

## DISCUSSION ON SERBIA'S WASTE MANAGEMENT CHALLENGES AND FUTURE DIRECTIONS

Maja Jokic<sup>1</sup> [0009-0004-4622-6264], Anna Frank<sup>2</sup>

### Abstract

*Despite global efforts to reduce emissions and mitigate the effects of climate change, these measures have largely failed to curb the ongoing impacts. Achieving sustainability in the face of evolving environmental conditions requires participation from every country. However, significant discrepancies exist among nations regarding their contributions to environmental degradation, their contingency and sustainability efforts, and their capabilities to balance economic growth with environmental protection. Consequently, expecting equal financial contributions and governance efforts from all countries is unrealistic. This discussion presents the problem for low-income countries to adopt adequate waste management regulation to protect its own interests and the environment. It is informed by a comprehensive literature review, encompassing scientific papers, policy documents, government reports, guidelines, and international frameworks.*

**Key words:** waste management policy, national policy, sustainable strategies, mitigation measures, sustainability, climate change

### 1. Introduction

The global socio-political and environmental landscape is characterized by a complex web of relationships. Each nation must prioritize the protection and advancement of its national interests while actively engaging in the global economy. However, nations do not start from an equal footing; developed countries often hold significant advantages in the marketplace and exert considerable cultural influence. This dynamic can affect the social status of populations in less fortunate nations, which have struggled to establish peace and stability over the past half-century.

While this paper primarily focuses on the environmental aspects of waste management policy development, the authors emphasize the critical importance of understanding these regulations within the broader context of social equality and future sustainability. This holistic approach is essential to comprehensively address the interrelationships impacted by waste management. Scientific analysis has

<sup>1</sup> Melbourne University Alumni, Australia, majajokic85@gmail.com

<sup>2</sup> Yordas Group, a.frank@yordasgroup.com

demonstrated that the intensity, speed, and spatial distribution of industrial waste are significantly influenced by human activities—such as lifestyles and the reliance on fossil fuels for both industrial processes and daily living (UN Environment Program, 2024). Without targeted actions for climate change mitigation, these levels are expected to rise even further. By 2050, it is imperative that we achieve an 80% reduction in greenhouse gas (GHG) emissions (UNDP Serbia, n.d.f.).

The distribution of industrial waste has an unequal impact on various social groups, often resulting in those who contribute the least to the problem suffering the most. This disparity is frequently linked to access to cheaper resources and the unfair treatment of labor, commonly referred to as "cheap labor." The burden of providing low-cost raw materials often falls on countries that are already politically destabilized. For instance, nations like the Democratic Republic of the Congo, rich in natural resources, have experienced significant economic turmoil exacerbated by corporate corruption. Here, powerful multinational corporations exploit the country's resources while disregarding the welfare of local communities, leading to environmental degradation and social unrest. Developed countries leverage this situation to export dirty industries and secure resources for their own benefit, often at the expense of the nations from which these resources are extracted. As a result, the responsibility for managing industrial waste and mitigating its environmental effects predominantly falls on countries lacking the political power or financial resources to implement necessary environmental measures.

For example, Serbia faces significant challenges in this regard. With inadequate economic power to sustain long-term investments and a lack of enforcement mechanisms to combat corruption and misuse of public resources, Serbia struggles to fulfill its environmental commitments and protect its ecosystems.

The research presented in this paper is grounded in two primary principles: first, to assess the current situation in the Republic of Serbia and examine existing legislative measures concerning industrial waste management; and second, to evaluate how these strategies and policies have evolved to pave the way for a justifiable transition to sustainable waste management practices and a circular economy (RES Foundation, 2016). The arrangement of propositions aims to address specific gaps in the literature, focusing on information transparency (UNDP Serbia, n.d.g), the UN Framework Convention on Climate Change, waste management strategies, and policy development instruments (FAOLEX, 2020).

Two central research questions are posed: 1. Is it possible to develop a unified industrial waste management strategy that encompasses all governmental sectors in Serbia, allowing for the ambitious adaptation and integration of their goals in line with global climate change initiatives? 2. What challenges does Serbia, as a developing country, face in effectively implementing industrial waste reduction initiatives and securing sustainable development in the global market?

## 1.1 Methods

### Research Design

This study employs a mixed-methods research approach, utilizing both qualitative and quantitative analysis to examine waste management policies in the Republic of Serbia. The research methodology is grounded in relevant information derived from published documentation, scientific literature, and principles of policy analysis.

### Data Collection

The research followed key steps commonly used in Regulatory Impact Studies, Cost-Benefit Analysis, and Strategic Environmental Assessments. The specific methodologies encompassed the following steps:

- **Defining the Scope:** The research scope was established to identify the nature, coverage, boundaries, level of detail, and extent of the waste management issues addressed in Serbia (OECD, 2020).
- **Identifying Risks and Setting the Baseline:** A comprehensive understanding of the risks associated with waste management policies was conducted. A baseline was established to measure and understand the differences presented by potential policy alternatives, essential for assessing various scenarios and options (Treasury Board of Canada Secretariat, 2007).
- **Setting Objectives:** Objectives for the waste management policy were defined, encompassing measures such as introducing new environmental taxes, setting performance targets, and establishing limitations. The focus of these objectives was on the practical pathways for achieving desired outcomes (Lee & Walsh, 1992).
- **Identifying Options:** Various viable alternatives were identified for regulatory and non-regulatory comparison. These options were assessed within the established scope, with one alternative serving as a baseline for comparative analysis (Australian Government, 2020).
- **Early Scenario/Options Assessment:** An early assessment of scenarios and options was conducted to facilitate timely modifications to the proposed policies (Lee & Walsh, 1992).
- **Stakeholder Engagement and Consultation:** Stakeholder engagement was prioritized throughout the research process, providing valuable insights and facilitating the design of alternatives at all assessment stages (OECD, 2020).
- **Adopting Proper Indicators:** Suitable indicators were selected for assessing and comparing the impacts of different policy alternatives, enabling effective monitoring of regulatory performance in the future (OECD, 2020).

## Operationalization

Operationalization, as discussed by Bhattacharjee in "Social Science Research: Principles, Methods, and Practices," was integral to the research design. This process allowed for the integration of researchers' perceptions, theories, hypotheses, and assumptions into the study. Researchers articulated reference claims or assumptions and sought confirmation or disconfirmation, thus establishing a robust research framework. The operationalization process involved defining and measuring theoretical constructs, determining the level of measurement, attributes, and procedures necessary for data collection. This step was critical for ensuring scientific validity in the research design. The choice of measurement influenced the development of data collection instruments and the selection of analytical methods.

## Information Sources

To support the research, information was gathered from diverse sources, including international and national legislative bodies, technical reports, books, conference papers, research articles, and relevant websites within the last decade. Keywords guiding this search included "Serbia," "obligation," "mitigation," "adaptation," and "industrial waste."

Reports referenced utilized specific terms such as "Waste management policies," "Food and Agriculture Organization of the UN," "Regulation on Waste Management and Measures," "UN Environment Program," "ECOLEX," "Paris Agreement," "UNECE," and "Law on Waste Management" (UNECE). Certain resources were excluded based on the absence of relevant keywords related to policy regulation, sustainable mitigation strategies, climate change, and local waste management governance (Energy community Secretariat, 2021).

## Classification of Information

Information classification was conducted based on findings related to waste management benefits (FAOLEX, 2020), inter-institutional collaboration, adaptation actions (Berkhout, 2011), GHG emission reduction, environmental sustainability, waste management regulations in Serbia (Noges et al., 2010), local development, monitoring and reporting, climate strategy, and climate action planning (FAO, 2021).

The study primarily focused on the strategies and policies of international and national legislation in the Republic of Serbia, emphasizing the critical role of industrial waste management and its importance within the framework established by the Food and Agriculture Organization of the UN (UNDP Serbia, n.d.b).

## 2. Discussion

Greenhouse gas (GHG) emissions are recognized as a primary driver of the intensification of climate change. To date, Serbia has met its legal obligations regarding the preparation of relevant documentation. This includes long-term strategies under the Low Carbon Development Strategy (LCDS) and waste

management policies, which are complemented by mid-term plans aimed at reducing GHG emissions through sustainable industrial strategies outlined in the GHG Emission Mitigation Plan over the next five years, also known as the Nationally Determined Contributions (NDC) (FAO, 2021).

However, it is concerning that the absence of a crucial document committed to greenhouse gas (GHG) emission reduction reflects significant shortcomings in the economic development strategy of the country, which is vital for its enduring presence in the global market. This omission is particularly troubling given that the incurred capital and operational costs associated with sustainable initiatives are expected to be substantial. Currently, there is insufficient infrastructure to support a transition to a sustainable economy focused on GHG reduction. Moreover, the government is planning to invest in the raw material extraction industry, a major contributor to global GHG emissions and a source of persistent environmental pollutants. The anticipated benefits of emission reductions through the implementation of technologies reliant on these mined resources are unlikely to materialize swiftly enough to avert catastrophic damage from climate change and industrial environmental degradation.

The primary focus of this paper is on the industrial waste management policies and strategies in the Republic of Serbia, which are essential prerequisites for the country's accession to the European Union (UNDP Serbia, n.d.e). The "Climate Strategy and Action Plan" (FAO, 2021) was created to promote cross-sectoral interaction and includes specific objectives concerning waste management (OECD, 2018). However, due to the disparity between government investments, development targets, and the actual implementation of this action plan, the authors contend that it lacks the necessary enforcement measures to be effective without appropriate waste management laws or regulations. Consequently, this research aims to investigate how the intentions articulated in these policy documents are translated into practical reality.

As part of the Law on Waste Management (United Nations Serbia, 2021), the EU Green Agreement, which includes provisions for Strategic Low-Carbon Development (UNDP Serbia, n.d.d), requires the integration of waste management plans within the broader framework of energy and climate (Integrated National Energy and Climate Plans – NECPs) for a decadal period, with the first report due by 2030 (UNDP Serbia, n.d.f). This document aims to secure policies and measures for decarbonization across various sectors (UNECE); however, its focus primarily addresses energy consumption. Although this document is not directly covered by the Paris Agreement, it remains relevant to Serbia as a member of the Energy Community Treaty (EnZ) (Ekstrom et al., 2018). Serbia is therefore obligated to deliver a long-term strategy document by June 30, 2024, which will incorporate permanent industrial waste strategies aligned with climate change measures (FAOLEX, 2020).

In addition to the three key components—mitigation, adaptation, and technology—financing plays a crucial role in effective implementation (Res Foundation, 2016). The Green Agenda is designed to facilitate the transition from coal to renewable energy sources and to drive investment in this area. The Green

Agenda and Industrial Policy (Coffey & Thornley, 2015) for the Western Balkans aim to address the commitments of all member nations to create a climate-neutral Europe by 2050 (UNDP Serbia, n.d.f). This commitment is reflected in the Sofia Declaration, which Serbia signed in November 2020, supporting inclusivity among all parties, including the United Nations. This underscores the importance of inter-sectoral governance (OECD, 2018; UNECE) and the unification of waste policies as key components of significant legislation.

Despite these frameworks, Serbia has faced challenges due to a variety of changing circumstances that have negatively impacted its progress. In particular, the lack of appointed laws, undefined timeframes, and uncertainties regarding the economic sector have further hindered the country's financial stability. Moreover, critical issues related to GHG emission reductions and the integration of industrial waste management policies are often overlooked. Consequently, the sharing of vital data among authorities is frequently inadequate, hampering the prompt and effective implementation of legislation.

## 2.1 Identifying Risks and Setting the Baseline

Serbia faces several significant challenges in securing an effective waste management response, particularly in light of its international obligations, including the Paris Agreement, the UN Environment Program, and the UNECE (UNECE), as well as its accession to the European Union. On one hand, Serbia must meet substantial requirements for both mitigation and adaptation measures, which will in turn inform the incorporation of effective industrial waste management policies to address climate change risks (Abbass et al., 2022).

To this end, five pivotal features must be prioritized: (1) the provision of waste data planning; (2) early warning systems and disaster relief; (3) the identification of adaptation opportunities; (4) the dissemination of information regarding industrial waste management impacts; and (5) the supervision of critical infrastructure developments. These initiatives should be implemented from both public and private sectors, establishing necessary prerequisites for society that cater to both immediate and long-term needs (Berkhout, 2011).

On the other hand, to position itself as a global leader in combating climate change, the EU has established ambitious goals and standards for mitigating GHG emissions from industrial waste. Central to EU legislation is the Directive on the establishment of a trading scheme for emission units, which aims for a 40% GHG reduction by 2030 compared to 1990 levels, with even more stringent targets set for 2050 (UNDP Serbia, n.d.f). As Serbia works toward EU membership, it is imperative that it accelerates its climate change and waste management measures (UNECE) to ensure legislative implementation aligns with EU standards (UNDP Serbia, n.d.g).

Moreover, Serbia must adhere to EU standards not only in terms of pace but also in the efficiency of its legislative measures (Ekstrom et al., 2018). This alignment is essential for achieving compliance with EU unification requirements and IPA guidelines (UNDP Serbia, n.d.e). To facilitate this, significant transformations in current regulations are needed. Specifically, the implications of

Chapter 27—Environment and Climate Change, excessive reliance on fossil fuels (UNEP, 2024), and the recorded increase in carbon intensity present considerable challenges for the genuine implementation of effective waste management policies and a circular economy (UNECE) in Serbia. Consequently, the forthcoming Law on Waste Management United Nations Serbia, 2021) must align with the previously mentioned UN Environment Program and address municipal solid waste disposal (FAOLEX, 2020).

However, keeping pace with EU directives can be daunting. The establishment of an emission trading system in Serbia (UNDP Serbia, n.d.d) is vital for improving industrial waste management and stems from the adaptation of certain regulations (UNECE). This system faced delays due to the transition to EU legislation, which envisaged the adaptation of laws transposing the MMR Regulation (IPA 2013) into national legislation by 2018 (UNDP Serbia, n.d.e), (UNDP Serbia, n.d.h).

As a result, Serbia must continue to await the introduction of new laws on waste management that will define its approach to GHG emission reduction in response to evolving climate conditions (Noges et al., 2010) and the management of industrial waste. Nonetheless, by enhancing the country's resilience, the government can secure a brighter economic future for its citizens and promote the growth of a green and circular economy, thereby strengthening Serbia's competitiveness in the global market (Res Foundation, 2016).

The most critical aspect of Serbia's current situation that jeopardizes national interests is its role as an alternative source of critical raw materials for the European Union, which seeks to reduce its dependency on China. The EU Green Deal and Critical Raw Materials Act pose significant challenges for the EU in sourcing materials internally, increasing pressure on countries like Serbia to provide essential resources. Accordingly, Serbia finds itself in a lose-lose situation: it cannot compete effectively in global markets without the support of the EU, yet EU demands for resources often lead to environmental degradation and pose risks to human health. This dilemma is exacerbated by the absence of adequate waste management laws and a governance environment prone to corruption, which further complicates Serbia's ability to meet EU demands sustainably

## 2.2 Setting objectives and Suggestions

The adoption of the Low-Carbon Development Strategy serves as a protection document that should offer a new direction for the development of Serbia as a country that wants to secure rightful waste management practices (FAOLEX, 2020). Providing a brief description of regulated by-laws, availability, and methods for information sharing on GHG emissions through different sectors is of great importance as for industries that have crucial impact on it.

In this regard, it is desirable that the exhibited industrial waste management policy draft clearly states which strategy implies which sector and within which time frame these sustainable strategies are to be employed. Most significantly, the draft should emphasize the significance of each work carried out.



While in previous cases, for instance, a period of two years was planned for the finalization and implementation of the Low-Carbon Development Strategy (UNDP Serbia, n.d.d) and the Program for Adaptation to Changed Climate Conditions, the goal of the current Rule will have to be to reduce GHG emissions, comply with public documents, and to transparently, efficiently and correctly report on waste management information verification, within observed industries and fulfillment of the obligations, with which one is obliged through UN Environment Program (UNECE). With the reliance on the Paris Agreement, observation of human activities that lethally impact climate change must be reported, as the insurance of cost-effective climate change measures. (OECD, 2014)

Current laws on climate change in Serbia observe system regulations and their limitations for greenhouse gas emissions (hereinafter: GHG). Systematically, this adaptation measured for changed climatic conditions needs to be monitored regularly and reported on the matters of chosen waste strategy for low-carbon development initiatives (FAOLEX, 2020), (United Nations Serbia, World Bank Group, EU), (UNECE).

However, due to a consistent lack of crucial data within certain institutions, it may become significant for all governmental bodies to consider implying a rather complex analysis of industrial waste indicators (Coffey & Thornley, 2015) with a unified goal which is industrial waste mitigation policy, as to possibly more effectively overcome these in a unified demeanor. This is essential to be performed promptly before the situation becomes lethal for the lawful adaptation of industrial waste policy or becomes destructive to the environment and society. Thereupon, a multi-analysis (preferably longitudinal one) followed by integrated metrics can be required to better comprehend observed data correlation (Coffey & Thornley, 2015) and further implement justifiable techniques that will obtain environmental protection towards a successful national intersectoral governance (OECD, 2018), (UNEP, 2021), (UNEP, 2024), (UNECE). Having the right attitude with inclusion of all responsible authorities, will as well, further aid governments to properly prepare their future disaster and waste risk response (FAOLEX, 2020).

With this in mind, SDGs goals and all 3 pillars (economic, social, and environmental welfare) for sustainable development must be covered and straightened (United Nations Serbia, World Bank Group, EU, 2014) as certain GHG gas emitters, such as road and air traffic, predominantly affect climate change and can be significantly regulated by the incorporation of the climate change law on all national levels. (OECD, 2014).

Furthermore, Serbia should leverage the EU urgency for alternate sources of critical raw materials by demanding that the European Union (EU) ensure the enforcement of appropriate waste management activities. This includes providing legislative and financial support for every tonne of material extracted. Additionally, Serbia must actively participate in promoting socio-economic equality, treating its citizens with the same rights and protections as EU citizens. This includes fair compensation, safe working conditions, and long-term environmental protection for Serbian communities.



Without legally binding agreements and guarantees from the EU, Serbia is at a disadvantage when trying to implement new industries that primarily serve resource exports. These industries often operate outside the control of the Serbian public and do not prioritize the best interests of the local population. It is evident that without adequate support from the global community, Serbia lacks the leverage to resist EU pressures to provide cheap resources and labor, which are seen as prerequisites for accessing larger markets.

The ongoing geopolitical tensions, including conflicts in the Middle East, compound Serbia's challenges. As a major transit zone in the Balkans, Serbia finds itself in a precarious position under EU scrutiny. Therefore, it is crucial to prevent any new projects from moving forward until adequate waste management laws are implemented and enforced. Establishing a strong coalition with other countries to advocate for equitable resource management and environmental protections is essential to prevent further inequalities and ensure sustainable development.

Research indicates that countries with robust waste management policies are better positioned to engage in sustainable trade practices and uphold environmental standards (World Bank, 2021; Aaheim et al., 2022; Abbass et al., 2022). Additionally, studies show that socio-economic equity is essential for sustainable development, as marginalized communities often bear the brunt of resource extraction and environmental degradation (Berkhout, 2011).

### 2.3 Scenarios evaluation

The most probable scenario will follow the pathway of low-income countries. Losos et al. (2024) elaborate on the challenges faced by low- and middle-income countries in their fight against climate change. In her article published in *Science*, Elizabeth Losos discusses the interconnected crises of national debt, biodiversity loss, and climate change, emphasizing the urgent need for integrated approaches to address these global issues. The article highlights that developing countries, particularly those in the Global South, are grappling with significant levels of debt exacerbated by the impacts of climate change and biodiversity loss.

Losos argues that the current debt crisis severely limits these countries' ability to invest in sustainable development and conservation efforts. She advocates for debt relief initiatives tied to environmental goals, suggesting that restructuring debt could improve funding for biodiversity and climate resilience projects. By aligning financial incentives with conservation efforts, these countries can prioritize ecological health while simultaneously promoting economic recovery.

The article underscores the importance of collaboration among governments, financial institutions, and conservation organizations to develop policies that support both economic stability and environmental sustainability. Losos calls for innovative solutions to address the underlying socio-economic issues driving biodiversity loss and climate change, ultimately proposing a holistic strategy that recognizes the interconnected nature of these global challenges.

In summary, Losos emphasizes that effectively tackling national debt, biodiversity loss, and climate change requires a coordinated effort and an integrated

framework to foster sustainable development and environmental protection for the benefit of both nature and human communities.

These insights are particularly relevant for Serbia, which, despite its central location in Europe, grapples with similar challenges. As previously noted, without strategic alliances, Serbia lacks the capacity to avert national environmental and economic crises exacerbated by climate change and both external and internal economic pressures. Losos's analysis serves as a crucial reminder of the importance of integrated solutions and collaborative efforts in addressing these pressing issues.

To ensure a viable future, Serbia must establish legally binding alliances that mandate the implementation of the "polluter pays principle." This principle requires corporate and industrial users of the country's resources to manage waste responsibly and ensure long-term intergenerational environmental protection. Research indicates that the polluter pays principle can significantly enhance waste management practices and promote sustainable resource use (OECD, 2018; World Bank, 2020; Aaheim et al., 2022; Abbass et al., 2022).

However, developing such legal frameworks takes time, political will, and strategic effort. The current global imbalance places Serbia in a precarious position, as its closest economic partners often exert considerable negative pressures. Any alliances pursued beyond these existing relationships are likely to face scrutiny and potential political favoritism, complicating Serbia's efforts to create effective environmental policies.

This situation underscores the importance of a holistic approach to waste management policymaking, as the forces impacting waste production are frequently driven by political influences and consumer demands that span beyond national borders. An integrated policy framework can help Serbia align its environmental goals with global sustainability initiatives, ensuring that local practices contribute to broader international efforts to combat climate change and protect biodiversity (United Nations Environment Programme, 2021; Berkhout, 2011).

#### **2.4. Stakeholders engagement**

It is the responsibility of authorities to establish transparent monitoring, reporting, and verification systems to effectively implement the Waste Management Law (OECD, 2014). Such systems will enhance stakeholder engagement, enabling Serbia to provide robust reports to the UNFCCC and explore new avenues for national participation under the Nationally Determined Contributions (NDC) framework (UNDP Serbia, n.d.a).

To achieve comprehensive policy integration across all inter-sectoral levels (OECD, 2018), (UNECE), it is essential to implement an efficient Monitoring Mechanism Regulation (MMR) (UNDP Serbia, n.d.h), an Emission Trading System Directive (UNDP Serbia, n.d.d), (UNDP Serbia, n.d.e), and a directive for information transparency regarding greenhouse gas (GHG) emissions across various industrial sectors (Aaheim et al., 2022), (UNDP Serbia, n.d.g). Furthermore, it is crucial that representatives from all segments of Serbian society—including agriculture, industry, and both state and local authorities—are involved in the drafting of relevant documents, including the Draft Law on Waste Management (FAOLEX, 2020;

United Nations Serbia, 2021). This law, in alignment with the UN Environment Program, should be applied both nationally and internationally, serving as a regulatory framework to facilitate climate change mitigation and adaptation efforts.

In this context, transparency must be complemented by regular reporting that systematically addresses climate change indicators, such as variations in temperature, and encourages collaboration among all responsible authorities (FAO, 2021). Additionally, securing financial resources and ensuring effective dissemination of information about these resources is of paramount importance. The successful implementation of the Draft Law on Waste Management will require local municipalities (UNECE, United Nations Serbia, 2021) to adhere to established recommendations for evaluating and identifying essential policy components, thus reducing their vulnerabilities (Energy Community Secretariat, 2021). This process will necessitate comprehensive social and economic assessments to effectively gather measurable data from all communities—both industrial and social (Coffey & Thornley, 2015). Furthermore, qualitative assessments of each region and sector can be conducted to analyze their sensitivity to various industrial waste indices (FAOLEX, 2020).

#### **2.4.1 Encouragement of inter-institutional cooperation and its benefits**

The impact of persistent climate change has underscored the need for governments and authorities in Serbia to broaden their resilience strategies regarding effective waste management (UNEP, 2021). It is critical to create risk-informed investments, maintain ongoing progress, and promote information sharing amidst the industrial waste crisis without compromising long-term sustainability. Regular updates on crucial information systems are essential for this effort (Rosenzweig et al., 2017).

Swart et al. (2009) emphasize the importance of governance that combines both bottom-up and top-down approaches for the successful implementation of industrial environmental policies and their management. Such governance supports effective policy implementation at all national levels (Biesbroek et al., 2010).

The benefits of adopting this cooperative framework are numerous. By integrating this approach, Serbia can promote efficient resource governance (UNEP, 2021), secure bilateral funding that is invaluable for inter-institutional resource management (Aaheim et al., 2022; Res Foundation, 2016), and ultimately strengthen the national economy.

By fostering an integrated approach to combat inter-sectoral industrial waste management, Serbia can create cross-sectoral interactions (OECD, 2018) that mitigate the effects of climate change and reduce harmful industrial waste, along with their associated environmental and health risks. This strategy will also promote macroeconomic efficiency and facilitate the transition toward a circular economy (Aaheim et al., 2022; Ekstrom et al., 2018; FAOLEX, 2020; Res Foundation, 2016; United Nations Serbia, 2021). Implementing these recommendations aligns with the principles outlined in the UN Sustainable Development Goals, particularly in promoting sustainable cities and communities (Goal 11) and responsible consumption and production (Goal 12) (Brankov et al., 2019).

## 4. Adopting proper indicators

In June, the U.S. Supreme Court overturned the Chevron doctrine, a 40-year legal principle that directed courts to defer to federal agencies on regulatory interpretations when congressional legislation was unclear. Chief Justice John Roberts criticized the Chevron doctrine as “fundamentally misguided,” asserting that only the courts have the authority to interpret the laws they administer. This decision is expected to lead to an increase in litigation challenging federal regulatory actions, with courts now required to independently review scientific evidence behind those regulations, rather than relying on the expertise of federal agencies.

Federal agency staff, particularly those in the Departments of Health and Human Services, Energy, and Agriculture, have historically been trained to interpret complex legislation. Under the Chevron doctrine, courts deferred to these agencies' expertise in regulatory matters. However, with the recent overturning of this doctrine, Congress may need to improve its own scientific literacy and draft more precise legislation to minimize ambiguity. Vague language in laws can invite extensive legal challenges and litigation, which may hinder effective policy implementation (Aaheim et al., 2022).

Judges will increasingly require access to scientific information as they adjudicate cases related to public health, the environment, education, and other critical issues. Currently, resources such as the Federal Judicial Center's Reference Manual on Scientific Evidence may not be sufficient to navigate this new legal landscape, where agency expertise is no longer given deference. Scientific organizations must engage actively to ensure that legislation is informed by precise scientific knowledge. Groups like the American Educational Research Association and the American Psychological Association are examples of organizations that monitor relevant lawsuits and can submit “friend of the court” briefs to provide scientific context (Abbass et al., 2022).

Looking forward, the next generation of scientists should develop a deeper understanding of how regulations affect their fields and the broader scientific community. This could be achieved through training programs that emphasize the intersection of science, law, and policy. Losing legal power, such as Chevron doctrine, the scientific community must play a more significant role in guiding lawmakers and courts to ensure that legislation, policy, legal interpretations, and oversight are informed by the best available science amidst the complexities of government policy and conflicting interests (Gonzalez et al., 2020; Berkhout, 2011).

More than ever, adopting appropriate indicators to evaluate regulatory impacts, climate change effects, and environmental consequences of industrial activities and waste is crucial. Decision-making often suffers when politicians lack a scientific foundation and approach, as has been well documented in studies examining the influence of corporate interests on politics (Stigler, 2020; Biesbroek et al., 2010). It is essential for industries to move beyond merely evaluating quarterly financial reports, which are relevant only for profit estimations, towards more holistic and sustainable measures of success.

To advance effectively in monitoring and evaluating policy and industry impacts, indicators must be grounded in physical and chemical principles and based on measurable variables. These indicators, such as land stability and pollution gradients, should be mapped in risk assessments that also incorporate social aspects and human behavior. For instance, considerations for evacuation routes, access to natural resources essential for spiritual and recreational well-being, and the availability of clean air, water, and soil are crucial for ensuring a sustainable future for generations to come.

To facilitate this discussion, the authors have initiated an extensive literature review and will further evaluate existing indicators that provide a valuable resource for decision-makers seeking valid and scientifically vetted information on efficiency of policies and regulations, such as waste management laws.

## 5. Conclusions

The necessity for both public and private investments is paramount to support mitigation efforts through structural and non-structural initiatives across all national sectors. These investments are essential for reinforcing the economic, social, health, and cultural resilience of communities, countries, and their resources. Notably, clean energy projects have attracted approximately €300 billion, highlighting the potential financial benefits of advancing climate initiatives. Thus, fostering inter-institutional cooperation toward low-carbon cities and communities is crucial for preserving vital resources and significantly driving the economies of all involved sectors (European Commission, 2021).

In Serbia, various waste management strategies have been implemented, exemplified by the Strategy for Sustainable Development and Integrated Urban Development, which addresses urban development challenges until 2030 (Government of the Republic of Serbia, 2019). This strategy positions urban settlements as catalysts for development and informs public policy effectively. The same principles can be extended to create industrial waste management policies tailored to meet sector-specific needs and address climate change initiatives.

Two research questions were addressed in this review. First, developing a unified strategy that efficiently covers all inter-governmental sectors is currently impractical due to their diverse purposes. However, a viable solution exists for ministries whose sectors share analogous characteristics, allowing for targeted substructural categorizations. Second, the challenges Serbia faces can be mitigated by strategically allocating investments across key sectors to enhance waste management and address climate change. The current strategy, if effectively implemented, can ensure Serbia's competitive advantage in the global climate change market through the establishment of necessary infrastructure and planned long-term investments (UN Environment Programme, 2020).

To support the implementation of a comprehensive policy, a standardized approach is necessary across all inter-sectoral levels, built upon international conventions and best practices (UNESCO, 2017). However, Serbia has struggled to demonstrate adequate innovation and efficiency, particularly in its infrastructure,

which has hindered overall development and inter-sectoral collaboration (OECD, 2020). As global shifts toward low-carbon economies gain momentum, it is imperative for Serbia to align its policies with frameworks established by the UN Environment Programme and the Paris Agreement, which set critical deadlines for implementing industrial waste management strategies that promote a circular economy.

This literature review has limitations, notably its focus solely on climate change policy adaptation and waste management mitigation in Serbia, without examining transboundary regulations that also affect the implementation of sustainable industrial and waste strategies (World Bank, 2018). Furthermore, the integration of these policies across the Danube region is essential for fostering more effective waste management practices that can significantly enhance local policy instruments.

Moreover, the review highlights time constraints related to the implementation of regulatory measures that Serbia is obligated to fulfill, as well as the limited quantity of research conducted on this subject. Due to strict timelines for executing international conventions, there remains a lack of pragmatic perspectives on these issues.

Despite these challenges, Serbia is well-positioned to revise its existing documentation to ensure alignment with the Paris Agreement. The National Waste Strategy serves as a crucial framework in this endeavor, incorporating both national and local strategies essential for developing innovative policies that facilitate Serbia's integration into the European Union (European Union, 2019). The EU's commitment to ambitious waste management policies requires that current and future member states adopt similar standards to promote sustainable practices.

In addition to aligning with waste management directives, Serbia must also consider EU regulations on critical raw materials (CRMs). The EU's Critical Raw Materials Act emphasizes the importance of securing a reliable supply of essential materials—such as lithium, cobalt, and rare earth elements—while minimizing their environmental impact (European Commission, 2020). This framework encourages member states to develop strategies that protect targeted resources, ensuring their sustainable extraction and use for future generations. By integrating these regulations into its waste management strategy, Serbia can safeguard its natural resources while promoting economic growth and environmental protection.

In conclusion, Serbia must prioritize the development of comprehensive strategies and policies within all institutional frameworks to foster collaboration among national institutions and authorities. This unified approach will significantly enhance the creation and implementation of genuine industrial waste management policies and facilitate the adoption of an inclusive circular economy (UNIDO, 2021) (Energy Community Secretariat, 2021). Consequently, by adapting international governance and implementing robust industrial waste reduction strategies, the government of the Republic of Serbia can foster national collaboration that will dramatically impact sustainable resource management. This, in turn, will strengthen the country's resilience to climate change and attract essential public and private investments across all levels.



## REFERENCES

- [1] Aaheim, A., Orlov, A., & Sillmann, J. (2022). Cross-Sectoral Challenges for Adaptation Modelling. In Kondrup, C. et al. (Eds.), *Climate Adaptation Modelling*. Springer Climate. Springer. [https://doi.org/10.1007/978-3-030-86211-4\\_2](https://doi.org/10.1007/978-3-030-86211-4_2)
- [2] Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, 29(28), 42539–42559. <https://doi.org/10.1007/s11356-022-19718-6>
- [3] Berkhout, F. (2013). Rationales for adaptation in EU climate change policies. In *Climate Policy Options Post-2012* (pp. 377–391). Routledge.
- [4] Bhattacharjee, A. (2012). *Social science research: Principles, methods, and practices*. University of South Florida.
- [5] Biesbroek, G.R., Swart, R.J., Carter, T.R., Cowan, C., Henrichs, T., Mela, H., Morecroft, M.D., & Rey, D. (2010). Europe adapts to climate change: Comparing National Adaptation Strategies. *Global Environmental Change*, 20(3), 440–450. <https://www.sciencedirect.com/science/article/abs/pii/S0959378010000269>
- [6] Brankov, B., Nenkovic-Riznic, M., & Pucar, M. (2019). Role of urban systems as part of the infrastructure in reduction of climate change effects in the cities. *Seventh National Scientific and professional meeting with international participation of installation and architecture 2019*, 9–17. <https://raumplan.iaus.ac.rs/handle/123456789/648>
- [7] Coffey, D., & Thornley, C. (2015). Industrial policy: A green agenda. *Bailey et al. (Hrsg.), aaO*, 395–419.
- [8] Ekström, M., Gutmann, E. D., Wilby, R. L., Tye, M. R., & Kirono, D. G. (2018). Robustness of hydroclimate metrics for climate change impact research. *Wiley Interdisciplinary Reviews: Water*, 5(4), e1288.
- [9] Energy community Secretariat. (2021). *Serbia-Annual Implementation Report*. <https://www.energy-community.org/implementation/Serbia.html>
- [10] European Commission. (2020). *Critical Raw Materials Resilience: Charting a Path Towards Greater Security and Sustainability*. <https://ec.europa.eu/docsroom/documents/42930>
- [11] European Commission. (2021). *Powering a climate-neutral economy: The European Green Deal*. [https://ec.europa.eu/clima/policies/eu-green-deal\\_en](https://ec.europa.eu/clima/policies/eu-green-deal_en)
- [12] Government of the Republic of Serbia. (2019). Strategy for Sustainable Development and Integrated Urban Development until 2030. <http://www.urbanizam.gov.rs/eng/>
- [13] European Union. (2019). *The European Green Deal*. [https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal\\_en](https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en)

- [14] European Commission. (2020). *Critical Raw Materials Resilience: Charting a Path Towards Greater Security and Sustainability*.  
<https://ec.europa.eu/docsroom/documents/42930>
- [15] FAO. (2021). *Climate change vulnerability in Serbia – An assessment of exposure, susceptibility and capacity at municipal level*. Budapest.  
<https://doi.org/10.4060/cb4916en>
- [16] FAOLEX. (2020, December 13). *Serbia, Law on Waste Management*.  
<https://www.fao.org/faolex/results/details/en/c/LEX-FAOC104373/>
- [17] Harris, T., & Alexander, R. (2024). Science in a shifting policy system. *Science*, 386(6718), 125–125.
- [18] Lee, N., & Walsh, F. (1992). Strategic Environmental Assessment: an overview. *Project Appraisal*, 7(3), 126–136.
- [19] Losos, E. C., Pfaff, A., & Pimm, S. L. (2024). Tackling debt, biodiversity loss, and climate change. *Science*, 384(6696), 618–621.
- [20] MMR-Serbia. (2017, December 2). *Law on Climate Change prepared with the support of the EU*. <https://mmr-serbia.info/>
- [21] Noges, T., Noges, P., & Cardoso, A. *Review of Published Climate Change Adaptation and Mitigation Measures Related with Water*. EUR 24682 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2010. JRC62545  
<https://publications.jrc.ec.europa.eu/repository/handle/111111111/15801>
- [22] OECD. (2014). Local community and the problem of flash floods.  
<https://www.osce.org/files/f/documents/4/0/148311.pdf>
- [23] OECD, The World Bank, & UN Environment. (2018). *Financing Climate Futures: Rethinking Infrastructure*, OECD Publishing, Paris,  
<https://doi.org/10.1787/9789264308114-en>.
- [24] OECD. (2018). The Polluter-Pays Principle. <https://www.oecd.org/env/tools-evaluation/polluter-pays-principle.htm>
- [25] Parliament of Serbia. (2021). *Climate Change Law*.  
[http://www.parlament.gov.rs/upload/archive/files/lat/pdf/predlozi\\_zakona/2021/337-21%20-%20Lat..pdf](http://www.parlament.gov.rs/upload/archive/files/lat/pdf/predlozi_zakona/2021/337-21%20-%20Lat..pdf)
- [26] RES Foundation. (2016, December). *National Strategy for Combating Climate Change: Contribution of Local Governments and the Private Sector*. [brochure].
- [27] Rosenzweig, C., Arnell, N.W., Ebi, K.L., Lotze-Campen, H., Raes, F., Rapley, C., Smith, M. S., Cramer, W., Frieler, K., Reyer, C.P.O. (2017). Assessing inter-sectoral climate change risks: the role of ISIMIP, *Environmental Research Letters*, 12(1). <https://iopscience.iop.org/article/10.1088/1748-9326/12/1/010301/pdf>
- [28] United Nations Serbia, World Bank Group, EU. (2014). *Serbia Floods 2014*.
- [29] Stigler, G. J. (2021). The theory of economic regulation. In *The political economy: Readings in the politics and economics of American public policy* (pp. 67–81). Routledge.

- [30] UN environment programme (2021, December 9). *Changing Finance to Catalyze Transformation: How Financial Institutions can Accelerate the Transition to an Environmentally Sustainable Economy*.  
<https://www.unep.org/resources/publication/changing-finance-catalyze-transformation-how-financial-institutions-can>
- [31] UN environment programme (2021, November 18). *Equitable future cities hold answers to pollution, climate and nature breakdown*.  
<https://www.unep.org/news-and-stories/press-release/equitable-future-cities-hold-answers-pollution-climate-and-nature>
- [32] UN Environment Program. (2024). *Moving towards zero waste*.  
<https://www.unep.org/topics/chemicals-and-pollution-action/waste>
- [33] UNECE. *Dealing with Waste*. <https://unece.org/circular-economy/dealing-waste>
- [34] UNDRR. (2015, September 30). *Serbia to turn Sendai Framework into law*.  
<https://www.undrr.org/news/serbia-turn-sendai-framework-law>
- [35] UNDRR. (2015). *Sendai Framework for Disaster Risk Reduction 2015-2030*.  
<https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>
- [36] United Nations Serbia. (2021). *Thematic Update Climate Change, Energy, Environment*. [https://serbia.un.org/sites/default/files/2021-09/UN%20Serbia%20Thematic%20Update%20%232%20\\_%20Climate%20Change%20Energy%20Environment%20Aug%202021.pdf](https://serbia.un.org/sites/default/files/2021-09/UN%20Serbia%20Thematic%20Update%20%232%20_%20Climate%20Change%20Energy%20Environment%20Aug%202021.pdf)
- [37] UNDP Serbia (n.d.a). *Climate Strategy and Action Plan*. Klimatske promene.  
<https://www.klimatskepromene.rs/en/projects/climate-change-strategy/>
- [38] UNDP Serbia (n.d.b). *NAMA Projects in Serbia*. Klimatske promene.  
<https://www.klimatskepromene.rs/obaveze-prema-un/unfccc/nama-projekti/>
- [39] UNDP Serbia (n.d.c). *Mitigation Actions in Serbia*. Klimatske promene.  
<https://www.klimatskepromene.rs/en/unclimate/unfccc/mitigation-actions/>
- [40] UNDP Serbia (n.d.d). *UN supports Serbia in responding to climate change*. Klimatske promene. <https://www.klimatskepromene.rs/en/unclimate/>
- [41] UNDP Serbia (n.d.e). Klimatske promene. *Kyoto protocol*.  
<https://www.klimatskepromene.rs/obaveze-prema-un/kjoto-protokol/>
- [42] UNDP Serbia (n.d.f). *Climate Change Projects*. Klimatske promene.  
<https://www.klimatskepromene.rs/en/projects/>
- [43] UNDP Serbia (n.d.g). *EU Climate Requirements to Serbia*. Klimatske promene.  
<https://www.klimatskepromene.rs/en/euclimate/>
- [44] UNDP Serbia (n.d.h). *The EU's 2030 Goals for Climate and Energy*. Klimatske promene. <https://www.klimatskepromene.rs/en/euclimate/2030-framework-for-climate-and-energy-policies/>
- [45] UNDP Serbia (n.d.i). *Establishing a transparency framework in accordance to the Paris Agreement*. Klimatske promene.  
<https://www.klimatskepromene.rs/projekti/uspostavljanje-okvira-transparentnosti-prema-sporazumu-o-klimi-iz-pariza/>

- [46] UN Environment Programme. (2020). *The Circular Economy: A Toolkit for Policy Makers*. <https://www.unep.org/resources/report/circular-economy-toolkit-policy-makers>
- [47] UNESCO. (2017). *Advancing the 2030 Agenda for Sustainable Development*. <https://en.unesco.org/themes/>
- [48] United Nations Environment Programme. (2021). *The State of the Environment Report*. <https://www.unep.org/resources/state-environment-report>
- [49] World Bank. (2021). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. <https://www.worldbank.org/en/news/press-release/2018/09/27/what-a-waste-2-0>
- [50] World Bank. (2020). *Waste Management in a Time of COVID-19*. <https://www.worldbank.org/en/topic/environment/brief/waste-management>



© 2024 Authors. Published by the University of Novi Sad, Faculty of Technical Sciences, Department of Industrial Engineering and Management. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>).