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ENVIRONMENTAL SUSTAINABILITY IN HIGHER EDUCATION: QUANTITATIVE ANALYSIS OF INSTITUTIONAL PRACTICES IN LATIN AMERICAN UNIVERSITIES

Fermín Carreño Meléndez[1], Miriam Elizabeth Erazo Rodríguez[2], Alejandra Carpio Herrera[3], [4]Alex Joffre Quimis Gómez

[1]Universidad Autónoma del Estado de México, México
ORCID: https://orcid.org/0000-0002-6485-1053
[2]Universidad Nacional de Chimborazo, Ecuador
ORCID: https://orcid.org/0000-0003-1569-7245
[3]Universidad Nacional de Chimborazo, Ecuador
ORCID: https://orcid.org/0000-0002-7254-7430
[4]Carrera de Ingeniería Ambiental, Facultad de Ciencias Naturales y de la Agricultura, Universidad Estatal del Sur de Manabí, Ecuador
ORCID: https://orcid.org/0000-0001-7434-0655

fermin_carreno@yahoo.com.mx | fcarrenom@uaemex.mx[1]
miriamerazo@unach.edu.ec[2]
alejandra.carpio@unach.edu.ec[3]
alex.quimis@unesum.edu.ec[4]

Summary
This article quantitatively examines institutional environmental sustainability practices in universities in Latin America and the Caribbean (LAC) based on recent indicators and public reports. External evaluation sources – UI GreenMetric, THE Impact Rankings and QS Sustainability – are integrated and compared with UNESCO Education for Sustainable Development (ESD) guidelines. The findings show a sustained expansion of regional participation in sustainability rankings (e.g., 138 LAC institutions in QS Sustainability 2025) and heterogeneous advances in operational dimensions (energy, waste, water, mobility, and education) reported by GreenMetric. Gaps persist between declarative commitments and measurable outcomes, especially in curriculum integration and data transparency. A synthetic index of practices (ISU-LAC) and a reproducible methodological design for annual monitoring are proposed. Implications: Strengthen standardized measurement, the curriculum-operation link, and regional comparability.

Keywords: university sustainability; higher education; Latin America; UI GreenMetric; THE Impact Rankings; QS Sustainability; EDS; indicators.

Introduction

Higher education occupies a strategic position in the promotion of environmental sustainability: it not only trains future professionals, but also manages infrastructures, consumes resources and generates direct impacts on its environment. Higher education institutions (HEIs) are increasingly conceived as "essential partners" for the implementation of the Sustainable Development Goals (SDGs) and the Ecological Transition, given their role in research, teaching, extension and governance (Herrera-Franco, Mora-Frank & Carrión-Mero, 2023). In the context of Latin America and the Caribbean, this role takes on particular relevance as the region faces profound environmental challenges—such as deforestation, climate vulnerability, biodiversity at risk, and structural inequalities—while expanding higher education coverage (UNESCO IESALC, 2023).

In this framework, Latin American HEIs have begun to incorporate environmental sustainability practices into their operations, curricula, and institutional policies. For example, recent studies show that processes linked to energy consumption, waste management, sustainable mobility, and water efficiency have received greater operational attention (Herrera-Franco et al., 2023). At the same time, "Education for Sustainable Development" (ESD) initiatives highlight the need to integrate the environmental dimension into the curriculum and institutionalized learning (Castro et al., 2023). However, considerable gaps persist in terms of data transparency, standardized measurement, governance, and consolidation of indicators that allow institutional performance to be evaluated in a comparative manner (Sigahi et al., 2022).

The growing visibility of university sustainability is also reflected in global rankings. The latest edition of the QS Intelligence Unit Sustainability Rankings 2025, for example, includes 138 institutions from Latin America and the Caribbean, which shows progress in the regional critical mass that is measured under sustainability criteria (QS, 2025). Even so, the region's average performance is below blocs such as the G7, which shows that there is still a long way to go (QS, 2025).

Additionally, the recent seminar of the UNESCO International Institute for Higher Education in Latin America and the Caribbean (IESALC) reaffirmed that institutional leadership, collaborative networks, and systematic evaluation are pillars for the transformation of HEIs towards "more resilient, inclusive, and sustainable institutions" (IESALC, 2025). This underscores that university sustainability should not be understood solely as an operational or infrastructure issue, but as a comprehensive approach that connects governance, curriculum, research, operations, and community engagement.

Therefore, it is urgent to carry out a quantitative analysis of institutional sustainability practices in Latin American HEIs: to identify which dimensions are advancing strongly, where there are lags, and which factors seem to facilitate improvements. This type of analysis helps to answer key questions: how well are sustainable practices integrated into the regional university structure? How aligned are they with international frameworks and the SDGs? And what are the obstacles that still prevent a comprehensive and comparative approach?

This article addresses the issue with the aim of quantitatively mapping sustainable practices in Latin American universities, proposing an adapted evaluation index (Synthetic Index of University Practices – ISU-ALC) and deriving implications for institutional and regional policies. Through this, it is expected to provide evidence that will strengthen the transformation of higher education towards more sustainable models free of contradiction between declaration and practice.

Theoretical Framework

2.1 Conceptualization of sustainability in higher education

Sustainability in higher education institutions (HEIs) is understood as the systematic integration of the environmental, social, and economic dimensions (the well-known "ESG" triangle: Environmental, Social, Governance) in the mission, operation, curriculum, research, and community engagement of these institutions (dos Santos Lima et al., 2023). In this sense, HEIs are key actors for the sustainable development agenda, not only as trainers of human capital, but also as managers of resources, infrastructure, and applied knowledge (UNESCO, 2022).

This holistic understanding assumes that sustainability is not an "add-on" or extracurricular module, but a strategic axis that crosses institutional governance, campus operations, research, and teaching (Oliveira et al., 2025). For example, a recent study identified the following five dimensions integrated into campus operations: carbon neutrality, energy efficiency, waste management, circular economy, and technological innovation, highlighting the interconnectedness between them (Oliveira et al., 2025).

In the Latin American context, HEIs have increased their commitment to sustainability, although with varying levels of progress: there is a growth in scientific production on sustainability in higher education, but also a concentration of operational initiatives (energy, waste) and a lower integration of the curricular dimension and strategic governance (dos Santos Lima et al., 2023; Klein et al., 2023).

2.2 Key dimensions for analyzing institutional practices

The key dimensions used in sustainability assessment frameworks in HEIs are reviewed below:

2.2.1 Governance and strategic integration

Institutional governance plays a fundamental role as an enabler or barrier to sustainability. A recent study concludes that governance structures—governing bodies, sustainability committees, institutional policies, reporting systems—have a high correlation with the degree of implementation of the SDGs in HEIs (Governance for Sustainability in HEIs, 2023). For example, the presence of a formalized and transparent sustainability committee can accelerate diagnosis, planning, and accountability processes (Governance for Sustainability in HEIs, 2023).

2.2.2 Campus Operations (Energy, Waste, Water, Mobility)

Campus operations constitute the most measured level in the global university sustainability rankings. According to Oliveira et al. (2025), a systematic analysis found that HEIs that report metrics on energy, waste, and water show better performance in the rankings. It should be noted that recent literature identifies that most research focuses on these operational dimensions, while others—such as community mobilization or curriculum—are still less developed (Oliveira et al., 2025).

2.2.3 Teaching and research with a sustainable approach

Integrating sustainability into teaching and research is a key challenge. A recent conceptual framework proposes that HEIs should act as adaptive systems, incorporating sustainability competencies into the curriculum, experiential learning, research applied to real challenges, and community engagement (Rethinking HEIs as complex adaptive systems, 2022). These challenges are amplified in the Latin American region, where curricular integration is more incipient (dos Santos Lima et al., 2023).

2.2.4 Education for Sustainable Development (ESD)

UNESCO (2022) notes that ESD must be present "at every level of the institution": in policy, in academic programmes, in research and in the operation of the campus. This involves training students to understand and act on sustainability challenges – climate change, inequality, biodiversity – and not just as a recipient of technical knowledge. In Latin America, the initiatives show progress, but also gaps in systematization and scale (Sustainable Development Goals in Latin-American Universities, 2023).

Table 1. Summary of dimensions and challenges

Dimension	*Description*	*Main challenges in LAC**
Governance/Strategy	Institutional policies, leadership, reporting systems sustainability	Formalization of committees, comparable data, accountability
Campus Operations	Energy, waste, water, mobility	Measurable data, infrastructure, financing
Teaching & Research	Integrating sustainability into curriculum and applied research	Curriculum still fragmented, limited research
Education for Sustainable Development (ESD)	Competencies, experiential learning, community engagement	Poor systematization, lack of scale

*LAC: Latin America and the Caribbean.

2.3 Indicators and evaluation frameworks in HEIs

The most widely used frameworks for assessing sustainability in HEIs cover multiple dimensions. Below is a comparative table of the main international frameworks, their dimensions and relevance to the Latin American context.

Table 2. Comparison of evaluation frameworks

Frame	*Main dimensions*	*Relevance for IES LAC*
UI GreenMetric	Infrastructure, energy & climate, waste, water, transport, education	High adoption in LAC, enables operational benchmarking
THE Impact Rankings	Research, teaching, administration, extension (aligned with SDGs)	Promotes "social impact" and international visibility
QS Sustainability	Environmental, Social, Governance (ESG)	Growing coverage in LAC (138 institutions 2025)
AASHE STARS	100+ metrics in operations, teaching, research, institutional planning	Detailed framework, allows internal tracking

2.4 Obstacles and facilitating factors

Recent literature has identified the following factors as obstacles or facilitators to the implementation of sustainability practices in HEIs:

- **Obstacles**: lack of comparable data, departmental silos, limited funding, resistance to institutional change, lack of visibility of ROI (return on investment) in sustainability (Integrating sustainability into HE challenges, 2024).
- **Enablers**: committed institutional leadership, multi-stakeholder participation (students, faculty, technicians), external partnerships, clear metrics, linking the campus with the local community (Transformative organizational learning for sustainability in HEIs, 2024).

Likewise, in the Latin American context, the need to build inter-institutional collaboration networks to share good practices and promote data transparency is reflected in order for

benchmarking to be meaningful (dos Santos Lima et al., 2023; Guest editorial: Latin American perspectives on sustainability in HE, 2023).

2.5 Specific gaps and opportunities in Latin America

The Latin American region exhibits particularities that affect sustainability in HEIs: rapid expansion of university coverage, inequality of resources between institutions, variety in national regulatory frameworks, and high environmental vulnerability. This generates a scenario of high challenges, but also of great opportunities (Sustainable Development in Latin American Higher Education Institutions, 2023). In this context, the integration of the environmental dimension can serve as a lever for institutional improvement and strengthening of the university mission.

Methodology

This section describes in detail the research design, data sources, variables, analysis procedure, and ethical considerations. Recent good practices in sustainability assessment in higher education institutions (HEIs) were adopted (Basheer et al., 2023; Justi, Soares & Ensslin, 2025).

3.1 Research design

A quantitative design of **a descriptive-comparative cross-sectional** type is used, complemented in part with qualitative documentary analysis (public reporting of global frameworks). This light mixed approach responds to the recommendation to use harmonized evaluation frameworks for HEIs (Embedding sustainability in higher education institutions: A review of ..., 2025).

3.2 Data sources

The selected sources meet the criteria of topicality (last five years) and public access:

- Framework engagement and coverage data: Times Higher Education (THE) Impact Rankings 2025.
- Cobertura regional de Quacquarelli Symonds (QS) Sustainability 2025.
- Methodological data and categories from UI GreenMetric World University Rankings 2024.
- Reviewed literature on indicator methodologies in HEIs (Basheer et al., 2025; Justi et al., 2025).
- UNESCO Guidance Documents on ESD (Education for Sustainable Development).

3.3 Variables and measurement index

A **Synthetic Index of University Practices (ISU-ALC) was constructed**, with the following dimensions, each operationalized through available or inferred secondary indicators:

Dimension	***Main indicators***	***Main source***
Energy and Climate Change (ECL)	Energy consumption, percentage of renewables, CO_2 footprint	UI GreenMetric (2024)
Waste (RES)	Recycling rate, hazardous waste, circular economy	UI GreenMetric (2024)
Water (AGU)	Consumption per student, reuse, rainwater harvesting	UI GreenMetric (2024)
Mobility (MOV)	Active transport, electric vehicles, mobility plan	UI GreenMetric (2024)
Education and	ESD curricular offer, sustainability	QS, THE, literature

Governance (EDU-GOB)	committee, ESG report	(2023-2025)

The weighting of each dimension was equal (0.20) to avoid predetermined biases towards a specific dimension.

3.4 Analysis procedure

1. 2024–2025 coverage data were extracted from the aforementioned frameworks for Latin American and Caribbean (LAC) universities.
2. The available indicators were normalized through **z-score** by dimension for each institution, when the data allowed it.
3. The ISU-ALC was calculated as a simple average of the five normalized dimensions.
4. Descriptive analysis (means, standard deviations, ranges) of each dimension and global index was performed.
5. Correlation analysis (Pearson) between operational dimensions (ECL, RES, AGU, MOV) and the EDU-GOB dimension was used to explore exploratory relationships.
6. It was complemented with documentary analysis of the level of institutional public reporting (number of institutions with a sustainability report published in the last year) as a qualitative variable of support.

3.5 Table of methodological steps

Step	*Activity*	*Expected Result*
1	Public secondary data collection (2024–2025)	LAC Regional Database
2	Standardization of indicators by dimension	Comparable data across institutions
3	Calculation of the ISU-LAC	Comparative global index
4	Descriptive and correlational analysis	Identifying patterns and relationships
5	Documentary complement (reports, policies)	Qualitative context for quantitative results

3.6 Methodological limitations

- The availability of microdata by institution is limited; Many dimensions require self-reporting. This coincides with the findings of Basheer et al. (2025) on fragmented indicators and disagreements among stakeholders.
- The heterogeneity of methodologies between international frameworks makes direct comparison difficult (Justi et al., 2025).
- As it is a cross-sectional analysis, longitudinal change dynamics are not captured.
- The ISU-ALC index is illustrative and does not replace full institutional audits.

3.7 Ethical considerations

The research uses only **public secondary data**, without access to student or personal information. Institutional **anonymity is guaranteed** in the aggregate presentation of data to avoid stigmatization. Ethics committees are not required for this type of study based on public data.

Results

4.1 Coverage and trends 2024–2025

The visibility of university sustainability in LAC is reflected in the expansion of global frameworks:

- **QS Sustainability 2025** includes **138** institutions in Latin America and the Caribbean (LAC), with Brazil as the country with the highest number of ranked universities and USP leading at the regional level.
- **THE Impact Rankings 2025** evaluated **2,526** universities from **130** countries/territories, consolidating itself as the most comprehensive comparative sustainability exercise (aligned with SDGs) to date.
- **UI GreenMetric 2024** maintains six operational categories (infrastructure, energy and climate, waste, water, transport, education) with self-reported data used for operational benchmarking.
- **AASHE STARS** reports **385** institutions with current ratings globally, useful as a complementary internal monitoring framework.

Table 1. Recent coverage of university sustainability frameworks (2014–2025)

Frame	*Last edition considered*	*Reported Coverage*	*Main focus*
QS Sustainability	2025	138 HEIs in LAC (almost 1,800 globally)	ESG and impact indicators
THE Impact Rankings	2025	2,526 HEIs from 130 countries/territories	Performance by SDGs (research, teaching, management, extension)
UI GreenMetric	2024	Global ranking (self-reporting by 6 categories)	Campus Operations & Education
AASHE STARS	2025	385 HEIs with current rating	Internal monitoring (operations, curriculum, R+D, planning)

Fuentes: QS (2025); THE (2025); UI GreenMetric (2024); AASHE STARS (2025).

4.2 Performance by observable dimensions

When triangulating frameworks, it is observed that **the operational dimensions** (energy/climate, waste, water, mobility) show greater relative maturity, while **education and governance (EDU-GOB) —** which includes integration of ESD, committees and reports **—** still show variability between institutions and countries. This coincides with global diagnoses that warn of North/South disparities and low relative participation in reports and rankings, especially in the Global South.

Table 2. Dimension coverage by frame (qualitative mapping)

Dimension	*UI GreenMetric 2024*	*THE Impact 2025*	*QS Sustainability 2025*	*STARS 2025*
Energy and climate (ECL)	✔	△ (e.g. SDG 7/13)	✔	✔
Waste (RES)	✔	△ (indirect)	△	✔
Water (AGU)	✔	△ (indirect)	△	✔
Mobility	✔	△ (indirect)	△	✔

(MOV) Education and Governance (EDU-GOB)	△ (education)	✔ (teaching/management/SDGs)	✔ (ESG)	✔

Caption: ✔ direct coverage; △ Partial/indirect coverage. *Sources: UI GreenMetric (2024); THE (2025); QS (2025); STARS (2025).*

4.3 Compiled indicators and public availability

The availability of **comparable microdata** remains a challenge. However, public evidence allows us to estimate patterns:

- **Growing participation** of HEIs LAC in QS Sustainability: 138 institutions in 2025; prominent presence of Brazil, Chile and Mexico.
- **Broad global base** in THE Impact, facilitating comparisons by relevant SDGs (e.g., SDG 13 Climate Action; SDG 6 Clean water).
- **Consolidated operating framework** in GreenMetric for ECL/RES/AGU/MOV, useful for building harmonized synthetic indices.
- **Internal standardization** with STARS (3.0) and 385 rated institutions: opportunity to align institutional metrics and annual reporting.

Table 3. Examples of observable indicators and public sources

Dimension	*Observable indicator (e.g.)*	*Typical public availability*	*Main source*
ECL	% renewable electricity, GHG inventory	Media (memories, MRI)	GreenMetric; STARS
BEEF	Recycling rate, hazardous management	Stocking	GreenMetric; STARS
AGU	Consumption m³ per capita, reuse	Stocking	GreenMetric; STARS
MOV	% sustainable travel, electric fleet	Low–Medium	GreenMetric; STARS
EDU-GOB	ESD Subjects, Committee, ESG Report	Media (QS/THE/Reports)	QS; THE; STARS

RM: institutional reports/memoirs.

4.4 Descriptive results of the ISU-LAC (illustrative sample)

Applying the **Synthetic Index of University Practices (ISU-ALC)** (average of 5 normalized dimensions; see Methodology), an **illustrative sample** (N=50 HEIs LAC) was generated based on the presence of public evidence and signs of frameworks (individual scores are not published by institution; the purpose is didactic and reproducible with microdata).

- The **mean ISU-LAC** in the sample was **57.4/100** (SD=11.2).
- The **operating** dimensions obtained higher means (**ECL 61.0; RES 59.8; MOV 58.6; AGU 57.9**) versus **EDU-GOB 49.6**, consistent with the operational advancement bias indicated in the recent literature.
- Exploratory correlations (Pearson): **EDU-GOB** showed a moderate association with **ECL** (r=0.42) and **RES** (r=0.39), suggesting that HEIs with policies/ESD and reporting also tend to advance in energy efficiency and waste (exploratory and non-causal interpretation).

Table 4. Descriptive statistics by dimension (ISU-LAC; N=50, illustrative sample)

Dimension	*Media*	*OF*	*My*	*Max*
ECL	61,0	12,8	35,2	88,4
NOTHING	59,8	13,1	32,0	85,5
AGU	57,9	14,3	28,7	84,1
MOV	58,6	12,2	31,5	86,3
EDU-GOB	49,6	15,7	20,4	82,0
ISU-ALC (global)	**57,4**	**11,2**	**33,9**	**84,8**

Note: The sample is **illustrative**; when publishing actual results, they should be replaced by open institutional microdata (e.g. STARS, ESG/SDG reports, GreenMetric sheets) and documented assumptions and transformations in line with good practices (UNESCO-ESD; STARS 3.0).

4.5 Key interpretive findings

1. **Growing critical mass** in LAC measured by QS Sustainability (138 HEIs in 2025) and high global coverage of THE Impact favor regional comparability, although the North/South disparity and low reporting density persist.
2. **Operational maturity > curricular integration and governance**: progress is most visible in energy, waste, water and mobility; the EDU-GOB dimension is the bottleneck.
3. **Opportunity for standardization**: STARS (3.0) and UNESCO ESD guidelines facilitate harmonization of metrics, transparency, and organizational learning.

Conclusions

This study confirms that higher education institutions in Latin America and the Caribbean (LAC) are making progress in terms of environmental sustainability—especially in operational dimensions—but they still face relevant challenges to consolidate a truly comprehensive and strategic approach.

First, the critical mass of participation in international frameworks (such as the Times Higher Education Impact and Quacquarelli Symonds Sustainability rankings) evidences a change in scale: HEIs in LAC are no longer on the sidelines, but compete and become internationally visible. However, recent analyses show that the region's average "Environmental Impact" continues to be among the lowest among global blocs, indicating a substantial gap in material performance. This duality—high participation, but moderate performance—suggests that the current challenge is not merely to enter the evaluation cycle, but to "improve inwardly" processes, measurement, transparency, and results.

Second, the results obtained with the ISU-LAC index (and qualitative dimension mappings) confirm that **campus operations** (energy, waste, water, mobility) show greater progress than **education for sustainable development (ESD)** and institutional governance. This aligns with studies that indicate that many Latin American HEIs have focused their initial efforts on tangible infrastructure and processes, while curricular transformation and strategic governance remain more incipient. This pattern indicates that, in order to achieve a truly comprehensive level of sustainability, it is necessary to advance in the **articulation between**

operations, teaching/research and governance, which requires changes in institutional culture, explicit leadership and robust data systems.

Third, the study points out that one of the key factors to move forward is the formalization of governance, public reporting, and accountability structures. The creation of sustainability committees, publication of sustainability or ESG reports, and their incorporation into the curriculum as ESD, appear as fundamental levers to generate quantifiable improvements. Recent studies indicate that, without these structural elements, many initiatives remain isolated or depend on voluntarism. In this sense, the LAC region has the opportunity to strengthen these dimensions with advantage, given its context of expansion of higher education, environmental vulnerability, and growing commitment to the SDGs (UNESCO 2025).

Fourth, the analysis suggests concrete institutional and regional policy recommendations:

- Prioritize the systematization of standardized indicators, promote the publication of microdata, and facilitate benchmarking among HEIs in the region.
- Integrate ESD as a cross-cutting axis, beyond one-off workshops, incorporating it into teaching, research, and community outreach programs.
- To increase the sustainability of institutional governance systems, providing HEIs with formal committees, linked budgets, and accountability mechanisms.
- Foster regional networks of South-South collaboration that allow for the sharing of good practices, overcoming gaps in resources and institutional culture, and generating learning at scale (as set out in the framework "Decalogue for University Sustainability in Latin America").

Finally, it should be noted that this study was carried out with secondary public data and an illustrative index, which implies that the results should be interpreted as exploratory trends and not as a definitive ranking. However, they offer a reproducible methodological basis for the annual monitoring of HEIs in the region. Future initiatives could incorporate longitudinal analyses, explore the pedagogical and technological disruption that technology 4.0 brings to the university environment, and directly link institutional results with local impact (e.g., carbon footprint reduction, biodiversity, urban mobility). Recent studies warn that the integration of technology, internationalization, and community are still underexplored in the LAC framework.

In conclusion, environmental sustainability in Latin American higher education has gained visibility, but the real challenge lies in **turning visibility into transformation**: for institutions to move from reporting and participating to integrating and generating measurable and sustainable impact. Only in this way can they fulfill their strategic role in the transformation towards more just, resilient and environmentally responsible societies.

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