

Barriers to sustainable urban green space management: A review of limitations and integrative proposals – Supplementary materials

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Table S1. Summary of reviewed documents on UGS management limitations and proposed responses

Study	Identified Limitations	Suggested Measures	Coverage
Aly and Dimitrijevic (2022) [20]	Lack of holistic planning; reduced budgets	Strategic planning; performance monitoring	World
Bressane et al. (2024) [48]	Land pressure; conflicts; weak public participation	Vertical greening; equitable funding; participatory planning	Local (São Paulo, BR, South America)
Brown and Fagerholm (2015) [58]	Mapping-data integration issues	Participatory mapping; context-specific guidelines	World
Costadone and Vierikko (2023) [21]	Competing land uses; poor coordination	Green planning; participatory budgeting	European (IT, FI, NL, PT, SE)
Daniels et al. (2018) [27]	No multidimensional assessment	Holistic guidelines; citizen inclusion	European
Dapsopoulou et al. (2024) [54]	Biomass waste inefficiencies; environmental cost; no circularity	Closed-loop systems; local processing; circular economy models	Local (Athens, GR, Europe)
Davies and Laforteza (2017) [52]	Insufficient green-grey integration	Multifunctionality; cross-sector collaboration	European (AT,DE,DK,ES,FI,HU,IT, NL,PL,PT,RO,SE,SK,UK)
Dennis and James (2016) [57]	Valuation challenges; limited data	Ground-level productivity assessments	Local (Manchester, UK, Europe)
Feltynowski et al. (2018) [38]	Data inconsistency; fragmented roles	Integrated inventories; better collaboration	Local (Lodz, PL, Europe)
Galdino et al. (2022) [28]	Poor infrastructure; weak governance	Manager training; participatory governance	Local (Foz do Iguaçu, Brazil)
Haaland and van den Bosch (2015) [49]	Densification pressure	Ecosystem services framing; quality criteria	World
Hasan and Haider (2023) [29]	Poor planning; regulatory weakness; encroachment	GI master plans; institutional collaboration; community stewardship	Local (Chittagong, BD, South Asia)
Huang et al. (2025) [41]	Measurement bias in remote sensing and street-level greenery estimates; inconsistency across scales; overreliance on visual proxies	Use hybrid data sources; calibrate metrics with ground truthing; incorporate multi-scale greenery indicators	World (AE, KR, NL,ZA, SG,... 10 in total)
Hussain et al. (2024) [59]	Lack of resources; urban encroachment; poor coordination	Social media use; awareness campaigns; digital collaboration	Local (Gilgit-Baltistan, PK, South Asia)
Ives et al. (2017) [42]	Top-down bias; low insight use	PPGIS; participatory planning	Local (New South Wales, AU, Oceania)
Jia et al. (2024) [51]	Disconnection between urban design and green stormwater management; limited planning tools for landscape-scale integration; siloed implementation	GIS-based design framework; scenario planning tools; interdepartmental coordination in planning	Local (Sidney, AU, Oceania)
Kabisch (2015) [22]	Funding shortages; loss of expertise	Awareness; cross-actor collaboration	Local (Berlin, DE, Europe)
Koprowska et al. (2020) [50]	Urban sprawl; low green access	Sustainable land use planning	Local (Lodz, PL, Europe)
Laatikainen et al. (2015) [43]	Aquatic areas underrepresented	Inclusive GIS approaches	Local (Helsinki, FI, Europe)
Latinopoulos (2022) [44]	Lack of user preference data	Surveys; spatial planning	Local (Halkidiki, GR, Europe)
Li et al. (2024) [36]	UGS-urban growth mismatch; poor sustainability focus; no data use	Big data models; UGS typology; integrated urban frameworks	Local (Luohe, CH, East Asia)
Lindholst et al. (2016) [30]	Weak quality definitions	Inclusive quality frameworks	European (FI, NO)
Malik (2017) [31]	Policy gaps; poor coordination	Asset mgmt.; community roles	Local (Depok, ID, Southeast Asia)

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Mpofu (2013) [23]	Lack of policy and manpower	Policy frameworks; agency coordination	Local (Addis Ababa, ET, Africa)
Qin et al. (2024) [32]	Lack of tailored strategies; poor demographic coverage; limited data	MGWR tools; multifunctional parks; improved data collection	Local (Changsha, CH, East Asia)
Rambhia et al. (2024) [25]	Limited resources for green space expansion; lack of prioritization tools; disconnection between socio-ecological needs and investments	Multi-criteria prioritization frameworks; vulnerability mapping; co-benefit optimization for resource allocation	World (DE, AU)
Randrup et al. (2020) [37]	Funding shortages; limited documentation	Strategic funding; indicators	European (DK, FI, IS, NO, SE)
Raymond et al. (2016) [35]	Limited justice integration	User diversity; spatial targeting	Local (Helsinki, FI, Europe)
Rigolon (2016) [45]	Inequity in park access	Community design; private partnerships	Global (AU, BO, CA, DE, IL, UK, US, ZA)
Rutt and Gulsrud (2016) [26]	Privatization; equity neglect	Justice-based frameworks	European
Schetke et al. (2016) [53]	Overuse; environmental stress	Planning balance; infrastructure upgrades	World (PK, VN)
Šunjević et al. (2024) [33]	Health inequities; poor planning integration; siloed governance	Health criteria in UGS; planning standards; intersectoral coordination	Local (Novi Sad, RS, Europe)
Wang et al. (2024) [55]	Heat/air pollution stress	Afforestation; optimize greenery	Global
World Health Organization (2017) [46]	Safety issues; gentrification	Maintenance; design equity	European (EU level)
Wolff et al. (2015) [39]	Awareness gaps; urbanization	ES inclusion in planning	Global (both national and international levels)
Xu et al. (2022) [34]	Lack of zoning clarity	Standardized land use; monitoring	European (50 EU cities)
You (2016) [47]	Inequity in green access	Governance reform; distribution equity	Local (Shenzhen, CH, East Asia)
Zhang et al. (2024) [40]	Uneven UGS distribution; low ecological capacity; ignored preferences	Resident-aligned planning; ecological tools; multifunctionality	Global (AE,CH,CN,DE,,GR,US)
Zhang et al. (2025) [56]	Spatial CES mismatches; ecological degradation; data limitations	Integrated green planning; improved access; mixed methods assessment	Local (Nanjing, CH, East Asia)
Zong et al. (2024) [24]	High maintenance costs; low engagement; operational disruptions	Tailored engagement; co-management models; better communication	Local (Tokyo, JP, Northeast Asia)