PRISMA

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	**Towards sustainable cities: A review of green street management practices and performance**	title
ABSTRACT			
Abstract	2	Rapid urbanization and climate-related pressures have intensified the need for sustainable and multifunctional urban infrastructure. Green streets—streets designed to integrate vegetation-based and nature-based solutions into the public right-of-way—have emerged as a key component of urban green infrastructure, providing environmental, social, and economic benefits. Despite a growing body of literature, knowledge on green street management practices and their performance remains fragmented across disciplines and regions. This study presents a comprehensive review of green street management, combining bibliometric analysis with qualitative content assessment to synthesize global research trends, design components, management strategies, and performance outcomes. A systematic search of the Scopus and Web of Science (SCI-Expanded) databases yielded 929 peer-reviewed publications, which were analyzed using bibliometric methods and thematic review. The bibliometric analysis reveals a strong increase in scientific output since 2018, with research dominated by environmental sciences, urban studies, forestry, and engineering, and led primarily by contributions from the United States, China, Australia, and Canada. The qualitative review identifies key green street components—including bioswales, permeable pavements, rain gardens, tree trenches, and curb extensions—and evaluates their hydrological, ecological, and socio-economic performance. Results indicate that green streets can significantly reduce stormwater runoff, improve water and air quality, mitigate urban heat, enhance biodiversity, and contribute to urban livability when appropriately designed and managed. However, performance varies widely depending on local conditions, vegetation structure, maintenance regimes, and governance frameworks. The review also highlights the growing importance of social perception, equity, and participatory planning, as well as advances in assessment methods using remote sensing, street-level imagery, and GIS-based tools. Persistent research gaps include limited long-term monitoring, underrepresentation of cities in the Global South, and insufficient integration of governance, economic, and social dimensions. Overall, this review underscores the role of green streets as multifunctional socio-ecological systems and provides an integrated knowledge base to support evidence-based planning, policy development, and future research aimed at fostering sustainable, resilient, and inclusive urban streetscapes	Abstract of the paper
INTRODUCTION			
Rationale	3	The goal of this study is to provide a comprehensive and systematic review of green street management practices and their performance in the context of sustainable urban development. Specifically, the article aims to (i) map and analyze global research trends through a bibliometric assessment of the scientific literature; (ii) synthesize existing knowledge on the design components, management strategies, and assessment methods associated with green streets; and (iii) evaluate the environmental, social, and economic performance of green street systems across diverse geographic and socio-economic contexts. By integrating quantitative bibliometric analysis with qualitative thematic review, this study seeks to identify key drivers, governance challenges, and	Introduction Pag 2

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		knowledge gaps, thereby supporting evidence-based planning, implementation, and policy development for sustainable and resilient urban streetscapes	
Objectives	4	Specifically, the article aims to (i) map and analyze global research trends through a bibliometric assessment of the scientific literature; (ii) synthesize existing knowledge on the design components, management strategies, and assessment methods associated with green streets; and (iii) evaluate the environmental, social, and economic performance of green street systems across diverse geographic and socio-economic contexts. By integrating quantitative bibliometric analysis with qualitative thematic review, this study seeks to identify key drivers, governance challenges, and knowledge gaps, thereby supporting evidence-based planning, implementation, and policy development for sustainable and resilient urban streetscapes.	Introduction Pag 3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. An initial search was conducted using the core term “green street management”, supplemented with additional keywords and Boolean operators to ensure broad thematic coverage. The extended keyword set included eco-street, sustainable street, green infrastructure. Boolean operators (AND/OR) were applied to refine and combine these terms. The selected keywords were intended to capture a diverse range of vegetation-based and agroforestry-related practices relevant to green street systems.	Material and methods Pag. 3
Information sources	6	To enhance reproducibility, the exact search strings used in each database were documented. Searches were conducted using advanced field tags, Boolean operators, quotation marks, and wildcards to account for plural forms and morphological variations. Scopus (advanced search; fields: TITLE-ABS-KEY): TITLE-ABS-KEY (“green street management” OR “green street*" OR "eco-street*" OR "sustainable street*" OR "green infrastructure"). Web of Science — SCI-Expanded (topic search; TS): TS=(“green street management*” OR green street*" OR "eco-street*" OR "sustainable street*" OR "green infrastructure").	Material and methods Pag. 3
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used. The search period was unrestricted, covering all years indexed up to the date of retrieval. Eligible document types included peer-reviewed journal articles, conference proceedings, book chapters, and review papers. Editorials, correspondence items, and academic theses were excluded during the screening phase. De-duplication and data quality assurance Duplicate records were identified and removed using a two-step procedure. First, automated filtering based on Digital Object Identifiers (DOIs) and exact title matches was performed using Microsoft Excel. Second, remaining records were manually reviewed by comparing titles, first authors, publication years, and journal names to resolve cases with missing or inconsistent DOI information. This process resulted in the removal of a defined number of duplicate entries.	Material and methods Pag. 4
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. Study selection followed a two-stage screening approach consisting of (i) title and abstract screening and (ii) full-text assessment. Inclusion criteria were: peer-reviewed articles or reviews published in English, a primary focus on green street management, and the availability of sufficient bibliographic metadata. Exclusion criteria included non-peer-reviewed material (editorials, correspondence, posters, theses, and patents), studies unrelated to green street management, marginal or peripheral mentions of the topic, inaccessible full texts, and records lacking	Material and methods Pag. 4

Section and Topic	Item #	Checklist item	Location where item is reported
		abstracts. Full-text exclusions were categorized using standardized codes: (A) out of scope, (B) non-peer-reviewed or editorial content, (C) absence of relevant green street or vegetation-based management data, (D) inaccessible full text, and (E) insufficient methodological detail. Representative examples of excluded studies are provided in the Supporting Information.	
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. Two independent reviewers (Reviewer A and Reviewer B) conducted the screening process. During the first stage, titles and abstracts were evaluated independently, and records identified as potentially relevant by either reviewer were advanced to full-text review. In the second stage, full texts were assessed independently. Any disagreements were resolved through discussion with a third senior reviewer (Reviewer C), who acted as an adjudicator. Final dataset and analytical procedures Following completion of the screening process and resolution of reviewer disagreements, a final set of 929 publications was selected for bibliometric and qualitative analysis (Figure 1). The bibliometric assessment examined nine dimensions: publication type, research discipline, year of publication, geographic distribution, authorship patterns, institutional affiliations, journals, publishers, and keyword usage. Data processing and visualization were conducted using Scopus, the Web of Science Core Collection (version 5.35, Clarivate), Microsoft Excel (version 2024), and Geochart. Network analyses of co-authorship, co-citation, and keyword co-occurrence were performed using VOSviewer (version 1.6.20)	Material and methods Pag. 4
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. The main result that we search for by keywords is a data structure that includes - the type of result - article, conference presentation, etc., the year, the authors and countries of which it is part and the abstract of the paper. Our bibliometric analysis took into consideration: (1) publication types, (2) research areas, (3) publication years, (4) countries, (5) authors, (6) institutions, (7) language, (8) journals, (9) publishers, and (10) keywords. We used Web of Science Core Collection tools (version 5.35, Clarivate), Scopus, Excel (version 2024), and Geochart in order to process the data. We also used VOSviewer (version 1.6.20) to generate the maps and analysis clusters	Material and methods Pag. 4
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. This analysis enabled a deeper exploration of thematic patterns and knowledge production within the field. The findings were organized into six major thematic domains: (1) Green Street components and design features; (2) Global research trends in green street management; (3) Case studies and examples of sustainable green street practices; (4) Assessment and monitoring methods for urban green streets; (5) Governance frameworks, management strategies, and implementation challenges; (6) Social perception, public participation, and equity considerations in green street planning	Material and methods Pag. 5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. In general, there is no automated stage. The findings were organized into six major thematic domains: (1) Green street components and design features; (2) Global research trends in green street management; (3) Case studies and examples of sustainable green street practices; (4) Assessment and monitoring methods for urban green streets; (5) Governance frameworks, management strategies, and implementation challenges; (6) Social perception, public participation, and equity considerations in green street planning	Material and methods section Pag 5

Section and Topic	Item #	Checklist item	Location where item is reported
		The thematic structure and analytical workflow are summarized in Figure 2.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. I don't think this question is applicable. We don't have a risk analysis, mean difference for a review article.	Material and methods section
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). Two independent reviewers (Reviewer A and Reviewer B) conducted the screening process. During the first stage, titles and abstracts were evaluated independently, and records identified as potentially relevant by either reviewer were advanced to full-text review. In the second stage, full texts were assessed independently. Any disagreements were resolved through discussion with a third senior reviewer (Reviewer C), who acted as an adjudicator.	Material and methods section Pag 4
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions. The methods that required to prepare data for presentation or synthesis, such as managing summary statistics, are based on the use of csv files. Mainly, statistical analyses performed with TIBCO Statistics V13 or SPSS version v.20 are based on database processing and the creation of correlations, graphs. etc..	Results section 3.1. A Bibliometric review Pag. 6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses. For visualization, we use methods such as histogram representation, box plot and scatter plot, or box-pie representations	Results section 3.1. A Bibliometric review Pag. 6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. Two independent reviewers (Reviewer A and Reviewer B) conducted the screening process. During the first stage, titles and abstracts were evaluated independently, and records identified as potentially relevant by either reviewer were advanced to full-text review. In the second stage, full texts were assessed independently. Any disagreements were resolved through discussion with a third senior reviewer (Reviewer C), who acted as an adjudicator. The methods that required to prepare data for presentation or synthesis, such as managing summary statistics, are based on the use of csv files. Mainly, statistical analyses performed with TIBCO Statistics V13 or SPSS version v.20 are based on database processing and the creation of correlations, graphs. etc. The bibliometric analysis identified a total of 929 publications on this topic. The vast majority consisted of research articles (722 records, 78%), followed by 137 proceedings papers (15%), 46 review articles (5%), and 24 book chapters (2%) (Figure 3).	Results section 3.1. A Bibliometric review Pag. 5
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression). The methods used to explore the possible causes of the heterogeneity of the study results cannot be applied in this case	Results section
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results. The bibliometric analysis identified a total of 929 publications on this topic. The vast majority consisted of research articles (722 records, 78%), followed by 137 proceedings papers (15%), 46 review articles (5%), and 24 book chapters (2%) (Figure 3).	Results section Pag 6

Section and Topic	Item #	Checklist item	Location where item is reported
		This method shows robustness of the synthesized results	
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). Screening and reviewer agreement Two independent reviewers (Reviewer A and Reviewer B) conducted the screening process. During the first stage, titles and abstracts were evaluated independently, and records identified as potentially relevant by either reviewer were advanced to full-text review. In the second stage, full texts were assessed independently. Any disagreements were resolved through discussion with a third senior reviewer (Reviewer C), who acted as an adjudicator. Following completion of the screening process and resolution of reviewer disagreements, a final set of 929 publications was selected for bibliometric and qualitative analysis (Figure 1). The bibliometric assessment examined nine dimensions: publication type, research discipline, year of publication, geographic distribution, authorship patterns, institutional affiliations, journals, publishers, and keyword usage. No biases and no missing results and no	Results section Pag 6
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. The bibliometric analysis identified a total of 929 publications on this topic. The vast majority consisted of research articles (722 records, 78%), followed by 137 proceedings papers (15%), 46 review articles (5%), and 24 book chapters (2%) (Figure 3).	Results section Pag 7
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. The bibliometric analysis identified a total of 929 publications on this topic. The vast majority consisted of research articles (722 records, 78%), followed by 137 proceedings papers (15%), 46 review articles (5%), and 24 book chapters (2%) (Figure 3).	Results section Pag 6
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. All retrieved records were screened and refined in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. This ensured transparency, reproducibility, and methodological consistency throughout the review process. Study selection followed a two-stage screening approach consisting of (i) title and abstract screening and (ii) full-text assessment. Inclusion criteria were: peer-reviewed articles or reviews published in English, a primary focus on green street management, and the availability of sufficient bibliographic metadata. Exclusion criteria included non-peer-reviewed material (editorials, correspondence, posters, theses, and patents), studies unrelated to green street management, marginal or peripheral mentions of the topic, inaccessible full texts, and records lacking abstracts. The large number of articles published on this topic has resulted in their classification across a wide range of research areas. Among the 70 identified categories, Environmental Sciences/Ecology is by far the most strongly represented (360 articles), followed by Urban Studies (162 articles), Forestry (120 articles), and Engineering (104 articles) (Figure 5).	Material and methods section Pag. 4
Study characteristics	17	Cite each included study and present its characteristics. This analysis enabled a deeper exploration of thematic patterns and knowledge production within the field. The findings were organized into six major thematic domains: (1) Green Street components and design features; (2) Global research trends in green street management; (3) Case studies and examples of sustainable green street practices; (4) Assessment and monitoring methods for urban green streets; (5) Governance frameworks, management strategies, and implementation challenges; (6) Social perception, public participation, and equity considerations in green street planning The thematic structure and analytical workflow are summarized in Figure 2	Material and methods section Pag. 5
Risk of bias in studies	18	Present assessments of risk of bias for each included study. I don't think this question is applicable. We don't have a risk analysis, mean difference for a review article.	Results section

Section and Topic	Item #	Checklist item	Location where item is reported
			Pag 7
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimates and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. This analysis enabled a deeper exploration of thematic patterns and knowledge production within the field. The findings were organized into six major thematic domains: (1) Green street components and design features; (2) Global research trends in green street management; (3) Case studies and examples of sustainable green street practices; (4) Assessment and monitoring methods for urban green streets; (5) Governance frameworks, management strategies, and implementation challenges; (6) Social perception, public participation, and equity considerations in green street planning The thematic structure and analytical workflow are summarized in Figure 2	Results section Pag 6
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. We made such synthesis as: Overview of the principal publication types on green streets management – see Figure 3. Distribution per year of articles concerning green streets management – see Figure 4. Distribution of the primary research areas in publications on green streets management – see Figure 5. Geographic distribution of authors contributing to green streets management research – see Figure 6. Country clusters of authors publishing on green streets management – see Figure 7. The main journals where articles on green streets management have been published. – see Figure 8. Commonly used keywords by authors in green streets management publications – see Figure 9. I don't think the question of risk of bias among contributing studies is applicable.	Results section Pag. 7 -13
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. Overview of the principal publication types on green streets management – see Figure 3. Distribution per year of articles concerning green streets management – see Figure 4. Distribution of the primary research areas in publications on green streets management – see Figure 5. Geographic distribution of authors contributing to green streets management research – see Figure 6. Country clusters of authors publishing on green streets management – see Figure 7. The main journals where articles on green streets management have been published. – see Figure 8. Commonly used keywords by authors in green streets management publications – see Figure 9. We did no analyse the statistical heterogeneity	Results section Pag. 7 -13
	20c	Present results of all investigations of possible causes of heterogeneity among study results. I don't think this question is applicable. We don't have of heterogeneity results analysis, mean difference for a review article.	Results section Pag. 7 -13
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. I don't think this question is applicable. We used the largest databases This bibliometric analysis identified a total of 929 publications on this topic. The vast majority consisted of research articles (722 records, 78%),	Material and methods section

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		followed by 137 proceedings papers (15%), 46 review articles (5%), and 24 book chapters (2%) (Figure 3).	Results section
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. I don't think this question is applicable. We did not assessments of risk of bias due to missing results	Material and methods section
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. We used the largest databases with relevant publications, we have used tools such as the Science Citation Index Expanded (SCI-Expanded) within the Web of Science database, and Scopus. We then proceeded to evaluate each strategy and identify the most used keywords. This bibliometric analysis identified a total of 929 publications on this topic. The vast majority consisted of research articles (722 records, 78%), followed by 137 proceedings papers (15%), 46 review articles (5%), and 24 book chapters (2%) (Figure 3).	Material and methods section
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence. As in other cases, journal articles account for the predominant share of publications on this topic; however, in the case of green streets, a notably high proportion of proceedings papers (15%) is observed, which is approximately double that reported in other contexts. The marked increase in the number of publications after 2018 is similar to trends identified in other studies and can be attributed, on the one hand, to the growing number of authors and specialized journals, and, on the other hand, to the increasing interest in this subject. The strong interest shown by researchers in this topic is reflected in the large number of research areas to which the published articles are assigned, the wide range of journals in which they appear, and the high number of countries represented. From this perspective, the countries ranking highest (the USA, China, Australia, and Canada) are also prominent in other topics, their presence in this case being partly explained by the large number of cities in these countries where street management is a priority. This is evidenced by the substantial number of case studies conducted in U.S. and Chinese cities, which have adopted and, in practice, implemented guidelines related to green streets management.	Discussion 4.1. A bibliometric review Pag. 22
	23b	Discuss any limitations of the evidence included in the review. In conclusion, green streets represent a critical interface between gray infrastructure, natural systems, and urban society. Their successful implementation requires interdisciplinary knowledge, context-sensitive design, inclusive governance, and long-term commitment. By synthesizing current evidence and identifying key research gaps, this review provides a foundation for future research and supports policymakers, planners, and practitioners in developing green street strategies that contribute meaningfully to sustainable, resilient, and livable cities.	Discussion 4.1. A bibliometric review Pag. 22
	23c	Discuss any limitations of the review processes used. The reviewed studies collectively demonstrate that social perception, participation, and equity are central to the success of green street planning and management. Across diverse geographic and cultural contexts, residents consistently value green streets for their aesthetic, environmental, and health-related benefits. However, perceptions are shaped by socioeconomic status, demographic factors, and local context, highlighting the need for equity-sensitive planning approaches. A key finding is the importance of integrating subjective perceptions with objective urban data. Participatory tools and mixed-method approaches provide richer insights into urban safety, livability, and infrastructure performance than technical assessments alone [154]. This integration remains underutilized in conventional urban governance, particularly in sectors such as security and infrastructure maintenance.	Conclusions section – pag. 26
	23d	Discuss implications of the results for practice, policy, and future research. Equity considerations emerge as a critical dimension. Preferences and perceptions vary across income levels and neighborhood types, suggesting that uniform green street strategies may reinforce existing inequalities if not carefully tailored. Valuation studies further indicate that	Conclusions section – pag. 26

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		street-level greening is particularly valued by residents, providing a strong justification for prioritizing such interventions in dense urban areas. Finally, multi-actor governance and institutional coordination are essential for scaling up green street implementation. Studies emphasize the need for standardized typologies, stakeholder alignment, and formal consultation mechanisms to navigate the contested nature of public space and ensure long-term sustainability. Overall, the evidence suggests that green streets function not only as technical solutions for stormwater and climate adaptation, but also as socio-ecological systems. Their success depends on meaningful participation, context-sensitive design, equitable distribution, and sustained engagement between public authorities, professionals, and urban residents.	
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered. This study was no registered	
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	
	24c	Describe and explain any amendments to information provided at registration or in the protocol. This study was no registered	
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. We provide such information for financial support.	
Competing interests	26	Declare any competing interests of review authors. No competing interests of review authors	
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. These elements - template data collection forms; data extracted from included studies will be provided after publication	

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.
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