Landscape Architecture

ARTICLE

Administrative Legibility of Urban Green Infrastructure: A Civic–Ecological Translation Index Across Five Cities

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Abstract

Urban green infrastructure provides local municipalities a way to speak about parks, rivers, wetlands, coastal areas, street trees, and urban forest systems as public resources rather than incidental spaces. Green infrastructure is, however, not an equal concept throughout cities. While some cities are endowed with significant ecological assets, yet tend to speak using adjacent terminologies like "ecological infrastructure," "climate adaptation" or "ecosystem services"; others possess less of green cover but are equipped with stronger policy languages that define green infrastructure in terms of planning and infrastructure. The purpose of this paper is to assess the legibility of administrative language in relation to the concept of green infrastructure in five cities—Cape Town, Durban, Johannesburg, Birmingham and London—using the Civic-Ecological Translation Index (CETI). The CETI assessment uses the five parameters of population pressure, ecological endowment, direct green-infrastructure language, balance of stakeholder sectors, and local narrative alignment. Five cities possess the data points of population size, administrative area, green-cover endowment, reference to policy documents and distribution of stakeholder sectors. London leads the pack with CETI of 0.923 due to significant direct language, high pressure from density, wide distribution of stakeholder sectors and National Park City narrative. Johannesburg and Birmingham are at an intermediate stage with CETI scores of 0.663 and 0.646 respectively, though Johannesburg tends to favor use of green resource and provision of services while Birmingham uses natural capital and ecosystem-services language. Cape Town scores 0.524 by use of ecological infrastructure and blue-green service language. Although Durban has 60 percent green cover, its low CETI score of 0.438 indicates that it uses language of adaptation and ecosystem services as a means of environmental management without direct green-infrastructure language in key policy documents.

Keywords: urban green infrastructure; policy narratives; civic–ecological translation; natural capital; ecological infrastructure; stakeholder entropy; urban planning

1. Introduction

Contemporary urban environmental policy is concerned not only with conserving green and blue areas, but with managing them as functional elements of the city rather than as residual land or amenities. Such an approach builds on a history of parks, greenways, garden city visions and ecological urbanism, but takes place against a

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contemporary policy backdrop characterized by stronger awareness of climate adaptation challenges, public health, species extinction, infrastructure strain and urban inequality [1, 6, 41]. Global trends in urbanization exacerbate the issue. Most of the world's population now lives in urban areas, requiring rapidly growing cities to accommodate new developments with respect to housing, mobility, drainage, energy consumption and public open space, while minimizing risk from heat waves, flooding, air pollution and ecological damage [37, 39]. As a result, international policy discourse links sustainable urbanization with accessible green public spaces [38]. The challenge, in other words, is to make urban environmental policy sensitive to the visible presence of green-blue infrastructure within the urban administration.

Green infrastructure is one of the leading terms used by urban planners to meet that challenge. As defined in the seminal planning literature, it is an integrated network of green space that conserves ecosystem value and function while providing human benefits [5, 6]. The idea appeals because it incorporates language of infrastructure — a concept already known to planning, engineering, municipal management and development communities [24, 32]. It can incorporate trees, wetlands, rivers, parks, allotments, coastal ecosystems and sustainable drainage into service delivery functions such as flood attenuation, cooling, biodiversity conservation, transport, leisure, food security and mental wellbeing [16, 19, 20]. By framing ecological functions in terms of infrastructure language, green infrastructure becomes a valuable tool for translating urban environmentalism to finance, public works, housing, regeneration and health care sectors.

The same scope that lends the concept policy leverage creates difficulty in comparative application. Depending on context, green infrastructure may refer to landscape networks, stormwater management, urban ecology, green roofs, biodiversity corridors, public realm improvements, natural capital and even social infrastructure [23, 25]. Studies consistently highlight variation in definition and application depending on profession, geographic location, scale and administrative tradition [2, 23, 25]. While some locations emphasize green infrastructure in strategic network planning, others see the term primarily in water management and climate adaptation discourse. In many African cities, related ideas are more frequently conveyed through the language of ecosystem services, ecological infrastructure, green economy or livelihoods rather than green infrastructure itself [22, 27, 34]. Such terminological differences can play an important role, influencing institutional responsibilities, budgets and evidence.

Another stream of scholarly literature focuses on concepts such as ecosystem services, natural capital and nature-based solutions. These fields share common ground with green infrastructure but differ in key aspects. While ecosystem services research tends to define benefits associated with ecosystems in terms of regulating, provisioning, cultural and supporting services, natural capital studies attempt to translate ecosystem benefits into assets that can be accounted for and invested. Nature-based solution scholarship tends to emphasize interventions, co-benefits and adaptation to climate change, particularly concerning water management, heat mitigation and social resilience [11, 15, 16]. The overlap of the three discourses is beneficial for policy, but also presents risks. A city can adopt a strong ecosystem service discourse without incorporating green infrastructure, and vice versa.

Finally, planning literature demonstrates that green infrastructure is a concept that straddles the line between strategic aspirations and implementation. Green infrastructure tends to be emphasized in strategic documents in terms of connectivity, multifunctionality and landscape-level benefits, but it is used differently in development control and engineering contexts as street planting, drainage management or pressure mitigation [18, 21, 26]. That means the ability to articulate green infrastructure in a particular policy context is just as important as conceptual clarity itself. The former may lead to failure of the latter.

The South African cities offer an especially challenging case study. Urban environmental policy in Cape Town, Durban and Johannesburg is shaped by biodiversity significance, water stress, climate exposure, service delivery pressures, urban poverty and spatial inequality in the aftermath of apartheid [3, 4, 33]. All of these factors do not make green infrastructure any less relevant; they require more effort to translate the concept successfully. Ecological language needs to compete and integrate with the social and economic imperatives. United Kingdom cities, in turn, present a different set of contrasts. While the language of formal green infrastructure plans and policies is relatively clear in Birmingham and London, implementation of green infrastructure remains difficult. By focusing on these two countries, the present study attempts to evaluate the capacity for translation rather than the mere presence of green infrastructure language.

Policy narratives shed light on the problem because policy narratives select problems, articulate causality and define relevant expertise while connecting environmental action to broader societal values [7, 13]. The narrative framework allows us to consider alternative interpretations of urban nature in terms of biodiversity protection, flood control, climate resilience, cultural heritage, economic valuation, public health, social equity and infrastructure equivalency. The distinction, however, is not merely theoretical. Policy narratives structure decisions about what seems reasonable and fundable and what not [15, 29]. For urban green infrastructure, the fundamental question, therefore, is not just how much green land cover is present in a particular city, but rather whether there is a dominant urban policy narrative that converts the existing land cover into an actionable policy function.

Numerous city-level case studies provide excellent examples of green-infrastructure planning, natural capital analysis, ecosystem-service mapping and implementation of nature-based solutions, but the literature remains difficult to compare owing to the qualitative, documentary and case-specific character of the evidence provided [11, 12, 18]. Statistical modelling would not be appropriate for comparison of small number of cities with vastly different histories, geographic locations and policy languages. Yet, ignoring the quantitative aspect can obscure the underlying relationships between measurable variables such as population density, green-cover share, language in policy and stakeholder diversity. A good method for comparison, therefore, needs to consider the contextual specificity while providing clarity in reasoning.

CETI addresses precisely this gap by measuring the city's ability to translate ecological endowment into administrative recognition. The index does not rate urban environmental quality, nor it claims that one city is environmentally better than the other. It measures the extent to which ecological endowment, civic pressure, direct wording, stakeholder diversity and narrative coherence converge in such a way as to facilitate incorporation of green infrastructure into the urban planning process and infrastructure responsibility. The current analysis seeks to evaluate city-level policy evidence as a source of separation between ecological endowment and administrative translation, as well as explore how CETI components explain the variation.

2. Materials and methods

2.1. Study area and evidence base

The city material comes from Washbourne (2021), which examines urban environmental policy narratives and green infrastructure usage in Cape Town, Durban, Johannesburg, Birmingham and London. The record includes an evaluation of twelve articles, seven reports and twenty-eight policy documents, plus thirty-one interviews with academics, practitioners, decision-makers and community actors. For purposes of this index computation, the full evidence base comprises the city statistics, sector counts in interviews, policy narratives and specific findings regarding the use of green infrastructure reported for each city, without any new data collection.

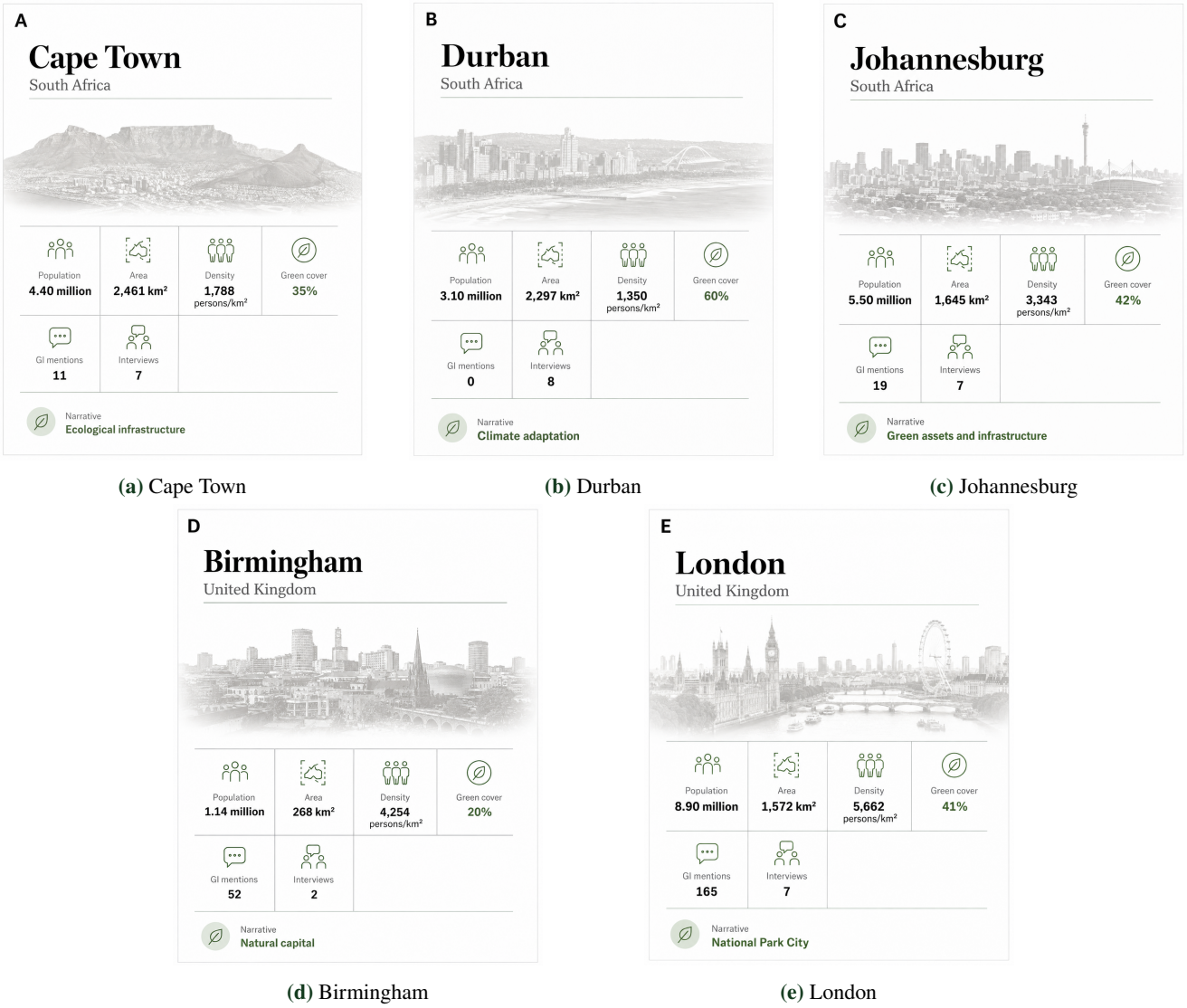
The five cities offer a wide variety of geographic, administrative and policy environments. Cape Town and London are capitals within their respective countries, while Durban, Johannesburg and Birmingham are secondary urban centers. Cape Town, Durban and Johannesburg represent South African urban environments characterized by biodiversity, ecological infrastructure, climate adaptation, resource provision and service delivery imperatives. Birmingham and London represent United Kingdom environments where green-infrastructure planning, natural capital and strategic discourse have greater visibility. The main empirical contribution of the present case selection lies in contrast: the cities do not feature identical ecological environment, administrative area, population density, green coverage share and environmental vocabulary.

2.2. City descriptors and policy evidence

Selected city characteristics were consolidated into a compact comparative profile in preparation for index calculation. Population, administrative area, population density, proportion of green cover, direct references to green infrastructure and interview sector distribution are recorded for each city.

The city comparison profiles presented in Figure 1 illustrate the empirical contrast motivating the study. While

Durban features the highest green-cover share, there are no references to green infrastructure within the analyzed policy documents. Conversely, London has the lowest green-cover share, but the greatest number of green infrastructure references. Similarly, despite smaller size and low green-cover percentage, Birmingham has relatively strong green-infrastructure wording. The evidence suggests that there is significant contrast between ecological endowment and administrative recognition of green infrastructure.



(a) Cape Town **(b)** Durban **(c)** Johannesburg

(d) Birmingham **(e)** London

Figure 1. Five-city evidence panels.

The values presented in Table 1 demonstrate that density and green cover provide distinct rankings of cities. London is the most densely populated city, with 5662 people per square kilometre. Next on the list are Birmingham with 4254 and Johannesburg with 3343. However, Durban has the least dense population and at the same time has the highest percentage of green cover. As it becomes evident, such an approach generates certain issues since a city with low population density and high green cover can be at risk of heat or flooding, whereas a densely populated city with low green cover requires treating every green-blue asset as infrastructure. That is why CETI evaluates density and green cover separately without merging them.

The data provided in Table 2 reveals the third important criterion – the institutional aspect. It should be admitted that London and Birmingham have the highest direct wording regarding green infrastructure. In turn, Durban's main municipal policies concerning green infrastructure are formulated through ecological infrastructure, ecosystem services, and climate adaptation. However, it is not less important to note that interview data is another essential consideration. London and Durban have all four stakeholder groups represented in their tables, while Cape Town

and Johannesburg do not have representatives from the community. In turn, Birmingham has two interviews, including decision makers and community actors.

Table 1. City descriptors.

City	Population (million)	Area (km^2)	Density (persons/km^2)	Green cover (%)
Cape Town	4.40	2461	1788	35
Durban (eThekwini)	3.10	2297	1350	60
Johannesburg	5.50	1645	3343	42
Birmingham	1.14	268	4254	20[a]
London	8.90	1572	5662	41

[a] Birmingham is entered at 20%, the conservative lower-bound value corresponding to the reported description of more than one fifth green area.

Table 2. Policy and interview evidence.

City	Direct GI references	Interviews	Academics	Practitioners	Decision-makers
Cape Town	11	7	2	3	2 / 0
Durban (eThekwini)	0	8	1	2	4 / 1
Johannesburg	19	7	2	1	4 / 0
Birmingham	52	2	0	0	1 / 1
London	165	7	1	2	3 / 1

2.3. Civic–Ecological Translation Index

The CETI identifies the critical point of transition from ecological existence or aspiration to administrative legibility of green-infrastructure capacity. The index is computed using five components. Population pressure quantifies the strength of urban demand placed on green-blue assets. Green-cover endowment measures the reported level of coverage within the urban area by green infrastructure. Direct policy wording measures the use of green-infrastructure terminology in the primary policy texts of the city. Stakeholder-sector balance measures whether the interviews reflect views in academic, practitioner, decision-maker and community perspectives. Narrative fit measures whether the local dominant environmental-policy narrative allows green infrastructure to serve as a policy and delivery issue. The computation of the CETI is transparent, not predictive. It describes the components of the translation state of each city.

2.4. Component Calibration

The population pressure component is measured using the ratio of population density. For city i,

$$D_i = \frac{P_i}{A_i}, \tag{1}$$

where P_i is population and A_i is administrative area. The density is standardized to the full range in the five cities as

$$U_i = \frac{D_i - \min(D)}{\max(D) - \min(D)}. \tag{2}$$

This standardization implies a maximum value of 1.000 for London, because it has the largest administrative density. In turn, it implies a minimum value of 0.000 for Durban, because it has the smallest administrative density.

This standardization does not imply that Durban does not face any environmental risks, it implies simply that the population pressure of Durban is less in administrative terms than other four cities in this case. This separation of the component ensures that climate risk or biodiversity value do not get conflated with compactness.

The green-cover endowment component is scaled up to the maximum observed value. The scaling equation is

$$G_i = \frac{g_i}{\max(g)} \tag{3}$$

where g_i is the reported green cover percentage. Durban has the maximum green cover, which implies that it receives 1.000. In turn, Birmingham has the smallest reported green cover value, implying that it receives the lowest score of 0.167. This component does not capture anything more than just the reported green cover percentage. Its measurement purposefully stays very focused. Despite its limitations, the green-cover percentage is important since it captures an essential indicator of physical existence of the ecosystem infrastructure.

The direct policy wording is measured as the logarithm of the number of references to green infrastructure in the policy texts reviewed for each city. The logarithmic function transforms the number of references into

$$T_i = \frac{\ln(1 + r_i)}{\ln(1 + \max(r))}. \tag{4}$$

The use of logarithm implies that the difference between zero and a few references is meaningful, but also prevents the dominance of London in the entire computation process. The component does not measure implementation of green infrastructure language into action, it measures merely its availability in the formal language.

The stakeholder-sector balance is captured using the normalized Shannon entropy metric [35]. If p_{is} is the proportion of stakeholders in the sector s of city i, then the normalized Shannon entropy is

$$E_i = -\frac{\sum_{s=1}^{4} p_{is} \ln(p_{is})}{\ln(4)}. \tag{5}$$

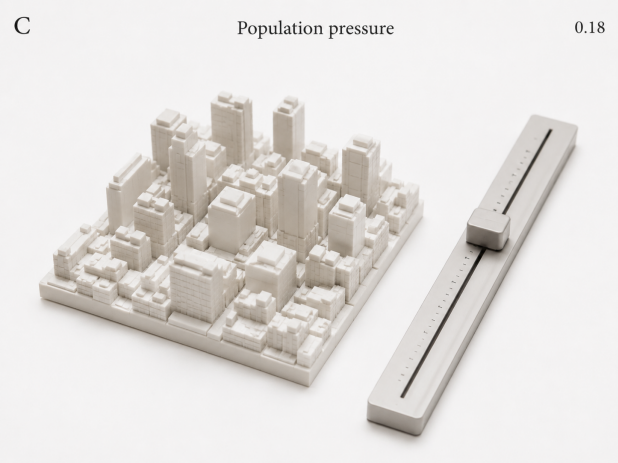
A city, where there is evidence across all four major categories (academics, practitioners, decision makers and community) receives the highest value. On the other hand, a city, where evidence is provided only by a few stakeholders, will have lower entropy. This component does not make any claims regarding representativeness. Its purpose is to quantify the breadth of sector representation required for green-infrastructure language to gain acceptance across professional, administrative and civic discourse.

The narrative fit uses an ordinal scale to calibrate the dominant environmental-policy narrative of each city into the CETI index. Following explicit partial membership approach in QCA [14, 28], narrative fit values are calculated as

- Cape Town = 0.70, because the dominant ecological infrastructure narrative is partially compatible with green infrastructure language;
- Durban = 0.62, because climate adaptation narrative gives substantial functionality to green infrastructure but has no wording;
- Johannesburg = 0.88, because natural capital narrative is substantially congruent with green-infrastructure concept;
- Birmingham = 0.80, because natural capital and ecosystem services narratives offer substantial justification for green infrastructure, even though green-infrastructure language may be less used;
- London = 0.95, because green infrastructure and national park city concepts are mutually supportive.

(a) Policy wording

(b) Narrative fit



(c) Population pressure

(d) Green cover

(e) Stakeholder balance

Figure 2. CETI components.

2.5. Index Weighting and Diagnostic Load

The combined CETI index is calculated as

$$CETI_i = 0.28T_i + 0.22N_i + 0.18U_i + 0.17G_i + 0.15E_i. \quad (6)$$

Weighting is motivated by analytical interest in administrative translation rather than simple existence of green infrastructure. The weight of direct policy wording component is highest because municipal administration must rely on formal language in the planning documents. The weight of narrative fit is second highest, because the wording gains meaning in the context of local problem identification. The weights of population pressure and green cover are lower than those of direct policy wording and narrative fit because they describe physical circumstances.

The component panels shown in Figure 2 underscore the importance of translation structure. The combination of policy wording and narrative fit contributes half of the final weight. That is justified since a planning term gains traction not only when it is part of the official vocabulary, but when it is also connected to the environmental policies of the city concerned. Population pressure and green-cover endowment stay crucial since a city with high policy wording but poor ecological capacity will be faced with a different challenge from a city with abundant green assets but little institutional recognition. Stakeholder balance finally shows if the vocabulary has crossed the borders of the communities reflected in the data.

An additional diagnostics is computed to illustrate pressure-adjusted green-cover load:

$$L_i = \frac{D_i}{g_i/100}. \tag{7}$$

The load does not enter CETI since population density and green cover are already in the index. It is listed here to highlight the effect of density on the understanding of green cover. The higher the value, the more pressure per unit of green cover the reported city faces. The lower the value, the less pressure per unit of green cover the city faces even though climate vulnerability, biodiversity value and spatial inequalities might make green-blue systems vital.

3. Results

3.1. Index scores and component contrasts

In Table 3, the scaled variables and final CETI values are shown. London has the highest translation capacity, as reflected in its CETI of 0.923. The cities of Johannesburg and Birmingham have similar middle scores: 0.663 and 0.646 respectively. Cape Town has 0.524. Lastly, despite having maximum green-cover endowment, Durban has the lowest CETI: 0.438. These values do not rank ecological significance. Rather, they indicate to what extent green infrastructure translates into the combination of policy wording, narrative fit, urban pressure, ecological endowment and stakeholder diversity.

Table 3. CETI values.

City	U_i	G_i	T_i	E_i	N_i	CETI
Cape Town	0.102	0.583	0.486	0.778	0.70	0.524
Durban (eThekwini)	0.000	1.000	0.000	0.875	0.62	0.438
Johannesburg	0.462	0.700	0.586	0.689	0.88	0.663
Birmingham	0.674	0.333	0.777	0.500	0.80	0.646
London	1.000	0.683	1.000	0.921	0.95	0.923

A more detailed analysis of each individual component provides further insight. The direct-wording component distinguishes London and Birmingham from other cities. The green-cover component highlights the distinction between Durban and others. Narrative-fit component gives an advantage to Johannesburg due to its narrative environment in which green assets can be discussed as part of the infrastructure and services delivered by the local government. Finally, the stakeholder component raises the standing of Durban thanks to the inclusion of the full range of stakeholders in the interviews, even though this cannot make up for the lack of policy wording. The population-pressure component adds to the standing of London and Birmingham owing to the fact that denser urban

form creates pressure to make the green-blue systems visible within the framework of planning and delivery of public services.

This ranking makes a case for interpreting the index compositionally. Considering only policy wording, Birmingham would have appeared much more advanced than the actual score suggests. Considering only green cover, Durban would come out strongest. Considering only narrative fit, Johannesburg would compete with London. Hence, the CETI is helpful in that it ensures that no single type of evidence becomes a substitute for the whole policy condition. Only when several kinds of evidence support a vocabulary in green infrastructure, the latter becomes legible to the institutions responsible for planning and service delivery. And this occurs only in the case of London among the studied cities.

According to the CETI values in Table 3, no single component accounts for all variations. First, London stands out because of four strong components and the moderate-high green-cover endowment. Second, Johannesburg marginally outperforms Birmingham since the former makes up for weaker wording by strong narrative fit and higher endowment of green cover. Third, Birmingham stays close to Johannesburg because its stronger wording and density offset moderate-low green-cover endowment and low stakeholder balance. Fourth, Cape Town has mid-lower standing because of moderate wording and high stakeholder balance, but low density pressure. Last but not least, Durban has lower value due to lack of direct green-infrastructure wording, not because of poor ecological endowment.

3.2. Green-cover and policy-wording divergence

The second comparison aims to explore the correlation between ecological availability and policy-language specificity. The necessity to separate ecological endowment from policy wording arises from the possibility that a city has plenty of green cover, but not policy wording, and vice versa.

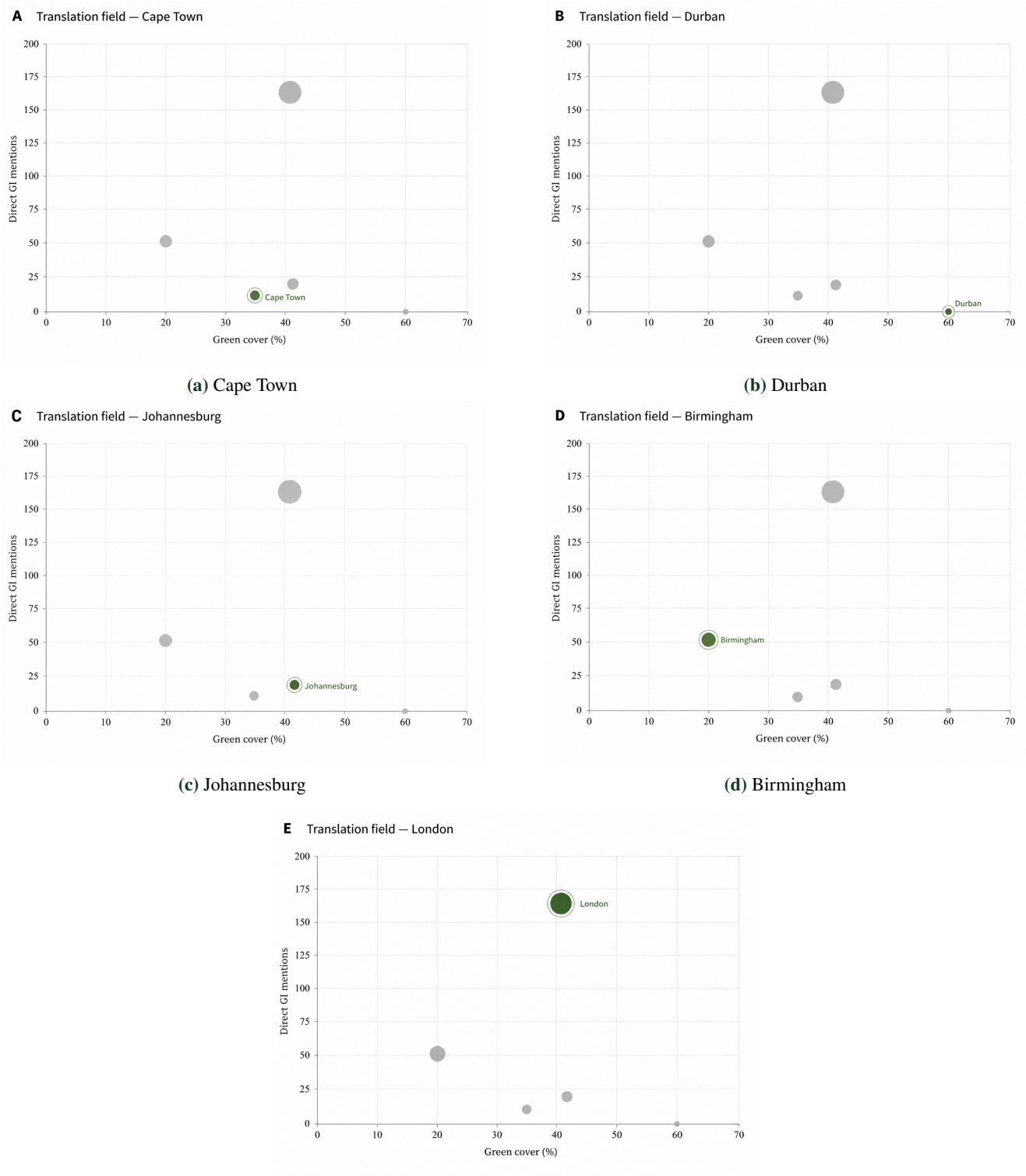
The translation field in Figure 3 highlights the core difference between green coverage and policy wording. Durban is placed on the right, having the lowest amount of wording, as it has only 60% green coverage but no specific mention of green infrastructure in its policies. London is on the highest level of wording, but it has the least amount of green coverage among the cities with 41%. Birmingham is an example of another situation where despite the city's poor green coverage, its wording is high. Johannesburg and Cape Town are in the middle, but the former wins in the translation scale due to the higher level of wording and closer narrative. Thus, it can be stated that green coverage cannot be a reliable indicator of green infrastructure capacity.

3.3. Component profiles by cities

Component profiles show how CETI score is formed through five scaled indicators. It allows analyzing the differences of the cities in terms of their components.

The next difference lies between compensatory and non-compensatory factors. While ecological endowment can partially compensate for poor policy wording provided that a city has a consistent narrative and wide stakeholder distribution, it cannot compensate for other factors in creating a high translation value. In this regard, Durban provides an example of non-compensability, as ecological endowment is high, but the indicator is low since the concept is not explicitly mentioned in the main policy documents. Birmingham shows a contrasting case. While the lack of green-cover endowment is partially compensated for by the existence of direct wording and density pressure, it does not allow the city to match London since stakeholder distribution and ecological endowment are not as developed. The middle position of Johannesburg is created through a balance, and none of the components reaches its maximum.

As one can see from the profiles of components in Figure 4, the same final results may be achieved through different policies. Both Johannesburg and Birmingham have approximately equal CETI scores, but Johannesburg has higher narrative fit and green-cover endowment. Meanwhile, the latter is better with direct wording and population pressure. Despite falling below the intermediate range, Cape Town and Durban have different configurations. The former city displays a moderate profile with direct wording, green cover endowment and balanced stakeholder distribution.



(a) Cape Town

(b) Durban

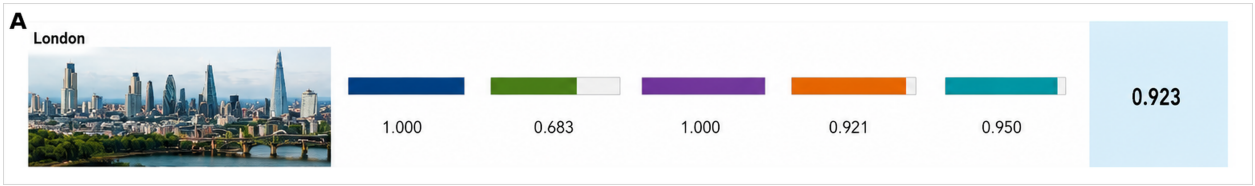
(c) Johannesburg

(d) Birmingham

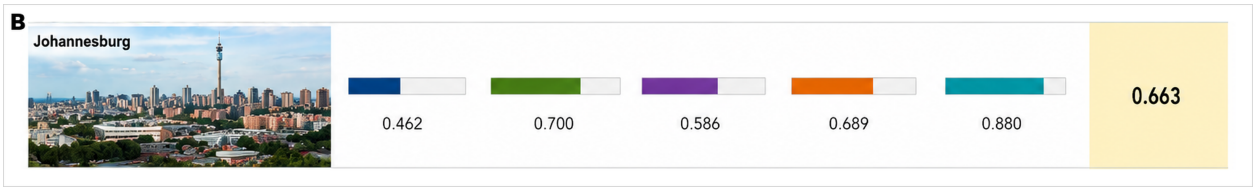
(e) London

Figure 3. Green cover and wording.

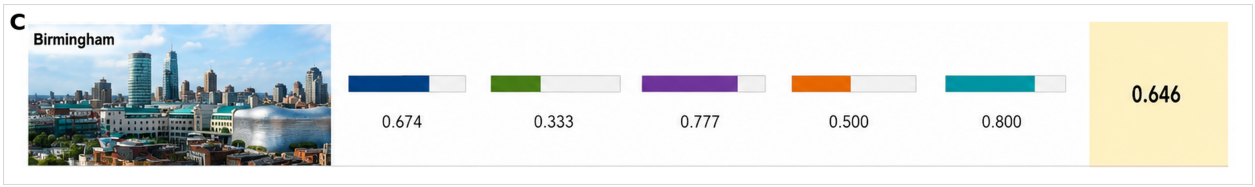
On the contrary, Durban is characterized by an imbalanced profile with maximum green cover endowment and stakeholder balance without any direct wording. This is what lowers the final result in Durban despite the ecological advantage.



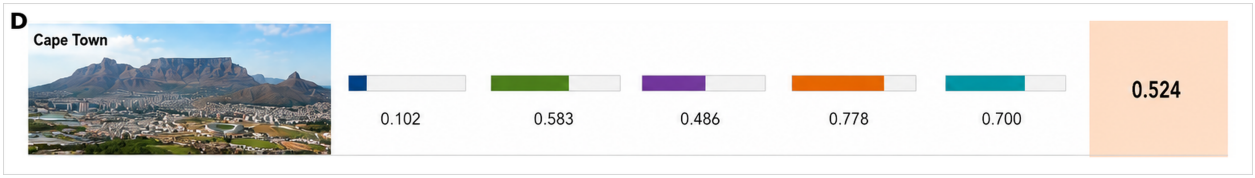
(a) London



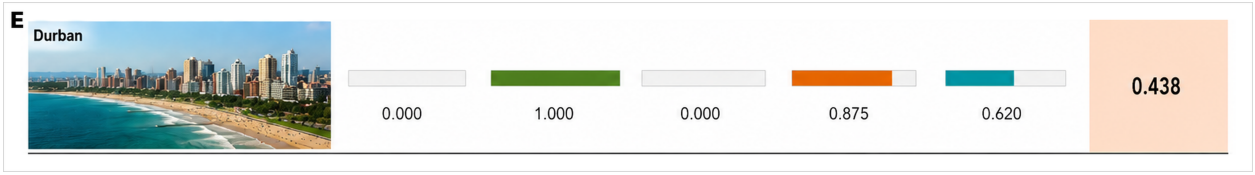
(b) Johannesburg



(c) Birmingham



(d) Cape Town



(e) Durban

Figure 4. City component profiles.

3.4. Stakeholder balance and pressure-adjusted load

Two more dimensions to diagnose administrative legibility lie in the stakeholder distribution and pressure-adjusted load. While the first one is based on sector breadth according to interview evidence, the second measures the effect of density on the share of green cover.

This is facilitated by the stakeholder panels illustrated in Figure 5. The panels from Durban and London have academics, practitioners, decision-makers, and community actors, making them have the highest stakeholder-balance scores. The interviews in Cape Town and Johannesburg have seven each, but neither of them has community actors in the distribution table, thus lowering the sector-balance score. The lowest number of interviews is found in Birmingham, where there is a decision-maker and a community actor, hence having the lowest entropy score owing to missing sectors. This is an important measure since the translation of policy depends not only on formal texts. It could be that a word that is popular within the planning field but unknown to the community may fail to foster public responsibility.

The load values in Table 4 explain why Birmingham remains near Johannesburg despite much lower green-cover endowment. Birmingham has the highest pressure-adjusted load because it combines compact administrative geography with the lowest green-cover percentage in the set. London follows because very high density outweighs

its moderate-high green-cover share. Durban has the lowest load, but this does not mean that Durban's green-blue systems are unimportant. It means that the density burden per unit of green-cover share is lower than in the other cities. The policy challenge in Durban is therefore less about scarcity of green cover in this measure and more about converting adaptation and ecological-infrastructure language into direct infrastructure responsibility.

(a) Cape Town **(b)** Durban **(c)** Johannesburg

(d) Birmingham **(e)** London

Figure 5. Interview-sector balance.

Table 4. Pressure-adjusted load.

City	Density (persons/km^2)	Green cover (%)	Load L_i
Birmingham	4254	20	21269
London	5662	41	13809
Johannesburg	3343	42	7961
Cape Town	1788	35	5108
Durban (eThekwini)	1350	60	2249

The change in the ranking of load values modifies the significance of policy urgency. London and Birmingham clearly face compelling incentives to develop green infrastructure because urban density increases competition for land and sets expectations about the performance of each green-blue asset. The middle ranking of Johannesburg

suggests that the asset-based policy language can operate in a significant urban context without achieving the level of density in the United Kingdom. Cape Town and Durban rank low in terms of load values, but the environmental context of the first city involves its coastline and high biodiversity, and the environmental context of the second is its climate-adaptation narrative. Thus, while load helps in capturing the urban density pressure, it fails to incorporate all dimensions of environmental need.

Visualized in Figure 6, the gauges for load capture the connection between density and green cover differently from the other two measures. Birmingham's tower rises because a small share of green cover has to provide for dense urban communities. Similar reasoning holds for London whose high ranking of the gauge supports the interpretation of strong strategic language not as an arbitrary choice. Durban's middle load score matches the city's status of a strong green cover provider but weak direct worder. Johannesburg occupies an intermediary position and demonstrates the same type of policy approach as the latter city. Cape Town shows low pressure on its green infrastructure, although, due to the city's coastal, hydrological and biodiversity contexts, its environmental problem differs qualitatively from those of the other two low-load cities.

(a) Birmingham **(b)** London **(c)** Johannesburg

(d) Cape Town **(e)** Durban

Figure 6. Green-cover load.

Thus, ecological availability and administrative translation have proven themselves to be two separate aspects of urban policy related to green infrastructure. While CETI does confirm that high load scores indicate urgent administrative action related to green infrastructure, it shows that a low score does not necessarily imply the absence of any such urgent action. Instead, cities with a lower load ranking but higher values for other components are

likely to rely on other forms of policy translation. Durban proves this point in particular, being the top scorer for the first of these measures and the lowest for the latter one. Similarly, while London achieves the highest score in all components but load, it still ranks second in the latter dimension.

4. Discussion

4.1. Interpretation of translation capacity

The results enrich the ongoing debates in the green-infrastructure literature in three ways. First, the findings corroborate the thesis according to which the notion of green infrastructure travels between policy contexts and cannot be considered as fixed [23, 25]. That means that depending on the case study, the term can refer to a landscape network, a stormwater device or even to the broader sense of public health or civic identity. Instead of trying to reduce the variety, CETI uses it as an indicator of translation, showing that stronger policy translation implies the presence of the term in documents, its compatibility with a city's environmental narrative and recognition in different stakeholder sectors.

Second, the results support literature devoted to ecosystem services and natural capital but also demonstrate its limitations in regard to urban governance [11, 15, 16]. Birmingham exemplifies that valuation of ecosystem services can serve as a strong policy entry point because it connects benefits with policy objectives and investment considerations. However, at the same time, it does not provide an automatic path to implementation, which is needed to manage green infrastructure properly. The high score of the current city in the load component emphasizes the importance of this insight.

Third, the results are aligned with a discussion on urban nature in the global south, according to which green infrastructure cannot be understood without service delivery and socioeconomic inequalities in cities [22, 27, 34]. Both Johannesburg and Durban prove this point in particular. The former city implements green infrastructure policy through green assets and service provision, which allows integrating environmental systems into economic and social processes. Meanwhile, the latter uses green-infrastructure-related terms in terms of climate adaptation, ecological services and infrastructure.

4.2. City-specific policy routes

City-specific routes help in translating the numerical results into policy recommendations. Specifically, each route starts with the dominant environmental vocabulary of a city and shows how the city connects it to the administration of infrastructure.

The environmental vocabulary dominating Cape Town is the vocabulary of ecological infrastructure, biodiversity and water-sensitive planning. Although the city uses green infrastructure directly, it is the unique characteristics of its environment (e.g., biodiversity and the need for water provision) that largely define its policy language [3, 10]. Accordingly, the practical task in Cape Town is to understand when ecological infrastructure has to perform the roles traditionally reserved for green infrastructure, such as flood attenuation, water purification, public access, maintenance and prioritizing investments.

Similarly to Cape Town, Durban uses green-infrastructure language indirectly as a part of the vocabulary of climate adaptation and ecological services. Durban demonstrates the largest number of stakeholders and the highest percentage of green cover, yet it is characterized by weak policy language. The CETI result reveals that, although the climate adaptation discourse is valid, there is no direct translation to green infrastructure policy in the city. In this sense, the best approach to translating it would involve identifying the city's assets, which would allow developing an asset register, budget line and drainage and public services functions.

Similarly to Durban, Johannesburg uses the green-infrastructure terminology indirectly as a part of the vocabulary related to green assets and remediation. Being characterized by a high share of green cover, rich urban forest and a complex environmental legacy, Johannesburg has a strong narrative of assets [8, 33]. In this respect, the city

demonstrates higher narrative fit compared with Birmingham, but the major problem here is the looseness of its definitions. It is necessary for Johannesburg to clarify whether the green infrastructure comprises all environmental assets.

The policy of Birmingham uses green infrastructure indirectly as a part of natural capital and ecosystem services vocabulary. The value of this policy approach consists in the fact that it can raise awareness of urban ecology and facilitate policy and investment decisions. However, the risk associated with it is that, unless it is used together with direct wording, it cannot ensure implementation. Considering the high score of Birmingham in the load component, a more effective use of the valuation approach would involve connecting it to the administration of infrastructure through specific obligations related to maintenance and development.

Unlike the rest of the cities, London combines the use of green-infrastructure language and the idea of a national park in one policy discourse. High CETI results reveal that London demonstrates a rare combination of strategic language, population pressure, wide stakeholder sector and narrative fit. The city shows an excellent case of the use of green infrastructure in planning, policy language and infrastructure policy [17, 25]. However, considering high translation capacity, the main challenge for the city is to make sure that it translates into tangible implementation.

Table 5. Translation diagnosis.

City	Main route	Limiting component	Policy task
Cape Town	Ecological infrastructure and blue-green services	Low density pressure and indirect terminology	Connect ecological infrastructure to investment and maintenance duties
Durban	Climate adaptation and ecosystem services	No direct green-infrastructure wording	Convert adaptation assets into explicit infrastructure responsibilities
Johannesburg	Green assets, remediation and service provision	Uneven stakeholder-sector breadth	Stabilize definitions across planning, development and public service functions
Birmingham	Natural capital and ecosystem-service valuation	Low green-cover endowment and small interview profile	Tie valuation to spatial delivery, access and maintenance
London	Strategic green infrastructure and National Park City identity	Implementation equity beyond strategic visibility	Translate strong policy language into neighbourhood-level outcomes

In Table 5, the city-specific findings are transformed into a policy diagnosis. The cities with a low value of CETI do not necessarily face the same problems. For instance, while Durban needs no proof of its green-blue systems' significance for the city's future, it requires stronger translation of adaptation language into infrastructure duties. At the same time, while Cape Town does not need abandoning the concept of ecological infrastructure, it faces the need to specify the place of the latter system in the investment and maintenance strategy. As for Birmingham, it requires linking the valuation with spatial duties and maintenance, whereas London requires equitable implementation.

4.3. Methodological implications and limitations

Thus, it appears clear that direct wording and narrative fit are the main differentiators in terms of the CETI value. London demonstrates the highest score for CETI as a city whose strategic documents frequently mention the term under examination and whose wording finds support in a wider narrative discourse. As for the other cities, while both Johannesburg and Birmingham are characterized by intermediate translation capacity, the former develops this capacity through green assets and remediation, and the latter – through valuing natural capital and ecosystem services. Meanwhile, the leading role in the green-infrastructure discourse belongs to Cape Town's ecological infrastructure.

At the same time, while the findings show the relevance of the separation between ecological availability and

administrative translation, the current paper also provides insights for policy-making. They come from the stakeholder entropy component, which helps in capturing the civic aspect of policy-making. Although green infrastructure is implemented through official policy documents, the interpretation of it also occurs at the civic level where it is translated by citizens and policymakers. Literature on urban environmental planning points out that certain concepts gain traction within administration but stay unknown to the general public [15, 21]. The entropy measure incorporates this issue into the comparative index.

As mentioned above, the stakeholder entropy in the five cities varies, reflecting the extent to which the stakeholders are diverse. As can be seen in the results presented in Table 5, London and Durban show greater diversity of interviewed sectors than Cape Town and Johannesburg. It is the result of the fact that, in the latter cases, community stakeholders did not participate in the interviews conducted.

While CETI proved to be an effective tool, the current research also faced several limitations in terms of calculation methods. Firstly, the green cover values are not equal to the quality of the green coverage, its biodiversity and accessibility or socioenvironmental distribution. Administrative density depends on the definition of the boundaries between the cities. Thus, the score of a city may vary depending on whether one examines it in a municipal or a metropolitan perspective. At the same time, the number of green-infrastructure references depends on the chosen sources. The narrative-fit calibration also implies judgement, albeit a well-substantiated one. Finally, stakeholder entropy is calculated on the basis of interview-sector numbers, and not their representation.

The limitations of the calculations reflect the gap between translation capacity and policy-making reality. While the current analysis helps in evaluating the former, a policy researcher can incorporate additional factors that relate to implementation: neighbourhood accessibility to green infrastructure, the degree of heat exposure, flood risks, public-space quality, canopy quality, budget and maintenance and development control outcomes. Such data will help transition from translation capacity towards implementation evaluation. For the current five cities, however, the key point of the analysis is that a city is likely to develop relevant policies once it finds ways to link environmental language to urban needs and administration.

5. Conclusions

In conclusion, this paper discussed how city-level policy data can distinguish between ecological availability and administrative translation of green infrastructure in Cape Town, Durban, Johannesburg, Birmingham and London and why combinations of components explain differences between them. The answer to the problem is that, unlike the former aspect of green infrastructure, the latter one should be distinguished from the former one before proceeding to their comparison. In this sense, ecological availability can be quantified in terms of green cover values, while administrative translation is captured with the help of a composite measure.

As demonstrated in the empirical section, direct wording and narrative fit turn out to be the main differentiating factors in terms of CETI. Specifically, London ranks as the top performer in CETI owing to its numerous strategic policy references to the term and the support these references receive from the wider narrative discourse. At the same time, Johannesburg and Birmingham have an intermediate position, which the former city acquires because of its emphasis on green assets, remediation and service delivery and the latter one because of natural-capital valuation. Meanwhile, Cape Town and Durban demonstrate low translation capacities due to their unique green-infrastructure-related approaches.

Thus, the paper demonstrates that the green infrastructure of any city can be effectively managed with the help of appropriate environmental vocabulary. For instance, Cape Town can connect its ecological infrastructure with water-sensitive investment and maintenance. Durban can link its climate-adaptation language to asset register and drainage policies. Johannesburg should clarify the meanings of green assets. Birmingham should ensure implementation in natural capital valuation. London should achieve implementation equality in neighbourhoods.

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