smart mobility in Sarajevo Canton.

There is a direct relationship between the number of inhabitants in some regions, the number of motor vehicles, and the increase in air pollution in that region. All of the data presented above indicate necessity that large public investments by the authorities and increased efforts to animate and involve private capital towards climate and environmental activities will be needed in the future to raise EV vehicles in public use. The main reason for that is huge amount of money and time needed to be done.

The Instrument for Pre-Accession Assistance (IPA) is the main financial instrument of the European Union for providing assistance to the beneficiary countries in gradual alignment with EU standards and policies, including the acquis, with the aim of membership in the European Union. IPA represents comprehensive support for the process of European integration, through financial, technical and expert support for reforms.[7]

In order to support potential candidate countries, in 2006 the European Union combined all previous forms of support for candidate countries (CARDS, SAPARD, ISPA, PHARE, instrument for Turkey) into one - Instrument for Pre-Accession Assistance.

IPA funds are intended primarily for institutions in order to undertake obligations and are also available to other users (non-governmental organizations, the business community, border regions, local self-government units, agricultural holdings and other persons and companies).

IPA III is the third generation of the European Union's pre-accession aid instrument for the countries of the Western Balkans and Turkey. With a budget of 14.2 billion euros in the seven-year period 2021-2027, the European Union through this instrument continues to financially support legal, economic and social reforms in candidate and potential candidate countries, enabling them to meet the criteria for EU membership. (Instrument for Pre-Accession Assistance (IPA) (2024))

2. Methodology

The aim of this paper is to stimulate thinking in the field of traffic and on the topic of improving air quality in the Sarajevo Canton, B&H. With the same aim, but in a different area, last year, the ENOVA[8] – Bosnia and Herzegovina organization, within the framework of the Replace project (Keeping the heat on in times of crisis, 2023, Promoting renewable heating in South Eastern

[7] https://www.dei.gov.ba/hr/instrument-pretpristupne-pomoci
[8] https://www.enova.ba/

Europe - Best of BiH, 2023[9]), published the results of how the population of the Sarajevo Canton heats their homes during the winter. The results of this project showed that coal combustion is primary in this process, which consequently leads to an increase in air pollution in this area. Knowing the situation with increased air pollution in the Sarajevo Canton in the winter, this paper will present the number of motor vehicles by type of engine, type of fuel that powers these motor vehicles, as well as the Euro standards of these engines. The data shown here are publicly available on the website of the Agency for Identification Documents, Records and Data Exchange of Bosnia and Herzegovina (IDDEEA)[10], which are used as the basis for the analysis presented in this paper.

This IDDEEA agency keeps a central record of all registered vehicles throughout Bosnia and Herzegovina, according to many different parameters, and this paper examines the parameters of vehicle type, engine type, fuel type and Euro standards for internal combustion engines. Recognizing the problem of increased air pollution at the European Union, the European Green Deal was approved in 2020 and represents a set of political initiatives of the European Commission with the aim of the European Union becoming climate neutral by 2050. This agreement lists several directions that need to be worked on at the level of each country in order to meet the set goals, which contribute, among other things, to better air quality for its citizens.

Considering that Bosnia and Herzegovina do not produce motor vehicles and electric vehicles, the import of vehicles from other countries is inevitable, and each individual need to invest large amount of money in order to import electric vehicles that have zero air pollution. Therefore, the state authorities should identify a way to stimulate the purchase, i.e., import of electric vehicles. The author's wish is that this paper encourages a young politician to help in new laws or entrepreneurs in B&H to make a contribution, in reducing the number of gasoline or diesel motor vehicles and increase the number of electric vehicles.

3. Results and discussion

Canton Sarajevo, next to Tuzla Canton, is the area with the largest number of registered vehicles in our country, and therefore motor vehicles, are shown in Table 1. In addition, Canton Sarajevo is home to the seat of the state and federal government, a large number of ministries and a large number of companies whose workers with a place of residence outside this canton.

This has the consequence that all these workers come to this canton on a daily

[9] https://www.youtube.com/watch?v=lCyYHKsWaWE
[10] https://www.iddeea.gov.ba/

basis by motor vehicles, which anyway the large number of motor vehicles registered in this canton significantly affects the increase in environmental pollution, with higher emissions of CO_2 greenhouse gases.

In addition to the motor vehicles listed in Table 1, there is also a smaller number of motor vehicles of the L (motorcycles) and T (wheeled tractors) category and work machines, but these vehicles are exempt from the process of checking exhaust gas emissions at the technical inspection in B&H according to Article 158 of the Ordinance on dimensions, total mass and axle load of vehicles, on devices and equipment that vehicles must have and on the basic conditions that must be met by devices and equipment in road traffic (Official Gazette of BiH, number 23/07, 54/ 07, 101/12, 26/19 and 83/20).

Table 1. Number of motor vehicles registered in Canton Sarajevo in 2023 for which exhaust gas emissions are checked before vehicle registration [11]

YEAR 2023	M1	M2	M3	N1	N2	N3	TOTALY
January	9187	1	6	591	67	95	9947
February	10180	5	42	577	86	130	11020
Mart	12847	4	21	664	104	183	13823
April	12942	3	13	587	98	169	13812
Maj	15074	2	39	654	106	174	16049
June	15528	2	65	608	110	155	16468
July	15789	2	50	637	125	173	16776
August	13449	6	66	608	102	166	14397
September	12139	6	39	639	94	142	13059
Oktober	12915	5	32	650	85	172	13859
November	11653	3	45	687	102	99	12589
December	10741	1	13	725	76	90	11646
TOTALY	152444	40	431	7627	1155	1748	163445

Column's M1, M2, M3, N1, N2 and N3 in Table 1. represents vehicle category according to Consolidated Resolution on the Construction of Vehicles (R.E.3)[12]:

- "Category M1": Vehicles used for the carriage of passengers and comprising not more than eight seats in addition to the driver's seat.
- "Category M2": Vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and

[11] https://www.iddeea.gov.ba/bs/bilteni/

[12] World Forum for Harmonization of Vehicle Regulations, Consolidated Resolution on the Construction of Vehicles (R.E.3), ECE/TRANS/WP.29/78/Rev.7

having a maximum mass not exceeding 5,000 kg.
- "Category M3": Vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5,000 kg.
- "Category N1": Vehicles used for the carriage of goods and having a maximum mass not exceeding 3,500 kg.
- "Category N2": Vehicles used for the carriage of goods and having a maximum mass exceeding 3,500 kg but not exceeding 12,000 kg.
- "Category N3": Vehicles used for the carriage of goods and having a maximum mass exceeding 12,000 kg.

The average age of all motor vehicles listed in Table 1. is about 15 years, and if we also take into account the vehicles transiting this area from other cantons, the small area, i.e., the weak road network on which these motor vehicles move through the Sarajevo basin and when you add to that the geographical arrangement of the high mountains that surround the city itself, the situation is reached years ago that the air in autumn and winter is of very poor quality for human life.

Based on the available data for passenger motor vehicles, which are the most numerous according to Table 1., the following is the schedule of euro standards from EURO 3 to EURO 6:
- EURO 3 – 27847,
- EURO 4 – 39606,
- EURO 5 – 41470,
- EURO 6 – 31210.

The fact that the majority of vehicles are EURO 5 coincides with the fact that the average age of the fleet is about 15 years. The rest of the passenger vehicles, about 23,000 of them, are below the EURO 3 standard.

The energy source, i.e., the fuel that drives the motor vehicles listed in Table 1, is shown in Table 2.

Table 2. Energy that drives motor vehicles in Canton Sarajevo in 2023

ENERGY	Value	%
Petrol:	36458	22,3 %
Petrol / LPG:	4826	3 %
Petrol / CNG:	101	0,06 %
Petrol / Electric:	1042	0,64 %
Petrol / Electric / LPG:	1	0,0006 %
CNG:	49	0,03 %
LPG:	19	0,01 %
Diesel:	120518	73,74 %

ENERGY	Value	%
Diesel / CNG:	3	0,0018 %
Diesel / Electric:	208	0,13 %
Biodiesel:	4	0,0024 %
Electric drive:	185	0,11 %

As can be seen from Table 2., the largest number of motor vehicles are powered by diesel and petrol, i.e., 96% of motor vehicles, in a ratio of 3.3:1 in favour of diesel engines.

So only 4% are energy sources that emit less environmental pollution. Of that 4%, only 0.11% are purely electric vehicles, which have zero emissions of CO_2 greenhouse gases.

This data points to the fact that the state and federal authorities need to increase funds to stimulate companies and persons to purchase electric vehicles (EV) and plug-in hybrid-electric vehicles (PHEV), and on the other hand, it is also necessary to increase the infrastructure of number of public chargers for such vehicles.

Another way for the government to be actively involved in increasing the number of EV and PHEV vehicles on the roads throughout in B&H is to exempt such vehicles from customs duties and taxes, and to have certain benefits when registering these vehicles.

Given that everything about these EV and PHEV vehicles is high-priced, it is necessary to ease the procedures and lower the price of permits that legal or natural persons have when opening a filling station for these vehicles in our country.

4. Conclusion

The area of the Canton Sarajevo, more specifically the city of Sarajevo, has for several decades had an increased emission of polluting substances into the environment, especially in the autumn and winter period.

In addition to motor vehicles powered by internal combustion engines, which in their operation produce exhaust gas emissions, i.e., in addition to CO_2 emissions, there is also a significant emission of solid particles (soot) that also comes from solid energies (wood, coal) combustion plants of legal and natural persons who use them to heat business or residential buildings.

The ratio of motor vehicles of 3.3:1, diesel to gasoline engines, unfortunately supports this negative emission of environmental pollution, as well as the fact that the largest number of motor vehicles are powered by diesel and gasoline, i.e., 96% of motor vehicles.

The rest of only 4% is made up of energy sources that emit less environmental pollution, and of that 4%, only 0.11% is made up of purely electric vehicles, which have zero emissions of CO_2 greenhouse gases.

In addition, the geographical position of the Sarajevo basin, surrounded by high mountains, negatively affects the emission of exhaust gases in this way, which prevents the good circulation of air currents that would "clean" the air in this area.

Given that mountains cannot be moved, and the construction of large tunnels through them would be futuristic, what should be done to reduce emissions of polluting components into the atmosphere from motor vehicles in the Canton Sarajevo area is:

- exemption from customs duty or tax, or abolish both when importing EV and PHEV vehicles,
- reduce certain payments when registering EV and PHEV vehicles,
- it is necessary to facilitate procedures and lower the price of permits that persons and companies have when opening a charging station for EV and PHEV vehicles in our country.

The funds that the federal authorities have so far provided as incentives to persons and companies for the purchase of electric vehicles (EV) and plug-in hybrid-electric vehicles (PHEV) are too small to significantly contribute to the reduction of environmental pollution by motor vehicles.

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Green Practices in the Business Sector in Montenegro

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Abstract

Achieving sustainable development goals outlined in Agenda 2030 necessitates the active involvement of all societal sectors, including businesses. As part of the 1FUTURE project, this study examines the state of green business practices in Montenegro, focusing on measures adopted by companies, their management's awareness and attitudes towards sustainability, and the challenges encountered in transitioning to environmentally responsible operations. Data were collected via a survey targeting businesses of various sizes and sectors, analyzing their engagement with practices such as waste reduction, energy efficiency, and pollution control. Results highlight a disparity in the implementation of green practices between large corporations and smaller enterprises, emphasizing the role of financial and institutional support in fostering sustainability. Recommendations are provided for enhancing awareness, education, and policy incentives to accelerate the adoption of green practices within Montenegro's business sector.

Keywords: *Sustainable development, green practices*

Jel code: Q01, Q56

1. Introduction

Sustainable development has become an omnipresent and crucial theme in recent decades, aligning economic and social progress with environmental preservation (Wellington, Silva, & Rodrigues, 2020). Since the introduction of the concept of sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Brundtland, 1987), numerous international organizations at key global events discussed and developed key policies and goals in these areas, such as UN Agenda 21 (1992), Kyoto Protocol (1997), UN Millennium Development Goals (2000), UN Agenda 2030 (2015), The Paris Agreement (2016) and Sofia Declaration (2018).

Achieving the sustainable development goals outlined in Agenda 2030 requires a collective effort from all sectors of society, including the private sector (Ehritt, 2024), which should broaden its business focus to include

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sustainable practices through an Environmental, Social, and Governance (ESG) strategy (Todos, 2023).

Implementing green practices is increasingly recognized as a vital component of sustainable development (Oludele & Obatunde, 2018). Green business practices refer to environmentally friendly activities undertaken by companies to promote sustainability and mitigate environmental harm. These efforts focus on minimizing environmental harm through actions such as waste reduction, environmental protection, responsible resource use, and fostering ethical environmental behaviors (Ahmad, 2016). Adopting green practices is a process that offers businesses numerous ways to operate more sustainably. This requires not only appropriate public policies and a supportive environment that fosters business sector initiatives but also the active engagement of the economy and cooperation with other stakeholders, particularly in raising awareness about the importance of sustainable development.

Montenegro has established an adequate institutional framework for sustainable development, but the implementation of sustainable practices at the company level and the transition to green practices are progressing slowly (Lojpur et al., 2023). Therefore, the research aims to identify the environmental practices adopted by companies operating in Montenegro and to explore the awareness, knowledge, and attitudes of their management regarding the importance and implementation of these practices. By analyzing the data collected, the research seeks to provide insights into the current state of green business practices among Montenegrin companies and to identify potential challenges and opportunities for further advancement in this field.

2. Literature review

Numerous practices can be followed by business organizations to become green and sustainable. An environmentally conscious business should participate at least in any of 4 of 5R's that is Refuse, Reduce, Reuse, Recycle/Reuse, and Repurpose. Each of these "R" can be achieved through various practices (Čekanavičius, Bazytė, & Dičmonaitė, 2014).

The classification and systematization of green business practices derive from multiple sources reflecting best practices and widely accepted frameworks in sustainability, corporate responsibility, and environmental management (ISO, 2015), (Moratis, Melissen, & Idowu, 2018), (Lacy et al., 2020).

The adoption of green practices by companies has a multifaceted impact on business performance, enhancing competitiveness (Alkhodary, 2023), economic outcomes (Omowole et al., 2024), (Dela Cruz & Hariharan, 2022), brand image and stakeholder relationships (Rani & Purohit, 2024).

However, adopting green practices across various sectors also presents significant challenges, including financial and technological barriers as well

as cultural and regulatory obstacles (Ali et al., 2023).
The progress of the Western Balkans countries in this area is rather slow, despite the aspiration of these countries to become members of the European Union is a significant incentive (EBRD, 2021), (OECD, 2022). In Montenegro, various projects have been implemented recently to raise awareness in the business sector, especially among small and medium-sized enterprises, about concepts such as the green economy, circular economy, sustainable consumption and production, and the costs and financing of the green economy (UNDP & Institute for Strategic Studies and Prognoses, 2021, as cited in Ministry of Economic Development and Tourism of Montenegro, 2022).

3. Methodology

This study employs primary data to answer the research questions. A survey was designed targeting representatives from companies located in Montenegro. The companies ranged in size from micro to large. The questionnaire consisted of 25 close-ended questions. We first collected basic information about the business (size, sector, years in operation, location, and so on) and then asked specific questions to address specific drivers. The responses were measured on a four-point Likert scale (always / frequently / sometimes / never), with an 'I don't know', and 'Not applicable' option. Finally, we sought the respondent's opinions about the importance of different green business practices. Their opinions were also measured on a four-point Likert scale (unimportant / slightly important / somewhat important / very important), with an 'I don't know' option. The list of potential practices was adapted from literature. It includes practices related to waste, recycling, supply, energy, water, and transportation.

The survey was conducted using an online questionnaire, which had been adopted beforehand by the project coordinator. The data collection process took place in two rounds: October-November 2023 and January-February 2024. A disproportionate stratified sampling technique was used (Table 1.). In total, in both rounds, we sent the survey to 5406 email addresses. The survey dataset was cleaned to eliminate duplicates or incomplete (2 in total). The responses were adjusted for descriptive statistics by converting textual answers into numerical form and aligning activity classifications with standard options using data from the Central Register of Business Entities.
The final sample consisted of 216 observations which were analysed further.

4. Analysis & Discussion

In the research, through an online questionnaire, information was collected about:

- Applied green business measures of the company,
- Respondents' opinions on the importance of different green business practices,
- Level of knowledge and awareness about green business and environmental protection measures and their importance.

Table 1. Disproportionate stratified sample

Sectors	*No. of companies*			
	*Active**	*Invited to participate in the research*	*Partaking in study*	*% Partaking in study*
Agriculture, Forestry, Fishing	495	234	10	2.02%
Extractive Industry	84	67		
Processing	3,064	1,439	23	0.75%
Electricity, gas supply, steam and air conditioning	150	8	2	1.33%
Water supply, waste treatment, and management activities	133	20	3	2.26%
Construction	5,236	230	21	0.40%
Wholesale or Retail Trade; Repair of vehicles and motorcycles	12,529	1,319	26	0.21%
Transport and Storage	2,030	231	6	0.30%
Accommodation and food service	5,494	117	1	0.02%
Information and communication	2,740	291	12	0.44%
Financial and insurance activities	240	97	3	1.25%
Real Estate Activities	2,008	74	1	0.05%
Professional, scientific, and technical activities	6,271	384	94	1.50%
Administrative and support services	2,513	384	5	0.20%
Public administration and protection; Compulsory social security	79	0		
Education	219	127	2	0.91%
Health and social work activities	81	0		
Arts, entertainment, and recreation	763	127	2	0.26%
Other service activities	1,546	233	5	0.32%
Activities of families as employers; Activities of production of goods and services of households for their own use		24		
Activities of organizations and international bodies		0		
Total	**45,675**	**5,406**	**216**	**0.47%**

4.1. Profile of Participating Businesses

More than 54% of the responses were obtained from companies headquartered in Podgorica, the capital of Montenegro, slightly more than 10% from companies based in Nikšić, and around 7% from companies based in Bar. According to available statistical data from the Statistical Office of Montenegro (2023), active companies in these municipalities respectively constituted 35.6%, 5.2%, and 9.3% of the total number of active companies in the year 2022.

In Montenegro, micro and small enterprises constitute 99.2% (Statistical Office of Montenegro, 2023), medium-sized enterprises 0.7%, and large enterprises 0.1%. The structure of the collected responses is slightly different (Table 2).

Table. 2. Main characteristics of the study sample (N=216)

Variables	*Descriptive statistics*
Average years in operation	15 (STD=14)
Average number of employees per company	21,42 (STD 67.37)
Female-led companies	53 (24.57 %)
Legal status/form of company[4]	Unincorporated business 7 (3,2%)
	Limited liability 196 (90,7 %)
	Joint stock (Corporation) 6 (2,8 %)
	Other 7 (3,2%)
Size of company[5]	Micro 163 (75,5%)
	Small 41 (19,0%)
	Medium 6 (2,8%)
	Large 6 (2,8%)

4.2. Applied green business measures of the company

The first set of questions was supposed to give an insight into which environmental measures companies most often apply and how much they adhere to sustainable practices in their business.

[4] The provided answers to the question about Legal status of company, are aligned with Companies Law. ("Official Gazette of Montenegro", No. 065/20 od 03.07.2020, 146/21 od 31.12.2021, 004/24 od 23.01.2024). However, in the statistical data processing, responses such as "entrepreneur/partnership/limited partnership" were treated as „Unincorporated business ".

[5] Classification of business entities based on tax burden (according to the Law on Accounting) ("Official Gazette of Montenegro", No. 145/21 od 31.12.2021, 152/22 od 30.12.2022), is not adequate for categorizing companies into micro, small, medium, and large enterprises. Therefore, in the analysis, a detailed examination of the financial statements of all companies from 2022 was undertaken (reports are available at https://eprijava.tax.gov.me/TaxisPortal), to classify them based on balance sheets, income statements, and the average number of employees of these companies

The following table (Table 3) shows the adopted measures in the business practice of the subjects.

The highest percentage of all companies (81.95%) implements measures to protect the environment, and pollution reduction (75.47%), suggesting that basic environmental practices are relatively present across companies. Participation in community-based environmental initiatives (52.78%) demonstrates companies' willingness to participate in broader environmental initiatives, thereby improving their image within the community and contributing to local environmental goals.

Table 3. Adoption of green businesses measures

	Companies that:	*All companies in %*	*Large corporations in %*	*Gap*
1	Have adopted a national/international environmental certification program	20.83%	66.67%	45.84%
2	Have a detailed plan to reduce the environmental impacts	47.69%	100.00%	52.31%
3	Designate an employee/team/structure for environmental management	10.65%	100.00%	**89.35%**
4	Collaborate with other businesses for environmental management	32.87%	83.33%	50.46%
5	Estimate the quantity of solid waste discharged	17.59%	50.00%	32.41%
6	Estimate the quantity of hazardous waste discharged	9.26%	50.00%	40.74%
7	Send delegates to environmental conferences/activities	36.11%	83.33%	47.22%
8	Hold staff meetings to address environmental issues	16.67%	66.67%	50.00%
9	Have an earmarked budget for adoption of green practices	7.87%	66.67%	58.80%
10	Estimate the level of noise emissions	16.20%	66.67%	50.47%
11	Publicize information about their environmental impact	20.83%	83.33%	62.50%
12	Have a green transport plan/procedure (for staff, customers, freight)	16.20%	50.00%	33.80%
13	Conduct environmental management training for staff	36.57%	100.00%	63.43%
14	Engage in community-based environmental initiatives	52.78%	100.00%	47.22%
15	Inform customers about their environmental effects	32.87%	100.00%	67.13%
16	Implement measures to protect the	**81.95%**	100.00%	18.05%

	environment			
17	Estimate the level of energy consumption/savings/losses	43.98%	83.33%	39.35%
18	Implement measures to reduce pollution	**75.47%**	100.00%	24.53%

However, the least accepted measure is budget allocation for green practices (7.87%). The low adoption rate of this measure, especially among smaller companies, indicates financial constraints or the perception that green practices represent a cost. Smaller companies may feel they lack the resources to formally budget for green initiatives.

However, only 10.65% of companies have a dedicated employee or team for environmental management, indicating a lack of organized and formalized responsibility for environmental issues

At least 50% of the large companies that were interviewed apply all the measures mentioned above. Besides that, all these interviewed large companies have a detailed plan to reduce the environmental impacts.

For most practices, there is a clear gap of over 50%, indicating that large corporations are far more engaged in environmental initiatives. The largest gap is seen in the designation of a responsible person or team for environmental management (GAP 89.35%). This suggests that smaller companies rarely have the resources or need for formalized environmental management, whereas for large corporations, it is standard practice. Large corporations are more likely (GAP of 67.13%) to inform their customers about the environmental impacts of their products or services, which may be part of their corporate responsibility and reputation. Smaller companies, on the other hand, may not see the need for this or lack the resources.

Large corporations usually provide training for employees on environmental issues to familiarize them with proper practices and procedures (GAP of 63.43%). Smaller companies rarely invest in such training, which may limit their ability to effectively implement environmental measures.

The measures implemented by the companies on their premises also were examined (Table 4).

The most popular measures, among these companies, are related to the usage energy energy-saving light bulbs (LED). On the other side, the least populated measures among these companies are measures related to the usage of energy-saving cards in less-used business environments.

The use of energy-saving light bulbs (LED) stands out with a 93.1% adoption rate, indicating that many companies prioritize energy efficiency in lighting. Practices like using separate recycling bins and sustainable cleaning methods show moderate adoption (53.2% and 56.0% respectively). This suggests that while companies recognize the importance of these measures, there may be barriers preventing wider implementation.

Measures such as using energy-saving cards and monitoring energy savings systems have low adoption rates (9.3% and 17.1%). This could indicate a lack of resources, awareness, or urgency regarding energy conservation in these specific areas.

Table 4. Using green measures in the company's premises

Measures	*Yes*	*No*	*Not applicable*
Using a system to monitor energy savings in the premises where customers are served	17.1%	45.37%	30.56%
Using energy-saving cards in less-used business environments (e.g. conference rooms)	9.3%	54.17%	32.41%
Using energy-saving light bulbs (LED)	**93.1%**	2.78%	2.31%
Using separate bins for recyclables (e.g. paper, metal, plastic)	**53.2%**	37.96%	6.02%
Using sensor-activated lighting in restrooms/hallways/and other places that require only intermittent lighting	48.1%	41.20%	9.26%
Using cleaning products with reduced amounts of chemicals (e.g. those that have a specified label)	**56.0%**	24.07%	9.26%
Using sustainable methods for cleaning work tools (such as clothing, tools, materials, equipment, etc.) that use less electricity (e.g. inverter washing machines, dishwashers)	**56.0%**	22.69%	16.20%

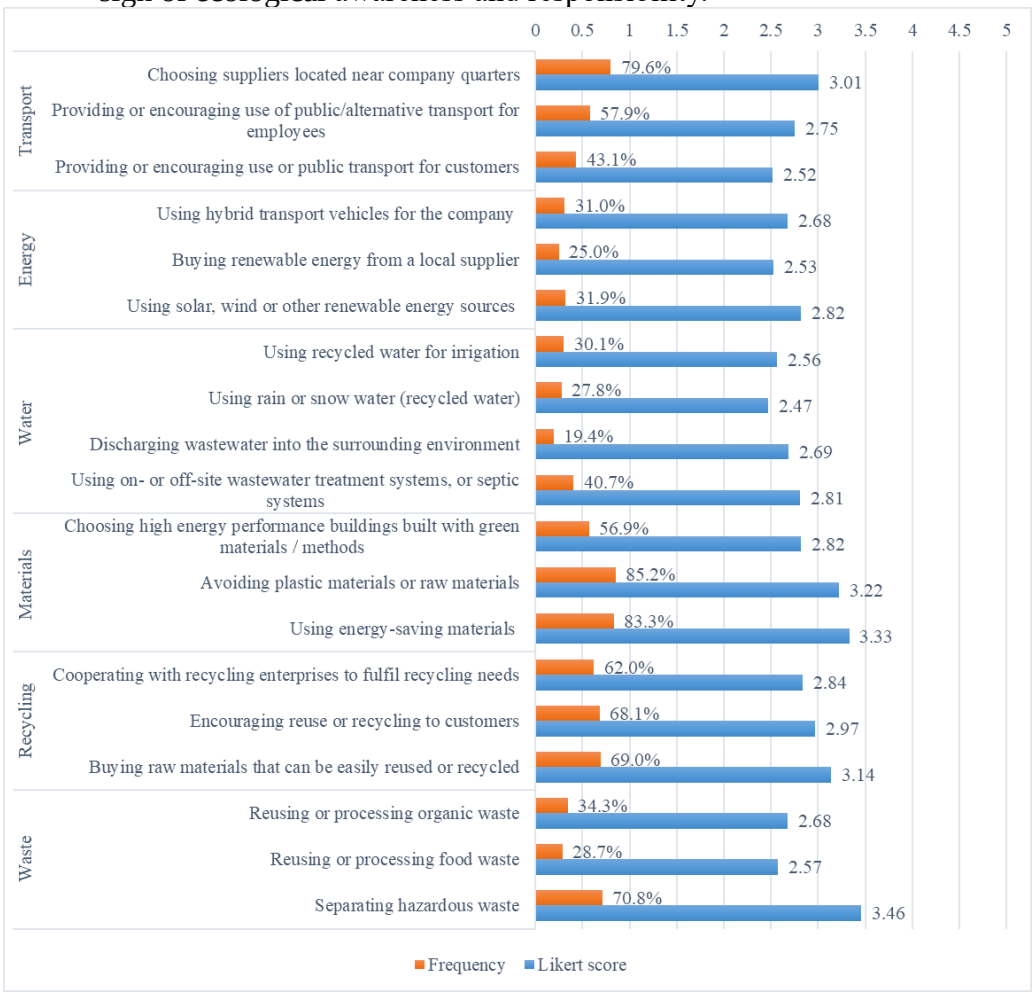
4.3. Level of knowledge and awareness about green business and environmental protection measures and their importance

The questions in the second part of the questionnaire assessed the company representatives' perception of available green practices and their importance.
The following picture (Picture 1) shows the assessment of the importance of the measures[6], according to the opinion of the respondents, as well as the frequency of their application.
According to the opinion of company representatives, the most important measures for achieving the environmental goals of its entity are:

- Separating hazardous waste (Likert score: 3.46)- , indicating that companies recognize the importance of proper hazardous waste management,
- Using energy-saving materials (Likert score: 3.33)- suggests that companies are actively seeking ways to reduce energy consumption, which can lead to significant savings and increased sustainability.
- Avoiding plastic materials or raw materials (Likert score: 3.22- shows

[6] Scale ranges from 1: (unimportant) to 4: (very important).

that companies are aware of the pollution problem caused by plastics and are taking steps to use alternative materials, which is a positive sign of ecological awareness and responsibility.



Picture 1. Company representatives' views on green business practices and the frequency of undertaking the relevant measures

In addition, the picture shows that the least important measures are considered to be using rain or snow water /recycled water (Likert score: 2.47), buying renewable energy from a local supplier (Likert score: 2.53), and providing or encouraging the use public transport for customers (Likert score: 2.52).

These data indicate that companies generally recognize the importance of green practices, especially in hazardous waste management, using energy-efficient materials, and avoiding plastic raw materials. Those measures received high Likert scores and high frequency of implementation and indicate strong agreement among company representatives on their importance, as well

as a commitment to integrating these practices. Companies see these measures as beneficial and are actively incorporating them into their operations.
However, there are significant differences in the importance of certain measures, especially in using renewable energy sources and water management systems. Additionally, providing support and encouraging the use of public transportation can significantly contribute to reducing emissions and enhancing the overall ecological profile of companies.
Looking at the overall ratings at the level of measure groups, it can be concluded that the most popular measures are those related to material usage, while measures related to water are rated slightly higher than slightly important. However, it should be borne in mind that these are opinions of managers regarding the importance of measures "to achieving the environmental objectives of your entity" and that not all measures are inherently applicable to all types of businesses.

5. Conclusions and Recommendations

Our survey has shown that only a small number of companies (a total of 8) "Never apply" or find "Not applicable" green business practices in their operations. However, in response to the question about the importance of these measures, the majority of these respondents chose answers "I don't know" or "Not important at all". This somewhat indicates that the reason for not implementing some measures, besides the specificity of certain activities, also lies in the insufficient understanding of their importance for environmental preservation and sustainability (Candrianto, 2023). In this regard, it should be noted that during the survey, we received several emails contesting the issue of sustainable development and climate change.

All of this indicates that there is insufficient knowledge and awareness on the mentioned topic, and that Montenegrin enterprises have room for improvement in environmental consciousness, which aligns with previous research conducted (Union of Employers of Montenegro, 2023). According to that research, although most companies are not familiar with environmental regulations and strategies for efficient energy and material use, more than half of them recognize the importance of being perceived as environmentally responsible companies that comply with regulations.
On the other hand, although more than 50% of respondents from our survey implement some of the green business measures in their operations, such as Engaging in community-based environmental initiatives (52.78%), measures to protect the environment (81.95%), and measures to reduce pollution (75.47%), only 7.87% of respondents have a specific budget for reducing environmental impacts. It can be assumed that the lack of financial resources is the reason why other measures are implemented to a lesser extent (Čekanavičius, Bazytė, & Dičmonaitė, 2014).

Our findings align with those of the UNDP and Institute for Strategic Studies and Prognoses (2021) study, where more than half of the companies indicated that reducing operating costs would motivate them to pursue additional activities and investments to align their operations with a green economy. They identified the main challenges in adapting their businesses to the green economy as financial (lack of funds within the company, cost levels, and difficulties in securing funds from external sources). On the other hand, only 20% of companies are familiar with programs and support measures for the green economy, with half that percentage having applied for any of the programs, and only 4.5% of companies having utilized any of the programs.

Based on the results of our research, as well as other studies conducted Union of Employers of Montenegro (2023) and UNDP and Institute for Strategic Studies and Prognoses (2021) we believe that it is necessary to continuously promote measures that can help establish sustainable development and mitigate climate change. This can be achieved through media campaigns, organizing informational days or workshops, scientific conferences, various forms of education and/or training, and similar activities.

The large companies more effectively integrate green practices through structured approaches, budgeting, and training, while smaller firms are less organized in this regard, primarily due to limited resources (Wellington, Silva, & Rodrigues, 2020). The differences in the adoption of these measures suggest a potential for targeted support programs for smaller businesses to facilitate the implementation of basic environmental measures.

It is also essential to increase companies' awareness of funding opportunities for implementing sustainable development, green and circular economy measures, and climate change prevention and mitigation (Clark & Sunderland, 2018). Special attention should be given to funding possibilities from budgetary sources, the Eco-fund, the Investment and Development Fund, international organizations, and commercial banks managing international credit lines aimed at the green economy. For example, one of the survey participants from the banking sector mentioned as part of the measures they implement the measure of credit policy, where they do not finance clients who are problematic from an ESG perspective, i.e., they develop so-called green loans.

To improve ecological sustainability, it is recommended that companies focus their efforts on education and training regarding sustainable practices, as well as on developing supporting infrastructure (Union of Employers of Montenegro, 2023). Education and training programs could be implemented to raise awareness and encourage more robust participation in eco-friendly practices. Implementing some or all of these measures would not only improve their reputation but also enable them to become more competitive in a market that increasingly values sustainability.

To enhance overall sustainability, companies could benefit from targeted initiatives to increase the frequency of some green practices (as related to water conservation or renewable energy).
It is necessary to provide interested parties with information and knowledge through collaboration among various stakeholders. Additionally, fostering collaborations with local suppliers and recycling enterprises may further support the implementation of green initiatives, leading to a more sustainable business model.

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The Role of European Higher Education Institutions (HEIs) in Advancing the Sustainable Development Goals (SDGs): a Survey of Five Universities

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Abstract

This article examines how Sustainable Development Goals (SDGs) may be integrated into the academic and operational practices of universities. As part of the 1FUTURE project, a structured survey was conducted among five European Higher Education Institutions (HEIs)to map and assess the alignment of their programs, research, and management strategies with global sustainability frameworks. The study explores the extent to which these European HEIs have embedded sustainability across curricula, from specialized degree programs to individual courses, and highlights key initiatives in research and stakeholder collaboration focused on environmental and social resilience. Additionally, university management practices aimed at promoting sustainability and reducing environmental impact are analysed, revealing a multidimensional approach to sustainability that includes energy efficiency, waste management, and carbon footprint reduction. The findings underscore the importance of aligning HEI strategies with SDGs to support the transition toward a sustainable future. The presented survey may inspire other institutions seeking to advance sustainability within higher education, emphasizing the critical role of HEIs in driving global sustainability agendas.

Keywords: *Sustainable Development Goals, Higher Education Institutions, Climate Resilience, Sustainability, Academic growth*.

Jel code: Q01, I23, O13

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1. Introduction

Between 1980 and 2022, weather and climate extremes caused economic losses of property estimated at 650 billion euros in EU member states (Figure 1), of which 59.4 billion euros in 2021 and 52.3 billion euros in 2022. Analyzing trends in economic losses is difficult, partly due to the large variability from year to year. However, some statistical analyses have revealed that economic losses increase over time. Since extreme events related to weather and climate conditions are expected to intensify further, it is unlikely that associated economic losses will decrease by 2030.

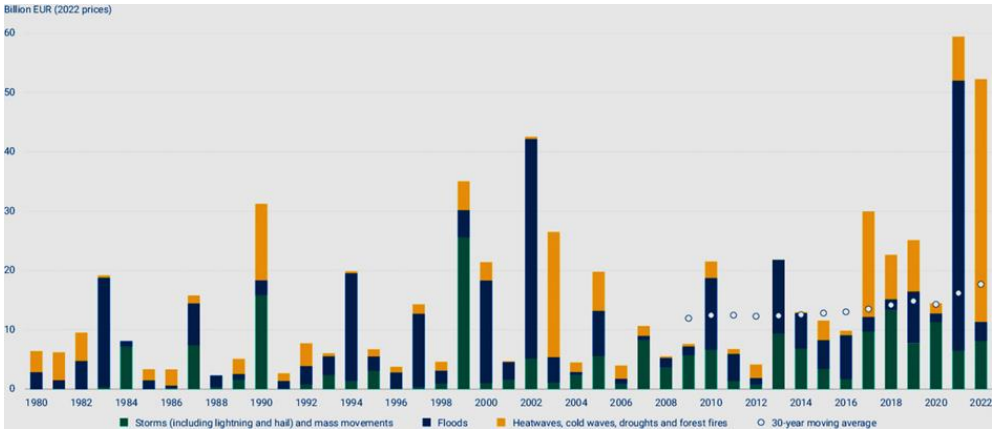

Figure 1: Annual economic losses in European Union countries caused by atmospheric and hydrological climate-related hazards

The Sendai Framework for Disaster Risk Reduction[8] and the Sustainable Development Goals (SDGs)[9] were adopted in 2015. However, in the years since, we still have accelerated climate change, growing inequality, poverty and humanitarian needs due to unsustainable development choices. Building in resilience-thinking can accelerate the required paradigm shift for the benefit of people, the planet and prosperity, and future generations. The key elements for sustainable development need to include understanding risk, recognizing systems are interconnected, including stakeholders and building capacities for resilience (Figure 2).

[8] United Nation Sendai Framework for Disaster Risk Reduction 2015-2030 https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030

[9] UNDP Sustainable development goals Booklet https://www.dev-practitioners.eu/media/key_documents/SDGs_Booklet_Web_En.pdf

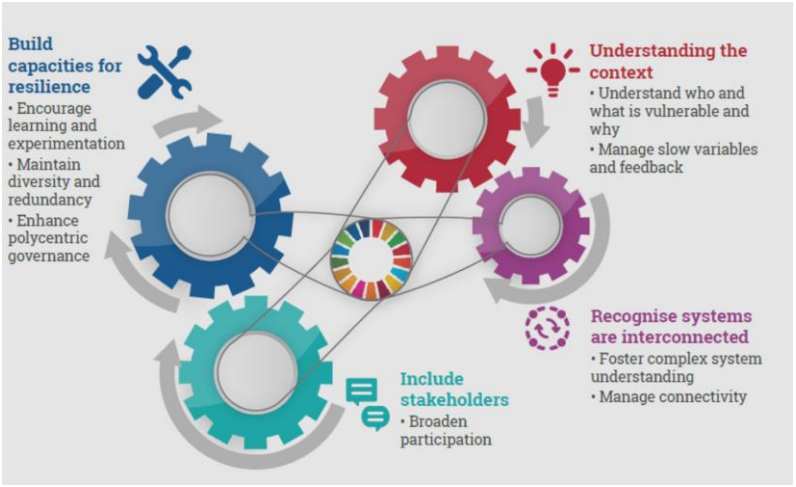

Figure 2: Elements of sustainable development [10]

Given its primary role as knowledge producer, higher education can serve as a powerful means to help create a more sustainable future. Thus, the concept of 'education for sustainable development' has become, in recent years, one of the core educational initiatives to help address many of the problems associated with human development. According to UNESCO, "Education for Sustainable development (ESD) empowers people to change the way they think and work towards a sustainable future"[11]. ESD is widely recognized as an integral element of Agenda 2030, Sustainable Development Goal 4 (SDG 4), and a key enabler of all the other SDGs.

Responding to escalating environmental challenges and a growing global imperative for ecological transition, universities are increasingly recognized as powerful agents of change. Through their roles in education, research, and policy development, HEIs are essential in preparing future leaders with the knowledge and values required to tackle today's urgent environmental challenges. By demonstrating successful ways of transforming to more sustainable practices, HEIs may also act as role models for other types of organization.

The 1FUTURE project, funded by the European Union through Erasmus+, exemplifies this academic commitment by fostering a comprehensive approach to sustainability within HEIs across Europe and the Western Balkans. Aiming to build climate-resilient academic communities, 1FUTURE

[10] United Nations Office for Disaster Risk Reduction (2023). *GAR Special Report: Measuring Resilience for the Sustainable Development Goals*. Geneva. https://www.undrr.org/gar/gar2023-special-report

[11] UNESCO Education for Sustainable Development, A roadmap, 2020, https://unesdoc.unesco.org/ark:/48223/pf0000374802

promotes collaborative networks that incorporate climate action and sustainability practices within educational frameworks, research, and institutional operations. By emphasizing an interdisciplinary, cross-sectoral approach, the project aligns with the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement, thereby contributing to a unified European strategy for sustainable development.

Central to this initiative, a survey was conducted among five European partner universities to assess how sustainability practices, guided by the SDGs and international frameworks, are translated into sustainable policies and academic programs within higher education. This survey aimed to investigate how these universities interpret and implement broad sustainability objectives in the specific context of degree programs, thus serving as a basis for understanding how HEIs may embed SGDs within their curricula and institutional strategies. The rationale behind this investigation lies in highlighting examples of how international sustainability directives may be translated into practical, educational outcomes that equip students with relevant skills and knowledge. Leaders from Western Balkans in Sofia 2020 at the WB Summit agreed to develop a plan for economy-specific and regional awareness-raising activities, reflecting the Green Agenda for Western Balkans[12] in the reforms of the educational systems: the HEI curricula across WBC should embrace the issues of green economy, climate change and sustainability in order to implement and develop the institutional reforms and to satisfy the requirements of the labour markets in the future.

The findings from this survey provide critical insights into the state of sustainability practices in a sample of HEIs across different parts of Europe, illustrating how global sustainability goals are currently being integrated into degree programs and highlighting areas for potential improvement. This analysis may serve as a valuable resource for other universities aiming to embed sustainability within their academic framework, offering a reference for institutions globally on the role of HEIs in advancing sustainability and climate resilience through education. By documenting current practices and identifying common challenges, this study aims to support HEIs in effectively implementing sustainability goals, thus reinforcing the role of higher education in addressing the global sustainability agenda.

2. Literature review

The global community is confronting immense challenges. To meet the 1.5-degree target, drastic measures are required to reduce greenhouse gas

[12] European Commission COMMISSION STAFF WORKING DOCUMENT Guidelines for the Implementation of the Green Agenda for the Western Balkans, https://enlargement.ec.europa.eu/system/files/2020-10/green_agenda_for_the_western_balkans_en.pdf

emissions. The ongoing impacts of global warming—such as extreme heat waves, heavy rainfall, and droughts—along with their consequences, are regularly analyzed and summarized in the IPCC Assessment Report. Given these global challenges, competencies in Education for Sustainable Development (ESD) are essential as key skills across all professional fields (Molitor et al. 2024). Educational institutions have been called upon to address sustainable development since the 1992 Rio Summit with Agenda 21 (UNCED 1992). This mandate continues at the federal level through the National Action Plan (NAP) for implementing the UNESCO *World Action Program on Education for Sustainable Development* (2015–2019) and the UNESCO *ESD for 2030* program, which guide efforts from 2020 to 2030 (German Commission for UNESCO [DUK] 2022; National Action Plan on Education for Sustainable Development [NAP] 2017).

The concept of Education for Sustainable Development (ESD) has emerged as a framework for embedding sustainability into the academic environment, emphasizing the need to equip students with the skills, knowledge, and values necessary to address pressing ecological issues. Universities, in particular, play a crucial role as key learning environments where ecological, social, and economic dimensions are considered holistically, innovative solutions for present and future challenges are developed, and future decision-makers are trained across various fields (HRK 2018). Universities are uniquely positioned to influence a wide demographic, shaping the perspectives and behaviors of future leaders.

Education for sustainable development is an all-encompassing educational approach designed to systematically integrate (university) teaching that empowers students to drive transformation toward sustainable development. The core learning objective of "change agent competency" (Bellina et al. 2020, p. 29) can be broken down into four key areas.

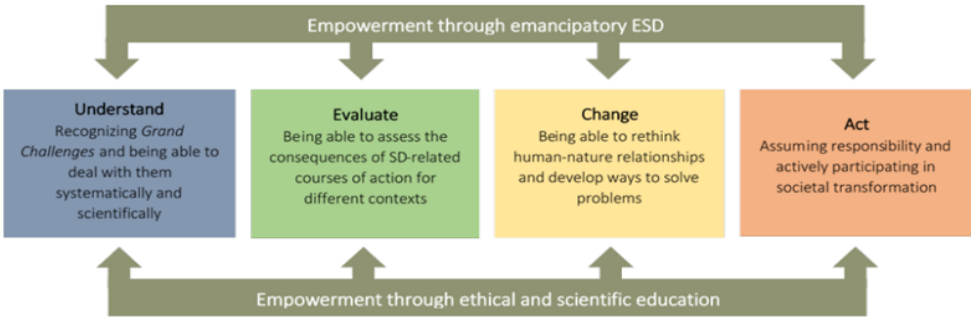

Figure 3: Aims of higher education for sustainable development (Source: Adapted from Bellina et al. 2020, p. 33, and translated by Molitor et al. 2024)

Sustainable development is an intricate issue that often involves conflicting goals, as exemplified by the Sustainable Development Goals (SDGs), the aim of Education for Sustainable Development (ESD) should be to foster the development of dilemma sensitivity or ambiguity tolerance (Müller-Christ & Weßling 2007), enabling individuals to recognize, accept, and effectively address these contradictions and trade-offs (Molitor et al. 2024).

The UNESCO program *ESD for 2030* provides a roadmap for integrating ESD into the education sector, calling on all member states to implement it at the national level. For universities, this means embedding ESD into key institutional frameworks to ensure sustainability is integrated into teaching (BNE, n.d.). A crucial step for universities is embedding sustainability into study and examination regulations, as well as integrating it into module descriptions across study programs (Molitor et al. 2024).

The framework for higher education for sustainable development (HESD) outlined in the HOCH-N guideline "Education for Sustainable Development in Higher Education" defines the core components of HESD. The goal of HESD is to empower students and teachers to (co-)create sustainable development and critically reflect on their own actions and values. To achieve this, merely reproducing knowledge is not enough. It is crucial, therefore, to foster the development of competencies for sustainable development. Over the past 25 years, various competency models for sustainable development have been proposed, sharing common elements but emphasizing different aspects (Krah et al. 2021; Molitor et al. 2022; UNESCO 2017; Wiek et al. 2016). The framework of key competencies in sustainability, outlined by Brundiers et al. (2021), focuses on the essential competencies needed to effectively contribute to sustainable development. The key competencies are: (1) implementation competency, (2) strategic-thinking competency, (3) values-thinking competency, (4) futures-thinking competency and (5) systems-thinking competency. These key competencies are completed by "*enabling*" competencies: (1) integrated problem-solving competency, (2) interpersonal competence and (3) intrapersonal competence. This competency framework connects key competencies in sustainability with the foundational academic skills developed throughout higher education, as well as the specialized knowledge from various disciplines (Molitor et al. 2024).

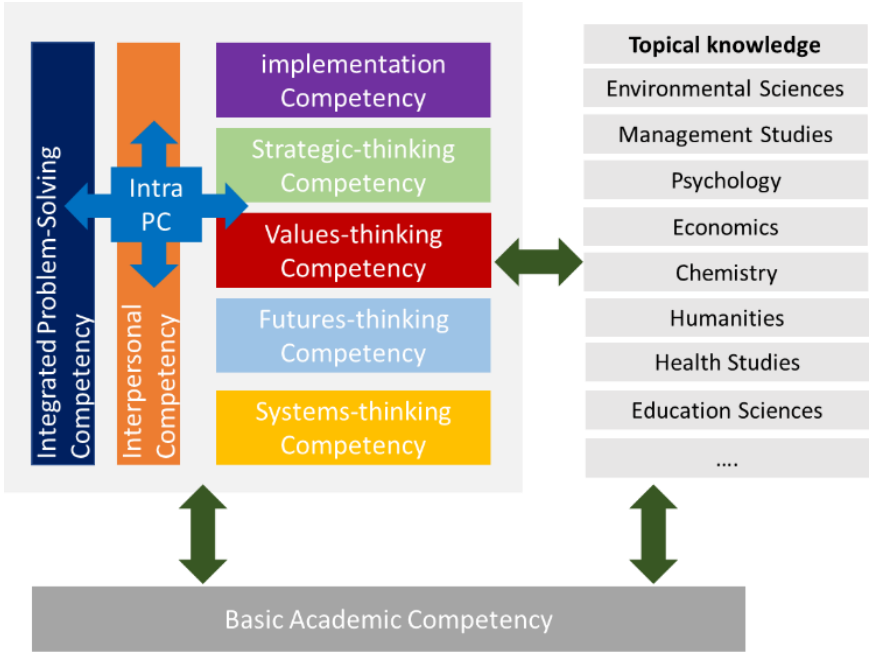

Figure 4: Key competencies in sustainability linked to discipline-specific knowledge and basic academic competencies (Source: Brundiers et al. 2021)

In accordance with the requirements for study program accreditation and competency-oriented teaching, the competencies to be acquired must be clearly outlined in each module description. To ensure nationwide comparability, these competencies are structured according to the Higher Education Quality Framework (HQR) (Molitor et al. 2024). The SDGs also offer new frameworks for Education for Sustainable Development (ESD). Notably, SDG 4—Quality Education—aims to provide lifelong, quality education for everyone and is crucial for all other SDGs since ESD fosters key competencies that support social, economic, and ecological objectives especially SDG 4.7) (ibid).

In fact, the integration of sustainability within higher education institutions (HEIs) has garnered increasing attention in recent years, as universities worldwide acknowledge their critical role in addressing global environmental and social challenges. Researchers emphasize that HEIs not only serve as centers for knowledge transfer but also function as proactive agents of change, instilling a comprehensive understanding of sustainability that spans economic, social, and environmental dimensions (Tilbury, 2011; Barth & Rieckmann, 2022). In recent literature, HEIs are seen adopting a wide array of sustainability initiatives, encompassing everything from curriculum development to campus management and research. Many institutions have

established sustainability offices or centers dedicated to integrating sustainable practices across both academic and operational spheres. Such offices play an essential role in managing environmental policies, implementing carbon reduction measures, and fostering a campus culture that emphasizes climate action and resilience. Cross-disciplinary programs are also increasingly common, with universities developing specialized degrees and research initiatives that align with sustainability goals, particularly the Sustainable Development Goals (SDGs). These goals, set forth by the United Nations, provide HEIs with a structured framework for addressing urgent environmental, social, and economic issues through education, research, and community engagement (Lozano et al., 2015; Leal Filho et al., 2018).

Despite notable progress, several challenges continue to impede the widespread adoption of sustainability within academic frameworks. Financial and structural limitations, for example, can hinder universities from fully implementing sustainability initiatives, particularly those requiring significant curriculum adjustments or cross-disciplinary collaboration. Scholars also point to cultural and operational differences among institutions as barriers to a standardized approach, with some universities struggling to balance sustainability goals against other institutional priorities. The literature suggests that both top-down and bottom-up initiatives are essential for addressing these challenges effectively, encouraging a flexible yet unified approach that engages faculty, administration, and students alike in the sustainability mission (Ferrer-Balas et al., 2010).

The role of European initiatives, including Erasmus+ and Horizon Europe, has been instrumental in supporting sustainability in higher education by funding collaborative projects and fostering international partnerships that encourage mutual knowledge transfer. Such programs enable universities to share best practices, innovate in curriculum design, and build sustainability networks that transcend national borders. Erasmus+ projects provide crucial support for universities aiming to incorporate sustainability into academic and operational practices. The 1FUTURE project exemplifies this collaborative approach by creating a cross-sectoral network between universities in the European Union and the Western Balkans. With emphasis on interdisciplinary collaboration, 1FUTURE promotes resilience-building and capacity development in sustainability, aligning with both the SDGs and the Paris Agreement, and fostering a unified response to the challenges posed by climate change.

3. Methodology

The survey aimed to capture a comprehensive view of current sustainability practices, focusing on how international frameworks, particularly the Sustainable Development Goals (SDGs), are embedded within academic

programs, research, and management practices. It was distributed as a shared Excel file to five European partner universities: Lund University (LU) in Sweden, Eberswalde University for Sustainable Development (HNEE) in Germany, University of Novi Sad (UNS) in Serbia, Ss. Cyril and Methodius University in Skopje (UKIM) in North Macedonia, and IUAV University of Venice (IUAV) in Italy. This format enabled structured, comparable data collection and facilitated collaboration among institutions.

Due to the scope and diversity of educational and research activities, each university submitted a representative selection of its programs and initiatives, aligned with *1FUTURE* project's objectives and the specific capacities of Western Balkan faculties.

3.1. Survey design and data collection

The survey was designed to cover multiple facets of sustainability in universities, with questions crafted to elicit both qualitative and quantitative responses. Key areas included curriculum, research, stakeholder collaboration, and institutional management. In the curriculum section, universities were asked to specify details on undergraduate, master's, and doctoral programs focused on sustainability, including course names, content, and SDG alignment. This approach allowed for a detailed assessment of how sustainability is embedded at various educational levels. Research-related questions asked universities to describe both EU-funded and internally led projects focused on sustainability and climate issues, highlighting the role of research in advancing sustainability goals and fostering interdisciplinary collaboration. Management-related questions captured sustainability practices across campus operations, emphasizing energy efficiency, waste management, and carbon footprint reduction. This holistic design ensured a thorough view of how each institution incorporates sustainability into its core functions.

3.2. Results and considerations

Upon data collection, a multi-step analysis process identified trends, highlighted best practices, and facilitated comparisons between institutions. Responses were organized into the four focus areas of the survey: curriculum, research, collaboration, and management. Quantitative data, such as the number of sustainability programs or research projects, was analyzed to offer a metric-based view of engagement, while qualitative responses underwent thematic analysis to uncover insights into institutional motivations, challenges, and future sustainability goals.

The analysis also mapped each initiative against the SDGs, assessing how comprehensive institutions address global sustainability goals. This mapping process identified gaps in sustainability practices and suggested areas where

additional development or support may be beneficial. These findings provided a basis for recommendations to enhance sustainability efforts within partner institutions and the broader academic community.

Throughout data collection and analysis, strict ethical standards were upheld. Each participating institution provided informed consent for the inclusion of its data in the project report, with assurances of confidentiality and restricted use for research purposes only. Methodological limitations include reliance on self-reported data, which may reflect institutional perspectives rather than a complete account of all activities. Additionally, the focus on the five specific partner institutions may limit the generalizability of findings to universities with different structures or priorities. However, the survey's structured design, consistent data collection, and rigorous analysis offer valuable insights and a robust foundation for advancing sustainability in higher education.

4. Analysis & Discussion

This section discusses the findings in curriculum development, research initiatives, and management practices within each partner institution, with a particular focus on alignment with the Sustainable Development Goals (SDGs).

4.1. Curriculum development

Survey responses show a strong emphasis on incorporating sustainability into educational programs, with each partner university offering specialized courses or degree programs focused on climate and environmental issues. At Lund University (LU), for instance, sustainability is central to multiple bachelor's and master's programs. LU offers a range of degrees, including a master's in environmental engineering and strategic environmental work, that directly address SDGs on climate action (SDG 13), sustainable cities (SDG 11), and responsible consumption (SDG 12). These programs cover both scientific and policy aspects, exemplifying a holistic approach to sustainability education.

IUAV University of Venice has integrated sustainability into disciplines closely related to urban design, architecture, and the arts. Its bachelor's program in Industrial Design and master's in architecture and construction engineering prioritize sustainable design principles, aligning with SDG 11 (Sustainable Cities and Communities) and SDG 12. This approach underscores IUAV's commitment to sustainability within its unique disciplinary focus, with added attention to cultural preservation in Venice's urban setting.

Similarly, Eberswalde University for Sustainable Development (HNEE) incorporates sustainability into all its bachelor and master programs – it forms

an integral part of teaching and research. It is aimed to anchor the concept of Education for Sustainable Development (ESD) across all disciplines**.** Due to the variety of study programs, the SDGs are widely covered in all programs with different focal points. For example, the HNEE's bachelor program "Landscape Use and Nature Conservation" and its Master program "Global Change Management" cover all SDGs and prepare students as change agents and professionals being able to cope with the challenges of natural resource management under global change and to develop goal-oriented solutions for a sustainability transition.

The University of Novi Sad (UNS) offers programs like Clean Energy Technologies and Environmental Engineering, targeting both theoretical and practical aspects of sustainability. These programs link SDGs 7 (Affordable and Clean Energy) and 13, with a particular focus on renewable energy and disaster risk management, preparing students for sustainability challenges from an engineering perspective.

Lastly, Ss. Cyril and Methodius University in Skopje (UKIM) offers specialized programs in energy and ecology, particularly through the Faculty of Mechanical Engineering. At the Faculty of Architecture and Civil Engineering Faculty there are several courses dedicated to ecology, energy efficiency and sustainable development. Courses like Architecture and the Environment and Sustainable Urban Development align closely with SDGs 7, 11, and 13, emphasizing competencies in energy efficiency and environmental impact assessment within technical disciplines.

The survey results emphasize that many universities offer specialized master's programs with a strong focus on SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production), often incorporating actions for climate (SDG 13) and partnerships for goals (SDG 17). Additionally, numerous undergraduate and postgraduate courses address sustainability, with emphasis on SDGs 11, 12, and 13. An interesting observation is that even courses not directly centered on sustainability often foster competencies that are key for sustainability education as for example outlined in section 2 of this paper (e.g. Futures-thinking and Systems-thinking).

4.2. Research Projects and Stakeholder Collaboration

In the realm of research, survey findings reveal that partner universities actively engage in sustainability-related projects, many of which are funded through European Union programs. LU's research is particularly interdisciplinary, with over 365 projects and 3,700 publications attached to the topic. In several cases the research is organized in center or knowledge hubs, including research centers such as the International Institute for Industrial

Environmental Economics (IIIEE), LUSUS (Lund University Center for Sustainability Studies) and the LU Urban Arena, which foster collaboration across faculties and with external stakeholders. These centers address complex sustainability issues through cross-sectoral research, aligning closely with SDGs 9 (Industry, Innovation, and Infrastructure) and 17 (Partnerships for the Goals).

IUAV's research projects reflect urban and architectural focus. Notable initiatives include the "HYPERION" project, which utilizes decision support systems to enhance the resilience of historic areas against climate change, and the "CITIES2030" project, which aims to develop sustainable food systems. Both projects exemplify IUAV's strategy of combining sustainability with cultural and social resilience, demonstrating alignment with SDGs 11 and 2 (Zero Hunger). Through collaborations with municipalities and international organizations, IUAV leverages its research to address specific community needs while contributing to broader sustainability goals.

At HNEE, applied research is a cornerstone counting with interdisciplinary research centres, e.g., the Biosphere Reserves Institute (main focus: "Man and the Biosphere" program of UNESCO), the Centre for Economics and Ecosystem Management and The Research Centre [Sustainability - Transformation - Transfer]. Collaboration with various public and private institutions integrates diverse expertise and perspectives, creating a practice-oriented, inclusive approach to research. This allows findings to be shared, discussed, and applied within professional networks, driving societal transformation toward sustainability through private sector and community engagement. This practice-oriented approach has positioned HNEE as a leader in promoting sustainability within forestry, environmental management, and nature conservation.

UNS has a strong record in EU-funded projects, including Horizon 2020 and Erasmus+, with numerous initiatives linked to sustainable energy and disaster resilience. Examples include the "GREENELIT" project, which focuses on developing green electronic devices, and the "WBC-RRI.NET," a project aimed at fostering responsible research and innovation in the Western Balkans. These projects align with SDGs 13 and 7, positioning UNS as a proactive player in advancing sustainability research through international collaboration.

UKIM participates in various interdisciplinary research projects, often focusing on energy transformation and climate adaptation. Key initiatives such as the "TRANSIT" project, funded under Horizon Europe, seek to foster societal changes necessary for a sustainable energy transition, demonstrating UKIM's commitment to SDG 7 and SDG 13. These research initiatives at

UKIM underscore the role of energy and urban infrastructure in building climate-resilient communities.

Across the research domain, the partner universities are engaged in sustainability projects largely funded by European sources, primarily aligning with SDGs 11, 13, and 17. Additional projects, often in collaboration with public stakeholders, address goals related to sustainable cities, responsible consumption, and climate action, particularly SDGs 11, 12, and 13.

4.3. University Management Initiatives

In terms of internal management, the survey reveals a variety of practices aimed at reducing environmental impact across university operations. LU has established a university-wide Sustainability Forum, which coordinates initiatives such as the annual Sustainability Week and manages the university's compliance with the Swedish Climate Framework. LU's environmental management practices emphasize reducing the institution's carbon footprint and include comprehensive reporting on sustainability outcomes, aligning with SDG 12 (Responsible Consumption and Production).

IUAV's management initiatives include promoting waste reduction, supporting local food sourcing, and implementing energy efficiency measures within its campuses. These initiatives, coupled with social inclusion programs, reflect a multifaceted approach to campus sustainability. For instance, IUAV's participation in the "Too Good to Go" network minimizes food waste while promoting sustainable consumer behaviors. These management strategies align with SDGs 11 and 12, underscoring IUAV's commitment to sustainable urban living.

HNEE has implemented a climate protection strategy aiming at "climate neutrality. Initiatives include resource management and protection (EMAS-certified), sustainable mobility solutions and sustainable procurement. To point out, the university has a sustainable canteen that emphasizes sustainable, regional food choices. HNEE has received Europe's most prestigious and largest sustainability award, the German Sustainability Award (DNP), in the category "education and research". Through these efforts, HNEE showcases a commitment to SDGs 4, 12 and 13, prioritizing energy efficiency, waste reduction, and sustainable procurement.

UNS has adopted a comprehensive environmental policy focused on reducing greenhouse gas emissions and enhancing green spaces on campus. Management initiatives include energy-efficient renovations and promoting waste sorting, reflecting UNS's dedication to SDGs 13 and 15. Additionally, UNS encourages the integration of sustainability into institutional policies and practices, promoting a culture of environmental responsibility.

UKIM's efforts in sustainability management focus on energy-saving infrastructure upgrades, including the installation of energy-efficient heating and cooling systems. The university also participates in recycling initiatives, though challenges persist due to the limited waste management infrastructure in North Macedonia. UKIM's commitment to environmental protection aligns with SDGs 11 and 13, as the institution actively pursues green policies despite infrastructural limitations.

Across these institutions, SDGs 12 (Responsible Consumption and Production) and 13 are frequently addressed in university management practices, supported by additional initiatives aligned with SDG 4 (Quality Education), SDG 7 (Affordable and Clean Energy), and SDG 8 (Decent Work and Economic Growth).

4.4. Discussion of Trends and Challenges

The survey highlights several trends and challenges in sustainability practices. One trend is the prioritization of interdisciplinary approaches in curricula and research, as universities recognize the interconnected nature of sustainability issues. SDG alignment across institutions reflects a shared commitment to global sustainability goals. Furthermore, the survey underscores the value of partnerships within universities and with external stakeholders. Collaboration helps institutions leverage diverse expertise, access funding, and align practices with broader societal needs.

However, several challenges persist. First, there is a high reliance on external funding which may limit the longevity of sustainability initiatives at the universities. Clearly, a changed global political climate may negatively affect the abilities of universities to promote sustainability in society. Secondly, integrating sustainability into university management remains challenging due to resource limitations, particularly in areas with underdeveloped infrastructure. Thirdly, there are difficulties in ensuring that overall university policies reach far out into institutional practices. Since the main focus of the survey presented in this paper has been on documentation concerning sustainability initiative some questions still remain on the degree of actual implementation of the sustainability policies of the five reviewed European HEIs. More research is clearly needed.

Overall, the analysis reveals significant efforts by partner universities to integrate sustainability across academic and operational domains. Although substantial progress has been made, opportunities remain for growth to ensure sustainability becomes a core, enduring component of university operations and education. Finally, there are also opportunities to more systematically implement the growing body of knowledge in the field of Education for Sustainable Development (ESD), as discussed in section 2. A key issue here is

to balance existing institutional practices with the emerging knowledge about ESD being developed worldwide.

5. Conclusions and Recommendations

This study presents a survey of sustainability practices among five European universities, showcasing integrated approaches to embedding sustainability within academic programs, research initiatives, and institutional operations. Findings from this survey reveal a diverse array of interconnected educational fields and operational strategies, underscoring the multifaceted role that higher education institutions (HEIs) may play in supporting global sustainability efforts and advancing the Sustainable Development Goals (SDGs).

It is recognized that the survey is limited to how a sample of five European universities address sustainability in their academic practices. However, other universities are encouraged to use the survey methodology to conduct similar reviews to provide additional accounts of how sustainability can be addressed and thus fostering the exchange of insights that can unify and strengthen sustainability strategies across the higher education sector. Despite the small sample, the findings presented here may serve as inspiration for other HEIs in the efforts of developing their sustainability practices.

The survey shows that each of the five universities have unique approaches to integrating sustainability into their practices. However, some of the practices can be highlighted as particularly important. First, establishing an administrative unit dedicated to sustainability and with a clear mandate from the university management is recognized as a success factor for coordinating sustainability efforts university-wide. Secondly, distributing responsibility across all levels of the university, with adequate resource support, is essential for embedding sustainability deeply within the university culture. The integration of sustainability at all educational levels, accompanied by support functions that create arenas for dialogue, collaboration and reflection is also seen as crucial. Opportunities for collaboration on sustainability issues across disparate fields of study is apparent e.g. due to the need for educating students on the key sustainability competencies which are generic in nature (as was discussed in Section 2). Thirdly, collaborative networks and inter-university partnerships, e.g. through “Round Table for Sustainable Development”, facilitate the exchange of best practices, support curriculum enhancement, and connect stakeholders who are encouraged to translate research insights into practical applications. Finally, ensuring financial sustainability through collaborative funding sources is a recurring recommendation, as stable funding not only supports the continuity of individual projects but also strengthens the institution’s long-term capacity for sustainable development.

In conclusion, this study offers a review of how five European universities translate international sustainability frameworks into actionable academic and operational practices. By documenting practices, common challenges, and actionable recommendations, this study provides inspiration for other HEIs worldwide, illustrating the potential role of higher education in promoting sustainability in society. The collective dedication demonstrated by these institutions highlights a promising path toward a sustainable and equitable future, where universities act as key agents of change, advancing knowledge, fostering innovation, and driving societal transformation on a global scale.

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