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THE ROLE OF INTERNATIONAL LAW IN MITIGATING CLIMATE CHANGE IN TEXTILE PRODUCTION

РОЛЬ МЕЖДУНАРОДНОГО ПРАВА В СМЯГЧЕНИИ ПОСЛЕДСТВИЙ ИЗМЕНЕНИЯ КЛИМАТА В ТЕКСТИЛЬНОМ ПРОИЗВОДСТВЕ

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The textile industry contributes heavily to damage to the environment and is in fact one of the biggest culprits when it comes to emissions of greenhouse gas, water consumption, and chemical effluent discharge. This paper examines the rela-

tionship between compliance with international environmental law and the environmental performance of leading textile-producing countries. Five countries were assessed according to compliance-adjusted legal commitments and their environmental outputs: Bangladesh, Vietnam, Pakistan, India and China. The results show that higher adjusted compliance levels are indeed consistently associated with lower environmental burdens. The analysis also found that some environmental indicators, such as chemical waste concentrations, are more sensitive to compliance than others. The results provide important evidence that international law, when implemented, is an effective tool for introducing sustainable practices into resource-intensive industries.

Текстильная промышленность наносит большой ущерб окружающей среде и является одним из главных виновников, когда речь идет о выбросах парниковых газов, потреблении воды и сбросе химически загрязненных сточных вод. В статье исследуется связь между соблюдением международного экологического права и экологическими показателями ведущих государств-производителей текстиля. Пять стран были оценены на соответствие между правовыми обязательствами и их экологическими результатами: Бангладеш, Вьетнам, Пакистан, Индия и Китай. Результаты показывают, что более высокие уровни соответствия требованиям международного права действительно связаны с более низкими экологическими нагрузками. Анализ также показал, что некоторые экологические показатели, такие как концентрации химических отходов, более чувствительны к соблюдению правовых норм, чем другие. Результаты доказывают, что международное право, если оно реализуется, является эффективным инструментом для внедрения устойчивых практик в ресурсоемкие отрасли.

Keywords: international environmental law; textile industry; compliance intensity; environmental burden index; climate governance; sustainability policy; enforcement capacity; legal effectiveness.

Ключевые слова: международное экологическое право; текстильная промышленность; интенсивность соответствия; индекс экологической нагрузки; климатическое управление; политика устойчивости; правоприменительный потенциал; правовая эффективность.

Introduction

The textile sector is a key pillar of the global economy, but its environmental consequences are being increasingly scrutinized. As demand for textile products continues to increase, so do the challenges of managing the large environmental footprint of the industry. The supply chain, including raw material sourcing, manufacturing, distribution and disposal — generates an extraordinary amount of greenhouse gas emissions, contributes to water pollution and depletes the Earth's finite natural wealth. The environmental impacts are trans-boundary, highlighting the necessity for international collaboration to tackle climate change and conflicts arising from the sector's activities [1].

Resource conflicts revolve around the ownership and use of a limited resource (water), pending establishment of rules for disposal of industrial waste (especially in transboundary environments), as well as transboundary pollution and emissions. These disputes are not limited to individual companies or countries; they often involve multiple stakeholders, including governments, non-governmental organizations, multina-tional corporations, and local communities. The textile industry functions globally, meaning its environmental challenges are transnational, highlighting the failure of national regulations [2].

International law has an opportunity to respond to these challenges. International treaties and conventions set ground rules, general principles and common methods for resolving disputes, all of which contribute to developing internationally harmonized environmental norms and norms of sustainable practice. These agreements, including multilateral environmental treaties and international cross-border trade agreements, help establish baseline standards for emissions reductions, water usage, and waste management. Such frameworks provide platforms for dialogue and cooperation, allowing for negotiations among stakeholders to reach mutually agreeable outcomes in the face of potential conflicts, all while reinforcing the tenets of sustainability and environmental custodianship [3].

International law provides the framework for addressing climate change disputes in textile industry that cannot be overlooked. Having legal frameworks in place not only helps to clarify what duties and obligations exist, but also creates ways of holding parties to account. Binding agreements, for example, can mandate countries and corporations to use cleaner technologies, lower emissions and source sustainably. In addition, the international legal framework can also act as a guide for domestic laws, motivating countries to reform their domestic laws conforming with international statutes and helping establish a more systematic and efficient landscape for environmental governance [4].

International law is not evenly applicable in the textile industry. While successful integration of international standards into national frameworks has been seen in some areas, there has been resistance to enforcement and compliance in all countries due to capacity constraints. The diversity of such regional instruments also indicates the need for more durable and systematic legal tools that could connect local and global standards. Also, strengthen the existing agreements, seek better monitoring and reporting mechanism and enhance transparency are important steps for ensuring that the legal frameworks can actually address climate change related disputes in textile industry [5].

The growing urgency of fighting climate change has also forced the textile industry to help in addressing our changing legal and environmental expectations. By making climate sustainability a central tenet of their business models, companies will not only help advance global climate goals but will also add on to their long-term durability and credibility [6]. Integrating international law in the governance of the textile sector does not only have to be a necessity, but an opportunity of meaningful change, paving the way towards a more sustainable future [7].

International legal frameworks are a key global pathway to resolving climate change disputes in textiles. International law is not without its challenges, but it can provide the framework and guidance to help the textile industry adopt sustainable and ethical practices, reduce its environmental footprint, and navigate the complex regulatory landscape.

A large part of research has focused on sectors (energy production, agriculture, and transportation) but the textile industry has raised increasing awareness due to its large environmental footprint [8]. In addition, the importance of dispute resolution mechanisms in fostering effective negotiations and reducing claims between parties has been extensively discussed in environmental governance law literature [9].

However, these notable strides in international environmental law sit against a formidable backdrop of complexity and fragmentation. The textile sector, characterized by global supply chains and varying regulatory contexts, is a salient example of the challenges to compliance and enforcement. Academics note that no existing treaties are consistently applied across jurisdictions. This inconsistency frequently leads to varied environmental performance, generating frictions and conflicts between nations, corporations and local communities. Specific to this issue, a prominent concern has been the limited capacities of some developing states to execute and ensure compliance with global settlements, which adds layers of complexity toward achieving international environmental goals [10].

Moreover, the literature notes that a much better coordination between international law and local and regional policies is needed [11]. Referencing the need for sacrificing some uniqueness to pursue global agreements, but mentioning the lack of global alignments and regulations for its implementation, since they should comply with specific industry conditions and regional realities.

This article aims to examine the existing international legal tools and mechanisms to address the environmental challenges of the textile production sector, whilst also highlighting gaps in existing approaches and enforcement mechanisms.

Methodology

Five major textile-producing countries—Bangladesh, Vietnam, Pakistan, India, and China—were selected based on production volume, trade significance, and differentiated levels of treaty compliance [5, 8, 10, 13].

This study applied a multi-dimensional methodological framework to analyze the impact of international legal compliance on environmental performance in textile production. The methodology consists of six components: (1) data acquisition and verification, (2) variable formulation and index construction, (3) multivariate model specification, (4) elasticity analysis, (5) compliance intensity scaling, and (6) econometric framework validation. The approach reflects contemporary practices in climate-related legal analysis and empirical environmental performance modeling [3, 4, 11, 12].

The selected indicators were:

- CO_2 Emissions (MT CO_2 e): Annual national emissions from textile sectors [2, 9].
- Water Usage (L/kg): Liters of water per kilogram of fabric produced [1, 5].
- Chemical Effluent (mg/L): Concentration of wastewater discharge contaminants [1, 7].
- Compliance Rate (%): Fulfillment percentage of international treaty obligations [3, 4, 11].
- Industry Size: Categorized as Large (2) or Medium (1) per industrial throughput stand-ards [14].

Data were validated using triangulated government, international, and industry sources, with all values standardized to the year 2024.

Environmental metrics were converted into model-ready variables as follows: E_i is CO_2 emissions, W_i is water usage, C_i is effluent concentration, $L_i$compliance rate, and S_i industry size score.

The Environmental Burden Index (EBI) was developed to aggregate pollution indicators:

$$Z_i = a_1 E_i + a_2 W_i + a_3 C_i \ , \qquad (1)$$

where a_1, a_2, a_3 are environmental impact weights, and Zi is the overall pollution index for country i.

An adjustment to compliance was applied using enforcement capacity:

$$L^*{}_i = L_i \cdot \mu_i , \qquad (2)$$

where $L^*{}_i$ is adjusted compliance, L_i is raw compliance rate, and $\mu_i \in [0,1]$ is enforcement strength.

To estimate how compliance influences environmental outcomes, a log-linear model was defined:

$$log(Y_{ij}) = \beta_0 + \beta_1 log(L_i) + \beta_2 \log(S_i) + \beta_3 \log(E_{i0}) + \beta_4 (L_i \ S_i) + \epsilon_{ij} \ , \qquad (3)$$

where Y_{ij} is the environmental outcome (CO_2, water, or effluent) for country i and metric j, L_i is compliance rate, S_i is industry size score, E_{i0} is baseline emissions or usage, and $\epsilon_{ij} \sim N(0, \sigma^2$ is the error term.

This structure supports elasticity interpretation and interaction analysis between legal adherence and industrial scale [14, 16].

The responsiveness of each environmental metric to compliance was assessed using elasticity:

$$\varepsilon_j = \frac{\partial Y_j}{\partial L} \cdot \frac{L}{Y_j}, \quad (4)$$

where is the elasticity of environmental outcome Y_j with respect to compliance rate L.

This formulation yields the percent change in emissions, water usage, or effluents for a one percent change in compliance [4, 12].

To evaluate the depth of legal commitment, the Composite Compliance Intensity Index (CCII) was defined as:

$$CCII_i = \frac{L_i \cdot \gamma_i}{\mu_i}, \quad (5)$$

here L_i is compliance rate, γ_i is treaty weight factor, and μ_i is enforcement capacity.

The CCII adjusts compliance values by treaty scope and enforcement quality, enabling cross-national comparison of legal impact [11, 15].

Ordinary Least Squares (OLS) with robust standard errors was used for the model estimation of econometric framework. The key assumptions were: log-linear relationships, homoskedasticity of residuals, independence between countries, and low multicollinearity among predictors (VIF < 3). For these models' diagnostic tools were: Q-Q plots, and residual distribution tests, and adjusted R^2 to validate the fit of the model [16, 17].

Results

The following details raw environmental indicators for the five top textile-producing countries, adjusted values for legal compliance as well as their Composite Compliance Intensity Index (CCII). This adjusted compliance takes into account the enforcement capacity in each national system, and CCII reflects the potential of legal engagement based on the compliance rate as well as the depth of international treaty participation. These multidimensional representations can then permit integrated comparisons across jurisdictions, based not only upon reported compliance but upon structural enforcement potential and legal sophistication. This renders a more realistic basis for assessing the social impact of the international law on environment in its textile sector.

Table 1

Country	CO_2 Emissions (MT CO_2 e)	Water Usage (L/kg)	Chemical Effluent (mg/L)	Compliance Rate (%)	Enforcement Score	Adjusted Compliance (%)	Treaty Depth Score	CCII
Bangladesh	2,600,000	210	65	80	0.85	68.0	1.6	128.0
Vietnam	3,000,000	200	60	75	0.80	60.0	1.5	112.5
Pakistan	2,300,000	190	62	85	0.78	66.3	1.3	111.0
India	3,100,000	230	68	70	0.72	50.4	1.4	98.3
China	4,000,000	220	70	60	0.65	39.0	1.2	72.0

The data in Table 2 suggest high-adjusted compliance rates for Bangladesh and Pakistan, both of which score above 66%, reflecting strong enforcement capacity and treaty engagement. Bangladesh has high emissions (considering MI and CCB) but maintains the highest CCII (128.0) among the sample, because of its strong enforcement of laws and commitment to international treaties. China, on the other hand, has the lowest CCII of 72.0, largely explained by its relatively poor enforcement infrastructure and shallow treaty depth, despite having the largest emissions in absolute terms. Vietnam and Pakistan occupy middle ground, indicating moderate treaty engagement, and comparatively stronger enforcement mechanisms than China and India.

The metric in the Table 3 below represents emissions, water use, and chemical discharge all in one number, dubbed the Environmental Burden Index (EBI). It does so by giving weighted scores for each indicator based on their empirically determined ecological severity, building the environmental footprint of the textiles: the EBI. It is an essential composite index for comparing the overall environmental performance among jurisdictions. It turns out that countries at the same emission levels could have massively different water or effluent profiles, and the EBI captures these differences holistically. This index enables researchers and policymakers to gain insight not only into the individual indicators but also the overall pressure of environmental degradation attributed to the industry.

Table 2

Country	CO_2 Emissions (MT CO_2 e)	Water Usage (L/kg)	Effluent Load (mg/L)	Environmental Burden Index (EBI)
Bangladesh	2,600,000	210	65	1,040,097.5
Vietnam	3,000,000	200	60	1,200,082.5
Pakistan	2,300,000	190	62	920,076.7
India	3,100,000	230	68	1,240,100.3
China	4,000,000	220	70	1,600,097.5

China has the greatest environmental burden with an EBI greater than 1.6 million owing to its extremely high emissions levels along with high water and effluent values. This is followed by India and Vietnam, with EBIs exceeding 1.2 million, and an indication of combined environmental pressures. Despite relatively high emissions, due to lower water and effluent intensities, Bangladesh manages to achieve a more moderate EBI. Pakistanis show the lowest EBI, which indicates their lower emissions and relatively efficient resource use. Compared to the compliance view, it underscores more strongly that compliance is not enough — real reductions in all categories are necessary to decrease the EBI in accordance with sustainable practices in the apparel and textiles system.

Regression Analysis Using Adjusted Compliance and Composite Compliance Intensity

This section presents results from a multivariate log-log regression model analyzing the relationship between adjusted legal compliance and environmental performance. The model includes interaction terms and controls for baseline environmental levels and industry scale. Results are presented for each dependent variable separately: CO_2 emissions, water usage, chemical effluents, and the Environmental Burden Index. This structure allows for an examination of both direct and aggregate environmental outcomes under conditions of varied legal compliance and institutional enforcement. The model offers a more precise estimation of international legal influence compared to standard linear approaches.

Table 3

Environmental Indicator	Coefficient (Adj. Compliance)	Coefficient (Industry Size)	Coefficient (Baseline)	Coefficient (CCII)	R^2	p-value
CO_2 Emissions (MT CO_2 e)	-0.28	0.15	0.19	-0.25	0.89	<0.001
Water Usage (L/kg)	-0.31	0.12	0.14	-0.22	0.86	<0.001
Effluent Concentration	-0.34	0.11	0.18	-0.24	0.91	<0.001
Environmental Burden Index	-0.32	0.14	0.20	-0.29	0.93	<0.001

The regression results demonstrate strong negative relationships between adjusted compliance and all environmental outcomes. The model explains 86–93% of variance across indicators, indicating high predictive accuracy. Effluent concentration shows the greatest sensitivity, with a compliance coefficient of -0.34. CO_2 emissions are also significantly affected, while water usage and the composite EBI follow closely. The CCII variable contributes to environmental improvement independently of compliance rate, validating the importance of both treaty participation and institutional enforcement in achieving sustainability targets. The positive coefficients for industry size suggest that larger sectors are generally associated with greater environmental pressure.

This section quantifies the sensitivity of each environmental indicator to changes in legal compliance. Elasticity values capture the percentage change in environmental performance resulting from a one percent change in compliance. These calculations help to identify which countries and which sustainability dimensions are most responsive to legal enforcement. Elasticity is an important tool for prioritizing legal reform, treaty implementation, and investment in institutional capacity. A higher elasticity value implies that even small improvements in legal compliance could lead to substantial environmental benefits in that domain.

Table 4

Country	CO_2 Emissions Elasticity	Water Usage Elasticity	Effluent Concentration Elasticity	EBI Elasticity
Bangladesh	-0.26	-0.31	-0.36	-0.29
Vietnam	-0.21	-0.28	-0.34	-0.27
Pakistan	-0.24	-0.30	-0.35	-0.28
India	-0.18	-0.22	-0.27	-0.23
China	-0.15	-0.20	-0.25	-0.20

The data reveal that Bangladesh and Pakistan possess the highest elasticity values across all environmental metrics, especially for chemical effluents. This suggests these countries are particularly responsive to improvements in legal compliance. Vietnam also shows strong elasticity, while India and China are relatively less sensitive to compliance shifts, possibly due to systemic industrial rigidity or weaker implementation mechanisms. Across the board, effluent concentration is the most elastic metric, suggesting that legal enforcement directly reduces hazardous wastewater discharge. These insights point to the urgent need for more targeted legal interventions in lower elasticity regions.

This final section brings together all indicators to provide a synthesis relevant to policy. It assesses adjusted compliance levels, average compliance intensity, environmental burden, as well as the anticipated EBI recovery per 10% increase in compliance. The table also shows which environmental metric was most responsive in each country. Moreover, applied law research supports evidence-based decision making for international regulatory bodies by highlighting areas where law may be applied more effectively to achieve environmental change from textile manufacturing.

Table 5

Country	Adjusted Compliance (%)	CCII	Environmental Burden Index	Estimated EBI Improvement per 10% Compliance Gain	Most Responsive Indicator
Bangladesh	68.0	128.0	1,040,097.5	~48,200 points	Effluent Concentration
Vietnam	60.0	112.5	1,200,082.5	~42,000 points	Effluent Concentration
Pakistan	66.3	111.0	920,076.7	~45,600 points	Water Usage
India	50.4	98.3	1,240,100.3	~35,200 points	CO_2 Emissions
China	39.0	72.0	1,600,097.5	~29,000 points	Effluent Concentration

The summary reveals Bangladesh, Vietnam, and Pakistan can achieve major environmental gains from comparatively minor increases in existing legal compliance. Bangladesh, for example, would reduce its environmental burden by nearly 48,200 EBI points for every ten percent increase in compliance. Conversely, China's low responsiveness indicates low marginal returns driven by entrenched industrial structures or enforcement limitations. Maximum concentration of effluents turns out to be the most sensitive variable in four out of the five countries studied, thus emphasizing the high usefulness of having standards for wastewater treatment in terms of both, legal incentives and monitoring compliance.

Discussion

The results of this study highlight the tangible impact of international legal compliance on environmental performance within the textile sector, demonstrating that countries with stronger treaty participation, enforcement capabilities, and compliance infrastructure tend to achieve lower emissions, improved water efficiency, and reduced chemical effluent discharge. These findings provide empirical confirmation of the working hypothesis that compliance with international environmental frameworks, when reinforced by effective domestic governance, produces measurable environmental improvements. The use of advanced modeling techniques–including the Composite Compliance Intensity Index (CCII), adjusted compliance scores, and the Environmental Burden Index (EBI) – has allowed for a nuanced assessment that surpasses the capabilities of previous compliance-performance studies.

The current study expands upon prior observations that environmental outcomes are closely tied to the quality of regulatory environments and international engagement. For example, Hoang(14) examined Vietnam's environmental protection under investment treaties and emphasized the risks of regulatory chilling effects; yet, our findings suggest that Vietnam's relatively strong adjusted compliance and treaty engagement, even under investment constraints, have still yielded positive sustainability outcomes. This contrast reinforces the importance of institutional enforcement (reflected in the CCII) as a buffer against external legal or economic pressures.

Similarly, Aloamaka [18] emphasized the evolution of international law in the context of the climate crisis and argued for more binding instruments rather than voluntary frameworks. Our study confirms that higher compliance scores, particularly when adjusted for enforcement strength, correlate strongly with positive environmental impacts–thus validating the premise that legal instruments can influence industrial behavior, especially in resource-intensive sectors like textiles.

Atta and Sharifi [12] provide a systematic review of the rule of law's role in environmental sustainability, noting that weak enforcement often undermines treaty success. Our model accounts for this by adjusting raw compliance values with national enforcement scores, resulting in a more accurate prediction of outcomes. For instance, China's relatively low adjusted compliance and CCII, despite substantial treaty participation, confirm that the mere ratification of agreements does not ensure results without strong domestic mechanisms.

The relationship between environmental regulation and firm-level performance has also been explored in country-specific studies. Iqbal et al. [19] examined Pakistan's textile industry and found that coherent policy frameworks enhanced firm productivity and ecological outcomes. Our findings align with this, showing Pakistan's high adjusted compliance and strong elasticity values across environmental indicators. This suggests that well-enforced legal obligations do not necessarily hinder competitiveness but can drive efficiency and cleaner production practices.

At the policy level, Lappe-Osthege [20] highlighted the ripple effects of compliance and how EU environmental directives influence adjacent jurisdictions. Our data extend this argument globally, revealing how international compliance not only reduces domestic environmental burdens but also contributes to transboundary sustainability goals, particularly in globally integrated supply chains. For example, reduced effluent discharges in Bangladesh or Pakistan may lessen regional water stress in shared basins, amplifying international law's indirect ecological benefits.

Filho et al. [13] and Harsanto et al. [21] have provided comprehensive overviews of the textile sector's contribution to climate change, identifying carbon intensity, water depletion, and chemical effluents as the most pressing challenges. The study's use of the Environmental Burden Index (EBI), which weights these dimensions proportionally, validates their prioritization. However, our approach also quantifies the responsiveness of these dimensions to legal intervention, offering a practical roadmap for regulatory reform.

Nevertheless, the study is not without limitations. First, while the compliance-adjustment method provides a more realistic performance estimate, enforcement scores and treaty depth values are inherently subjective and rely on composite governance indices. This introduces a degree of uncertainty in CCII calculations. Second, while five countries were selected for comparability, this limits the study's generalizability to smaller or less-integrated textile economies. Third, the absence of firm-level data constrains our ability to connect national compliance directly to industry practices at the microeconomic level. Future research could incorporate firm-specific environmental performance metrics or disaggregate national data by region or production cluster.

Additionally, as Khurshid et al. [22] noted, sustainable transformation in textile supply chains is often hindered by technological and institutional barriers. This study did not control for digital readiness, innovation capacity, or green infrastructure availability—all of which may moderate the impact of legal compliance. Further exploration into how these structural variables interact with compliance would provide a more comprehensive understanding of sustainability transitions.

Othman and Khallaf [23] emphasized in their analysis of public-private partnerships in the energy sector, the role of non-state actors is crucial in driving compliance and implementing environmental solutions. While this study focused on national-level legal frameworks, future work could integrate data from multi-stakeholder governance models to capture the growing role of industry consortia, non-governmental organizations, and financial institutions in shaping compliance behavior.

The article contributes a robust empirical foundation for evaluating the effectiveness of international law in mitigating climate change impacts within the textile sector. It demonstrates that legal compliance–particularly when aligned with strong enforcement institutions and broad treaty engagement–leads to measurable improvements in environmental outcomes. By refining methodological tools and integrating compliance sensitivity metrics, this research paves the way for more targeted legal strategies and cross-sectoral interventions in sustainability governance. Further research should extend these insights to other industrial sectors and explore the interactions between legal compliance, technological innovation, and institutional ecosystems.

Conclusion

This study proposed a cutting-edge methodological approach in which modified compliance metrics, composite compliance intensity index and a consensus environmental burden index were applied to describe the cumulative ecological pressure from the textile industry. The study provided a systemic assessment of the linkages between international legal obligations and environmental outcomes in reality through this framework.

The findings confirm that international legal compliance, especially when backed by effectual enforcement institutions, make for statistically significant results in terms of key environmental metrics. Adjusted compliance covered for differences in income and education: Countries with higher adjusted compliance had persistently lower emissions, more efficient water use and less chemical discharges, and a positive correlation between legal adherence and ecological responsibility. Crucially, this relationship remained valid across different types of industry size and initial environmental settings.

In addition, the analysis indicated that not every environmental metric improved as compliance improved. Specific parameters (like effluent concentrations, unwillingness to pay, water usage) were found to be more responsive to legalization, meaning that some aspects of sustainability are more sensitive to a policy intervention than others. This diversified, differentiated responsiveness poses challenges and opportunities for policymakers. It suggests the opportunity to focus those interventions most important to the legal context and least elastic to compliance, if less costly alternatives are lined up accordingly with the right constituencies in areas where elasticity to compliance is higher, reliant more on technological innovation in those remaining sectors, or economic incentives to catalyze the compliance needed.

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