

**From Sectoral Silos to Climate Hegemony: Analysis of Global Urban Policies (1984-2025)**

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## **From sectoral silos to climate hegemony: analysis of global urban policies (1984-2025)**

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**Abstract:** Contemporary urban environmental governance faces a paradox: while international frameworks advocate integration, climate discourse appears to subsume. This study analyzed 202 urban policies from 85 countries (1984-2025) using various methods, temporal discourse analysis, keyword co-occurrence networks, framing detection, and sentiment analysis. Policies accelerated exponentially, with 2010-2025 comprising 82.2% of the output. Network analysis revealed climate hegemony: climate terminology appeared in 52.5% of the 2020s policies (climate-hazards: 232 co-occurrences), functioning as an organizing principle. The circular economy surged (% → 16.4%), while water (32%), biodiversity (26%), and participatory concepts (67%) declined, despite intensifying crises and SDG commitments. The Climate & Sustainability Core exhibited 5 times greater connectivity density versus water resource communities, indicating systematic displacement. Geographic patterns revealed epistemological divides: post-industrial economies privileged environmental framing (Oceania 5.9%), whereas Africa maintained infrastructure emphasis (1.6% environmental, 3.76% spatial). Sub-national policies (28%) challenged horizontal diffusion assumptions, with federal systems enabling experimentation (Oceania 75% sub-national versus Africa 0%). Rhetorical analysis showed aspirational dominance (71.3%) with a 2020s positivity surge (80.3%) despite crises. The findings confirm that climate-centric paradigms replace sectoral silos with conceptual hegemony, subordinating biodiversity, water security, equity, and participation beneath climate-mediated frameworks, raising critical questions about the urban realities that achieve policy codification.

**Keywords:** urban policy; discourse analysis; keyword networks; policy integration; global governance;

### **1. Introduction:**

Historically, urban environmental governance has functioned through fragmented sectoral silos, with isolated institutional domains operating on water, biodiversity, energy, waste, and climate issues in the absence of coordination (Sheng, 2021; Dindar, 2025). Fragmentation causes policy incoherence, competing priorities, and the failure to capitalize on synergies systematically, which are the very things needed for handling connected urban challenges (Rincón et al., 2021). For instance, water ministries optimize resource security without considering the biodiversity agencies responsible for protecting aquatic ecosystems, whereas energy departments promote renewable transitions in isolation from land-use planning authorities, who are supposed to handle the spatial integration of these transitions. This kind of structural fragmentation erodes the capacity for integrated responses to the interlocking crises of contemporary urbanization, marked by climate disruption, biodiversity collapse, resource depletion, and social inequity.

International frameworks explicitly advocating cross-sectoral integration have proliferated over the past few decades. The 2030 Agenda for Sustainable Development defines Sustainable Cities through a set of 17 interlinked SDGs, relying on SDG 11 for an interdisciplinary connection among urban planning, environmental management, and social inclusion (Sietchiping et al., 2016; Caprotti et al., 2017). The 2015 Paris Agreement mobilized subnational action, positioning cities as important actors in climate governance with the capacity to initiate decarbonization with multi-level coordination (Graute, 2016). The New Urban Agenda formalized principles of inclusive, safe, resilient, and sustainable urbanization in 2016, embedding environmental imperatives within comprehensive urban development frameworks (Satterthwaite, 2016). The Kunming-Montreal Global Biodiversity Framework (2022) mandated biodiversity mainstreaming across all sectors, explicitly targeting urban contexts as sites for priority intervention. These instruments collectively articulate a vision for holistic urban governance beyond narrow sectoral boundaries through integrated planning, participatory mechanisms, and coordinated implementation.

Despite rhetorical commitments to integration, a growing body of evidence suggests that climate discourse increasingly subsumes, rather than synthesizes, complementary environmental domains. While frameworks advocate multi-objective approaches that balance climate mitigation with biodiversity conservation, water security, and social equity, policy practice consolidates around climate-centric paradigms that marginalize non-climate priorities. This produces a fundamental paradox in which international agreements simultaneously mandate integration, even while climate framing achieves conceptual hegemony, potentially

replacing sectoral silos with new hierarchies in which climate mediates all environmental governance. Such dominance risks systematically displacing biodiversity, water management, participatory governance, and equity concerns beneath overarching climate frameworks, creating integration in name but subordination in practice.

Understanding this transformation requires an analysis of how policy discourse structures governance (Leifeld, 2020). Discourse shapes what constitutes a legitimate policy problem, which solutions appear feasible, which actors gain voice, and which priorities command resources (Leifeld, 2018). Discourse network analysis operationalizes this knowledge by mapping how actors and concepts connect through shared positions, thus revealing coalition structures, ideational dominance patterns, and conceptual hierarchies inculcated within policy language. Applied to policy texts, DNA exposes whether integration occurs through dense cross-connections among diverse themes or whether dominant concepts function as "super-hubs" that monopolize attention while peripheral concerns occupy marginalized positions in network topologies (Buckton et al., 2019; Fergie et al., 2019).

Recent methodological innovations have enabled the systematic analysis of policy discourses on an unprecedented scale. Network analysis quantifies keyword co-occurrence structures, allows for the identification of central versus peripheral concepts, and tracks conceptual emergence, decline, and transformation across time periods. Sentiment analysis assesses whether policies adopt crisis urgency framing or technical neutrality to highlight affective dimensions informing policy legitimacy and mobilization potential. The detection of framing distinguishes between problem-oriented and solution-focused discourse, aspirational and regulatory language, and participatory and technocratic orientations. Temporal trend analysis follows how shifts in vocabulary map to the evolution of priorities, the influence of international agreements, and paradigmatic reconfigurations (Gutiérrez-Meave, 2024; Lemke et al., 2024). The integration of these methods allows for mapping the conceptual architecture of urban environmental governance, that is, what policies emphasize, how themes interconnect, which concepts dominate, and crucially, what stays absent from policy discourse despite growing real-world urgency.

The 2030 Agenda's appeal for policy integration and emerging frameworks placing a high emphasis on climate-biodiversity-wellbeing synergies underline the requirement for truly integrated governance. However, authentic integration requires structural balance, where no

single domain systematically subordinates others through discursive dominance. If climate terminology structurally monopolizes policy networks, while water, biodiversity, and participatory governance occupy sparse peripheral positions, integration claims mask conceptual hegemony. Network analysis provides empirical evidence for diagnosing whether urban policies achieve multi-objective integration or reproduce hierarchies that replace sectoral silos with climate-centric frameworks. Differentiating between real synthesis and rhetorical homogenization requires a systematic study of policy language, keyword relationships, temporal evolution, geographic variation, and framing strategies across comprehensive policy corpora spanning multiple decades and diverse national contexts. This study aims to determine whether contemporary urban governance achieves the integration that international frameworks call for or reaffirms new forms of conceptual hierarchy in which climate supersedes rather than synthesizes the complementary environmental, social, and governance imperatives.

## **2. Literature review:**

Urban policy analysis has become a field concerned with political leadership, group theory, and neo-Marxist approaches to understanding city governments. More recently, the field has extended its reach to accommodate multi-level governance, participatory processes, and city-centered perspectives that focus on the uniqueness of urban contexts as alternative political ontologies.

Cities have risen as key nodes within global policy discourse, with scholars calling for an integrated representation of city interests within international decision-making processes. Scientific knowledge increasingly underpins policy formulation at the city level, connecting research and practice in complex urban problems (Acuto, 2018; McPhearson et al. 2016). This increasingly recognizes cities as crucial players in addressing global sustainability, climate change, and developmental imperatives.

Urban policy functions at different scales of governance, from sub-national to global levels. The Global State of National Urban Policy presents comprehensive monitoring frameworks for national urban policies worldwide, placing a strong emphasis on resilience and sustainable housing (OECD/UN-Habitat, 2024). Subnational policies coordinate national, regional, and local agendas with global ones through their regulatory frameworks, public service delivery,

and development financing (UN-Habitat, 2021). Historical evidence indicates that the trajectory of policy evolution differs significantly between countries because of diversified urbanization patterns and governance structures (Turok, 2014).

Computational methods have significantly impacted research on urban policy, as they have enabled the systematic analysis of large corpora of policy documents. Commonsense-based text mining extracts meaningful insights from urban policy texts using natural language processing (Puri et al., 2023). Recent applications have shown that text mining can be used to analyze environmental policy synergies and urban ecological resilience in China (Ge et al., 2025). An AI-driven framework with a large model coupled with text mining allows for a comprehensive analysis of urban greening policies, showing priority and implementation mechanisms. Topical modeling of Chinese urban renewal policy has disclosed the evolutionary pattern of policy discourse along temporal dimensions (Zhang et al., 2025).

Urban policy analysis includes various domains. A global survey of low-impact development for stormwater management found different adoption patterns and implementation approaches in different regions of the world (Chang et al., 2018). Urban food policies exhibit network properties that support food security in both developing and developed worlds, although coordination mechanisms differ according to the development context (Filippini et al., 2019). Internationalization of eco-city policy reveals the rapid spread of environmental urbanism concepts worldwide, even though implementation varies greatly from one context to another (Joss et al., 2013). National analyses of sustainable urban development in China have identified visible problems of policy coherence and integration gaps between environmental and economic objectives (Liu et al., 2014). Despite these advances, previous studies have limitations that constrain their comprehensive understanding of global trends. Previous research has concentrated only on single or regional contexts (Liu et al., 2014; Zhang et al., 2025), which inherently limits the generalizability and cross-national insights. Applications of existing text mining remain geographically limited to analyzing individual nations, rather than global patterns (Ge et al., 2025; Li et al., 2025). Language barriers constrain analyses, with most studies examining policies in single languages excluding non-English frameworks from systematic investigations (Puri et al., 2023). Temporal scope limitations prevent longitudinal understanding, whereby many studies cover discrete periods rather than multidecadal trajectories of change. Data fragmentation across different sources complicates systematic comparisons and meta-analyses. This study addresses these gaps in literature. We investigate:

- **RQ1:** How have urban policy themes evolved from the 1980s to the present? Which concepts emerged, peaked, or declined?
- **RQ2:** What network structure characterizes urban policy discourse? Which keywords act as ‘super-hubs’ bridging themes and which remain peripheral with sparse connections?
- **RQ3:** How do national contexts shape policy discourses? What distinctive ‘signatures’ characterize high-volume policy producers (e.g., Australia, UAE, China)?
- **RQ4:** What framings, stances, and sentiments appear in policy language? Do policies adopt a crisis urgency or technical neutrality?

### **3. Methodology:**

#### ***3.1. Data Source and Selection***

This study analyzed urban environmental policies from the Food and Agriculture Organization Legal Database (FAOLEX) accessed on Sep 11, 2025 (FAO, 2025). We systematically searched for the following ten urban-related keywords: urban, city, metropolitan, municipal, town, suburb, settlement, zoning, infrastructure, and built, following the PRISMA 2020 guidelines (Page et al., 2021).

From the initial database of 11,337 policy records, we excluded 94 repeated texts, leaving 11,243 active policies. After screening for urban relevance and completeness of data for the eventual analysis, 202 policies from 85 countries spanning 1984–2025 were retained. The final corpus included English-language abstracts ( $n = 202$ ), full titles, keywords, geographic metadata (country and administrative level), and temporal data (years of enactment).

#### ***3.2. Analytical Framework***

We employed a 7-stage analytical framework that integrated descriptive, temporal, network, and discourse methods. These were performed to understand what (descriptive corpus), where (geographic variation), when (temporal evolution), which (specific keywords), how connected (network structure), how framed (discursive positions), and how felt (affective tone).

### ***3.2.1. Descriptive and Exploratory Analysis***

We calculated corpus statistics, including temporal distribution (by decade), geographic representation (by region and country), administrative level distribution (national, sub-national, and multi-national), and domain frequency.

### ***3.2.2. Country-Specific Policy Profiling***

For the highest policy-producing countries ( $\geq 5$  policies), the following were extracted: (1) temporal concentration (peak decade), (2) domain focus (top domains), (3) keyword signatures (top keywords), and (4) distinctive thematic terms (via TF-IDF weighting). National policy ‘signatures’ were identified by comparing country-specific keyword prevalence against corpus-wide baselines.

### ***3.2.3. Temporal Evolution Analysis***

We tracked 9 thematic dimensions: Climate Action, Circular Economy & Waste, Sustainability, Biodiversity & Conservation, Governance & Capacity, Risk & Resilience, Water Resources, Energy Transition, and Health & Wellbeing, across three decades (2000s, 2010s, 2020s). Theme prevalence was calculated as the percentage of policies per decade mentioning  $\geq 1$  keyword from each theme cluster. Growth rates were computed as percentage point changes from 2000s baseline. Critical inflection points ( $\geq 10$  percentage points, pp shifts between five-year periods) were identified and contextualized with global policy events (e.g., Paris Agreement 2015, Rio+20 2012).

### ***3.2.4. Temporal Keyword Trend Analysis***

We analyzed 313 unique keywords to identify emerging (new or surging post-2010) and declining concepts (3% reduction from the 2000s). Keywords were parsed from semicolon-delimited FAOLEX keyword fields, standardized to lowercase, and tracked across decades. Emergence scores combined novelty (absent in the 2000s) with the current prevalence (2020s). Co-occurrence frequency matrices were constructed to identify temporal keyword associations.

### ***3.2.5. Network Analysis***

Keyword co-occurrence networks were constructed, where nodes represented keywords and edges were connected to keywords appearing in the same document. We retained edges with  $\geq 3$  co-occurrences (6,508 edges among the 271 keywords). The network metrics include (a) degree centrality (number of unique connections per keyword), (b) weighted degree (sum of co-occurrence strengths), and (c) bridge score [number of thematic communities connected ( $\geq 2$  keywords per community)].

### ***3.2.6. Stance Detection and Framing Analysis***

Policy abstracts were analyzed as follows: (a) problem-solution framing (identification of issue description versus intervention language), (b) temporal framing [present/ongoing (sustainability) versus future-oriented (adaptation) language], (c) action orientation [prescriptive (shall/must) versus aspirational (should/may) modal verbs], and (d) urgency markers [crisis terminology (urgent, critical, emergency) versus routine language]. Framing frequencies were compared across administrative levels and temporal eras using a chi-square test ( $\alpha=0.05$ ).

### ***3.2.7. Sentiment and Tone Analysis***

Using lexicon-based sentiment analysis (VADER algorithm; Hutto & Gilbert, 2014), abstract sentiments were scored on a continuous scale (-1=negative, 0=neutral, +1=positive). Sentiment distributions were visualized and compared across themes and countries using an ANOVA ( $\alpha=0.05$ ).

## ***3.3. Software and Tools***

All analyses used Python 3.12 with libraries: 'pandas' (data manipulation), 'scikit-learn' (TF-IDF, clustering), 'networkx' (network metrics), 'nltk' and 'vaderSentiment' (text processing, sentiment analysis), and 'matplotlib'/'seaborn' (visualization). Statistical tests were performed using 'scipy.stats'. Network graphs were visualized using force-directed layouts (Fruchterman-Reingold algorithm).

## 4. Results:

### 4.1. *Corpus characteristics and global patterns:*

These 202 policies show exponential acceleration (**Fig 1a, supplementary file 1**), from negligible pre-2000 activity (2,1%), through expansion in 2000-2009 (34, 168%), a peak in 2010-2019 (105,52%), and continuing from 2020 to 2025 (61, 302%), with the period 2010-2025 accounting for 822% of the total output. The 2021 apex of 20 policies could be interpreted as showing that Covid-19 catalyzed rather than hindered innovation, as cities became recognized as crucial nodes for public health, economic recovery, and resilience. This trajectory reflects the increasing pressure of global urbanization and a more intense focus on sustainable development following the 2015 UN SDGs and the 2016 New Urban Agenda. Thus, temporal patterns reveal fundamental conceptual transformations. While governance in the 1980s and the 1990s was conducted via piecemeal sectoral approaches to housing, transportation, and infrastructure, the post-2000 emergence evidences a paradigmatic shift towards holistic frameworks that regard cities as complex adaptive systems that require joined-up interventions rather than fragmented responses.

The dataset consists of 85 countries (**Fig 1b**) from six regions, with the top producers including Australia's 15 policies (76% (predominantly subnational, including Australian Capital Territories (ACTs) (14), the UAE (11, 56%), Bosnia and Herzegovina (10, 51%), Italy (8, 41%), and China (7, 36%). The regional distribution (**Fig 1c**) shows that the Americas (44, 223%) and Europe (43, 218%) topped the list, followed by Asia and the Middle East (34, 173%), Oceania (20, 102%), and Africa (18, 91%). National dominance was strong at 141 (698%) in the administrative hierarchy, with a substantial subnational presence (56, 277%) and negligible multi-national activity (5, 25%) (**Fig 1d**). The 28% share of subnational policies defies the nation-to-nation horizontal diffusion assumption and suggests vertical policy ecosystems, whereby subnational experimentation precedes national adoption. Moreover, regional variation is pronounced, with Oceania having 75% of subnational policies, while Africa records 0%, which means that federalism and decentralization are decisive preconditions for innovation at the subnational level. Leadership by Australia, despite its smaller population, presents evidence that policy productivity correlates with institutional capacity and multi-level governance maturity rather than demographic size or urbanization pressures. In contrast, the second position of the UAE offers a counternarrative: rapid urbanization in resource-rich contexts

leads to innovation via policy importation and adaptation mechanisms. Subnational production strongly correlates with federal forms of governance: Australia, Canada, the UAE, Italy, Bosnia, and Herzegovina, confirming theories in political science that federalism allows for policy experimentation, and capital regions such as the Australian Capital Territory serve as demonstration zones for national policy ideas.

Leadership switched from Australia (13), Italy (7), UAE (6) in 2010-2019 to Bosnia & Herzegovina (8), China (5), UAE (4) in 2020-2025, while Europe sustained consistent output and Asia & Middle East surged from 4 (2000-2009) to 14 (2020-2025). Regional administrative structures are very different: Oceania is dominated by a sub-national orientation (15 vs. 5 national), while Africa operates at the national level only; the Americas show 35/9 and Europe 24/19, reflecting balanced multi-level governance through their national/sub-national ratios. The proximity between the Americas (223%) and Europe (218%) masks critical disparities, not least the marginal representation of Africa (91%), despite experiencing some of the most acute urbanization pressures and extraordinary exponential growth. These negative correlation regions facing the most serious urbanization challenges generate the least policy innovation, which may indicate depleting capacity gaps but also points to whose urban realities gain formal codification into policy frameworks, raising further questions on knowledge asymmetries and institutional barriers stopping Global South experiences from translating into recognized policy instruments.

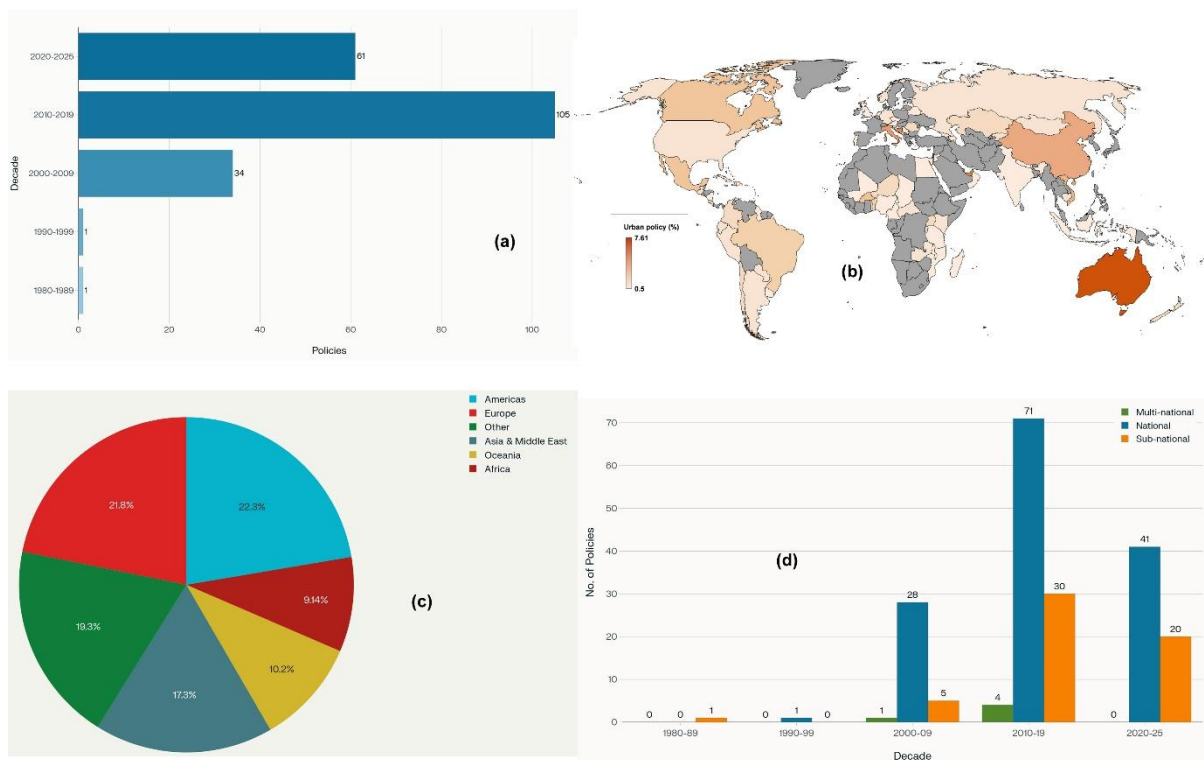


Figure 1. Descriptive & exploratory analyses on global urban policies. (a) cumulative decadal urban policy distribution highlighting the 2010-2019 surge. (b) geographic distribution of urban policies across 85 countries. (c) geographic distribution by regions. (d) administrative level trends of national, sub-national, and multi-national policies across decades.

#### 4.2. National policy signatures and geographic variation:

Policy production is highly concentrated ([Supplementary File 2](#)): three high-volume producers account for 36 policies: Australia 15 (74%), the UAE 11 (54%), and Bosnia and Herzegovina 10 (5%); six medium-volume contributors add another 36 (Italy 8, China 7, Vietnam 6, Mexico, Canada, and Burkina Faso 5 each). Beyond this core group of nine countries producing 72 policies (356%), the distribution becomes highly fragmented: 34 low-volume countries contribute between 2-4 policies each, while 42 countries (494%) produced single policies. This hierarchical pattern reflects extreme concentration, whereby 12% of countries correspond to the top producer with 74% output, while almost half participate minimally. This raises questions about knowledge transmission mechanisms, the institutional

infrastructure needed, and the extent to which single-policy countries are experimental pilots, isolated initiatives, or the result of engagement constrained by technical resource limitations.

Australia's policies reflect the notion of nature conservation as a national identity, through the integration of biodiversity into community participation and indigenous land management within urban governance. Australia's capital territory may be considered a conservation policy laboratory. In the UAE, policy is aspirational environmentalism within development frameworks; the UAE uses vision documents to coordinate strategic planning across economic, environmental, and social domains at the emirate level. Bosnia showcases post-conflict rural revitalization with standardized municipal agricultural strategies as evidence of systematic local-scale rural development planning. Italy's policies are representative of technical-regulatory urbanism, with a focus on waste infrastructure and environmental standards through regional-level waste management planning. Policies in China demonstrate the direction provided by the state, whereby investment and inspection become policy instruments within a five-year planning framework. Vietnam reflects the integration of socialist markets into selected master planning, indigenous rights, and traditional knowledge of equitable development. Policies in Mexico demonstrate rights-based environmentalism through the integration of indigenous people and traditional knowledge into conservation and rural development. Policies in Canada reflect adaptive water management through a strategy refinement approach, iteratively through provincial leadership on basin/water-shed governance. In Burkina Faso, emphasis is placed on institutional capacity development, reflecting global South priorities related to strengthening governance and disaster preparedness. Finally, policies in Costa Rica reflect One Health integration through water, health, indigenous rights, and urban agriculture within comprehensive frameworks.

With 494% of the countries (42 of 85) having only single policies, while three countries produced 36 policies (178%), the production of urban policies was highly concentrated. It reflects capacity disparities and policy entrepreneurship in Australia, the UAE, and Bosnia. In some respects, sub-national leadership in urban policy challenges the assumptions about the dominance of policy at the national level, as illustrated by Australia (ACT), the UAE (Abu Dhabi), Bosnia (municipalities), Italy (regions), and Canada (Alberta). Rather than generic urban policies, countries have developed distinctive sectoral signatures: Italy (waste), Canada (water), Mexico (indigenous-environment), and Costa Rica (health-environment), indicating a comparative advantage in policy expertise. Bosnia's 8 policies in 2020-25, China's 5 of 7 in

the 2020s, and Australia's 13 in 2010-19 show rapid policy production bursts reflecting specific governance moments of post-conflict reconstruction, five-year plans, and conservation campaigns.

#### **4.3. Temporal evolution of policy themes:**

Four themes showed explosive growth trajectories ([Supplementary File 3](#)). Waste and Circular Economy surged from 59% → 267% → 328% (2000s → 2010s → 2020s), with the critical 2010-14 inflection (+23.2pp) coinciding with UN Rio+20 and the emergence of a circular economy paradigm, transforming from near-absence to appearance in one-third of the policies. Climate Action grew 123% from 235% to the majority presence of 525%, with dual points of inflection: 2005-2009 emergence, +29.6pp post-Kyoto Protocol; and 2015-19 mainstreaming, +16.1pp Paris Agreement effect, now the dominant policy discourse. The energy transition expanded by 142% (88% → 213%) through steady linear progression, accelerating in the 2020s with a renewable energy momentum. Health and well-being increased by 56% (147% → 23%), likely amplified by Covid-19 as a health-environment nexus. These patterns illustrate thematic convergence around sustainability imperatives, with the circular economy as the most dramatic transformation, going from virtually absent pre-2010 to foundational, while climate action achieved majority penetration, signaling its complete mainstreaming from specialized concern to universal policy consideration across urban frameworks.

Governance and capacity remain remarkably stable between 75-85% for all periods, reaching 76% → 83% (2000s → 2020s), while policy/planning terminology is deployed in 60% of documents, a universal substrate rather than a trend, and a constant baseline underlying all urban frameworks. Sustainability presents a plateau behavior at 55% prevalence (55% → 58% → 54%), with an early peak at 71% (2000-04) followed by renormalization and a slight contraction (-32% overall). This contraction indicates a conceptual saturation. 'Sustainability' became an implicit baseline assumption by the 2020s, for which explicit emphasis as a core principle was no longer necessary because these principles were absorbed into standard practice. The divergence between these themes presents two archetypes of stability: governance as a permanent foundational need versus sustainability as a paradigm absorbed and now normalized into policy DNA. This points towards larger evolutionary stages in which transformative concepts, such as today's surge in the circular economy, finally

stabilize either as persistent infrastructure, like the governance model, or as internalized assumptions, as in the trajectory of sustainability. This could portend a similar normalization for today's emergent themes once they reach complete institutional integration.

Three themes showed major decline trajectories. Risk and resilience shrank by 41%, reflecting the conceptual migration from standalone disaster risk reduction frameworks to integrated climate adaptation approaches. Water Resources were reduced by 32% (412% → 279%), not by neglect but by absorption-water management subsumed within larger climate and environmental frameworks rather than maintaining a distinct policy identity. Biodiversity and Conservation decreased by 26% across the study period (265% → 238% → 197%), which is paradoxical and concerning. The prevalence fell despite the CBD Aichi Targets and the high profile of the Post-2020 Framework, which may indicate that the dominance of climate action crowds out biodiversity. These patterns reveal the dynamics of thematic consolidation through which specialized concerns are either integrated into an ascendant mega-theme-stemming from both water into climate and risk into the resilience-climate nexus or become marginalized, despite international agreements for biodiversity being eclipsed by the imperative for urgent climate action. Systematic decline suggests that policy attention represents a zero-sum competition wherein emergent priorities displace established themes through conceptual mergers or via resource/attention scarcity. This raises red flags regarding holistic sustainability when, even while recognizing interdependence with biodiversity conservation, climate mitigation overshadows pressing supplementary ecological imperatives.

Four inflection points punctuate the policy evolution. 2005-09 marked Climate Emergence: keywords surged % → 296%) driven by post-Kyoto Protocol implementation and IPCC report traction, introducing climate into the urban policy lexicon. 2010-14 witnessed the Circular Economy Breakthrough: waste terminology jumped from 74% → 306% (+23.2pp) catalyzed by Rio+20 (2012), the Ellen MacArthur Foundation, and the EU Circular Economy Package, signaling a paradigm shift from disposal logic to resource recovery systems. 2015-19 achieved the Paris Agreement Mainstreaming: climate-crossed majority threshold (522%), propelled by the Paris Agreement, SDG 13, and NDC frameworks, establishing climate as the default urban policy framing rather than a specialized concern. 2020-24 demonstrates Sustainability Normalization: prevalence peaked and then stabilized at 55% (from 71%), indicating language saturation where 'sustainability' became so universally embedded that it lost its distinctive character, transitioning from aspirational rhetoric to foundational assumption. The following

temporal ruptures show that policy discourse works by punctuation of equilibrium, with extended stability interspersed with rapid paradigmatic shifts in this case, catalyzed by landmark international agreements, such as the Kyoto and Paris Agreements, or institutional innovations in the form of circular economy frameworks, while others are driven by conceptual saturation, such as sustainability normalization. This indicates that the evolution of urban policy follows a nonlinear trajectory, in which external catalysts create sudden discursive reconfigurations rather than gradual incremental adjustments.

The urban policy evolution across four distinct eras moves from: the pre-2000 ‘Nuclear & Planning Era’, prioritizing technical concerns, nuclear energy, radiation, agricultural land without environmental framing; the 2000-2009 ‘Sustainability Era’, which secures and institutionalizes Rio Earth Summit Principles and the Millennium Development Goals (MDGs) focusing on sustainable development (47%, peaking 71% early decade), governance/capacity (76%), and risk management (5%), ultimately marking the apex of ‘sustainability’ before normalization; the 2010-2019 ‘Climate & SDG Era’, which brought about the mainstreaming of climate concern (47% rising to majority), sustained dominance of governance (84%), and normalized sustainability (58%), resulting from the implementation of SDGs and the Paris Agreement; and the 2020-2025 ‘Post-Covid Integration Era’, with thematic convergence: climate reaching 53%, circular economy maturing to 33%, and governance stabilizing at 84%, synthesizing pandemic recovery imperatives with climate urgency and circular metabolism thinking. The trajectory of paradigmatic evolution is thus achieved from a pre-environmental technocracy across sustainability institutionalization to climate hegemony and today’s multi-theme integration, where each era is marked by a distinct signature of discourse, from sustainability language saturation in the 2000s to the emergence of climate vocabulary in the 2010s and nexus complexity in the 2020s. This trend reflects how international frameworks, such as Rio, Kyoto, Paris, and the SDGs, precipitate discursive reconfigurations that restructure the priorities, vocabulary, and conceptual architecture of urban policies through successive generations of institutions.

#### **4.4. *Keyword emergence and decline patterns:***

Temporal keyword trend analysis ([Supplementary File 4](#)) was composed using 313 unique keywords, observed from 670 keyword-decades, comparing three decades: 2000s, 2010s, and the 2020s. Thirty concepts demonstrated explosive emergence trajectories ([Fig 2a](#)), led by

Circular Economy (highest growth: % → 19% → 164%, appearing first in 2016, now present in 1-in-six policies) catalyzed by Ellen's work. The MacArthur Foundation and EU frameworks represent the fastest policy innovation from a complete absence. Cultural Heritage surged (% → 124% → 82%, peaking in the 2010s) through UNESCO integration and conservation movements, while Air Quality jumped (% → 66%) post-Paris Agreement, emphasizing the health-environment nexus. Natural Gas (492%) and Human Rights (492%) have entered the discourse as energy transition bridge fuels and rights-based urban development, respectively. Three concepts emerged exclusively post-2020: plastic (328%, ocean crisis and microplastic awareness), One Health Approach (328%, Covid-19 catalyzing health-environment-animal connections), and Family Farming (328%, UN Decade 2019-2028), alongside Green Economy (328%, 2016 debut via Rio+20/UNEP initiatives). Surging existing concepts include Rural Development (29% → 197% through rural-urban integration), emissions (29% → 18% via NDCs and carbon accounting), Renewable Energy (29% → 18% through decarbonization momentum), and Waste Management (59% → 262% exponentially transforming from marginal to core concerns). These emergence patterns reveal that policy discourse rapidly assimilates previously absent concepts, particularly the circular economy's meteoric rise and post-2020 plastic/one health insertions, while accelerating established themes, such as renewables and emissions, indicating how international frameworks, environmental crises, paradigmatic shifts, circular metabolism, health-environment integration, precipitate vocabulary expansion, and priority reconfiguration within compressed timeframes.

One-quarter of the concepts show extreme decline or disappearance. The eight concepts (**Fig 2b**) that vanished were desertification (118% → %, fully absorbed within climate/land degradation frameworks), migration (59% → %, regardless of growing climate migration urgency), aquatic animal/freshwater fish/fishery management (88% each → %, shifting to broader ecosystem frames), biotechnology (59% → %), fuelwood (88% → %, through energy transition from traditional biomass), Social Impact Assessment (59% → %, despite growing accent on social), and Comparative Analysis (147% → %). The terms that severely declined (6% loss) are those that often pose critical paradoxes: Basin/Catchment/Watershed collapsed (324% → 49%); one-third to marginality; Decentralization dropped (88% → 16%), contradicting governance rhetoric; Inland Waters fell (353% → 82%), despite the water crisis; Community Management declined (294% → 82%); Environmental Impact Assessment contracted (176% → 49%), despite legal mandates; Public Participation decreased (294% → 98%); Potable Water reduced (324% → 115%), despite SDG 6 centrality; and

Traditional/Indigenous Knowledge diminished (88% → 33%), contradicting the CBD/Nagoya Protocol priorities. These systematic disappearances follow a disturbingly regular pattern, wherein participatory, community-oriented, and water-centric terminology is on the decline precisely during the time when democratic engagement, local governance, and water security remain or have become critical imperatives. This suggests a wholesale conceptual absorption of the former into macro-frames of understanding, such as climate and sustainability, or, worse still, a genuine de-prioritization of bottom-up, equity-sensitive, and resource-specific approaches in favor of top-down, technocratic climate-centric paradigms.

Five concept clusters depicted divergent trajectories (**Fig 2c**). Surging clusters demonstrated explosive growth; for instance, Circular Economy & Waste surged (59% → 344%) embracing the circular economy, waste management, plastic, and recycling keywords; Energy Transition grew (59% → 246%) with renewable energy, emissions, natural gas, and solar/wind keywords; and Climate & Resilience, which increased (235% → 492%), featured discourse centered on climate change, adaptation, and resilience. However, declining clusters revealed critical paradoxes: Traditional Conservation contracted (294% → 197%) despite biodiversity crises, with receding species and traditional knowledge terminology; Water Management declined (412% → 279%), embracing water resources, basin management, and potable water keywords despite the intensification of water scarcity. The cluster dynamics expose fundamental policy discourse restructuring: emergent sustainability paradigms, circular economy, energy transition, and climate adaptation are rapidly dominating, while established conservation and resource management frameworks dwindle, insinuating that climate-centric priorities systematically displace specialized environmental concerns. The paradox of conservation and water declining in the face of ecological crises offers a dual explanation of either thematic absorption into broader climate frameworks or actual marginalization. This offers a cause for concern over whether integrated climate discourse provides a suitable home for biodiversity loss and water security or inadvertently obscures these distinct imperatives through conceptual consolidation into undifferentiated sustainability rhetoric.

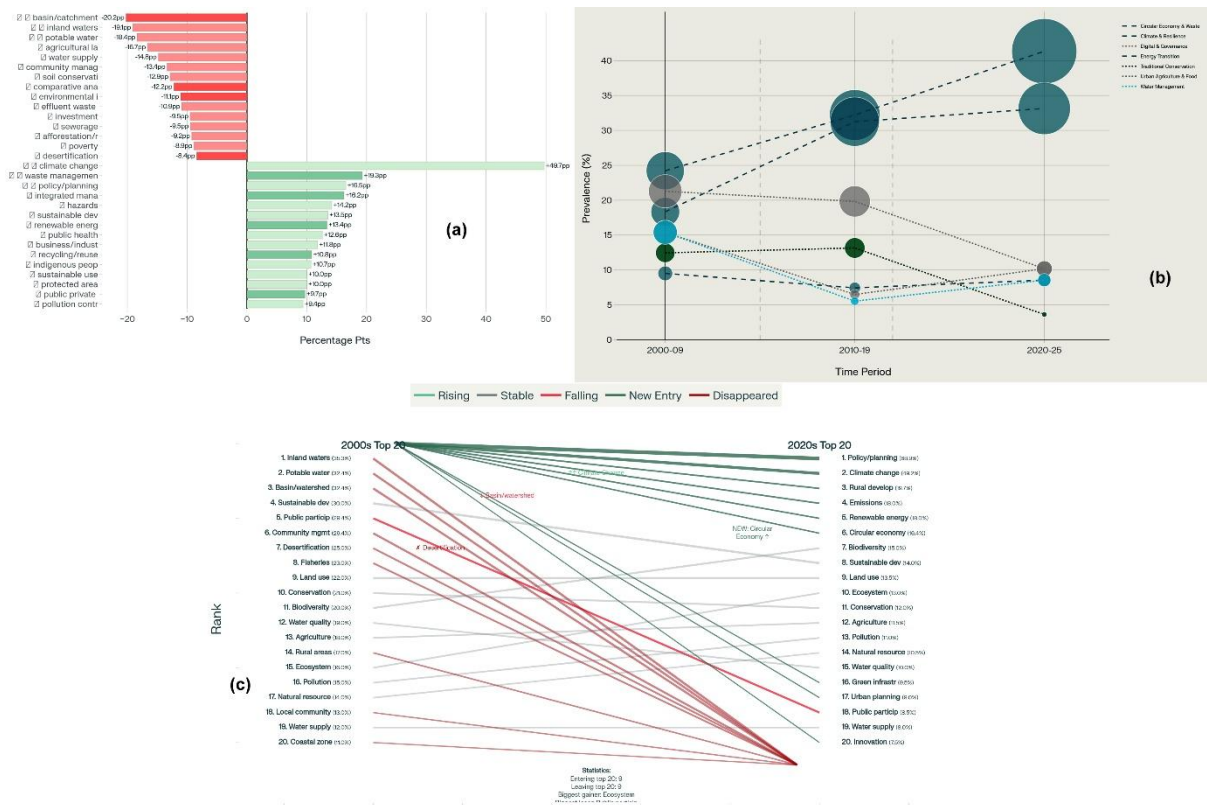


Figure 2. Temporal keyword trend analysis. (a) Emerging vs Declining Keywords [colour code: New (bright), Surging (medium), Growing (light)]. (b) Connected bubble plot showing 8 thematic cluster evolution paths [Solid thick lines for Surging: Circular Economy (green), Climate (red), Energy (orange); Dashed lines for Stable: Governance (blue); Dotted fading lines for Declining: Water (cyan), Conservation (dark green)]. (c) Keyword rank slope graph showing dominance ranking shifts [Left column: Top 20 keywords ranked by 2000s prevalence; Right column: Top 20 keywords ranked by 2020s prevalence; Connecting lines with variable thickness (prevalence-weighted) and color (trajectory-coded)].

#### 4.5. Conceptual networks and hub-periphery structures:

Network analysis of 313 unique keywords across 4,615 occurrences showed conceptual relationships, hub concepts, and thematic communities through 6,508 co-occurrence edges, whereas 271 keywords (866%) presented significant connections with  $\geq 3$  co-occurrences (Supplementary File 5). An average of 22.85 keywords per document creates a dense network topology that signals a highly interconnected conceptual landscape. In such a landscape, urban policy terms form a robust relational architecture, rather than being fragmented into isolated concepts. These are indicative of systematic integration patterns.

The ten hub keywords served as conceptual super-connectors across different policy domains (**Fig 3a**): policy/planning dominated, with 200 connections, 172 documents, and 85% corpus prevalence, followed by climate change (195 connections and 138 documents), sustainable development (192 and 136), biodiversity (180 and 91), protection of the environment (177 and 120), sustainable use (178 and 94), hazards (172 and 106), monitoring (168 and 70), pollution control (161 and 93), and data collection/reporting (167 and 60). These words comprise universal policy vocabulary found throughout thematic domains and serve as integrative frameworks that address sectoral concerns. Taken together, the hierarchy shows that governance terminology-policy/planning-reaches the highest connectivity, while climate and sustainability concepts yield similar connection density, which may suggest that procedural/administrative keywords are the strongest bridges, while substantive environmental themes, such as climate, biodiversity, and pollution-cluster, indicate urban policy functions through a dual architecture, one of governance scaffolding, which provides structural connectivity, and environmental priorities provide thematic content.

The ten most powerful keywords (**Fig 3b**) to disclose the conceptual architecture were Climate Change + Hazards (232 co-occurrences), followed by Climate Change + Protection of Environment (189), Sustainable Development + Sustainable Use (170), Climate Change + Policy/Planning (160), Climate Change + Sustainable Development (154), Biodiversity + Climate Change (150), Pollution Control + Protection of Environment (147), Biodiversity + Sustainable Use (143), Policy/Planning + Sustainable Development (142), and Climate Change + Pollution Control (131). Climate Change dominates the relational structure, being present in 6 of the 10 top pairs as the main integrative framework that connects the domains of hazards, environmental protection, sustainable development, biodiversity, policy/planning, and pollution control. This concentration indicates that climate discourse works as a core organizing principle, synthesizing different policy concerns, risk management, ecosystem protection, sustainability paradigms, governance mechanisms, and pollution mitigation into one conceptual architecture. It appears that contemporary urban policy has been radically reconstituted around the climate nexus, with climate terminology not as an isolated theme itself, but rather as a connective tissue that binds the hitherto separate environmental, social, and domains of governance into a climate-mediated framework, testifying to an epistemic shift whereby a climate lens becomes the mandatory interpretive filter through which all urban challenges are articulated, conceptualized, and tackled.

Eight thematic communities exhibited hierarchical connectivity patterns. The climate and Sustainability Core achieved the highest integration (5 keywords, 1,146 internal co-occurrences, 229.2 avg) encompassing climate change, sustainable development, sustainable use, hazards, and risk assessment/management as the densest cluster representing the dominant paradigm. Environmental Protection ranks second (6 keywords, 967 co-occurrences, 161.2 avg), covering protection of the environment, pollution control, biodiversity, ecosystem conservation, species protection, and protected areas as traditional conservation frameworks. Governance and planning demonstrated moderate connectivity (6 keywords, 458 co-occurrences, 76.3 avg) through policy/planning, governance, capacity building, public participation, access to information, and institutions as procedural architectures. Technical and monitoring cluster implementation functions (6 keywords, 262 co-occurrences, 43.7 avg) via monitoring, data collection/reporting, research, standards, inspection, and survey/mapping. Water Resources exhibit low integration (6 keywords, 214 co-occurrences, 35.7 avg), spanning water resources management, inland waters, quality standards, basin/catchment/watershed, potable water, and supply as a relatively isolated sector. Land and agriculture remained weakly connected (6 keywords, 135 co-occurrences, 22.5 avg), including land-use planning, agricultural development, soil conservation, rural development, crops, and agricultural land. Health and safety emerged as a small nexus (3 keywords, 54 co-occurrences, 18.0 avg) linking public health, hygiene/sanitary procedures, and risk assessment. Economic and Development shows the lowest integration (3 keywords, 33 co-occurrences, 11.0 avg) through investment, business/industry/corporations, and subsidy/incentive as least-connected communities, revealing climate-sustainability hegemony (5 times denser than water, 10 times denser than economic communities), whereas sectoral domains (water, agriculture, economics) remain fragmented, suggesting that policy discourse structurally privileges climate-centric integration over resource-specific or economic frameworks.

Twenty top bridge keywords span all 8 communities, demonstrating a flat hierarchical structure without specialized connectors linking only 2-3 to domains. The top 10 bridges, such as Policy/Planning, Climate Change, Sustainable Development, Biodiversity, Protection of the environment, Sustainable Use, Hazards, Monitoring, Pollution Control, and Data Collection/Reporting traverse all thematic clusters rather than mediating between specific pairs. This universal connectivity pattern, without domain-specific intermediaries, either indicates profound conceptual integration in which major policy constructs genuinely permeate all

sectoral boundaries or conversely suggests superficial keyword standardization where terminology proliferates across documents without substantive thematic synthesis. There are no specialized bridges, such as terms connecting agriculture-water exclusively or health economics specifically, which means that the vocabulary operates at macro-level abstraction rather than sectoral specificity. This may reflect genuine systems thinking, whereby climate, sustainability, and governance frameworks intersect with all domains.

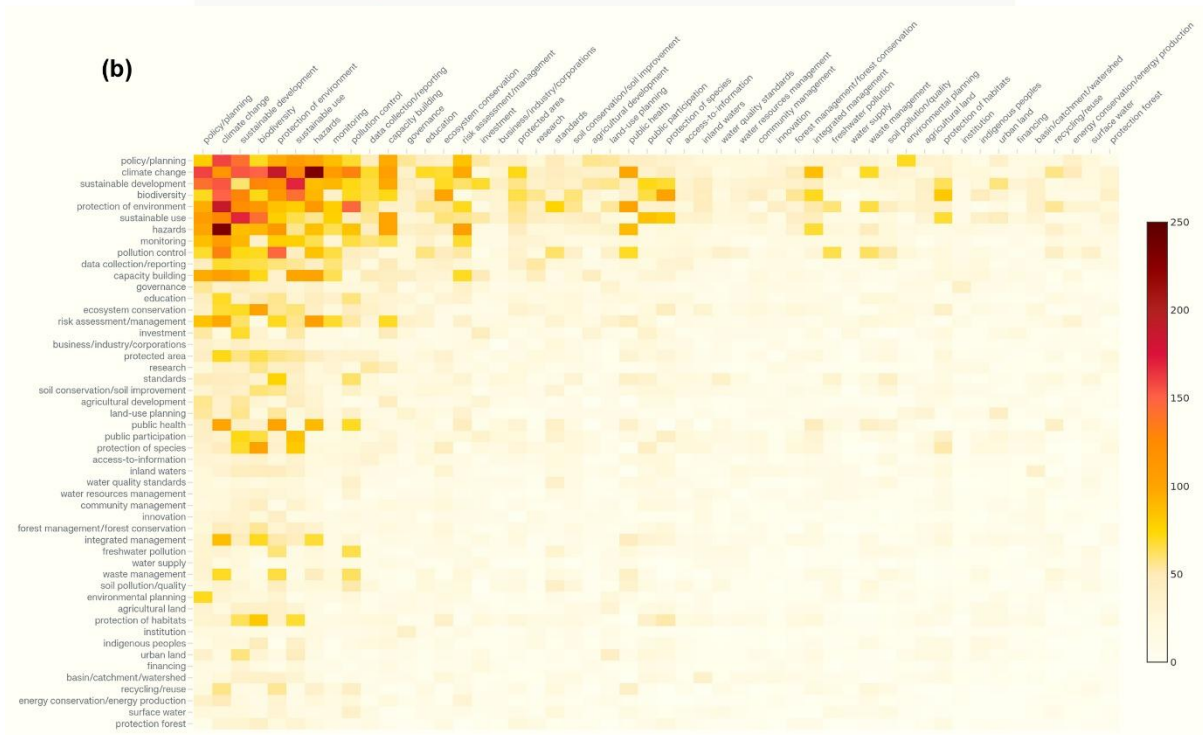
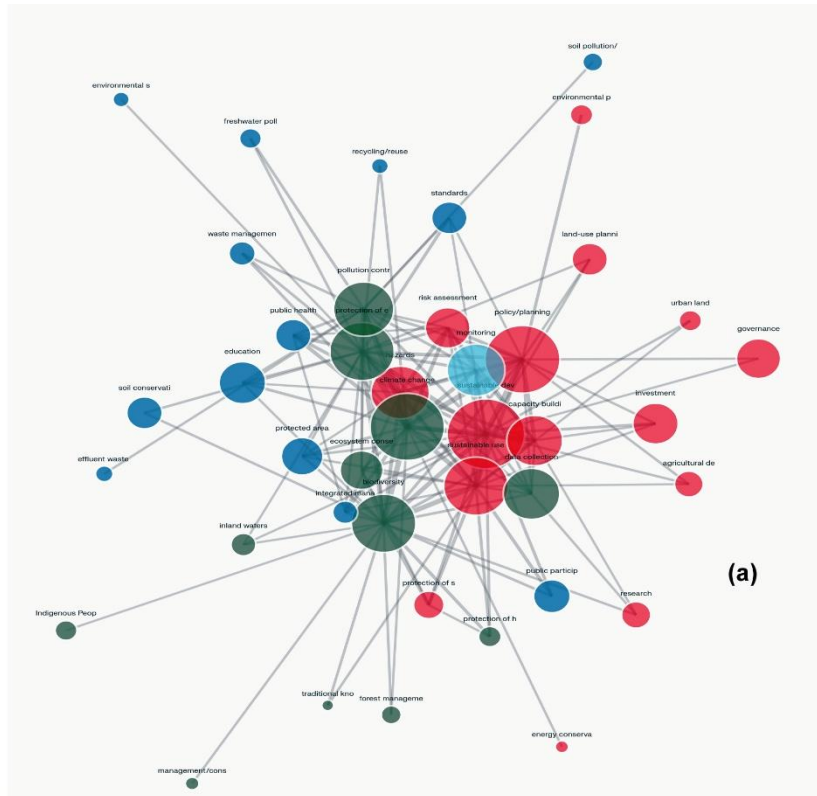


Figure 3. Network analyses. (a) Force-directed network graph [Node colors encode 8 thematic communities: Climate & Sustainability Core (bright red), Environmental Protection (dark green), Governance & Planning (deep blue), Water Resources (cyan), Land & Agriculture (brown), Health & Safety (teal), Technical & Monitoring (purple), and Economic

& Development (orange)]. (b) Co-occurrence intensity heatmap [Color gradient: White (0) → Yellow (FFF3B0) → Orange (FFAA00) → Red (EF233C) → Crimson (9D0208, >200); Scale: 0, 50, 100, 150, 200, 250+ co-occurrences].

#### **4.6. Framing and stance positioning in policy discourse:**

Domain-specific lexicon framing analysis ([Supplementary File 6](#)) across eight dimensions, temporal discourse patterns by decade and 5-year periods, 2000-2025, and regional/country profiling of the policies revealed a hierarchical intensity distribution ([Fig 4a](#)): Environmental/Ecological dominated (34% text density, 32.2% policies/65 documents), followed by economic/development (30.7%, 28.7%/58 documents), Spatial/Urban Planning (28.2%, 21.3%/43 documents), Technology/Innovation (15.7%), Governance/Institutional (14.5%), Social Justice/Equity (12.8%), Risk/Disaster Management (10.1%), and Health/Wellbeing (0.66%). Thus, environmental and economic framing co-dominated the discourse, with a 61% combined document prevalence, leading to the establishment of environmental framing as the single largest category, while economic concerns maintained a strong secondary presence. Policies have a multi-dimensional character, averaging 4.5 framings per document (median: 4), indicating integration rather than a single-issue orientation across environmental, economic, and spatial concerns. This diversity pattern reveals that urban policy works through layered conceptual frameworks that simultaneously deploy ecological, economic, spatial, technological, governance, equity, risk, and health lenses. In this respect, environmental discourse is recognized as providing a first-order interpretive architecture, while economic development maintains a co-equal influence in structuring the majority framing landscape, thus pointing to contemporary urban governance fundamentally anchored in the environment-economy nexus, incorporating subsidiary technological, institutional, social, and risk dimensions into a composite multi-framed policy architecture.

Five temporal trajectories were used to define the framing evolution (2000-2025). Environmental discourse surged (23.3% → 39.6%), the largest growth, accelerating post-2015 through the Paris Agreement and SDG catalysts, ultimately achieving dominance in 32.2% of all policies, representing a shift towards logical primacy. Economic framing demonstrated a surge in resilience (28.8% → 34.2%), stable at 3% through the 2000s-2010s before surging in the post-Covid 2020s to reflect recovery imperatives, which balances environmental dominance. The risk/disaster language exploded (0.52% → 10.2%), nearly doubling from the

early 2000s to the 2020s, signaling the normalization of climate hazards from exceptional circumstances to routine vocabulary as they became integrated into standard discourse. Spatial Planning contracted (406% → 298%), as traditional urban/planning terminology declined and environmental and climate framings absorbed spatial concerns, marking the transition from an ‘urban planning’ to an ‘environmental urbanism’ paradigm. Social Justice stagnated (12% → 136%), displaying a minimum 25-year change and remaining marginal at ~13% despite the SDG equity rhetoric, revealing how equity concerns are subordinated to environmental and economic priorities. These trajectories expose the fundamental reordering wherein the environmental framing ascended from a secondary to a dominant position, economic discourse maintained its co-dominant position, the risk vocabulary mainstreamed from periphery to baseline, spatial thinking lost its autonomous identity due to environmental absorption, while social justice failed to penetrate the policy discourse core despite international equity commitments, suggesting that the environment-economy nexus systematically marginalizes the consideration of equity within contemporary urban governance architecture.

The framing of regional patterns (**Fig 4b**) shows sharp specializations. The environmental emphasis ranges from Oceania (59%, Australia-driven conservation identity, twice the global average) to Asia and the Middle East (424%), the Americas (364%), Europe (225%), and Africa (16%, infrastructure priorities override ecological discourse). This hierarchy is inverted in economic framing: Europe leads with 356% (pragmatic development, 22/37 documents economic-dominant), followed by Asia, 339%; Africa, 323%; and the Americas, 216%, thus showing the crucial divergence between European and American nation-states, where Europe places much more emphasis on economics than the Americas, which prioritize environmental dimensions. The spatial/urban planning concentration peaked in Africa (376%, maintaining a traditional planning orientation resisting the environmental turn of infrastructure/land use centrality), followed by the Americas (309%) and Oceania (291%), whereas it was minimal in Asia (212%). Social Justice remains universally marginal: Oceania (173%), Africa (164%), the Americas (153%), and Europe (086%), demonstrating that equity rhetoric, despite international commitments, fails to translate into policy language intensity. Country-level profiles (**Fig 4c**) reveal extreme specialization: environmental leaders are Australia, 619% (nature conservation national identity); the UAE, 509% (environmental vision 2030); China, 494% (ecological civilizational discourse); economic framers are Vietnam, 609%; Bosnia and Herzegovina, 409%; Italy, 211% economic but spatial-dominant, 295%; and spatial specialists, Costa Rica (422%), Burkina Faso (393%), and Italy (295%) waste/spatial planning nexus. Patterns reveal

that developed nations from Oceania and the Americas privilege environmental discourse, whereas developing nations from Africa and parts of Asia maintain an infrastructure-economic-spatial emphasis. This suggests that framing hierarchies are correlated with development stages insofar as they are post-industrial economies that afford ecological prioritization, while urbanizing regions sustain materialist development frameworks. Such a view lays open the North-South epistemological divide, whereby environmental governance turns into a luxury discourse

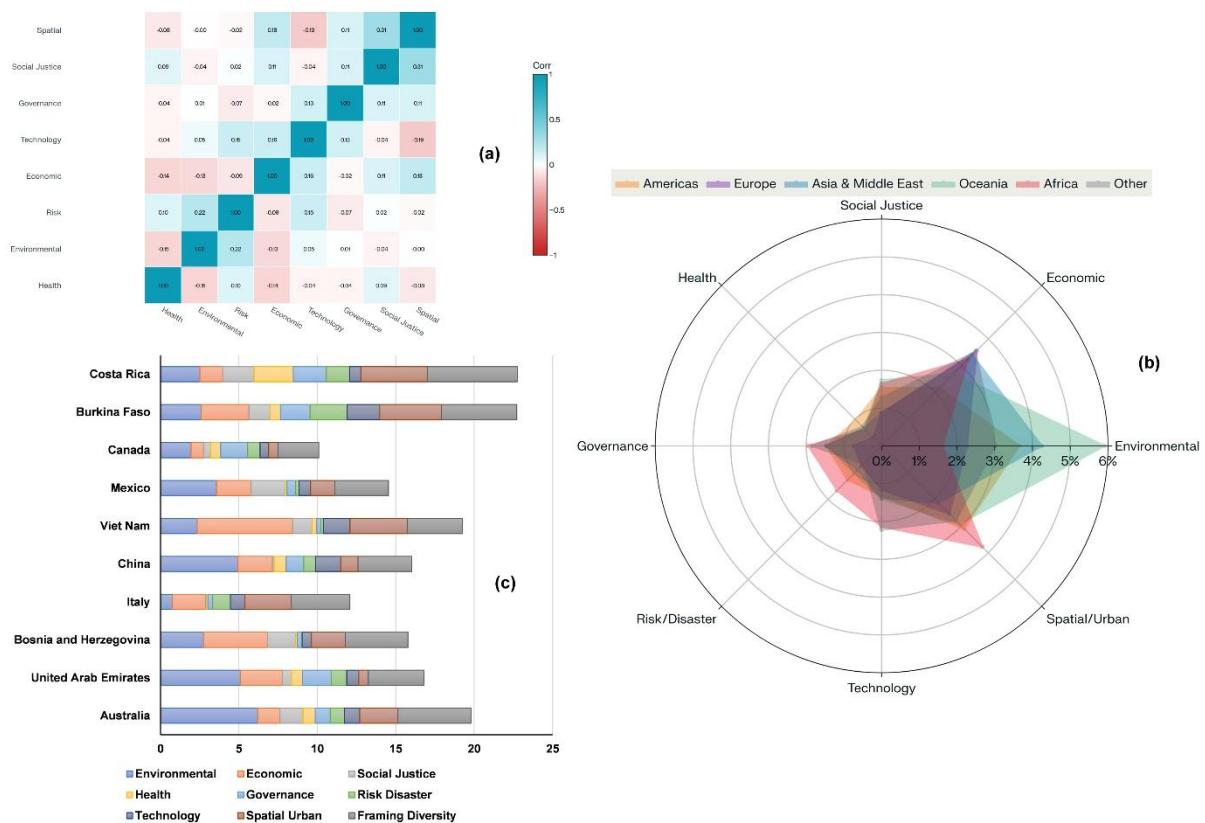


Figure 4. Stance detection and framing analyses. (a) Correlation matrix of policy theme scores. (b) Regional framing profiles. (c) Country-level framing profiles.

#### 4.7. Sentiment and affective dimensions of policy language:

Policy tone and sentiment analyses were performed ([Supplementary File 7](#)) using domain-specific lexicons across five categories: Aspirational, Regulatory, Problem-oriented, Technical, and Participatory, in concert with VADER-style positive/negative sentiment scoring. Temporal evolution was tracked across decades, 2000-2025, and geographic patterns were compared

across six regions and the top ten producing countries. This analytic framework allows for the measurement of policy discourse characteristics in a way that goes beyond mere content themes: rhetorical posture (aspirational versus regulatory), problem framing intensity, technical versus participatory orientation, and emotional valence or positive/negative sentiment—showing how policies communicate beyond topics of substance via tonal registers and affective dimensions that configure feasibility of implementation, stakeholder engagement potential, and perceived urgency across temporal periods and geographic contexts.

The policy tone hierarchy (**Fig 5a**) comes out as aspirational/visionary dominance, 2.97% text density, 71.3% documents/144 policies, followed by technical/neutral, 1.2%, 12.4%/25 documents, participatory, 1%, 6.9%/14 documents, problem/crisis-oriented, 0.6%, 4%/8 documents, and regulatory/prescriptive lowest, 0.56%, 54%/11 documents, showing overwhelming forward-looking positive framing over regulatory prescriptions or crisis rhetoric. Sentiment analysis showed a slight positive bias (mean compound 0.0125, with 72.3% positive policies, 146 documents), 22.3% neutral, 45, and 54% negative, 11, maintaining solution-oriented framing despite addressing urban challenges such as pollution, climate, and inequality. Temporal patterns reveal aspirational intensification: 2.65% for 2000-09 → 2.92% for 2010-19, +1% → 3.29% for 2020-25, +24% total, accelerating post-SDGs and the New Urban Agenda. Sentiment evolved through 73.5% positive for 2000-09 → 67.6% for 2010-19, dipping during peak activity → 80.3% for 2020-25, “positivity surge”, exhibiting rhetorical optimism despite Covid-19 and the climate crisis. Subsidiary trends included a technical tone decline (1.28% → 1.06%), less technocratic language, regulatory stability (~ 0.56% consistently low), problem-oriented fluctuation (0.5% → 0.71% → 0.48%), participatory stagnation (~ 1% throughout), and modest participatory rhetoric. The obtained patterns mean that urban policy operates along the axis of aspirational-technical rather than along regulatory-prescriptive frameworks, maintaining optimistic future-oriented discourse that becomes more intensive over time while crisis framing, regulatory prescription, and participatory emphasis are minimized. Such strategic rhetorical positioning favors visionary mobilization over compliance enforcement or problem acknowledgment, potentially reflecting the institutional preference for consensus-building aspirational narratives over confrontational crisis discourses or binding regulatory mandates.

Regional tone patterns (**Fig 5b**) reveal distinct rhetorical strategies. Aspirational emphasis peaked in Asia and the Middle East (3.12%), Oceania (3.11%), America (3%), Africa (2.82%),

and Europe (2.48%; most pragmatic orientation). On the other hand, regulatory intensity is the inverse: Africa leads (0.65%) as the highest governance prescription, followed by Asia (0.61%), Europe (0.52%), the Americas (0.51%), and Oceania (0.44%) as the least regulated. Problem-oriented framing is concentrated in Africa (1.05%, reflecting development challenges) and America (0.75%, reflecting concerns for inequality/sprawl), followed by Oceania (0.52%), Asia (0.44%), and Europe (0.43% (least crisis-focused)). The sentiment distribution ranges from the exceptionalism of Asia and the Middle East (88.2% positive and % negative policies) to unprecedented optimism; Oceania, 72.% but 12% negative (the highest negativity); the Americas, 68.2%; Europe, 64.9%, and 32.4% neutral (most cautious); and Africa (62.5%, and 12.5% negative). These patterns expose geographic epistemic divides: the extraordinary rhetorical optimism of Asia without crisis framing; pragmatic-cautious posturing in Europe, which minimizes aspiration while maximizing neutrality; Africa balances regulatory prescription with problem acknowledgment, reflecting infrastructure imperatives; Oceania combines high aspiration with notable negativity, which speaks to the honest recognition of crises alongside an optimistic vision; and the Americas occupy middle ground across dimensions. The variations across regions suggest that development contexts shape rhetorical strategies. Emerging economies deploy aspirational mobilization, as in Asia's zero-negative optimism-developed regions, which exercise cautious pragmatism-European neutrality, while in developing contexts, material constraints are confronted through regulatory-problem framings-African governance prescriptions and crisis acknowledgment.

The country-level analysis (**Fig 5c**) revealed distinct rhetorical profiles. Aspirational leadership is found in Bosnia and Herzegovina (4.18%, rural development rhetoric), the UAE (3.49%, vision-driven planning), and Australia (3.33%) for the highest forward-looking discourse intensity. Regulatory emphasis is concentrated in China (1.39%, for a centralized governance model), Mexico (0.94%), and Burkina Faso (0.88%), all of which demonstrate a prescriptive orientation. Stronger optimism framing was observed in China (0.024) as the highest compound score, followed by the UAE (0.02) and Costa Rica (0.018). Technical orientation was prominent in Burkina Faso (2.12% capacity-building focus), Italy (1.72% waste management technicality), and Canada (1.52%), reflecting implementation-focused discourse. These patterns expose correlations (**Fig 5d**) with governance models: authoritarian systems combine high regulatory prescriptions with exceptional positivity; Gulf states deploy an aspirational-positive nexus; post-conflict regions mobilize aspirational leadership; developed conservation leaders maintain a balance between aspiration and positivity; and capacity-

constrained contexts prioritize technical implementation discourses. These country profiles hint at the political economy of rhetorical strategies, where centralized systems afford regulatory-optimistic combinations, resource-rich contexts allow for vision-driven positivity, post-conflict transitions demand aspirational reconstruction narratives, and technical-capacity gaps necessitate pragmatic implementation-focused discourses whatever the wider political orientation may be.

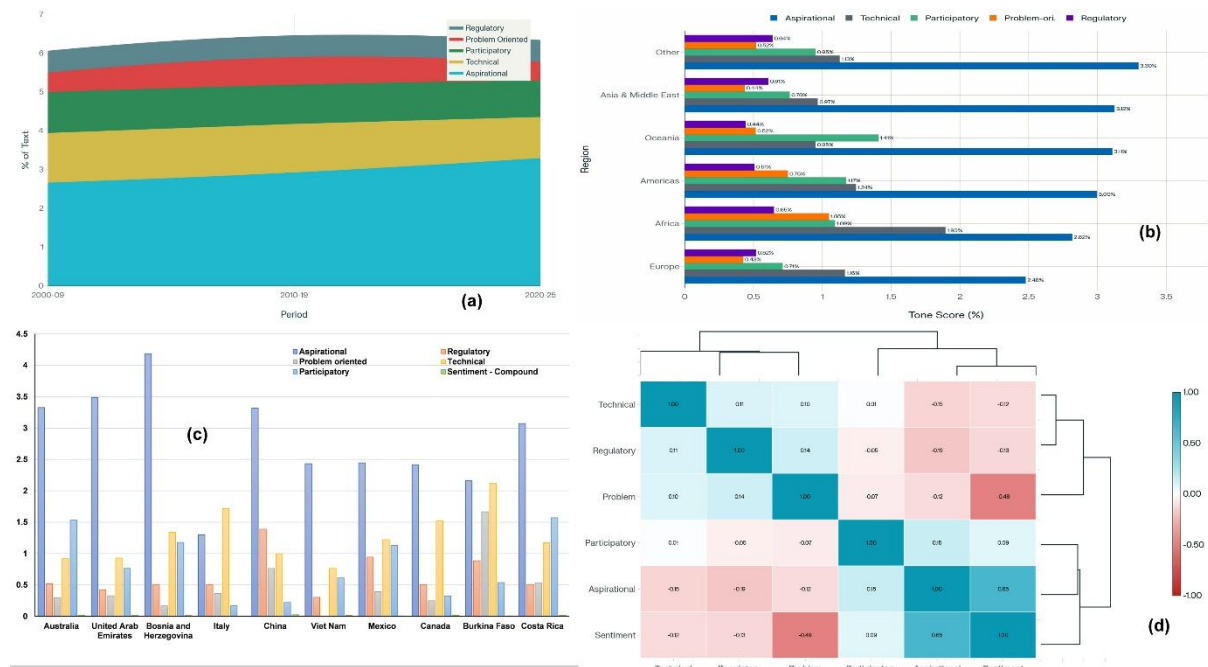


Figure 5. Sentiment & tone analyses. (a) Temporal evolution of policy tone. (b) Regional tone profiles. (c) Policy tone sentiment by country. (d) Correlation matrix of policy framing dimensions.

## 5. Conclusion:

This study of 202 global urban policies (1984-2025) from 85 countries reveals fundamental structuring in the environmental governance discourse. Climate terminology evolved from a specialized concern to an organizing principle, characterizing 52.5% of the 2020s policies and dominating the strongest keyword co-occurrence pairs. However, this mainstreaming generated paradoxical outcomes: the climate achieved conceptual hegemony rather than integration, systematically displacing rather than synthesizing complementary imperatives.

The network topology reveals asymmetric power structures, as the Climate & Sustainability Core had 5 times connectivity density compared to Water Resources and 10 times connectivity density compared to Economic Development communities. However, critical domains have been severely marginalized: water terminology, biodiversity, and participatory concepts. This is despite the escalation of ecological crises and international equity commitments (i.e., SDG 6, CBD Post-2020 Framework, New Urban Agenda). Certain buzzword concepts have emerged in this trend at the same time, such as the circular economy, which increased meteorically, while migration disappeared along with desertification, community management, and indigenous knowledge, all of which decreased. This shows evidence of zero-sum competition in policy discourse, wherein new, ascendant paradigms subsume or eliminate rather than add to established frameworks.

Geographic analysis reveals epistemological divides correlating with development stages: post-industrial economies privilege environmental framing, while the Global South maintains infrastructure-economic emphasis, exposing whose urban realities achieve codification, Australia's 15 policies versus Africa's systemic underrepresentation despite facing the most severe urbanization pressure. Federal governance structures enable sub-national experimentation in Oceania and Africa, confirming decentralization as a requisite for policy innovation, while capacity constraints prevent developing regions from translating lived experiences into recognized policy instruments.

Rhetorical analysis revealed the dominance of the aspirational-technical axis, with an extraordinary positivity surge in the 2020s despite the pandemic and climate crises, indicating a strategic preference for consensus-building mobilization over confrontational crisis framing or binding mandates. The regional disparities in sentiment are stark, ranging from Asia's exceptional optimism to Europe's cautious pragmatism. These show how political economy shapes discourse strategies: emerging economies deploy aspirational rhetoric while developed regions show restraint, and authoritarian systems combine optimism with regulatory prescriptions.

These patterns confirm the study's central thesis that contemporary urban governance replaced sectoral silos with climate hegemony, not with integration, creating new hierarchies subordinating biodiversity, water security, social equity, and participatory governance beneath climate-mediated frameworks. The presence of universal bridge keywords (Policy/Planning,

Climate Change, Sustainable Development) in all communities connecting eight out of eight thematic clusters could indicate either a genuine integration of the systems or superficial terminological unification masking persistent fragmentation; methodological limitations rule out any possibility of distinguishing authentic conceptual synthesis from bureaucratic language conventions.

Policy implications demand explicit rebalancing mechanisms: weighted integration indices that ensure that non-climate domains maintain autonomous visibility, protected vocabulary preventing their absorption into undifferentiated sustainability rhetoric, mandatory equity baselines that would translate SDG commitments into measurable discourse presence, and sub-national capacity investment enabling Global South policy entrepreneurship. Unless structural corrections are introduced, there is a risk that international frameworks will continue to promote Northern environmental priorities as universal governance templates while crowding out Southern development imperatives and participatory democratic approaches essential for just urban transitions. Future research should use longitudinal case studies that trace whether climate integration actually operationalizes biodiversity and equity goals or yields rhetorical compliance without substantive action; comparative policy outcome analysis that tests whether climate-centric versus multi-objective frameworks produce superior ecological and social outcomes; and discourse network analysis across non-English corpora that uncover whether observed patterns reflect global convergence or anglophone-specific trajectories. Understanding whether keyword co-occurrence measures authentic integration or bureaucratic homogenization requires qualitative validation through implementation assessments and stakeholder interviews that expose gaps between policy language and lived governance practices.

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### **List of Abbreviations**

1. ACT = Australian Capital Territory,
2. ANOVA = Analysis of Variance,
3. CBD = Convention on Biological Diversity,
4. DNA = Discourse Network Analysis,
5. EIA = Environmental Impact Assessment,
6. EU = European Union,
7. FAOLEX = Food and Agriculture Organization Legal Database,
8. GHG = Greenhouse Gas,
9. IPCC = Intergovernmental Panel on Climate Change,
10. MDGs = Millennium Development Goals,
11. NDCs = Nationally Determined Contributions,
12. OECD = Organisation for Economic Co-operation and Development,
13. pp = percentage points,
14. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses,
15. SDG = Sustainable Development Goal,
16. TF-IDF = Term Frequency-Inverse Document Frequency,
17. UAE = United Arab Emirates,
18. UN = United Nations,
19. UNEP = United Nations Environment Programme,
20. UNESCO = United Nations Educational, Scientific and Cultural Organization,
21. UNFCCC = United Nations Framework Convention on Climate Change,
22. UN-Habitat = United Nations Human Settlements Programme,
23. VADER - Valence Aware Dictionary and Sentiment Reasoner,

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