



Review

A systematic review on the ecosystem services provided by green infrastructure

Daniel Jato-Espino^{a,*}, Fabio Capra-Ribeiro^b, Vanessa Moscardó^a, Leticia E. Bartolomé del Pino^a, Fernando Mayor-Vitoria^a, Laura O. Gallardo^c, Patricia Carracedo^d, Kristin Dietrich^a

^a GREENIUS Research Group, Universidad Internacional de Valencia – VIU, Calle Pintor Sorolla 21, 46002 Valencia, Spain

^b College of Art & Design, Louisiana State University, 102 Design Building, 70803 Baton Rouge, LA, United States

^c Faculty of Social Sciences and Humanities, University of Zaragoza, Calle Atarazana 4, 44003 Teruel, Spain

^d Department of Applied Statistics, Operations Research and Quality, Universitat Politècnica de València, Plaza Ferrándiz y Carbonell s/n, 03801 Alcoy, Spain

ARTICLE INFO

Keywords:

Climate change
Biodiversity
Ecosystem services
Green infrastructure
Urbanization

ABSTRACT

Urbanization and climate change are endangering the sustainability of public spaces through increased land artificialization, ecological fragmentation, reduced resource availability, and limited accessibility to natural and seminatural areas. Properly managing Green Infrastructure (GI) can contribute to mitigating these challenges by delivering multiple provisioning, regulating, supporting and cultural Ecosystem Services (ES). This would facilitate the implementation of strategically planned GI networks in cities for urban regeneration purposes. In this context, this study developed a systematic review on the ES provided by GI using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The analysis of 199 eligible articles indicated that more efforts should be made to address more ES at once, which connects to the need for conceiving GI as a strategically planned network of areas aimed at delivering diverse benefits. Based on the methods used in the items reviewed, geoprocessing tools and multi-criteria decision analysis are proposed to develop systems of indicators capable of accounting for multiple ES. These systems should also rely on multidisciplinary and participative procedures to encompass various facets of GI and represent the priorities of all relevant stakeholders.

1. Introduction

Ecosystems underpin human quality of life through a variety of benefits that people obtain from them (Limburg et al., 2002). These are usually defined as Ecosystem Services (ES) and arranged into provisioning (food, water, timber or fiber), regulating (climate, floods, disease, waste or water quality), cultural (recreation, aesthetics or spiritual benefits) and supporting values (soil formation, photosynthesis or nutrient cycling) (Millennium Ecosystem Assessment Board, 2005).

Although there is a growing debate about ecosystems disservices that can be harmful to human wellbeing (pests, litter, biological hazards, etc.) (von Döhren and Haase, 2015), the maintenance of ecosystems has become a priority for years due to the increasing stress posed by land cover change, population density and urban sprawl (Long et al., 2014; Maes et al., 2015). The developments entailed by these phenomena often result in natural landscape alterations (Wang et al., 2020). In addition, some effects driven by climate change such as rising

temperature or droughts are also affecting the status of ecosystems (Turner et al., 2020).

As noticed by Tan et al. (2020), there is a paradox in the consideration of natural capital as the basis for human development and the constant exploitation of such capital. However, there is a need for supporting natural processes to face the current degradation of ecosystems, especially in urban areas (Adla et al., 2022). Hence, natural capital should be exploited responsibly to ensure the delivery of ES (Buonocore et al., 2020).

The use of Green Infrastructure (GI) has also been suggested in the scientific literature over the past years to better manage different ES (Amorim et al., 2021; Yacamán Ochoa et al., 2020). From the analysis of several definitions of GI (Interreg Central Europe, 2021), the EU project MaGICLandscape referred to GI as “a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned)

* Corresponding author.

E-mail address: djato@univiu.com (D. Jato-Espino).

<https://doi.org/10.1016/j.ufug.2023.127998>

Received 4 July 2022; Received in revised form 13 October 2022; Accepted 8 June 2023

Available online 9 June 2023

1618-8667/© 2023 The Authors. Published by Elsevier GmbH. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings" (European Commission, 2013).

More in detail, GI should contribute to better manage floods, heat stress, water scarcity, carbon storage, energy use, groundwater recharge, erosion, wellbeing, ecological connectivity, environmental education, aesthetics/amenity, food production or green job opportunities, among others (Choi et al., 2021). Even though these benefits are very diverse, most of them can be organized and understood as ES.

Considering the importance that GI and ES have in the present and future of the planet, the number of studies focused on both topics have increased over the past years. The literature contains different reviews on these topics whose figures vary depending on the search framework. Following the results of Parker and Zingoni de Baro (2019), the number of publications focused GI and ES have gone from less than 10 in 2010 to more than 180 in 2018.

These authors considered publications up to 2018, whilst others covered until 2016 (Wang and Banzhaf, 2018), 2017 (Suppakittpaisarn et al., 2017) and 2019 (Ying et al., 2022). The latter was particularly extensive by collecting more than 2000 publications; however, if the same search conditions were used again, 1500 new results would be obtained between 2020 and 2021. Considering this situation, we identified a need for developing a study to complement and update the trends in this field of research.

Among others, previous reviews highlighted important facts such as the ability of GI to positively affect the physical and mental health of individuals as well as the socio-economic conditions of communities (Suppakittpaisarn et al., 2017; Tzoulas et al., 2007). This links to the lack of studies focused on developing regions in Africa, Asia and South America as identified by Ying et al. (2022). The need for analyzing GI and its ES at different scales has also been emphasized by several authors (Lee and Oh, 2019; Minixhofer and Stangl, 2021; Tiwari et al., 2019). These facts, coupled with the urban and rural scope of the definition of GI considered, suggested that assessing the studies on GI and ES in geographic terms should be necessary.

Other authors put emphasis on multifunctionality as one of the key factors to magnify the benefits offered by GI (Caparrós-Martínez et al., 2021; Monteiro et al., 2020; Wang and Banzhaf, 2018). For this reason, addressing a topic as the combination of GI and ES has been argued to require a multidisciplinary approach. However, several authors agree in pointing out that this still needs to be addressed (Angelstam et al., 2013; Caparrós-Martínez et al., 2021; Choi et al., 2021; Wang and Banzhaf, 2018). Hence, analyzing the profiles of the authors who have published on the topic became a central concern of this study, since their most common fields of research may give insight into the involvement of different areas in the assessment of GI and ES.

The scope of these reviews is also quite diverse. For example, Tzoulas et al. (2007) focused on specific journals, Chatzimentor et al. (2020) studied only European publications, and Van Oijstaeijen et al. (2020) searched for toolkits. Likewise, some of them pointed to specific topics such as principles and urban and local practices (Monteiro et al., 2020), cultural services (Cheng et al., 2021) or climate change action, adaptation and mitigation (Choi et al., 2021). Despite this variety, we could not find any review that analyzed the different categories of ES and their relationships, which is essential to maximize the benefits delivered by strategically designed networks of GI. Therefore, it seemed relevant to account for the frequency, variety and form in which ES were addressed in the publications found. Finally, although some studies dealt with the methodological variety with which the subject is faced, we were also unable to find information on the specific methods used for planning, developing, applying and/or evaluating GI.

In light of these considerations, this review aimed at updating the existing knowledge on GI from the perspective of their ES, with emphasis on the analytical techniques used and the profile of the people participating in their assessment. With this, we sought to find response about which GI-related ES are more recurrent in the literature, how they

are addressed (methods applied) and who is conducting these studies (main disciplines involved).

The results to be achieved shall be of interest for policymakers because they can help identify priorities and strategies to preserve ecosystems due to their importance for human beings. Researchers can also benefit from the outputs of this review by finding knowledge gaps and ideas for collaboration opportunities, whereas practitioners and consultants might learn about methods to support the planning and implementation of GI for ES maximization.

The rest of the document is structured as follows: Section 2 describes the methodology used to conduct the review, which includes the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach as well as data mining and statistical tests. Next section presents and discusses the results collected, with emphasis on the ES addressed and the methods and research profiles involved in their analysis. The document ends by highlighting the main findings of the study, while suggesting some lines of research to develop in the future.

2. Methodology

The methodology used to conduct the systematic review was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach (Liberati et al., 2009), as shown in Fig. 1. The search strategy used before applying the PRISMA statement is described below. Furthermore, an overview of the process followed to examine the full texts is provided too. Finally, the text mining, frequency and statistical methods used to analyse the data extracted from these documents is outlined.

2.1. Search strategy

The motivation to develop this review follows a series of research questions (RQ) concerning the spatiotemporal trends of the publications in the field, as well as their scope in terms of ES, methods and profile of the researchers involved. These questions can be summarised as follows:

- RQ1: Is there any GI-related ES that is more frequently studied in the literature?
- RQ2: How many studies jointly address all the ES provided by GI?
- RQ3: What are the methods and models commonly used to assess GI benefits?
- RQ4: What are the profiles of the researchers involved in the study of GI and ES?
- RQ5: Are the existing scientific outputs evenly distributed in spatial terms (context, scale and country of origin)?
- RQ6: How is the evolution in the number of publications in this field of research since the last decade (2010–2021)?

To answer these questions, a search equation was built according to the following inclusion criteria (IC):

- IC1: The publications are original research articles involving novel contributions to the field of GI and ES AND
- IC2: The articles address GI from the perspective of their ES AND
- IC3: The articles are indexed in the Scopus database AND
- IC4: The articles are published in English, Spanish, Portuguese, Italian OR German

The first criterion (IC1) served to exclude publications derived from conferences, books, and book chapters. Furthermore, it also entailed the exclusion of papers lacking clear and original methodological contributions. This was important due to the scope of the review, which, among others, aimed at producing knowledge on the most suitable methods used to facilitate the strategic design of GI to maximize their ES. Therefore, publications exclusively focused on e.g., exploratory analyses or over-viewing case studies were discarded if they were not founded on the proposal and application of methods or combination of methods.

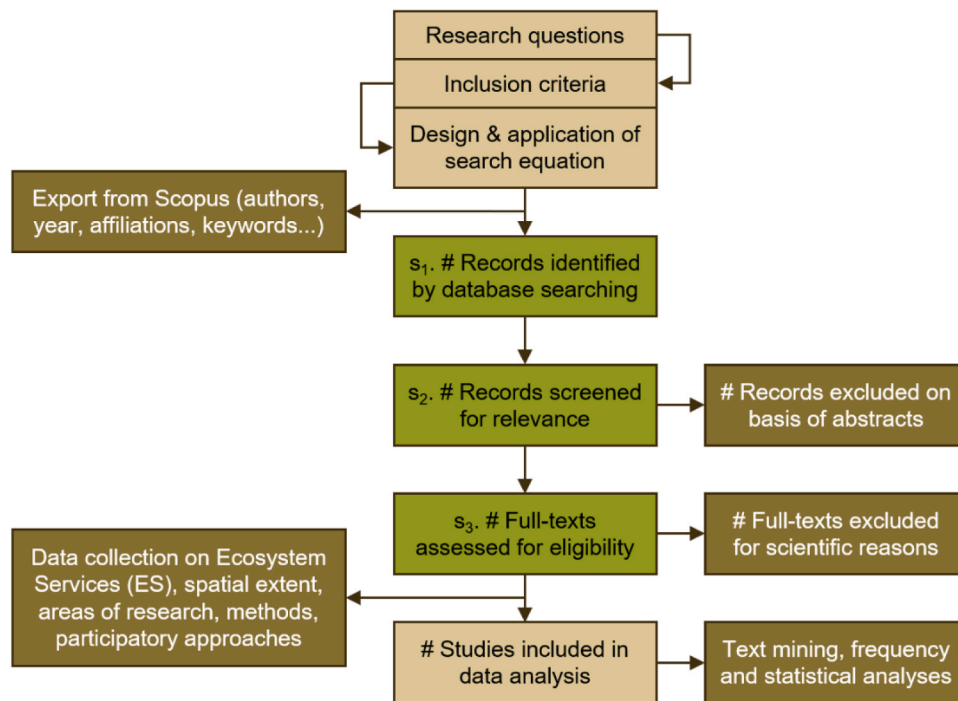


Fig. 1. Flowchart of the steps taken to conduct the systematic review. Adapted from the PRISMA statement (Liberati et al., 2009).

IC2 was relevant from a conceptual point of view, since linking GI with ES was the premise of this study. As such, those contributions not acknowledging this relationship explicitly were discarded. Despite the emergence of new scientific databases, Web of Science (WoS) and Scopus remain as the most comprehensive bibliographic sources nowadays. In line with the findings of Pranchutè (2021), the latter was chosen for being more practical and providing wider and more inclusive contents (IC3). It also includes profiles for all authors and institutions, which is especially relevant to apply the multidisciplinary approach proposed. The review was conceived to be carried out in English; however, other languages spoken fluently by the authors were also considered in IC4 for the sake of opportunity.

The combination of all these criteria resulted in the search query formulated in Eq. (1). As highlighted throughout this section, it included only two technical terms: GI and ES. The former was required in the title for being the core term of the review, while the latter was also accepted in the abstract and/or keywords of the documents.

TITLE (“green infrastructure”) AND TITLE-ABS-KEY (“ecosystem* service*”) AND DOCTYPE (“ar”) AND (LIMIT-TO (LANGUAGE,“English”) OR LIMIT-TO (LANGUAGE,“Spanish”) OR LIMIT-TO (LANGUAGE,“-Portuguese”) OR LIMIT-TO (LANGUAGE,“Italian”) OR LIMIT-TO (LANGUAGE,“German”)) (1)

The inclusion of ES in Eq. (1) instead of specific terms framed within these services aimed at encompassing studies showing a broad vision of the benefits of GI. This orientation is important to ensure a focus towards the very concept of GI, which must be understood as an interconnected network of spaces strategically planned to maximize its ES.

2.2. Data collection

The items returned by Eq. (1) were exported to comma-separated values (.csv) in Scopus, including the following fields: Author(s), Document title, Year (RQ6), Affiliations, Correspondence address, Abstract, Author keywords and Index keywords. Apart from these data, additional information was tabulated through the reading of the full-

texts of the remaining articles after the second filtering (s_2) of the PRISMA approach (Fig. 1).

Eight fields were added to identify the most frequently ES addressed in the literature (RQ1 and RQ2). Four of them indicated the absence (0) or presence (1) of the ES categories in the articles, whilst four others were devoted to indicating which terms in Table 1 were used for each category. These were established based on those suggested by international organisations (Egoh et al., 2012; FAO, 2022; National Wildlife Federation, 2022). In case some articles included terms not assimilable to those in Table 1, they were added separately.

Another field was added to specify the reasons for dropping articles throughout the different steps ($s_1 - s_3$) of the workflow (Fig. 1). The next two fields added manually were devoted to enumerating the methods applied in the articles and the use of participatory approaches (RQ3). In

Table 1

List of terms proposed to account for the Ecosystem Services (ES) provided by Green Infrastructure (GI).

Ecosystem Service	Terms
Provisioning	‘food’ OR ‘crop’ OR ‘raw material’ OR ‘biomass’ OR ‘freshwater’ OR ‘fresh water’ OR ‘harvest’ OR ‘medic’ OR ‘natural resource’ OR ‘fuel’ OR ‘timber’ OR ‘wood’ OR ‘nutrient’ OR ‘gas’ OR ‘oxygen’ OR ‘forest’
Regulating	‘air quality’ OR ‘air pollut’ OR ‘heat island’ OR ‘therm’ OR ‘energ efficien’ OR ‘carbon’ OR ‘greenhouse’ OR ‘climate change’ OR ‘flood’ OR ‘stormwater’ OR ‘water quality’ OR ‘drought’ OR ‘landslide’ OR ‘wastewater’ OR ‘soil ero’ OR ‘soil fert’ OR ‘land degrad’ OR ‘desertif’ OR ‘pollinat’ OR ‘biolog control’ OR ‘govern’ OR ‘decompos’ OR ‘purificat’
Supporting	‘biodiversity’ OR ‘habitat’ OR ‘species’ OR ‘gene’ OR ‘ecolog’ OR ‘connect’ OR ‘fragment’ OR ‘corridor’ OR ‘landscape’ OR ‘network’ OR ‘regen’ OR ‘conservat’ OR ‘preservat’ OR ‘protect’ OR ‘plant’ OR ‘animal’ OR ‘wildlife’
Cultural	‘recreation’ OR ‘social’ OR ‘mental’ OR ‘physical’ OR ‘walk’ OR ‘sport’ OR ‘touris’ OR ‘aesthetic’ OR ‘relie’ OR ‘inspir’ OR ‘sense’ OR ‘emotion’ OR ‘belonging’ OR ‘experience’ OR ‘creativ’ OR ‘educat’ OR ‘spiritu’ OR ‘enrich’ OR ‘heritag’ OR ‘artistic’ OR ‘dignif’ OR ‘enjoy’ OR ‘entertain’

the first instance, the methods were recorded as reported in the articles. Then, they were progressively grouped until reaching representative heterogeneous clusters. If participatory methods were adopted, the profiles of the participants were specified to differentiate among academics, authorities, citizens, practitioners, and volunteers. The resulting table, provided as [supplementary material](#), can be consulted in Appendix A.

To complement the information provided by the affiliations of the authors, their predominant areas of research were also retrieved (up to a maximum of six) based on their most contributed SciVal's Topics between 2016 and 2020 according to Scopus (RQ4). The spatial extent of the studies (RQ5) was represented by two fields: context (urban, peri-urban and/or rural) and scale (micro, meso and/or macro). Microscale referred to site-specific locations such as buildings or neighbourhoods, whereas mesoscale accounted for broader areas like cities or municipalities. Macroscale was the term used when the extent of the study amounted to provinces, watersheds or even countries.

2.3. Data analysis

The analysis of eligible documents was conducted using R 4.1.0 (R Core Team, 2022). The approach taken for the revision led to the compilation of three kinds of data: text, binary and frequency. Text data was processed through mining techniques (Feinerer and Hornik, 2020), which enabled creating a corpus, eliminating undesired characters and words, reducing the terms to their roots (basic words to which affixes are added) and building document-term matrices. The correlation among the most frequent terms thus identified was also explored (Wijffels et al., 2021).

Binary data resulted from setting some of the characteristics considered in the review as dichotomous variables, such that the reading of the publications served to determine their presence (1) or absence (0). The numeric nature of these data enabled conducting correlation analyses to identify whether certain aspects were related to each other (Kirch, 2008). This was particularly applied to determine the intra- and extra- interconnections involving the four categories of ES.

Frequency data resulting from counting present and absent characteristics were used to identify differences in the proportions in which the different categories included in the fields appeared in the publications. This was checked using the two-proportions Z test (Agresti, 2019), which served to determine whether such differences were statistically significant or not and, if positive, in what sense. In addition, this test served to compute the probability that a certain characteristic is present in a study on GI and ES.

The results obtained for the correlation coefficients and the tests for comparing independent samples were referred to significance levels of 0.01, 0.05 and 0.10 (Labovitz, 1968). Hence, the correlation coefficients determined were considered significant when their associated p-values were below these thresholds. Similarly, p-values below the significance levels for the two-proportions test indicated that the categories under analysis were statistically different from each other.

3. Results and discussion

3.1. Search results

When entering the search equation (Eq. (1)), 273 publications were returned (s_1). Among these, five were discarded because of their restricted accessibility, which was limited to their abstract. In accordance with IC1, another 24 items were not considered further because they were review articles but not tagged as such.

As a result, the number of full texts to review amounted to 244 (s_2). After reading, additional 45 records were excluded because of their lack of specific methodologies to address any facet related to GI and ES. Instead, they were rather descriptive studies focused on aspects such as lessons learned, best practices or policies' comparison. In the end, the

number of items remaining for data analysis was 199 (s_3). Only one of these articles was not written in English, so that this study can be concluded to be a review in the language of science (Elnathan, 2021).

Table 2 provides a summary of the number of publications per year referred to the categories in four fields: ES, Scale, Context and Participation. These variables were presented as an overview because they were arranged according to fixed categories, unlike other variables such as methods or research topics. All details for each item can be consulted in Appendix A.

3.2. General trends

The wordclouds in Fig. 2 pointed out to a bias in the publications towards urban areas, which are particularly prone to denaturalization processes and ES deficits (Elliot et al., 2022). This is especially remarkable in the abstracts (Fig. 2a), which also include the term 'citi' and other related words such as 'develop' and 'studi'. There are also other recurrent terms that concern the spatial dimension of GI, such as 'land', 'landscap', 'area', 'architecture' and 'environment'. The presence of these terms may point out to a focus on planning GI for its integration in the landscape rather than as a separate element.

Affiliations (Fig. 2b) corresponds to the only wordcloud in which 'urban' is not the most frequent term. This fact might be linked to the multidisciplinary nature of both the departments or research groups included in the review and the urban environment, a context where a variety of areas can converge (architecture, civil engineering, landscape planning, geography, etc.).

The wordcloud for author keywords (Fig. 2c) were aligned with the trends observed in the abstracts, revealing a great difference between its first two terms ('urban' and 'plan') and the others. Instead, the index keywords (Fig. 2d) contained other frequent terms such as 'area', 'environment', 'biodivers', 'manage', 'water', etc.

Although the trends are similar in the four wordclouds, the roots 'climat' and 'change' are more frequent in both types of keywords than in the abstracts and the affiliations. This may have to do with the breadth of the concept of climate change, which is an illustrative tag for many publications but is less representative than specific terms such as floods, warming, droughts, etc.

The most frequent terms included in these four fields were further explored using correlation plots. According to these plots, there were strong links between generic terms such as 'urban' and 'space' or 'develop', 'plan' and 'benefit' in the abstracts (Fig. 3a). Fig. 3b clarified the focus of some of the most recurrent affiliations, such as built environment, civil engineering, landscape architecture or natural resource management. The associations found for Fig. 3c and d were more specific by underlining adaptation to climate change as a recurrent concept in both types of keywords, as well as biodiversity conservation in the case of index keywords.

To explore general trends with respect to the fields in Table 2, the two-proportions Z test was run (Tables 3 and 4). The results revealed a significantly higher probability (p) for mesoscale ($p = 0.593$) than for the two other categories at a 0.01 level. Although the differences remained when comparing microscale ($p = 0.151$) and macroscale ($p = 0.231$), their significance was only at a 0.10 level. The situation was even clearer for the context, with urban areas being very recurrent ($p = 0.889$). Again, the less frequent categories showed differences at a 0.10 level in favour of peri-urban contexts ($p = 0.301$), which were slightly more frequent than rural studies ($p = 0.216$).

The share of proportions was much more balanced in the case of participation, with a slight preponderance of citizens ($p = 0.191$), whose presence was significantly higher (0.01 level) than that of academics ($p = 0.075$), practitioners ($p = 0.085$) and volunteers ($p = 0.055$). This means that authorities were the other main target of participatory studies ($p = 0.136$), whereas the three less frequent profiles were similar in terms of proportion.

The values obtained for the ES revealed that the presence of

Table 2

Number of publications per year identified for the categories in Ecosystem Services (ES), Scale, Context and Participation. More details be consulted in Appendix A.

Year	References	ES				Scale			Context			Participation				
		Prov	Reg	Supp	Cult	Mic	Mes	Mac	Urb	P-Urb	Rur	Aca	Aut	Cit	Pra	Vol
2021	(Bai, Guo (2021); Barrios-Crespo et al., (2021); Alizadehtazi et al., (2020); Anisimova, (2020); Badenhausser et al., (2020); Basnou et al., (2020); Blazy et al., (2021); Borysiak et al., (2017); Bush et al., (2021); Calderón-Contreras and Quiroz-Rosas, (2017); Campbell-Arvai and Lindquist, (2021); Caparrós Martínez et al., (2020); Castelli et al., (2017); Chen et al., (2020); Dai et al., (2021); de Manuel et al., (2021); Deeb et al., (2018); Delgado-Capel and Cariñanos, (2020); Derkzen et al., (2017); Dimitrov et al., (2018); Dipeolu and Ibem, (2020); Xia et al., (2021); Xu, Zhao (2021); Zulian et al., (2021))	13	24	20	19	3	22	7	28	9	4	3	3	6	2	2
2020	(Abramowicz, Stępniewska (2020); Andersson et al., (2020); Donaldson and João, (2020); Drius et al., (2020); Elbakidze et al., (2017); Elliott et al., (2020); Fňukalová et al., (2021); Furberg et al., (2020); Fusaro et al., (2015); Garau and Annunziata, (2019); García et al., (2020); Garcia-Cuerva et al., (2018); Ghofrani et al., (2020); Gill et al., (2020); Gómez-Villarino et al., (2021); Guo and Bai, (2019); Hamann et al., (2020); Hansen et al., (2019); Hermoso et al., (2020); Hernández-Moreno and Reyes-Paecke, (2018); Hoerbingner et al., (2018); Honeck et al., (2020); Wuyts et al., (2020); Zalejska-Jonsson et al., (2020))	14	39	28	23	9	27	12	44	10	7	4	5	7	2	1
2019	(Bartesaghi-Koc et al., (2019a); Bartesaghi-Koc et al., (2019b); Caplan et al., (2019); Capotorti et al., (2019a); Capotorti et al., (2019b); Hu et al., (2018); Huera-Lucero et al., (2020); Hysa, (2021); Jerome et al., (2019); Khoshnava et al., (2020); Kimic and Ostrysz, (2021); Klimanova et al., (2021); Klimanova and Illarionova, (2020); Kopp and Preis, (2019); Kowarik et al., (2019); La Rosa and Privitera, (2013); Lai et al., (2019); Lai et al., (2018); Landor-Yamagata et al., (2018); Langemeyer et al., (2020); Lanzas et al., (2019); Leonard et al., (2019); Li et al., (2020b); Liao et al., (2020); Lieberherr and Green, (2018); Zhang, Muñoz Ramírez (2019); Zhang et al., (2019); Zöich et al., (2019))	12	25	19	14	2	22	5	28	13	6	1	4	6	4	2
2018	(Cannas et al., (2018); Cortinovic et al., (2018); de la Fuente et al., (2018); Lin et al., (2016); Lin et al., (2019); Liqueste et al., (2015); Liu and Russo, (2021); Liu et al., (2020); Lonsdorf et al., (2021); Lynch, (2016); Ma et al., (2021); Majekodunmi et al., (2020); Maragno et al., (2018); Marando et al., (2019); Marcucci and Jordan, (2013); McWilliam et al., (2017); Meerow, (2019); Meerow et al., (2021); Meerow and Newell, (2017); Mekala and Hatton MacDonald, (2018); Miller and Montalto, (2019); Moyzeová, (2018); Muvuna et al., (2020); Nguyen et al., (2021); Vasiljević et al., (2018); Wong et al., (2018); Wong, Jim (2018))	11	17	20	14	5	17	9	27	9	10	3	5	6	4	1
2017	(Albert, Von Haaren (2017); Angelstam et al., (2017a); Angelstam et al., (2017b); Artmann et al., (2017); Zardo et al., (2017); Zhang et al., (2017); Zidar et al., (2017))	7	13	15	13	4	12	8	21	7	11	1	4	6	3	1
2016	(Di Leo et al., (2016); Guerrero et al., (2016); Kati, Jari (2016); Niedźwiecka-Filipiak et al., (2019); Nielsen et al., (2017); Niță et al., (2018); Norman et al., (2021); Orantes et al., (2017); Padró et al., (2020); Palliwoda et al., (2020); Palme et al., (2020); Pappalardo et al., (2017); Parker and de Baro, M.E., (2019); Paulin et al., (2020); Pavao-Zuckerman and Sookhdeo, (2017); Pelorosso et al., (2017); Piacentini and Rossetto, (2020); Piedelobo et al., (2019); Privitera and La Rosa, (2018); Rall et al., (2019); Ramyar et al.,	2	4	3	3	2	7	0	9	1	1	0	1	1	0	0

(continued on next page)

Table 2 (continued)

Year	References	ES				Scale			Context			Participation				
		Prov	Reg	Supp	Cult	Mic	Mes	Mac	Urb	P-Urb	Rur	Aca	Aut	Cit	Pra	Vol
2015	(2020); Ring et al., (2021); Montgomery et al., (2016); Pinho et al., (2016); Zölch et al., (2016)) (Barau (2015);Kim et al., (2016);Kim et al., (2015);Kim et al., (2021);Kim et al., (2020); Rodríguez-Espinosa et al., (2020); Rodríguez-Loinaz et al., (2018); Ronchi et al., (2020); Rubiano Calderón, (2019); Russo et al., (2021); Salomaa et al., (2017); Sanesi et al., (2017); Santiago Ramos and Hurtado Rodríguez, (2021); Schiavon et al., (2021); Schiffman et al., (2018); Schmidt and Hauck, (2018); Sebastiani et al., (2021); Semeraro et al., (2020); Shackleton et al., (2018); Shi and Qin, (2018); Shi et al., (2021); Shifflett and Yess, (2019); Sikorska et al., (2017); Mathey et al., (2015);Mekala et al., (2015);Sussams et al., (2015))	2	6	6	4	1	4	2	7	4	2	1	1	2	1	1
2014	(Faehnle et al., (2014); Kopperoinen et al., (2014))	1	1	1	2	0	1	1	2	1	1	0	2	1	0	1
2013	(Andersson et al., (2013); Barbati et al., (2013); Farrugia et al., (2013); Simić et al., (2017); Sturiale, (2019); Sun et al., (2021); Svensson et al., (2019); Tran et al., (2020); Valente et al., (2020); Valeri et al., (2021); Vallecillo et al., (2018); van Vliet and Hammond, (2021); Venter et al., (2021); Venter et al., (2020b); Wang et al., (2019); Wang et al., (2021); Wijffels, (2021); Wong and Montalto, (2020); Young, (2011); Roe, Mell (2013); Schäffler, Swilling (2013); Young, McPherson (2013))	2	5	5	4	4	3	1	8	4	1	2	2	1	1	2
2012	(Barnhill, Smardon (2012))	0	1	1	1	0	1	0	1	0	0	0	0	1	0	0
2011	(La Greca et al., (2011))	0	2	1	1	0	2	0	1	2	0	0	1	0	0	
2010	(Isely et al., (2010))	1	1	1	1	0	0	1	1	0	0	0	0	0	0	
Frequency per field (f)		65	138	120	99	30	118	46	177	60	43	15	27	38	17	11

ES = Ecosystem Services / Prov = Provisioning; Reg = Regulating; Supp = Supporting; Cult = Cultural / Mic = Microscale; Mes = Mesoscale; Mac = Macroscale / Urb = Urban; P-urb = Peri-urban; Rur = Rural / Aca = Academics; Aut = Authorities; Cit = Citizens; Pra = Practitioners; Vol = Volunteers. Dots (...) in the 'References' field stand for the remaining and nonexplicitly cited authors of the publications per year.

provisioning services (p = 0.327) was significantly lower than the others (0.01 level). Instead, regulating (p = 0.693) and supporting (p = 0.603) ES were the dominant categories, to the extent that their proportions only differed at a 0.10 level. Cultural ES (p = 0.497) were in an intermediate situation, showing a significantly lower frequency than supporting ES at a 0.05 level.

3.3. Ecosystem Services (RQ1 and RQ2)

Delving into the results of Table 3, Fig. 2 shows the terms with the highest frequency (f) for each ES according to the words proposed in Table 1. The most frequent term was 'biodiversity' (f = 74), followed by 'recreation' (f = 68), 'air quality' (f = 52), and 'stormwater' (f = 50). Apart from its own relevance as a global concern (Roe, 2019), the predominance of 'biodiversity' may relate to the role of supporting ES as basic ecological processes that sustain the remaining services, whereby they might be considered even if the articles primarily focus on another ES category. In the case of cultural services, Fig. 2c emphasized the recreational, social, and aesthetic values of GI. The contribution of GI to physical health was the main specific subject of research, with the combination of 'physical', 'walk', and 'sport' resulting in f = 52. Regarding regulating services, their relevant role might have to do with the increasing importance of climate change, as suggested by the most frequent words in Fig. 2b. Provisioning services were the least approached ES group in the records reviewed, proving that the use of GI as a source of natural resources still needs to be further investigated. Although the provision of water, raw materials, and energy was addressed in some publications, the feeding potential of GI was the most frequent topic of study in this group (f = 58 when combining 'food',

'crop', 'nutrient', and 'agricultur') Fig. 4.

Regarding the combined assessment of several ES, the two-proportions Z test indicated that the number of publications focused on only one group (f = 87) was significantly higher (0.01 level) than those addressing two (f = 34), three (f = 41) and four (f = 36) ES at once. The joint frequency of combined approaches proved that the records involving two or more ES (f = 111) were significantly higher (0.05 level) than those targeting a single ES group. Although all ES should be considered to achieve strategic networks of GI, these results suggest that most studies provided broad perspectives by accounting for diverse ES values.

The specific associations among the ES families were examined through a correlation analysis. Table 3 compiles the correlation coefficients obtained from the presence (1) or absence (0) of ES categories in the publications. The only ES groups lacking a statistically significant correlation were regulating and cultural, whereas the association between regulating and supporting services was negative. However, it corresponded to the weakest significant correlation coefficient, so that the relevance of this result was limited.

The strongest coefficients corresponded to the relationships of provisioning services with regulating and cultural services. The former may lay in the multiple implications of water management, since its catchment and retention (regulation) are a precursor to its potential reuse for potable and non-potable purposes (provisioning). The association between provisioning and cultural services might relate to the agricultural use of GI, which entails a recreational component because of the care of crops.

Table 3
P-values yielded by the two-proportions Z test when comparing the categories in different fields.

Field	Probability (p)	Comparison	p-value
Scale	Microscale (0.151)	Microscale vs Mesoscale	0.000
	Mesoscale (0.593)	Microscale vs Macroscale	0.056
	Macroscale (0.231)	Mesoscale vs Macroscale	0.000
Context	Urban (0.889)	Urban vs Peri-urban	0.000
	Peri-urban (0.301)	Urban vs Rural	0.000
	Rural (0.216)	Peri-urban vs Rural	0.067
Participation	Academics (0.075)	Academics vs Authorities	0.072
	Authorities (0.136)	Academics vs Citizens	0.001
	Citizens (0.191)	Academics vs Practitioners	0.854
	Practitioners (0.085)	Academics vs Volunteers	0.543
	Volunteers (0.055)	Authorities vs Citizens	0.175
		Authorities vs Practitioners	0.150
		Authorities vs Volunteers	0.010
		Citizens vs Practitioners	0.004
		Citizens vs Volunteers	0.000
Ecosystem Services	Provisioning (0.327)	Practitioners vs Volunteers	0.327
	Regulating (0.693)	Provisioning vs Regulating	0.000
	Supporting (0.603)	Provisioning vs Supporting	0.000
	Cultural (0.497)	Provisioning vs Cultural	0.001
		Regulating vs Supporting	0.074
		Regulating vs Cultural	0.000
		Supporting vs Cultural	0.044

3.5. Interactions among fields (RQ1-RQ5)

The analysis of interactions concerned the examination of the relationships between ES and the remaining fields considered. Their correlation coefficients with the other fields in Table 2 are provided in Table 6. Although the strength of these associations was reduced in most cases, they highlighted some interesting trends.

Provisioning and regulating ES were found to have opposite relationships to macroscales. This is consistent with some of the terms considered in regulating ES (Fig. 4), such as flooding, air quality or the Urban Heat Island effect, which are especially relevant at limited scales. Similarly, provisioning ES were positively correlated to rural contexts, due to the potential of these areas to support the use of GI for producing food and energy.

Regarding participation, the clearest association corresponded to citizens and cultural ES, probably because these are more tangible for people due to their daily life impact. Instead, provisioning ES had a high share of studies involving authorities, which is reasonable considering the role played by administrations in the supply of services such as water or energy. The highest and most significant correlation of supporting ES was with practitioners. This might lay in the professionalism of Geographic Information Systems (GIS) (Li et al., 2020) and the spatial importance of supporting services, which deal with broad aspects such as ecological connectivity and landscape design.

The interactions of ES with other fields were explored through a frequency analysis. The values obtained in Fig. 7a for the methods used highlighted the polyvalence of regulating ES for modelling a variety of aspects through either indicators, questionnaires, statistical tools, or spatial methods. Although this also applied to supporting ES, this group often resorted to map overlays through reclassification, indicators, spatial algebra, and MCDA, which links to the geographical component inherent in these services. The high frequency of correlation analysis for cultural ES may respond to the use of this test to support the

Table 4
Correlation coefficients among the Ecosystem Services (ES).

	Provisioning	Regulating	Supporting	Cultural
Provisioning	1.000	0.324*	0.149*	0.400*
Regulating		1.000	-0.205*	0.095
Supporting			1.000	0.212*
Cultural				1.000

* Statistically significant at a 0.01 level

identification of significant relationships between accessibility to GI and the social benefits of green areas. The distribution of ES across the most frequent countries (Fig. 7b) was similar to that observed for the whole list of publications in Table 2, with regulating and supporting services being the most widely addressed GI benefits.

Fig. 7c shows logical results regarding the main SciVal's Topics of the authors. For instance, regulating ES had strong associations with T.4552 and T.7284 (Table 5) due to the role of trees and urban forests for heat attenuation and water retention, respectively. As for supporting ES, their highest frequency corresponded to T.4585, T.1364 and T.2041, which deal with stable ecosystems and biological corridors to ensure biodiversity and habitat protection. Cultural ES had remarkable frequencies in topics such as T.1410 or T.1567, probably because of the use of parks for multiple purposes, including thermal comfort. Provisioning ES had the lowest frequency for all topics except T.7284. This may relate to the potential of GI for water harvesting and reuse.

3.6. Spatiotemporal trends (RQ5 and RQ6)

In general, the number of publications released about GI and ES has grown during the last years, except for 2021 (Fig. 8). This anomaly might be due to the COVID-19 pandemic, which caused a general shift of scientific productions towards this topic (Aviv-Reuven and Rosenfeld, 2021). According to Fig. 8a, regulating services were the ES group that grew faster, followed by cultural ES. The increase in provisioning and supporting ES-related papers was less pronounced, despite the latter was the group with the second highest number of documents in the review.

In line with the increase in the number of publications over the years, participation experienced a substantial growth as of 2017 (Fig. 8b). With some nuances, this is common for all types of participants. The implication of citizens has remained almost constant, whereas academics and volunteers have increased their participation. Instead, authorities and especially practitioners are the two profiles whose engagement has decreased. Although this fact might be due to a variety of reasons, it is important to stress that the achievement of significant progress in the academia largely depends on its linkage with reality and practicality. In this sense, involving authorities and practitioners shall be a priority in future research to keep a broad perspective.

The trends with regards to the country revealed a constant predominance of European countries over time (Fig. 8c). The growth experienced by China and Spain is especially remarkable, with both countries increasing their release of publications on the topic in 2020

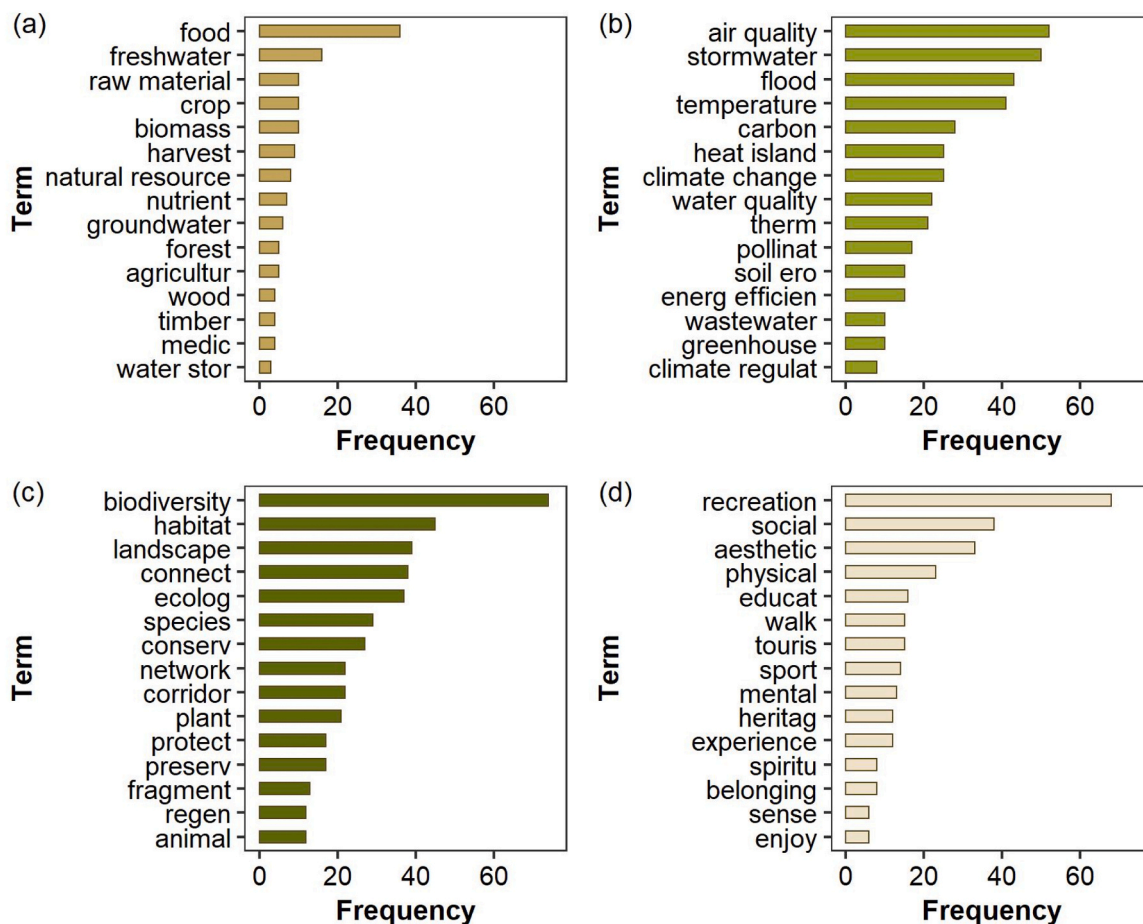


Fig. 4. Most frequent terms associated with the Ecosystem Services (ES): (a) Provisioning services, (b) Regulating services, (c) Supporting services and (d) Cultural services.

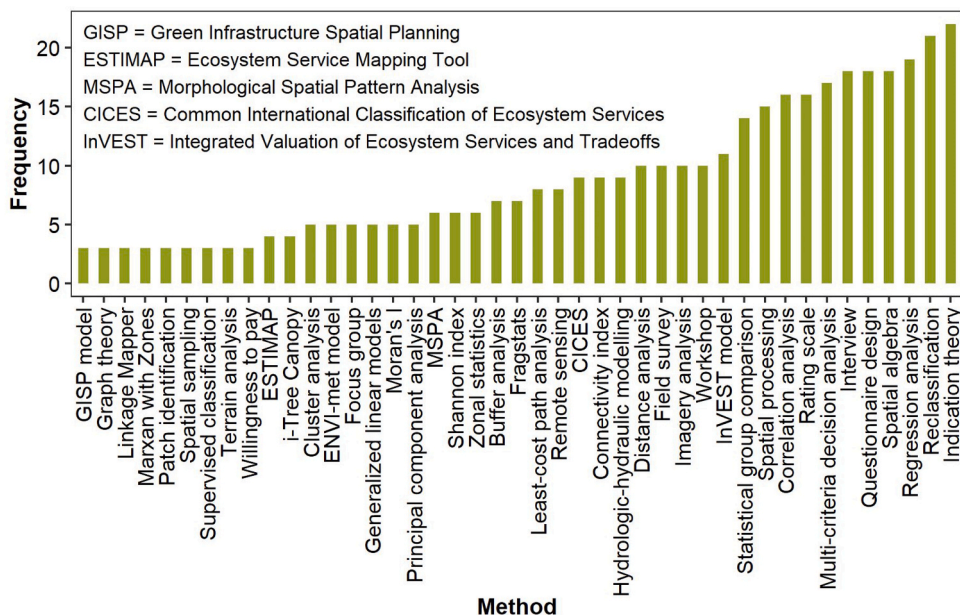


Fig. 5. Most frequent methods used to assess the Ecosystem Services (ES) of Green Infrastructure (GI).

Table 5
Code and full meaning of the most frequent SciVal's Topics.

Code	SciVal's Topic
T.2046	Cultural Ecosystem Services; China; Natural Capital
T.4552	Street Trees; Urban Forests; Green Infrastructure
T.1410	Greenspace; Green Infrastructure; National Parks
T.2433	Heat Islands; Land Surface Temperature; Land Cover
T.7284	Bioretention Areas; Stormwater Management; Green Infrastructure
T.1567	Climate Change Adaptation; Urban Climate; Resilience
T.1364	Ecosystem; Plant Communities; Ecosystem Stability
T.48272	Forest Policy; Landscape History; Forestry
T.7304	Thermal Comfort; Hot Temperature; Microclimate
T.5774	Street Canyon; Air Quality; Deposition Velocity
T.3781	Dead Wood; Saproxilic Organism; Beetles
T.2696	Conservation Planning; Reserve Design; Environmental Protection
T.2041	Bombus; Bees; Neonicotinoids
T.1857	Sleuths; Cellular Automaton Model; Urbanization
T.3646	Resilience; Ecological Resilience; Advocacy Coalition Framework
T.7718	Green Roofs; Hot Temperature; Sedum acre
T.8537	Urban Biodiversity; Urbanization; Birds
T.4585	Ecosystem; Landscape Genetics; Biological Corridors
T.3095	Community Supported Agriculture; Urban Agriculture; Local Food Systems
T.809	Maximum Entropy; Ecosystem; Environmental Space
T.3433	Brazilian Amazon; Tropical Deforestation; Land Cover
T.2347	Decision Making; Social Impact Assessment; Environmental Impact Statements

and 2021. Instead, Italy, which was one of the greatest contributors to the review between 2015 and 2019, has slightly reduced its production in the last years.

Regarding the topics (Fig. 8d), one of the clearest trends found corresponds to T.7718 (Table 5), which grew rapidly until the general decline observed in 2021. Another topic whose production increased steadily, even in 2021, is T.2433. Both cases are related to the thermo-regulation potential of GI, which may reflect an increasing importance of climate change in daily life. The use of automaton models to deal with the other great challenge for sustainable development (urbanization) was the only topic (T.1857) experiencing a notable increase in 2021 with respect to previous years (more than twice the number of publications).

3.7. Discussion

The results of the data analysis pointed out to regulating services as the most frequently addressed ES. The coupling of this fact with the results obtained for the context of study (Table 3) aligns with the growing stress posed by urbanization and climate change, which increase the vulnerability of communities to multiple hazards (Williams et al., 2019). There are multiple reviews on the potential of GI to increase urban resilience, especially against floods (Li et al., 2019) and the Urban Heat Island effect (Balany et al., 2020).

Along with climate change, the loss of biodiversity entailed by urbanization is the other main environmental impact caused by humanity (Skogen et al., 2018). This coincides with the results of Fig. 4, whereby biodiversity was the most frequent term among all ES. The concerns raised by some publications years back (Garmendia et al., 2016; Salomaa et al., 2016) about the lack of specific strategies to enhance biodiversity through GI are reflected in our results, which indicate a substantial increase in the number of studies devoted to this matter from 2017 onwards (Fig. 8a). Although not all these works may result in specific strategies, the preponderance of biodiversity as a research topic in the review might indicate that at least the basis to developing such strategies are being addressed.

Despite the need for planning multifunctional GI to maximize its ES is being emphasized for years (Lovell and Taylor, 2013), only about a quarter of the publications reviewed accounted for the four ES groups at once. This connects with collaboration among different disciplines, which is another requirement for properly managing GI (Pauleit et al., 2019). Although the results in Figs. 2b and 6 suggested that the authors involved in the review belonged to divergent research areas and had different topics of publication, this variety was not aligned with the number of ES categories addressed in the articles, which was limited to one in almost half of the cases.

The engagement of academics was also addressed from the perspective of participatory approaches, whose proportion is provided in Table 2. Considering that not all studies may require stakeholder engagement, the share of articles involving at least one stakeholder profile (28.64%) was fair. However, this figure might still be far from the prominent role of participatory frameworks allocated to landscape and urban planning by Pamukcu-Albers et al. (2021). The rather stagnant

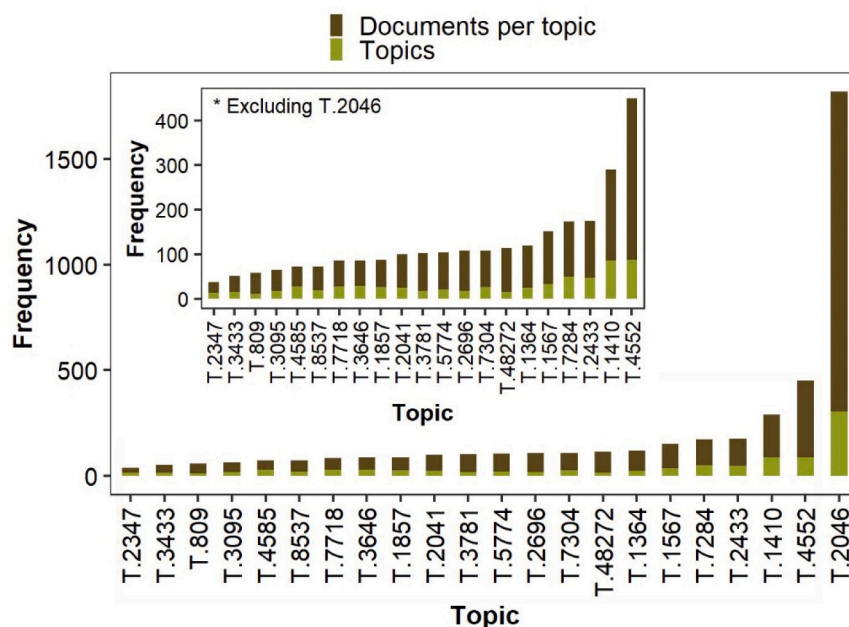


Fig. 6. Most frequent SciVal's Topics of the authors of the publications reviewed. The figures are referred to either the number of documents by the authors for each topic or the number of times each topic appears in the review. The full meaning of the topics can be consulted in Table 5.

Table 6
Correlation coefficients of the Ecosystem Services (ES) with other variables.

Ecosystem Services	Scale		Context		Participation		
	Meso	Macro	Urban	Rural	Authorities	Citizens	Practitioners
Provisioning	-0.201 **	0.203 **	-0.039	0.230 **	0.131 *	0.043	0.132 *
Regulating	0.115	-0.127 *	0.125 *	-0.131 *	0.104	0.101	0.086
Supporting	-0.108	0.079	-0.113	0.081	0.111	0.081	0.138 **
Cultural	-0.055	0.003	0.016	0.059	0.134 *	0.335 **	0.091

Statistically significant at a * 0.10 / ** 0.05 / *** 0.01 level.

trend in Fig. 8b between 2017 and 2021 with respect to that of Fig. 8a may also be insufficient compared with the importance of participation for assessing all the ES values of GI (Venter et al., 2020a), which is especially crucial to implement cross-scale planning strategies (Zulian et al., 2021).

Stakeholder engagement was also emphasized by Adegun et al. (2021) as a key aspect to sustain rapid urban development in Nigeria through GI planning. This same author also pointed out to GI for improving the lives of slum dwellers in African countries through improved food security, environmental quality, etc. (Adegun, 2021). As such, the spatial distribution of results depicted in Fig. 8c should ideally evolve towards a better representation of developing countries, given the potential of GI to balance societal progress with environmental protection and primary production (Haase, 2021).

The general rise in the production of articles observed in Fig. 8 from 2017 might respond to the permeation of the concept of GI in worldwide policies. For instance, the US Congress approved an act in 2019 to provide an integrated planning process for promoting GI (US EPA, 2015). In China, the Ministry of Housing and Urban-Rural Development declared the Greenway Planning and Design Guidelines in 2016, which provides evidence of the recognition of GI to achieve sustainable urbanization (Zhang et al., 2020,2020). Although the EU Strategy to promote investments in GI dates from 2013 (European Commission, 2016), the Council conclusions of 2015 called for putting forward a

trans-EU network for GI by 2017. However, the cross-boundary cooperation required for this approach still needs more time to be successful, as demonstrated by e.g., the Spanish Strategy for Green Infrastructure and Ecological Connectivity and Restoration (MITECO, 2021), which took effect in late 2021.

Comparing the findings of this study with those of previous reviews is not easy, because the approach taken here was deliberately different from theirs to result in a new perspective. For instance, some previous reviews were limited to a single ES category (Cheng et al., 2021; Suppakittpaisarn et al., 2017), whilst others used narrower concepts of ES (Chatzimentor et al., 2020). Still, several studies coincided in pointing out to multifunctionality as a key issue to deliver multiple ES and develop potential avenues for future research (Choi et al., 2021; Wang and Banzhaf, 2018). Our outcomes also agreed with previous reviews in specific matters such as the clear focus on urban areas (Ying et al., 2022), bias in the number of publications according to the region of origin (Parker and Zingoni de Baro, 2019) or the involvement of different stakeholders, especially academics, practitioners and authorities (Monteiro and Ferreira, 2020; Ferreira et al., (2021); Van Oijstaeijen et al., 2020). Therefore, this review can be argued to update the conclusions drawn by other authors and provide new insights into the ES delivered by GI, as well as into the methods and research disciplines involved in their analysis.



Fig. 7. Frequency values across the Ecosystem Services (ES): (a) Method, (b) Country and (c) Topic. The full meaning of the topics can be consulted in Table 5.

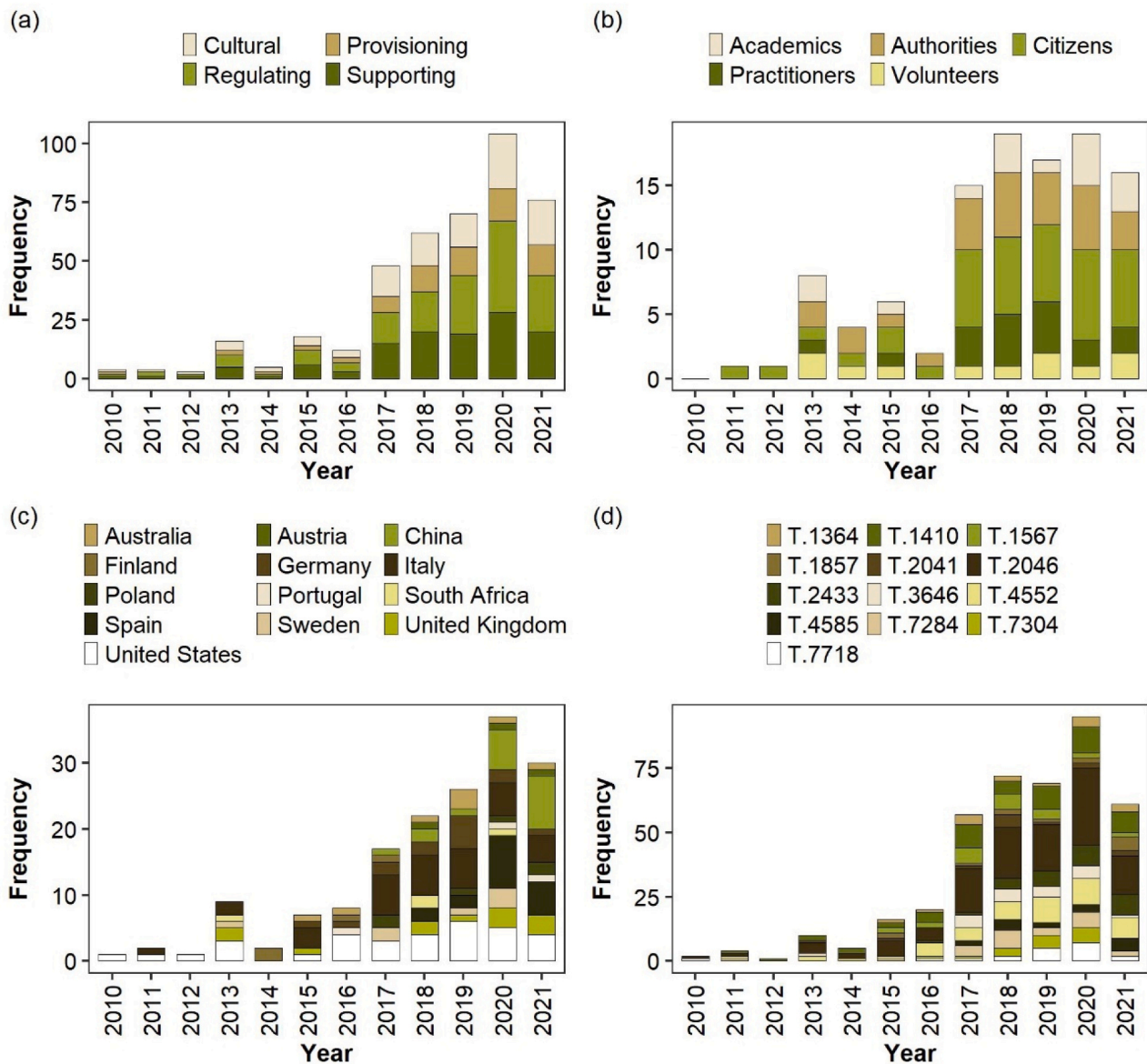


Fig. 8. Breakdown of the publications released over time with respect to (a) Ecosystem Services, (b) Participation, (c) Country and (d) SciVal's Topic. The full meaning of the topics can be consulted in Table 5.

4. Conclusions

The outcomes of this review provide insight into the patterns according to which the ES delivered by GI have been investigated for more than ten years. The 199 eligible research papers were examined according to multiple fields whose analysis gave response to the research questions set before conducting the review:

- There is a growing trend in the number of publications over the years, especially between 2017 and 2020. This has changed in 2021, probably due to the COVID-19 pandemic.
- The U.S. concentrated most of the publications reviewed, followed by European countries such as Italy or Spain. Except for China, the presence of Asian and African countries was marginal.
- The profiles of the authors highlighted by their variety, including affiliations such as architecture, civil engineering, geography, or ecology. The most frequent research topics were slightly biased towards climate change adaptation; still, they covered the four ES.

- The proportion of studies addressing regulating services was significantly higher than any other group, although supporting ES were also very recurrent.
- There were not too many studies jointly addressing all the ES, although the number of investigations addressing two or more ES was significantly higher than that of the studies focused on a single ES.
- The largest cluster of frequent methods found concerned the use of spatial techniques, which were present in almost half of the publications reviewed.

Overall, the outputs of this review contribute to generating knowledge about the current state of research on GI and its ES. The breakdown of these results underlined an imbalance in the analysis of the ES, with provisioning and cultural services being less addressed than regulating and supporting services. This stresses the need for either delving into these two types of ES individually or carrying out multidisciplinary investigations where they are addressed along with other services framed within other categories.

In this sense, the diversity of affiliations and research topics associated with the authors of the documents suggests that the evaluation of GI and ES involves a wide range of disciplines. Hence, researchers in this broad field of study should seek for intradepartmental collaborations in which several of these perspectives are brought together to foster the effective deployment of ES at different scales. However, specific studies carried out by researchers specialized in individual disciplines are also important to properly understand the conditions required for the provision of different ES.

The same logic applies to stakeholder engagement, whereby involving other actors outside the academia should be prioritized in the future to facilitate the implementation of GI. Due to their flexibility, online questionnaires are suggested as a first step to get insight into the perceptions of citizens, administrations, professionals, and NGOs. For a more elaborated vision of their interests, workshops including representatives for all these profiles can be arranged to favour discussion and opinion sharing.

The body of scientific findings in the topic of GI and ES is increasing, so that the priorities and research needs might fluctuate in the future. However, based on the most frequent methods observed in the review, the design of systems of indicators to be processed using multi-criteria decision analysis and geoprocessing tools is proposed to account for the variety of ES that can be delivered by GI at once. If developed, these systems might guide the regeneration of urban areas by maximizing the benefits of GI.

This is of particular interest in a context where climate change and rapid urbanization are posing increasing stress to current cities. The ES-oriented strategic planning of GI provides an opportunity to mitigate climate impacts such as global warming, while contributing to the environmental sustainability of urban developments.

Still, the scope of this study is affected by certain limitations. The ES-targeted approach taken in the design of the search equation can have caused the exclusion of some scientific studies in which these services are not explicitly referred to. Also, some other GI-related experiences may also have been omitted because they were not presented as research articles. Finally, the focus of the review has left aside the ecosystem disservices caused by GI, as well as other potential obstacles associated with the development of these nature-based solutions.

Therefore, there are several lines of research to explore in the future. First is using other terms in the search equation and/or accounting for other sources beyond scientific databases. There is also an interest in focusing on the concept of natural capital to translate the ES of GI into economic benefits and social well-being that could build a bridge to governments and institutions. In this sense, this research might be used to support the development of educational resources to teach minors about the importance and possibilities of ES and GI.

Funding

This research was financed by the Conselleria for Innovation, Universities, Science and Digital Society of the Generalitat Valenciana, grant number CIGE/2021/079.

CRediT authorship contribution statement

Daniel Jato-Espino: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing, Visualization. **Fabio Capra-Ribeiro:** Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Vanessa Moscardó:** Investigation, Methodology, Writing – review & editing. **Leticia E. Bartolomé del Pino:** Investigation, Writing – review & editing. **Fernando Mayor-Vitoria:** Investigation, Writing – review & editing. **Laura O. Gallardo:** Investigation, Writing – review & editing. **Patricia Carracedo:** Investigation, Writing – review & editing. **Kristin Dietrich:** Investigation, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.ufug.2023.127998](https://doi.org/10.1016/j.ufug.2023.127998).

References

- Abramowicz, D., Stępniewska, M., 2020. Public investment policy as a driver of changes in the ecosystem services delivery by an urban green infrastructure. *Quaest. Geogr.* 39, 5–18. <https://doi.org/10.2478/quageo-2020-0001>.
- Adegun, O.B., 2021. Green infrastructure can improve the lives of slum dwellers in African Cities. *Front. Sustain. Cities* 3, 621051. <https://doi.org/10.3389/fsc.2021.621051>.
- Adegun, O.B., Ikudayisi, A.E., Morakinyo, T.E., Olusoga, O.O., 2021. Urban green infrastructure in Nigeria: A review. *Sci. Afr.* 14, e01044 <https://doi.org/10.1016/j.sciaf.2021.e01044>.
- Adla, K., Dejan, K., Neira, D., Dragana, Š., 2022. Degradation of ecosystems and loss of ecosystem services. In: *One Health*. Elsevier, pp. 281–327. <https://doi.org/10.1016/B978-0-12-822794-7.00008-3>.
- Agresti, A., 2019. *An introduction to categorical data analysis*, Third edition. ed. Wiley series in probability and statistics. John Wiley & Sons, Hoboken, NJ (U.S.).
- Albert, C., Von Haaren, C., 2017. Implications of Applying the Green Infrastructure Concept in Landscape Planning for Ecosystem Services in Peri-Urban Areas: An Expert Survey and Case Study. *Plan. Pract. Res.* 32, 227–242. <https://doi.org/10.1080/02697459.2014.973683>.
- Alizadehtazi, B., Gurian, P.L., Montalto, F.A., 2020. Observed variability in soil moisture in engineered urban green infrastructure systems and linkages to ecosystem services. *J. Hydrol.* 590, 125381 <https://doi.org/10.1016/j.jhydrol.2020.125381>.
- Amorim, J.H., Engardt, M., Johansson, C., Ribeiro, I., Sannebro, M., 2021. Regulating and Cultural Ecosystem Services of Urban Green Infrastructure in the Nordic Countries: A Systematic Review. *IJERPH* 18, 1219. <https://doi.org/10.3390/ijerph18031219>.
- Andersson, E., Haase, D., Scheuer, S., Wellmann, T., 2020. Neighbourhood character affects the spatial extent and magnitude of the functional footprint of urban green infrastructure. *Landsc. Ecol.* 35, 1605–1618. <https://doi.org/10.1007/s10980-020-01039-z>.
- Andersson, K., Angelstam, P., Elbakidze, M., Axelsson, R., Degerman, E., 2013. Green infrastructures and intensive forestry: Need and opportunity for spatial planning in a Swedish rural–urban gradient. *Scand. J. For. Res.* 28, 143–165. <https://doi.org/10.1080/02827581.2012.723740>.
- Angelstam, P., Andersson, K., Annerstedt, M., Axelsson, R., Elbakidze, M., Garrido, P., Grah, P., Jönsson, K.I., Pedersen, S., Schlyter, P., Skärbäck, E., Smith, M., Stjernquist, I., 2013. Solving Problems in Social–Ecological Systems: Definition, Practice and Barriers of Transdisciplinary Research. *AMBIO* 42, 254–265. <https://doi.org/10.1007/s13280-012-0372-4>.
- Angelstam, P., Khaulyak, O., Yamelynets, T., Mozgeris, G., Naumov, V., Chmielewski, T. J., Elbakidze, M., Manton, M., Prots, B., Valasiuk, S., 2017a. Green infrastructure development at European Union's eastern border: Effects of road infrastructure and forest habitat loss. *J. Environ. Manag.* 193, 300–311. <https://doi.org/10.1016/j.jenvman.2017.02.017>.
- Angelstam, P., Yamelynets, T., Elbakidze, M., Prots, B., Manton, M., 2017b. Gap analysis as a basis for strategic spatial planning of green infrastructure: a case study in the Ukrainian Carpathians. *Écoscience* 24, 41–58. <https://doi.org/10.1080/11956860.2017.1359771>.
- Anisimova, S., 2020. Inventory of allergenic pollen urban dendroflora as a basis for designing healthier green infrastructure. *For. Ideas* 26, 452–470.
- Artmann, M., Bastian, O., Grunewald, K., 2017. Using the Concepts of Green Infrastructure and Ecosystem Services to Specify Leitbilder for Compact and Green Cities—The Example of the Landscape Plan of Dresden (Germany). *Sustainability* 9, 198. <https://doi.org/10.3390/su9020198>.
- Aviv-Reuven, S., Rosenfeld, A., 2021. Publication patterns' changes due to the COVID-19 pandemic: a longitudinal and short-term scientometric analysis. *Scientometrics* 126, 6761–6784. <https://doi.org/10.1007/s11192-021-04059-x>.
- Badenhausser, I., Gross, N., Mornet, V., Roncoroni, M., Saintilan, A., Rusch, A., 2020. Increasing amount and quality of green infrastructures at different scales promotes biological control in agricultural landscapes. *Agric. Ecosystems Environ.* 290, 106735 <https://doi.org/10.1016/j.agee.2019.106735>.
- Bai, Y., Guo, R., 2021. The construction of green infrastructure network in the perspectives of ecosystem services and ecological sensitivity: The case of Harbin, China. *Glob. Ecol. Conserv.* 27, e01534 <https://doi.org/10.1016/j.gecco.2021.e01534>.
- Balany, F., Ng, A.W., Muttill, N., Muthukumar, S., Wong, M.S., 2020. Green Infrastructure as an Urban Heat Island Mitigation Strategy—A Review. *Water* 12, 3577. <https://doi.org/10.3390/w12123577>.

- Barau, A.S., 2015. Perceptions and contributions of households towards sustainable urban green infrastructure in Malaysia. *Habitat Int.* 47, 285–297. <https://doi.org/10.1016/j.habitatint.2015.02.003>.
- Barbati, A., Corona, P., Salvati, L., Gasparella, L., 2013. Natural forest expansion into suburban countryside: Gained ground for a green infrastructure. *Urban For. Urban Green.* 12, 36–43. <https://doi.org/10.1016/j.ufug.2012.11.002>.
- Barnhill, K., Smardon, R., 2012. Gaining ground: green infrastructure attitudes and perceptions from stakeholders in Syracuse. *N. Y. Environ. Pract.* 14, 6–16.
- Barrios-Crespo, E., Torres-Ortega, S., Díaz-Simal, P., 2021. Developing a Dynamic Model for Assessing Green Infrastructure Investments in Urban Areas. *IJERPH* 18, 10994. <https://doi.org/10.3390/ijerph182010994>.
- Bartesaghi-Koc, C., Osmond, P., Peters, A., 2019a. Spatio-temporal patterns in green infrastructure as driver of land surface temperature variability: The case of Sydney. *Int. J. Appl. Earth Obs. Geoinf.* 83, 101903 <https://doi.org/10.1016/j.jag.2019.101903>.
- Bartesaghi-Koc, C., Osmond, P., Peters, A., 2019b. Mapping and classifying green infrastructure typologies for climate-related studies based on remote sensing data. *Urban For. Urban Green.* 37, 154–167. <https://doi.org/10.1016/j.ufug.2018.11.008>.
- Basnou, C., Baró, F., Langemeyer, J., Castell, C., Dalmases, C., Pino, J., 2020. Advancing the green infrastructure approach in the Province of Barcelona: integrating biodiversity, ecosystem functions and services into landscape planning. *Urban For. Urban Green.* 55, 126797 <https://doi.org/10.1016/j.ufug.2020.126797>.
- Blazy, R., Hrehorowicz-Gaber, H., Hrehorowicz-Nowak, A., Plachta, A., 2021. The synergy of ecosystems of blue and green infrastructure and its services in the metropolitan area—chances and dangers. *Sustainability* 13, 2103. <https://doi.org/10.3390/su13042103>.
- Borysiak, J., Mizgajski, A., Speak, A., 2017. Floral biodiversity of allotment gardens and its contribution to urban green infrastructure. *Urban Ecosyst* 20, 323–335. <https://doi.org/10.1007/s11252-016-0595-4>.
- Buonocore, E., Donnarumma, L., Appolloni, L., Miccio, A., Russo, G.F., Franzese, P.P., 2020. Marine natural capital and ecosystem services: An environmental accounting model. *Ecol. Model.* 424, 109029 <https://doi.org/10.1016/j.ecolmodel.2020.109029>.
- Bush, J., Ashley, G., Foster, B., Hall, G., 2021. Integrating Green Infrastructure into Urban Planning: Developing Melbourne's Green Factor Tool. *UP* 6, 20–31. <https://doi.org/10.17645/up.v6i1.3515>.
- Calderón-Contreras, R., Quiroz-Rosas, L.E., 2017. Analysing scale, quality and diversity of green infrastructure and the provision of Urban Ecosystem Services: A case from Mexico City. *Ecosystem Serv.* 23, 127–137. <https://doi.org/10.1016/j.ecoser.2016.12.004>.
- Campbell-Arvaí, V., Lindquist, M., 2021. From the ground up: Using structured community engagement to identify objectives for urban green infrastructure planning. *Urban For. Urban Green.* 59, 127013 <https://doi.org/10.1016/j.ufug.2021.127013>.
- Cannas, I., Lai, S., Leone, F., Zoppi, C., 2018. Green infrastructure and ecological corridors: a regional study concerning Sardinia. *Sustainability* 10, 1265. <https://doi.org/10.3390/su10041265>.
- Caparrós Martínez, J.L., Milán García, J., Rueda López, N., de Pablo Valenciano, J., 2020. Mapping green infrastructure and socioeconomic indicators as a public management tool: the case of the municipalities of Andalucía (Spain). *Environ. Sci. Eur.* 32, 144. <https://doi.org/10.1186/s12302-020-00418-2>.
- Caparrós-Martínez, J.L., Milán-García, J., Martínez-Vázquez, R.M., de Pablo Valenciano, J., 2021. Green Infrastructures and Grand Environmental Challenges: A Review of Research Trends by Keyword. *Agronomy* 11, 782. <https://doi.org/10.3390/agronomy11040782>.
- Caplan, J.S., Galanti, R.C., Olshevski, S., Eisenman, S.W., 2019. Water relations of street trees in green infrastructure tree trench systems. *Urban For. Urban Green.* 41, 170–178. <https://doi.org/10.1016/j.ufug.2019.03.016>.
- Capotorti, G., Alós Ortí, M.M., Copiz, R., Fusaro, L., Mollo, B., Salvatori, E., Zavattero, L., 2019a. Biodiversity and ecosystem services in urban green infrastructure planning: A case study from the metropolitan area of Rome (Italy). *Urban For. Urban Green.* 37, 87–96. <https://doi.org/10.1016/j.ufug.2017.12.014>.
- Capotorti, G., De Lazzari, V., Alós Ortí, M., 2019b. Local Scale Prioritisation of Green Infrastructure for Enhancing Biodiversity in Peri-Urban Agroecosystems: A Multi-Step Process Applied in the Metropolitan City of Rome (Italy). *Sustainability* 11, 3322. <https://doi.org/10.3390/su111123322>.
- Castelli, G., Foderi, C., Guzman, B., Ossoli, L., Kempff, Y., Bresci, E., Salbitano, F., 2017. Planting Waterscapes: Green Infrastructures, Landscape and Hydrological Modeling for the Future of Santa Cruz de la Sierra, Bolivia. *Forests* 8, 437. <https://doi.org/10.3390/f8110437>.
- Chatzimitor, A., Apostolopoulou, E., Mazaris, A.D., 2020. A review of green infrastructure research in Europe: Challenges and opportunities. *Landscape Urban Plan.* 198, 103775 <https://doi.org/10.1016/j.landurbplan.2020.103775>.
- Chen, S., Wang, Y., Ni, Z., Zhang, X., Xia, B., 2020. Benefits of the ecosystem services provided by urban green infrastructures: Differences between perception and measurements. *Urban For. Urban Green.* 54, 126774 <https://doi.org/10.1016/j.ufug.2020.126774>.
- Cheng, X., Van Damme, S., Uyttenhove, P., 2021. A review of empirical studies of cultural ecosystem services in urban green infrastructure. *J. Environ. Manag.* 293, 112895 <https://doi.org/10.1016/j.jenvman.2021.112895>.
- Choi, C., Berry, P., Smith, A., 2021. The climate benefits, co-benefits, and trade-offs of green infrastructure: A systematic literature review. *J. Environ. Manag.* 291, 112583 <https://doi.org/10.1016/j.jenvman.2021.112583>.
- Cortinovis, C., Zulian, G., Geneletti, D., 2018. Assessing nature-based recreation to support urban green infrastructure planning in Trento (Italy). *Land* 7, 112. <https://doi.org/10.3390/land7040112>.
- Dai, X., Wang, L., Tao, M., Huang, C., Sun, J., Wang, S., 2021. Assessing the ecological balance between supply and demand of blue-green infrastructure. *J. Environ. Manag.* 288, 112454 <https://doi.org/10.1016/j.jenvman.2021.112454>.
- de la Fuente, B., Mateo-Sánchez, M.C., Rodríguez, G., Gastón, A., Pérez de Ayala, R., Colomina-Pérez, D., Melero, M., Saura, S., 2018. Natura 2000 sites, public forests and riparian corridors: The connectivity backbone of forest green infrastructure. *Land Use Policy* 75, 429–441. <https://doi.org/10.1016/j.landusepol.2018.04.002>.
- de Manuel, B.F., Méndez-Fernández, L., Peña, L., Ametzaga-Arregi, I., 2021. A new indicator of the effectiveness of urban green infrastructure based on ecosystem services assessment. *Basic Appl. Ecol.* 13, 12–25. <https://doi.org/10.1016/j.baae.2021.02.012>.
- Deeb, M., Groffman, P.M., Joyner, J.L., Lozefski, G., Paltseva, A., Lin, B., Mania, K., Cao, D.L., McLaughlin, J., Muth, T., Prithiviraj, B., Kerwin, J., Cheng, Z., 2018. Soil and microbial properties of green infrastructure stormwater management systems. *Ecol. Eng.* 125, 68–75. <https://doi.org/10.1016/j.ecoleng.2018.10.017>.
- Delgado-Capel, M., Carinanos, P., 2020. Towards a standard framework to identify green infrastructure key elements in Dense Mediterranean Cities. *Forests* 11, 1246. <https://doi.org/10.3390/f1121246>.
- Derksen, M.L., van Teeffelen, A.J.A., Verburg, P.H., 2017. Green infrastructure for urban climate adaptation: How do residents' views on climate impacts and green infrastructure shape adaptation preferences? *Landscape Urban Plan.* 157, 106–130. <https://doi.org/10.1016/j.landurbplan.2016.05.027>.
- Di Leo, N., Escobedo, F.J., Dubbeling, M., 2016. The role of urban green infrastructure in mitigating land surface temperature in Bobo-Dioulasso, Burkina Faso. *Environ. Dev. Sustain* 18, 373–392. <https://doi.org/10.1007/s10668-015-9653-y>.
- Dimitrov, S., Georgiev, G., Georgieva, M., Gluschkova, M., Chepishcheva, V., Mirchev, P., Zhiyanski, M., 2018. Integrated assessment of urban green infrastructure condition in Karlovo urban area by in-situ observations and remote sensing. *OE* 3, e21610. <https://doi.org/10.3897/oneeco.3.e21610>.
- Dipeolu, A.A., Ibem, E.O., 2020. Green infrastructure quality and environmental sustainability in residential neighbourhoods in Lagos, Nigeria. *Int. J. Urban Sustain. Dev.* 12, 267–282. <https://doi.org/10.1080/19463138.2020.1719500>.
- Donaldson, G.H., João, E.M., 2020. Using green infrastructure to add value and assist place-making in public realm developments. *Impact Assess. Proj. Apprais.* 38, 464–478. <https://doi.org/10.1080/14615517.2019.1648731>.
- Drius, M., Sams, K.T., Knopper, F., Hainz-Renetzed, C., Brandenburg, C., Wrška, T., 2020. Assessing landscape services as foundation for Green Infrastructure functionality: the case of the Wienerwald Biosphere Reserve. *LO* 84, 1–39. <https://doi.org/10.3097/LO.202084>.
- Egoh, B., Drakou, E.G., Dunbar, M.B., Maes, J., Willems, L., 2012. Indicators for mapping ecosystem services: a review (No. JRC73016), JRC Scientific and Policy Reports. Publications Office of the European Union, Luxembourg.
- Elbakidze, M., Angelstam, P., Yamelynets, T., Dawson, L., Gebrehiwot, M., Straymets, N., Johansson, K.-E., Garrido, P., Naumov, V., Manton, M., 2017. A bottom-up approach to map land covers as potential green infrastructure hubs for human well-being in rural settings: A case study from Sweden. *Landscape Urban Plan.* 168, 72–83. <https://doi.org/10.1016/j.landurbplan.2017.09.031>.
- Elliot, T., Goldstein, B., Gómez-Baggethun, E., Proença, V., Rugani, B., 2022. Ecosystem service deficits of European cities. *Sci. Total Environ.* 837, 155875 <https://doi.org/10.1016/j.scitotenv.2022.155875>.
- Elliott, R.M., Motzny, A.E., Majd, S., Chavez, F.J.V., Laimer, D., Orlove, B.S., Culligan, P. J., 2020. Identifying linkages between urban green infrastructure and ecosystem services using an expert opinion methodology. *Ambio* 49, 569–583. <https://doi.org/10.1007/s13280-019-01223-9>.
- Elnathan, R., 2021. English is the language of science — but precision is tough as a non-native speaker. *Nat.* d41586-021-00899-Y. <https://doi.org/10.1038/d41586-021-00899-y>.
- European Commission, 2016. Green Infrastructure - Environment [WWW Document]. The EU Strategy on Green Infrastructure. URL https://ec.europa.eu/environment/nature/ecosystems/strategy/index_en.htm (accessed 6.20.22).
- European Commission, 2013. Green Infrastructure (GI) — Enhancing Europe's Natural Capital. COM(2013).
- Faehnel, M., Bäcklund, P., Tyrväinen, L., Niemelä, J., Yli-Pelkonen, V., 2014. How can residents' experiences inform planning of urban green infrastructure? Case Finland. *Landscape Urban Plan.* 130, 171–183. <https://doi.org/10.1016/j.landurbplan.2014.07.012>.
- FAO, 2022. Ecosystem Services & Biodiversity (ESB) [WWW Document]. Food and Agriculture Organization of the United Nations. URL <https://www.fao.org/ecosystem-services-biodiversity/en/> (accessed 1.26.22).
- Farrugia, S., Hudson, M.D., McCulloch, L., 2013. An evaluation of flood control and urban cooling ecosystem services delivered by urban green infrastructure. *Int. J. Biodivers. Sci., Ecosystem Serv. Manag.* 9, 136–145. <https://doi.org/10.1080/21513732.2013.782342>.
- Feinerer, I., Hornik, K., Artifex Software, Inc., 2020. tm: Text Mining Package.
- Ferreira, J.C., Monteiro, R., Silva, V.R., 2021. Planning a green infrastructure network from theory to practice: the case study of Setúbal, Portugal. *Sustainability* 13, 8432. <https://doi.org/10.3390/su13158432>.
- Frnkalová, E., Zýka, V., Romportl, D., 2021. The network of green infrastructure based on ecosystem services supply in Central Europe. *Land* 10, 592. <https://doi.org/10.3390/land10060592>.
- Furberg, D., Ban, Y., Mörtberg, U., 2020. Monitoring Urban Green Infrastructure Changes and Impact on Habitat Connectivity Using High-Resolution Satellite Data. *Remote Sens.* 12, 3072. <https://doi.org/10.3390/rs12183072>.
- Fusaro, L., Salvatori, E., Mereu, S., Marando, F., Scasellati, E., Abbate, G., Manes, F., 2015. Urban and peri-urban forests in the metropolitan area of Rome: Ecophysiological response of *Quercus ilex* L. in two green infrastructures in an

- ecosystem services perspective. *Urban For. Urban Green.* 14, 1147–1156. <https://doi.org/10.1016/j.ufug.2015.10.013>.
- Garau, C., Annunziata, A., 2019. Smart City Governance and Children's Agency: An Assessment of the Green Infrastructure Impact on Children's Activities in Cagliari (Italy) with the Tool "Opportunities for Children in Urban Spaces (OCUS). Sustainability 11, 4848. <https://doi.org/10.3390/su11184848>.
- García, A.M., Santé, I., Loureiro, X., Miranda, D., 2020. Green infrastructure spatial planning considering ecosystem services assessment and trade-off analysis. Application at landscape scale in Galicia region (NW Spain). *Ecosystem Serv.* 43, 101115 <https://doi.org/10.1016/j.ecoser.2020.101115>.
- García-Cuerva, L., Berglund, E.Z., Rivers, L., 2018. An integrated approach to place Green Infrastructure strategies in marginalized communities and evaluate stormwater mitigation. *J. Hydrol.* 559, 648–660. <https://doi.org/10.1016/j.jhydrol.2018.02.066>.
- Garmendia, E., Apostolopoulou, E., Adams, W.M., Bormpoudakis, D., 2016. Biodiversity and Green Infrastructure in Europe: Boundary object or ecological trap. *Land Use Policy* 56, 315–319. <https://doi.org/10.1016/j.landusepol.2016.04.003>.
- Ghofrani, Z., Sposito, V., Faggian, R., 2020. Maximising the Value of Natural Capital in a Changing Climate Through the Integration of Blue-Green Infrastructure. *J. Sustain. Dev. Energy Water Environ. Syst.* 8, 213–234. <https://doi.org/10.13044/j.sdewes.d7.0279>.
- Gill, A.S., Purnell, K., Palmer, M.I., Stein, J., McGuire, K.L., 2020. Microbial composition and functional diversity differ across urban green infrastructure types. *Front. Microbiol.* 11, 912. <https://doi.org/10.3389/fmicb.2020.00912>.
- Gómez-Villarino, M.T., Gómez Villarino, M., Ruiz-García, L., 2021. Implementation of Urban Green Infrastructures in Peri-Urban Areas: A Case Study of Climate Change Mitigation in Madrid. *Agronomy* 11, 31. <https://doi.org/10.3390/agronomy11010031>.
- Guerrero, P., Møller, M.S., Olafsson, A.S., Snizek, B., 2016. Revealing Cultural Ecosystem Services through Instagram Images: The Potential of Social Media Volunteered Geographic Information for Urban Green Infrastructure Planning and Governance. *UP* 1, 1–17. <https://doi.org/10.17645/up.v1i2.609>.
- Guo, R., Bai, Y., 2019. Simulation of an Urban-Rural Spatial Structure on the Basis of Green Infrastructure Assessment: The Case of Harbin, China. *Land* 8, 196. <https://doi.org/10.3390/land8120196>.
- Haase, D., 2021. Integrating Ecosystem Services, Green Infrastructure and Nature-Based Solutions—New Perspectives in Sustainable Urban Land Management: Combining Knowledge About Urban Nature for Action. In: Weith, T., Barkmann, T., Gaasch, N., Rogga, S., Strauß, C., Zscheischler, J. (Eds.), *Sustainable Land Management in a European Context, Human-Environment Interactions*. Springer International Publishing, Cham (Germany), pp. 305–318. https://doi.org/10.1007/978-3-030-50841-8_16.
- Hamann, F., Blecken, G.-T., Ashley, R.M., Viklander, M., 2020. Valuing the Multiple Benefits of Blue-Green Infrastructure for a Swedish Case Study: Contrasting the Economic Assessment Tools BÉST and TEEB. In: *J. Sustainable Water Built Environ.* 6, p. 05020003. <https://doi.org/10.1061/JSWBAY.0000919>.
- Hansen, R., Olafsson, A.S., van der Jagt, A.P.N., Rall, E., Pauleit, S., 2019. Planning multifunctional green infrastructure for compact cities: What is the state of practice. *Ecol. Indic.* 96, 99–110. <https://doi.org/10.1016/j.ecolind.2017.09.042>.
- Hermoso, V., Morán-Ordóñez, A., Lanzas, M., Brotons, L., 2020. Designing a network of green infrastructure for the EU. *Landscape Urban Plan.* 196, 103732 <https://doi.org/10.1016/j.landurbplan.2019.103732>.
- Hernández-Moreno, A., Reyes-Paecke, S., 2018. The effects of urban expansion on green infrastructure along an extended latitudinal gradient (23°S–45°S) in Chile over the last thirty years. *Land Use Policy* 79, 725–733. <https://doi.org/10.1016/j.landusepol.2018.09.008>.
- Hoerlinger, S., Immitzer, M., Obriejetan, M., Rauch, H.P., 2018. GIS-based assessment of ecosystem service demand concerning green infrastructure line-side vegetation. *Ecol. Eng.* 121, 114–123. <https://doi.org/10.1016/j.ecoleng.2017.06.030>.
- Honeck, E., Moilanen, A., Guinaudeau, B., Wyler, N., Schlaepfer, M., Martin, P., Sanguet, A., Urbina, L., von Arx, B., Massy, J., Fischer, C., Lehmann, A., 2020. Implementing Green Infrastructure for the Spatial Planning of Peri-Urban Areas in Geneva, Switzerland. *Sustainability* 12, 1387. <https://doi.org/10.3390/su12041387>.
- Hu, T., Chang, J., Liu, X., Feng, S., 2018. Integrated methods for determining restoration priorities of coal mining subsidence areas based on green infrastructure: –A case study in the Xuzhou urban area, of China. *Ecol. Indic.* 94, 164–174. <https://doi.org/10.1016/j.ecolind.2017.11.006>.
- Huera-Lucero, T., Salas-Ruiz, A., Chango Luisa, D., Bravo-Medina, C., 2020. Towards Sustainable Urban Planning for Puyo (Ecuador): Amazon Forest Landscape as Potential Green Infrastructure. *Sustainability* 12, 4768. <https://doi.org/10.3390/su12114768>.
- Hysa, A., 2021. Introducing Transversal Connectivity Index (TCI) as a method to evaluate the effectiveness of the blue-green infrastructure at metropolitan scale. *Ecol. Indic.* 124, 107432 <https://doi.org/10.1016/j.ecolind.2021.107432>.
- Interreg Central Europe, 2021, Green Infrastructure Definitions [WWW Document]. MAGICLandscape. URL (<http://www.interreg-central.eu/ContentNode/Definitions.html>) (accessed 9.29.22).
- Isely, E.S., Isely, P., Seedang, S., Mulder, K., Thompson, K., Steinman, A.D., 2010. Addressing the information gaps associated with valuing green infrastructure in west Michigan: INtegrated Valuation of Ecosystem Services Tool (INVEST). *J. Gt. Lakes Res.* 36, 448–457. <https://doi.org/10.1016/j.jglr.2010.04.003>.
- Jerome, G., Sinnamon, D., Burgess, S., Calvert, T., Mortlock, R., 2019. A framework for assessing the quality of green infrastructure in the built environment in the UK. *Urban For. Urban Green.* 40, 174–182. <https://doi.org/10.1016/j.ufug.2019.04.001>.
- Kati, V., Jari, N., 2016. Bottom-up thinking—Identifying socio-cultural values of ecosystem services in local blue-green infrastructure planning in Helsinki, Finland. *Land Use Policy* 50, 537–547. <https://doi.org/10.1016/j.landusepol.2015.09.031>.
- Khoshnava, S.M., Rostami, R., Zin, R.M., Štreimikiene, D., Yousefpour, A., Mardani, A., Alrasheedi, M., 2020. Contribution of green infrastructure to the implementation of green economy in the context of sustainable development. *Sustain. Dev.* 28, 320–342. <https://doi.org/10.1002/sd.2017>.
- Kim, G., Miller, P., Nowak, D., 2016. The Value of Green Infrastructure on Vacant and Residential Land in Roanoke, Virginia. *Sustainability* 8, 296. <https://doi.org/10.3390/su8040296>.
- Kim, G., Miller, P.A., Nowak, D.J., 2015. Assessing urban vacant land ecosystem services: Urban vacant land as green infrastructure in the City of Roanoke, Virginia. *Urban For. Urban Green.* 14, 519–526. <https://doi.org/10.1016/j.ufug.2015.05.003>.
- Kim, H., Shoji, Y., Tsuge, T., Kubo, T., Nakamura, F., 2021. Relational values help explain green infrastructure preferences: The case of managing crane habitat in Hokkaido, Japan. *People Nat.* 3, 861–871. <https://doi.org/10.1002/pan3.10231>.
- Kim, S.K., Joosse, P., Bennett, M.M., van Gevelt, T., 2020. Impacts of green infrastructure on flood risk perceptions in Hong Kong. *Clm. Change* 162, 2277–2299. <https://doi.org/10.1007/s10584-020-02803-5>.
- Kimic, K., Ostrysz, K., 2021. Assessment of Blue and Green Infrastructure Solutions in Shaping Urban Public Spaces—Spatial and Functional, Environmental, and Social Aspects. *Sustainability* 13, 11041. <https://doi.org/10.3390/su131911041>.
- Pearson's Correlation Coefficient. In: Kirch, W. (Ed.), 2008. *Encyclopedia of Public Health*. Springer, Netherlands, Dordrecht, pp. 1090–1091. https://doi.org/10.1007/978-1-4020-5614-7_2569.
- Klimanova, O., Illarionova, O., Grunewald, K., Bukvareva, E., 2021. Green Infrastructure, Urbanization, and Ecosystem Services: The Main Challenges for Russia's Largest Cities. *Land* 10, 1292. <https://doi.org/10.3390/land10121292>.
- Klimanova, O.A., Illarionova, O.I., 2020. Green infrastructure indicators for urban planning: applying the integrated approach for Russian largest cities. *GES* 13, 251–259. <https://doi.org/10.24057/2071-9388-2019-123>.
- Kopp, J., Preis, J., 2019. The potential implementation of stormwater retention ponds into the blue-green infrastructure of the suburban landscape of Pilsen, Czechia. *Appl. Ecol. Env. Res* 17. https://doi.org/10.15666/aer/1706_1505515072.
- Kopperoinen, L., Itkonen, P., Niemelä, J., 2014. Using expert knowledge in combining green infrastructure and ecosystem services in land use planning: an insight into a new place-based methodology. *Landscape Ecol.* 29, 1361–1375. <https://doi.org/10.1007/s10980-014-0014-2>.
- Kowarik, I., Hiller, A., Planchuelo, G., Seitz, B., von der Lippe, M., Buchholz, S., 2019. Emerging Urban Forests: Opportunities for Promoting the Wild Side of the Urban Green Infrastructure. *Sustainability* 11, 6318. <https://doi.org/10.3390/su11226318>.
- La Greca, P., La Rosa, D., Martinico, F., Privitera, R., 2011. Agricultural and green infrastructures: The role of non-urbanised areas for eco-sustainable planning in a metropolitan region. *Environ. Pollut.* 159, 2193–2202. <https://doi.org/10.1016/j.envpol.2010.11.017>.
- La Rosa, D., Privitera, R., 2013. Characterization of non-urbanized areas for land-use planning of agricultural and green infrastructure in urban contexts. *Landscape Urban Plan.* 109, 94–106. <https://doi.org/10.1016/j.landurbplan.2012.05.012>.
- Labovitz, S., 1968. Criteria for Selecting a Significance Level: A Note on the Sacredness of .05. *Am. Sociol.* 3, 220–222.
- Lai, S., Leone, F., Zoppi, C., 2019. Assessment of Municipal Masterplans Aimed at Identifying and Fostering Green Infrastructure: A Study Concerning Three Towns of the Metropolitan Area of Cagliari, Italy. *Sustainability* 11, 1470. <https://doi.org/10.3390/su11051470>.
- Lai, S., Leone, F., Zoppi, C., 2018. Implementing Green Infrastructures beyond Protected Areas. *Sustainability* 10, 3544. <https://doi.org/10.3390/su10103544>.
- Landor-Yamagata, J., Kowarik, I., Fischer, L., 2018. Urban Foraging in Berlin: People, Plants and Practices within the Metropolitan Green Infrastructure. *Sustainability* 10, 1873. <https://doi.org/10.3390/su10061873>.
- Langemeyer, J., Wedgwood, D., McPhearsen, T., Baró, F., Madsen, A.L., Barton, D.N., 2020. Creating urban green infrastructure where it is needed – A spatial ecosystem service-based decision analysis of green roofs in Barcelona. *Sci. Total Environ.* 707, 135487 <https://doi.org/10.1016/j.scitotenv.2019.135487>.
- Lanzas, M., Hermoso, V., de-Miguel, S., Bota, G., Brotons, L., 2019. Designing a network of green infrastructure to enhance the conservation value of protected areas and maintain ecosystem services. *Sci. Total Environ.* 651, 541–550. <https://doi.org/10.1016/j.scitotenv.2018.09.164>.
- Lee, D., Oh, K., 2019. The Green Infrastructure Assessment System (GIAS) and Its Applications for Urban Development and Management. *Sustainability* 11, 3798. <https://doi.org/10.3390/su11143798>.
- Leonard, L., Miles, B., Heidari, B., Lin, L., Castronova, A.M., Minsker, B., Lee, J., Scaife, C., Band, L.E., 2019. Development of a participatory Green Infrastructure design, visualization and evaluation system in a cloud supported jupyter notebook computing environment. *Environ. Model. Softw.* 111, 121–133. <https://doi.org/10.1016/j.envsoft.2018.10.003>.
- Li, C., Peng, C., Chiang, P.-C., Cai, Y., Wang, X., Yang, Z., 2019. Mechanisms and applications of green infrastructure practices for stormwater control: A review. *J. Hydrol.* 568, 626–637. <https://doi.org/10.1016/j.jhydrol.2018.10.074>.
- Li, D., Li, Y., Nguyen, Q.C., Siebeneck, L.K., 2020. A Study on the GIS Professional (GISP) Certification Program in the U.S. *IJGI* 9, 523. <https://doi.org/10.3390/ijgi9090523>.
- Li, L., Uyttenhove, P., Van Eetvelde, V., 2020a. Planning green infrastructure to mitigate urban surface water flooding risk – A methodology to identify priority areas applied in the city of Ghent. *Landscape Urban Plan.* 194, 103703 <https://doi.org/10.1016/j.landurbplan.2019.103703>.
- Li, L., Van Eetvelde, V., Cheng, X., Uyttenhove, P., 2020b. Assessing stormwater runoff reduction capacity of existing green infrastructure in the city of Ghent. *Int. J.*

- Sustain. Dev. World Ecol. 27, 749–761. <https://doi.org/10.1080/13504509.2020.1739166>.
- Liao, Q., Wang, Z., Huang, C., 2020. Green Infrastructure Offset the Negative Ecological Effects of Urbanization and Storing Water in the Three Gorges Reservoir Area, China. *IJERPH* 17, 8077. <https://doi.org/10.3390/ijerph17218077>.
- Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gotzsche, P.C., Ioannidis, J.P.A., Clarke, M., Devereaux, P.J., Kleijnen, J., Moher, D., 2009. The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration. *PLoS Med* 6, e1000100. <https://doi.org/10.1371/journal.pmed.1000100>.
- Lieberherr, E., Green, O., 2018. Green Infrastructure through Citizen Stormwater Management: Policy Instruments, Participation and Engagement. *Sustainability* 10, 2099. <https://doi.org/10.3390/su10062099>.
- Limburg, K.E., O'Neill, R.V., Costanza, R., Farber, S., 2002. Complex systems and valuation. *Ecol. Econ.* 41, 409–420. [https://doi.org/10.1016/S0921-8009\(02\)00090-3](https://doi.org/10.1016/S0921-8009(02)00090-3).
- Lin, B., Meyers, J., Beaty, R., Barnett, G., 2016. Urban Green Infrastructure Impacts on Climate Regulation Services in Sydney, Australia. *Sustainability* 8, 788. <https://doi.org/10.3390/su8080788>.
- Lin, B.B., Meyers, J.A., Barnett, G.B., 2019. Establishing Priorities for Urban Green Infrastructure Research in Australia. *Urban Policy Res.* 37, 30–44. <https://doi.org/10.1080/08111146.2018.1523054>.
- Liquete, C., Kleeschulte, S., Dige, G., Maes, J., Grizzetti, B., Olah, B., Zulian, G., 2015. Mapping green infrastructure based on ecosystem services and ecological networks: A Pan-European case study. *Environ. Sci. Policy* 54, 268–280. <https://doi.org/10.1016/j.envsci.2015.07.009>.
- Liu, O.Y., Russo, A., 2021. Assessing the contribution of urban green spaces in green infrastructure strategy planning for urban ecosystem conditions and services. *Sustain. Cities Soc.* 68, 102772. <https://doi.org/10.1016/j.scs.2021.102772>.
- Liu, Z., Xiu, C., Ye, C., 2020. Improving Urban Resilience through Green Infrastructure: An Integrated Approach for Connectivity Conservation in the Central City of Shenyang, China. *Complexity* 2020, 1–15. <https://doi.org/10.1155/2020/1653493>.
- Long, H., Liu, Y., Hou, X., Li, T., Li, Y., 2014. Effects of land use transitions due to rapid urbanization on ecosystem services: Implications for urban planning in the new developing area of China. *Habitat Int.* 44, 536–544. <https://doi.org/10.1016/j.habitatint.2014.10.011>.
- Longato, D., Cortinovis, C., Albert, C., Geneletti, D., 2021. Practical applications of ecosystem services in spatial planning: Lessons learned from a systematic literature review. *Environ. Sci. Policy* 119, 72–84. <https://doi.org/10.1016/j.envsci.2021.02.001>.
- Lonsdorf, E.V., Nootenboom, C., Janke, B., Horgan, B.P., 2021. Assessing urban ecosystem services provided by green infrastructure: Golf courses in the Minneapolis-St. Paul metro area. *Landsc. Urban Plan.* 208, 104022. <https://doi.org/10.1016/j.landurbplan.2020.104022>.
- Lovell, S.T., Taylor, J.R., 2013. Supplying urban ecosystem services through multifunctional green infrastructure in the United States. *Landsc. Ecol.* 28, 1447–1463. <https://doi.org/10.1007/s10980-013-9912-y>.
- Lynch, A.J., 2016. Is It Good to Be Green? Assessing the Ecological Results of County Green Infrastructure Planning. *J. Plan. Educ. Res.* 36, 90–104. <https://doi.org/10.1177/0739456X15598615>.
- Ma, Q., Li, Y., Xu, L., 2021. Identification of green infrastructure networks based on ecosystem services in a rapidly urbanizing area. *J. Clean. Prod.* 300, 126945. <https://doi.org/10.1016/j.jclepro.2021.126945>.
- Maes, J., Barbosa, A., Baranzelli, C., Zulian, G., Batista e Silva, Vandecasteele, F., Hiederer, I., Liquete, R., Paracchini, C., Mubareka, M.L., Jacobs-Crisioni, S., Castillo, C., Lavalle, C., C.P., 2015. More green infrastructure is required to maintain ecosystem services under current trends in land-use change in Europe. *Landsc. Ecol.* 30, 517–534. <https://doi.org/10.1007/s10980-014-0083-2>.
- Majekodunmi, M., Emmanuel, R., Jafry, T., 2020. A spatial exploration of deprivation and green infrastructure ecosystem services within Glasgow city. *Urban For. Urban Green.* 52, 126698. <https://doi.org/10.1016/j.ufug.2020.126698>.
- Maragno, D., Gaglio, M., Robbi, M., Appiotti, F., Fano, E.A., Gissi, E., 2018. Fine-scale analysis of urban flooding reduction from green infrastructure: An ecosystem services approach for the management of water flows. *Ecol. Model.* 386, 1–10. <https://doi.org/10.1016/j.ecolmodel.2018.08.002>.
- Marando, F., Salvatori, E., Sebastiani, A., Fusaro, L., Manes, F., 2019. Regulating Ecosystem Services and Green Infrastructure: assessment of Urban Heat Island effect mitigation in the municipality of Rome, Italy. *Ecol. Model.* 392, 92–102. <https://doi.org/10.1016/j.ecolmodel.2018.11.011>.
- Marcucci, D.J., Jordan, L.M., 2013. Benefits and Challenges of Linking Green Infrastructure and Highway Planning in the United States. *Environ. Manag.* 51, 182–197. <https://doi.org/10.1007/s00267-012-9966-7>.
- Mathey, J., Röbler, S., Banse, J., Lehmann, I., Bräuer, A., 2015. Brownfields As an Element of Green Infrastructure for Implementing Ecosystem Services into Urban Areas. *J. Urban Plann. Dev.* 141. [https://doi.org/10.1061/\(ASCE\)UP.1943-5444.0000275](https://doi.org/10.1061/(ASCE)UP.1943-5444.0000275).
- McWilliam, W., Fukuda, Y., Moller, H., Smith, D., 2017. Evaluation of a dairy agri-environmental programme for restoring woody green infrastructure. *Int. J. Agric. Sustain.* 15, 350–364. <https://doi.org/10.1080/14735903.2017.1314749>.
- Meerow, S., 2019. A green infrastructure spatial planning model for evaluating ecosystem service tradeoffs and synergies across three coastal megacities. *Environ. Res. Lett.* 14, 125011. <https://doi.org/10.1088/1748-9326/ab502c>.
- Meerow, S., Helmrich, A.M., Andrade, R., Larson, K.L., 2021. How do heat and flood risk drive residential green infrastructure implementation in Phoenix, Arizona. *Urban Ecosyst* 24, 989–1000. <https://doi.org/10.1007/s11252-020-01088-x>.
- Meerow, S., Newell, J.P., 2017. Spatial planning for multifunctional green infrastructure: Growing resilience in Detroit. *Landsc. Urban Plan.* 159, 62–75. <https://doi.org/10.1016/j.landurbplan.2016.10.005>.
- Mekala, G.D., Hatton MacDonald, D., 2018. Lost in Transactions: Analysing the Institutional Arrangements Underpinning Urban Green Infrastructure. *Ecol. Econ.* 147, 399–409. <https://doi.org/10.1016/j.ecolecon.2018.01.028>.
- Mekala, G.D., Jones, R.N., MacDonald, D.H., 2015. Valuing the Benefits of Creek Rehabilitation: Building a Business Case for Public Investments in Urban Green Infrastructure. *Environ. Manag.* 55, 1354–1365. <https://doi.org/10.1007/s00267-015-0471-7>.
- Millennium Ecosystem Assessment Board, 2005. *Ecosystems and human well-being. Synthesis.* Island Press, Washington, D.C.
- Miller, S.M., Montalto, F.A., 2019. Stakeholder perceptions of the ecosystem services provided by Green Infrastructure in New York City. *Ecosystem Serv.* 37, 100928. <https://doi.org/10.1016/j.ecoser.2019.100928>.
- Minixhofer, P., Stangl, R., 2021. Green Infrastructures and the Consideration of Their Soil-Related Ecosystem Services in Urban Areas—A Systematic Literature Review. *Sustainability* 13, 3322. <https://doi.org/10.3390/su13063322>.
- MITECO, 2021. Estrategia Nacional de Infraestructura Verde y de la Conectividad y Restauración Ecológicas [National Strategy for Green Infrastructure and Ecological Connectivity and Restoration] [WWW Document]. URL (<https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/infraestructura-verde/Infra-verde.aspx>) (accessed 6.20.22).
- Monteiro, R., Ferreira, J.C., 2020. Green Infrastructure Planning as a Climate Change and Risk Adaptation Tool in Coastal Urban Areas. *J. Coast. Res.* 95, 889. <https://doi.org/10.2112/SI95-173.1>.
- Monteiro, R., Ferreira, J.C., Antunes, P., 2020. Green Infrastructure Planning Principles: An Integrated Literature Review. *Land* 9, 525. <https://doi.org/10.3390/land9120525>.
- Montgomery, J.A., Klimas, C.A., Arcus, J., DeKnock, C., Rico, K., Rodriguez, Y., Vollrath, K., Webb, E., Williams, A., 2016. Soil Quality Assessment Is a Necessary First Step for Designing Urban Green Infrastructure. *J. Environ. Qual.* 45, 18–25. <https://doi.org/10.2134/jeq2015.04.0192>.
- Moyzeová, M., 2018. Inclusion of the Public in the Natural Capital, Ecosystem Services and Green Infrastructure Assessments (Results of Structured Interviews with Stakeholders of Commune Liptovská Teplička). *Ekológia (Bratisl.)* 37, 42–56. <https://doi.org/10.2478/eko-2018-0005>.
- Muvuna, J., Boutaleb, T., Mickovski, S.B., Baker, K., Mohammad, G.S., Cools, M., Selmi, W., 2020. Information Integration in a Smart City System—A Case Study on Air Pollution Removal by Green Infrastructure through a Vehicle Smart Routing System. *Sustainability* 12, 5099. <https://doi.org/10.3390/su12125099>.
- National Wildlife Federation, 2022. *Ecosystem Services* [WWW Document]. Wildlife is important to the heritage, culture, and heart of America, and we want to preserve it as a legacy for our children. URL (<https://www.nwf.org/Home/Educational-Resources/Wildlife-Guide/Understanding-Conservation/Ecosystem-Services>) (accessed 1.26.22).
- Nguyen, T.T., Meurk, C., Benavidez, R., Jackson, B., Pahlow, M., 2021. The Effect of Blue-Green Infrastructure on Habitat Connectivity and Biodiversity: A Case Study in the Ōtākaro/Avon River Catchment in Christchurch, New Zealand. *Sustainability* 13, 6732. <https://doi.org/10.3390/su13126732>.
- Niedzwiecka-Filipiak, I., Rubaszek, J., Potyrała, J., Filipiak, P., 2019. The Method of Planning Green Infrastructure System with the Use of Landscape-Functional Units (Method LaFU) and its Implementation in the Wrocław Functional Area (Poland). *Sustainability* 11, 394. <https://doi.org/10.3390/su11020394>.
- Nielsen, A.B., Hedblom, M., Olafsson, A.S., Wiström, B., 2017. Spatial configurations of urban forest in different landscape and socio-political contexts: identifying patterns for green infrastructure planning. *Urban Ecosyst* 20, 379–392. <https://doi.org/10.1007/s11252-016-0600-y>.
- Niță, M.R., Pătroescu, M., Badiu, D.L., Gavrilidis, A.A., Avram, M.-E., 2018. Indicators for evaluating the role of green infrastructures in sustainable urban development in Romania. *fg XVII* 75–81. <https://doi.org/10.5775/fg.2018.106.i>.
- Norman, L.M., Ruddell, B.L., Tosline, D.J., Fell, M.K., Greimann, B.P., Cederberg, J.R., 2021. Developing Climate Resilience in Aridlands Using Rock Detention Structures as Green Infrastructure. *Sustainability* 13, 11268. <https://doi.org/10.3390/su132011268>.
- Orantes, M., Kim, Jinki, Kim, Jiseok, 2017. Socio-Cultural Asset Integration for a Green Infrastructure Network Plan in Yesan County, Korea. *Sustainability* 9, 192. <https://doi.org/10.3390/su9020192>.
- Padró, R., La Rota-Aguilera, M.J., Giocoli, A., Cirera, J., Coll, F., Pons, M., Pino, J., Pili, S., Serrano, T., Villalba, G., Marull, J., 2020. Assessing the sustainability of contrasting land use scenarios through the Socioecological Integrated Analysis (SIA) of the metropolitan green infrastructure in Barcelona. *Landsc. Urban Plan.* 203, 103905. <https://doi.org/10.1016/j.landurbplan.2020.103905>.
- Palliwoda, J., Banzhaf, E., Priess, J.A., 2020. How do the green components of urban green infrastructure influence the use of ecosystem services? Examples from Leipzig, Germany. *Landsc. Ecol.* 35, 1127–1142. <https://doi.org/10.1007/s10980-020-01004-w>.
- Palme, M., Privitera, R., La Rosa, D., 2020. The shading effects of Green Infrastructure in private residential areas: Building Performance Simulation to support urban planning. *Energy Build.* 229, 110531. <https://doi.org/10.1016/j.enbuild.2020.110531>.
- Pamukcu-Albers, P., Ugolini, F., La Rosa, D., Grădinaru, S.R., Azevedo, J.C., Wu, J., 2021. Building green infrastructure to enhance urban resilience to climate change and pandemics. *Landsc. Ecol.* 36, 665–673. <https://doi.org/10.1007/s10980-021-01212-y>.

- Pappalardo, V., La Rosa, D., Campisano, A., La Greca, P., 2017. The potential of green infrastructure application in urban runoff control for land use planning: A preliminary evaluation from a southern Italy case study. *Ecosystem Serv.* 26, 345–354. <https://doi.org/10.1016/j.ecoser.2017.04.015>.
- Parker, J., de Baro, M.E., Zingoni, 2019. Green Infrastructure in the Urban Environment: A Systematic Quantitative Review. *Sustainability* 11, 3182. <https://doi.org/10.3390/su11113182>.
- Pauleit, S., Ambrose-Oji, B., Andersson, E., Anton, B., Buijs, A., Haase, D., Elands, B., Hansen, R., Kowarik, I., Kronenberg, J., Mattijssen, T., Stahl Olafsson, A., Rall, E., van der Jagt, A.P.N., Konijnendijk van den Bosch, C., 2019. Advancing urban green infrastructure in Europe: Outcomes and reflections from the GREEN SURGE project. *Urban For. Urban Green.* 40, 4–16. <https://doi.org/10.1016/j.ufug.2018.10.006>.
- Paulin, M.J., Remme, R.P., de Nijs, T., Rutgers, M., Koopman, K.R., de Knegt, B., van der Hoek, D.C.J., Breure, A.M., 2020. Application of the Natural Capital Model to assess changes in ecosystem services from changes in green infrastructure in Amsterdam. *Ecosystem Serv.* 43, 101114 <https://doi.org/10.1016/j.ecoser.2020.101114>.
- Pavao-Zuckerman, M.A., Sookhdeo, C., 2017. Nematode Community Response to Green Infrastructure Design in a Semi-arid City. *J. Environ. Qual.* 46, 687–694. <https://doi.org/10.2134/jeq2016.11.0461>.
- Pelorusso, R., Gobattoni, F., Geri, F., Leone, A., 2017. PANDORA 3.0 plugin: A new biodiversity ecosystem service assessment tool for urban green infrastructure connectivity planning. *Ecosystem Serv.* 26, 476–482. <https://doi.org/10.1016/j.ecoser.2017.05.016>.
- Piacentini, S.M., Rossetto, R., 2020. Attitude and Actual Behaviour towards Water-Related Green Infrastructures and Sustainable Drainage Systems in Four North-Western Mediterranean Regions of Italy and France. *Water* 12, 1474. <https://doi.org/10.3390/w12051474>.
- Piedeloblo, L., Taramelli, A., Schiavon, E., Valentini, E., Molina, J.-L., Nguyen Xuan, A., González-Aguilera, D., 2019. Assessment of Green Infrastructure in Riparian Zones Using Copernicus Programme. *Remote Sens.* 11, 2967. <https://doi.org/10.3390/rs11242967>.
- Pinho, P., Correia, O., Lecoq, M., Munzi, S., Vasconcelos, S., Gonçalves, P., Rebelo, R., Antunes, C., Silva, P., Freitas, C., Lopes, N., Santos-Reis, M., Branquinho, C., 2016. Evaluating green infrastructure in urban environments using a multi-taxa and functional diversity approach. *Environ. Res.* 147, 601–610. <https://doi.org/10.1016/j.envres.2015.12.025>.
- Pranckuté, R., 2021. Web of Science (WoS) and Scopus: The Titans of Bibliographic Information in Today's Academic World. *Publications* 9, 12. <https://doi.org/10.3390/publications9010012>.
- Privitera, R., La Rosa, D., 2018. Reducing Seismic Vulnerability and Energy Demand of Cities through Green Infrastructure. *Sustainability* 10, 2591. <https://doi.org/10.3390/su10082591>.
- R Core Team, 2022. R: The R Project for Statistical Computing [WWW Document]. R-4.1.0 for Windows. URL (<https://www.r-project.org/index.html>) (accessed 1.28.22).
- Rall, E., Hansen, R., Pauleit, S., 2019. The added value of public participation GIS (PPGIS) for urban green infrastructure planning. *Urban For. Urban Green.* 40, 264–274. <https://doi.org/10.1016/j.ufug.2018.06.016>.
- Ramyar, R., Saeedi, S., Bryant, M., Davatgar, A., Mortaz Hedjri, G., 2020. Ecosystem services mapping for green infrastructure planning—The case of Tehran. *Sci. Total Environ.* 703, 135466 <https://doi.org/10.1016/j.scitotenv.2019.135466>.
- Ring, Z., Damyranovic, D., Reinwald, F., 2021. Green and open space factor Vienna: A steering and evaluation tool for urban green infrastructure. *Urban For. Urban Green.* 62, 127131 <https://doi.org/10.1016/j.ufug.2021.127131>.
- Rodríguez-Espinoza, V.M., Aguilera-Benavente, F., Gómez-Delgado, M., 2020. Green infrastructure design using GIS and spatial analysis: a proposal for the Henares Corridor (Madrid-Guadalajara, Spain). *Landscape Res.* 45, 26–43. <https://doi.org/10.1080/01426397.2019.1569221>.
- Rodríguez-Loinaz, G., Peña, L., Palacios-Agundez, I., Ametzaga, I., Onaindia, M., 2018. Identifying Green Infrastructure as a Basis for an Incentive Mechanism at the Municipality Level in Biscay (Basque Country). *Forests* 9, 22. <https://doi.org/10.3390/f9010022>.
- Roe, D., 2019. Biodiversity loss—more than an environmental emergency. *Lancet Planet. Health* 3, e287–e289. [https://doi.org/10.1016/S2542-5196\(19\)30113-5](https://doi.org/10.1016/S2542-5196(19)30113-5).
- Roe, M., Mell, I., 2013. Negotiating value and priorities: evaluating the demands of green infrastructure development. *J. Environ. Plan. Manag.* 56, 650–673. <https://doi.org/10.1080/09640568.2012.693454>.
- Ronchi, S., Arcidiacono, A., Pogliani, L., 2020. Integrating green infrastructure into spatial planning regulations to improve the performance of urban ecosystems. Insights from an Italian case study. *Sustain. Cities Soc.* 53, 101907 <https://doi.org/10.1016/j.scs.2019.101907>.
- Rubiano Calderón, K.D., 2019. Distribución de la infraestructura verde y su capacidad de regulación térmica en Bogotá, Colombia. *Colomb* 22, 83–100. <https://doi.org/10.14483/2256201X.14304>.
- Russo, A., Chan, W.T., Cirella, G.T., 2021. Estimating Air Pollution Removal and Monetary Value for Urban Green Infrastructure Strategies Using Web-Based Applications. *Land* 10, 788. <https://doi.org/10.3390/land10080788>.
- Salomaa, A., Paloniemi, R., Kotiaho, J.S., Kettunen, M., Apostolopoulou, E., Cent, J., 2017. Can green infrastructure help to conserve biodiversity. *Environ. Plan. C: Polit. Space* 35, 265–288. <https://doi.org/10.1177/0263774X16649363>.
- Salomaa, A., Paloniemi, R., Kotiaho, J.S., Kettunen, M., Apostolopoulou, E., Cent, J., 2016. Can green infrastructure help to conserve biodiversity. *Environ. Plan. C: Polit. Space* 35, 265–288. <https://doi.org/10.1177/0263774X16649363>.
- Sanesi, G., Colangelo, G., Lafortezza, R., Calvo, E., Davies, C., 2017. Urban green infrastructure and urban forests: a case study of the Metropolitan Area of Milan. *Landscape Res.* 42, 164–175. <https://doi.org/10.1080/01426397.2016.1173658>.
- Santiago Ramos, J., Hurtado Rodríguez, C., 2021. Análisis de servicios ecosistémicos para la configuración de una infraestructura verde en el área metropolitana de Sevilla. *ACE: Archit., City Environ.* 16. <https://doi.org/10.5821/ace.16.46.9884>.
- Schäffler, A., Swilling, M., 2013. Valuing green infrastructure in an urban environment under pressure — The Johannesburg case. *Ecol. Econ.* 86, 246–257. <https://doi.org/10.1016/j.ecolecon.2012.05.008>.
- Schiavon, E., Taramelli, A., Tornato, A., 2021. Modelling stakeholder perceptions to assess Green Infrastructures potential in agriculture through fuzzy logic: A tool for participatory governance. *Environ. Dev.* 40, 100671 <https://doi.org/10.1016/j.envdev.2021.100671>.
- Schifman, L.A., Prues, A., Gilkey, K., Shuster, W.D., 2018. Realizing the opportunities of black carbon in urban soils: Implications for water quality management with green infrastructure. *Sci. Total Environ.* 644, 1027–1035. <https://doi.org/10.1016/j.scitotenv.2018.06.396>.
- Schmidt, J., Hauck, J., 2018. Implementing green infrastructure policy in agricultural landscapes—scenarios for Saxony-Anhalt, Germany. *Reg. Environ. Change* 18, 899–911. <https://doi.org/10.1007/s10113-017-1241-2>.
- Sebastiani, A., Buonocore, E., Franzese, P.P., Riccio, A., Chianese, E., Nardella, L., Manes, F., 2021. Modeling air quality regulation by green infrastructure in a Mediterranean coastal urban area: The removal of PM10 in the Metropolitan City of Naples (Italy). *Ecol. Model.* 440, 109383 <https://doi.org/10.1016/j.ecolmodel.2020.109383>.
- Semeraro, T., Aretano, R., Barca, A., Pomes, A., Del Giudice, C., Gatto, E., Lenucci, M., Buccolieri, R., Emmanuel, R., Gao, Z., Scognamiglio, A., 2020. A Conceptual Framework to Design Green Infrastructure: Ecosystem Services as an Opportunity for Creating Shared Value in Ground Photovoltaic Systems. *Land* 9, 238. <https://doi.org/10.3390/land9080238>.
- Shackleton, C.M., Blair, A., De Lacy, P., Kaoma, H., Mugwagwa, N., Dalu, M.T., Walton, W., 2018. How important is green infrastructure in small and medium-sized towns? Lessons from South Africa. *Landscape Urban Plan.* 180, 273–281. <https://doi.org/10.1016/j.landurbplan.2016.12.007>.
- Shi, X., Qin, M., 2018. Research on the Optimization of Regional Green Infrastructure Network. *Sustainability* 10, 4649. <https://doi.org/10.3390/su10124649>.
- Shi, X., Qin, M., Li, B., Zhang, D., 2021. A Framework for Optimizing Green Infrastructure Networks Based on Landscape Connectivity and Ecosystem Services. *Sustainability* 13, 10053. <https://doi.org/10.3390/su131810053>.
- Shifflett, Newcomer-Johnson, Yess, Jacobs, 2019. Interdisciplinary Collaboration on Green Infrastructure for Urban Watershed Management: An Ohio Case Study. *Water* 11, 738. <https://doi.org/10.3390/w11040738>.
- Sikorska, D., Sikorski, P., Hopkins, R., 2017. High Biodiversity of Green Infrastructure Does Not Contribute to Recreational Ecosystem Services. *Sustainability* 9, 334. <https://doi.org/10.3390/su9030334>.
- Simić, I., Stupar, A., Djokić, V., 2017. Building the Green Infrastructure of Belgrade: The Importance of Community Greening. *Sustainability* 9, 1183. <https://doi.org/10.3390/su9071183>.
- Skogen, K., Helland, H., Kaltenborn, B., 2018. Concern about climate change, biodiversity loss, habitat degradation and landscape change: Embedded in different packages of environmental concern. *J. Nat. Conserv.* 44, 12–20. <https://doi.org/10.1016/j.jnc.2018.06.001>.
- Spanò, M., Gentile, F., Davies, C., Lafortezza, R., 2017. The DPSIR framework in support of green infrastructure planning: A case study in Southern Italy. *Land Use Policy* 61, 242–250. <https://doi.org/10.1016/j.landusepol.2016.10.051>.
- Sturiale, Scuderi, 2019. The Role of Green Infrastructures in Urban Planning for Climate Change Adaptation. *Climate* 7, 119. <https://doi.org/10.3390/cli7100119>.
- Sun, H., Liu, C., Wei, J., 2021. Identifying Key Sites of Green Infrastructure to Support Ecological Restoration in the Urban Agglomeration. *Land* 10, 1196. <https://doi.org/10.3390/land10111196>.
- Suppakkittpaisarn, P., Jiang, X., Sullivan, W.C., 2017. Green Infrastructure, Green Stormwater Infrastructure, and Human Health: A Review. *Curr. Landscape Ecol. Rep.* 2, 96–110. <https://doi.org/10.1007/s40823-017-0028-y>.
- Sussams, L.W., Sheate, W.R., Eales, R.P., 2015. Green infrastructure as a climate change adaptation policy intervention: Muddying the waters or clearing a path to a more secure future. *J. Environ. Manag.* 147, 184–193. <https://doi.org/10.1016/j.jenvman.2014.09.003>.
- Svensson, J., Andersson, J., Sandström, B., Mikusiński, G., Jonsson, B.G., 2019. Landscape trajectory of natural boreal forest loss as an impediment to green infrastructure. *Conserv. Biol.* 33, 152–163. <https://doi.org/10.1111/cobi.13148>.
- Tan, P.Y., Zhang, J., Masoudi, M., Alemu, J.B., Edwards, P.J., Grêt-Regamey, A., Richards, D.R., Saunders, J., Song, X.P., Wong, L.W., 2020. A conceptual framework to untangle the concept of urban ecosystem services. *Landscape Urban Plan.* 200, 103837 <https://doi.org/10.1016/j.landurbplan.2020.103837>.
- Tiwari, A., Kumar, R., Baldauf, R., Zhang, K.M., Pilla, F., Di Sabatino, S., Brattich, E., Pulvirenti, B., 2019. Considerations for evaluating green infrastructure impacts in microscale and macroscale air pollution dispersion models. *Sci. Total Environ.* 672, 410–426. <https://doi.org/10.1016/j.scitotenv.2019.03.350>.
- Tran, T.J., Helmus, M.R., Behm, J.E., 2020. Green infrastructure space and traits (GIST) model: Integrating green infrastructure spatial placement and plant traits to maximize multifunctionality. *Urban For. Urban Green.* 49, 126635 <https://doi.org/10.1016/j.ufug.2020.126635>.
- Turner, M.G., Calder, W.J., Cumming, G.S., Hughes, T.P., Jentsch, A., LaDeau, S.L., Lenton, T.M., Shuman, B.N., Turetsky, M.R., Ratajczak, Z., Williams, J.W., Williams, A.P., Carpenter, S.R., 2020. Climate change, ecosystems and abrupt change: science priorities. *Philos. Trans. R. Soc. B* 375, 20190105. <https://doi.org/10.1098/rstb.2019.0105>.
- Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemela, J., James, P., 2007. Promoting ecosystem and human health in urban areas using Green

- Infrastructure: A literature review. *Landscape Urban Plan.* 81, 167–178. <https://doi.org/10.1016/j.landurbplan.2007.02.001>.
- US EPA, 2015, What is Green Infrastructure? [WWW Document]. Green Infrastructure URL (<https://www.epa.gov/green-infrastructure/what-green-infrastructure>) (accessed 6.20.22).
- Valente, D., Pasimeni, M.R., Petrosillo, I., 2020. The role of green infrastructures in Italian cities by linking natural and social capital. *Ecol. Indic.* 108, 105694 <https://doi.org/10.1016/j.ecolind.2019.105694>.
- Valeri, S., Zavattero, L., Capotorti, G., 2021. Ecological Connectivity in Agricultural Green Infrastructure: Suggested Criteria for Fine Scale Assessment and Planning. *Land* 10, 807. <https://doi.org/10.3390/land10080807>.
- Vallecillo, S., Polce, C., Barbosa, A., Perpiña Castillo, C., Vandecasteele, I., Rusch, G.M., Maes, J., 2018. Spatial alternatives for Green Infrastructure planning across the EU: An ecosystem service perspective. *Landscape Urban Plan.* 174, 41–54. <https://doi.org/10.1016/j.landurbplan.2018.03.001>.
- Van Oijstaeijen, W., Van Passel, S., Cools, J., 2020. Urban green infrastructure: A review on valuation toolkits from an urban planning perspective. *J. Environ. Manag.* 267, 110603 <https://doi.org/10.1016/j.jenvman.2020.110603>.
- van Vliet, K., Hammond, C., 2021. Residents' perceptions of green infrastructure in the contemporary residential context: a study of Kingswood, Kingston-upon-Hull, England. *J. Environ. Plan. Manag.* 64, 145–163. <https://doi.org/10.1080/09640568.2020.1756757>.
- Vasiljević, N., Radić, B., Gavrilović, S., Šljukić, B., Medarević, M., Ristić, R., 2018. The concept of green infrastructure and urban landscape planning: a challenge for urban forestry planning in Belgrade, Serbia. *iForest* 11, 491–498. <https://doi.org/10.3832/ifer2683-011>.
- Venter, Z.S., Barton, D.N., Martinez-Izquierdo, L., Langemeyer, J., Baró, F., McPhearson, T., 2021. Interactive spatial planning of urban green infrastructure – Retrofitting green roofs where ecosystem services are most needed in Oslo. *Ecosystem Serv.* 50, 101314 <https://doi.org/10.1016/j.ecoser.2021.101314>.
- Venter, Z.S., Krog, N.H., Barton, D.N., 2020a. Linking green infrastructure to urban heat and human health risk mitigation in Oslo, Norway. *Sci. Total Environ.* 709, 136193 <https://doi.org/10.1016/j.scitotenv.2019.136193>.
- Venter, Z.S., Shackleton, C.M., Van Staden, F., Selomane, O., Masterson, V.A., 2020b. Green Apartheid: Urban green infrastructure remains unequally distributed across income and race geographies in South Africa. *Landscape Urban Plan.* 203, 103889 <https://doi.org/10.1016/j.landurbplan.2020.103889>.
- von Döhrn, P., Haase, D., 2015. Ecosystem disservices research: A review of the state of the art with a focus on cities. *Ecol. Indic.* 52, 490–497. <https://doi.org/10.1016/j.ecolind.2014.12.027>.
- Wang, J., Banzhaf, E., 2018. Towards a better understanding of Green Infrastructure: A critical review. *Ecol. Indic.* 85, 758–772. <https://doi.org/10.1016/j.ecolind.2017.09.018>.
- Wang, J., Pauleit, S., Banzhaf, E., 2019. An Integrated Indicator Framework for the Assessment of Multifunctional Green Infrastructure—Exemplified in a European City. *Remote Sens.* 11, 1869. <https://doi.org/10.3390/rs11161869>.
- Wang, W., Wu, T., Li, Y., Xie, S., Han, B., Zheng, H., Ouyang, Z., 2020. Urbanization Impacts on Natural Habitat and Ecosystem Services in the Guangdong-Hong Kong-Macao “Megacity. *Sustainability* 12, 6675. <https://doi.org/10.3390/su12166675>.
- Wang, Y., Chang, Q., Fan, P., 2021. A framework to integrate multifunctionality analyses into green infrastructure planning. *Landscape Ecol.* 36, 1951–1969. <https://doi.org/10.1007/s10980-020-01058-w>.
- Wang, Y., Ni, Z., Hu, M., Li, J., Wang, Yue, Lu, Z., Chen, S., Xia, B., 2020. Environmental performances and energy efficiencies of various urban green infrastructures: A life-cycle assessment. *J. Clean. Prod.* 248, 119244 <https://doi.org/10.1016/j.jclepro.2019.119244>.
- Wijffels, J., BNOSAC, Institute of Formal and Applied Linguistics, Faculty of Mathematics and Physics, Charles University in Prague, Czech Republic, Straka, M., Straková, J., 2021. udpipe: Tokenization, Parts of Speech Tagging, Lemmatization and Dependency Parsing with the “UDPipe” “NLP” Toolkit.
- Williams, D.S., Mániz Costa, M., Sutherland, C., Celliers, L., Scheffran, J., 2019. Vulnerability of informal settlements in the context of rapid urbanization and climate change. *Environ. Urban.* 31, 157–176. <https://doi.org/10.1177/0956247818819694>.
- Wong, C.P., Jiang, B., Kinzig, A.P., Ouyang, Z., 2018. Quantifying multiple ecosystem services for adaptive management of green infrastructure. *Ecosphere* 9. <https://doi.org/10.1002/ecs2.2495>.
- Wong, G.K.L., Jim, C.Y., 2018. Abundance of urban male mosquitoes by green infrastructure types: implications for landscape design and vector management. *Landscape Ecol.* 33, 475–489. <https://doi.org/10.1007/s10980-018-0616-1>.
- Wong, S.M., Montalto, F.A., 2020. Exploring the Long-Term Economic and Social Impact of Green Infrastructure in New York City. *Water Resour. Res.* 56. <https://doi.org/10.1029/2019WR027008>.
- Wuyts, K., Smets, W., Lebeer, S., Samson, R., 2020. Green infrastructure and atmospheric pollution shape diversity and composition of phyllosphere bacterial communities in an urban landscape. *FEMS Microbiol. Ecol. Fiz.* 173. <https://doi.org/10.1093/femsec/fiz173>.
- Xia, H., Ge, S., Zhang, X., Kim, G., Lei, Y., Liu, Y., 2021. Spatiotemporal Dynamics of Green Infrastructure in an Agricultural Peri-Urban Area: A Case Study of Baisha District in Zhengzhou, China. *Land* 10, 801. <https://doi.org/10.3390/land10080801>.
- Xu, H., Zhao, G., 2021. Assessing the Value of Urban Green Infrastructure Ecosystem Services for High-Density Urban Management and Development: Case from the Capital Core Area of Beijing, China. *Sustainability* 13, 12115. <https://doi.org/10.3390/su132112115>.
- Yacamán Ochoa, C., Ferrer Jiménez, D., Mata Olmo, R., 2020. Green Infrastructure Planning in Metropolitan Regions to Improve the Connectivity of Agricultural Landscapes and Food Security. *Land* 9, 414. <https://doi.org/10.3390/land9110414>.
- Yamaguchi, R., Shah, P., 2020. Spatial discounting of ecosystem services. *Resour. Energy Econ.* 62, 101186 <https://doi.org/10.1016/j.reseneeco.2020.101186>.
- Ying, J., Zhang, X., Zhang, Y., Bilan, S., 2022. Green infrastructure: systematic literature review. *Econ. Res. - Ekon. Istraživanja* 35, 343–366. <https://doi.org/10.1080/1331677X.2021.1893202>.
- Yiwo, E., Jato-Espino, D., Carracedo, P., de Brito, M.M., 2022. Multi-stakeholder perception on flood management in Ghana: Analysis of drivers and potential solutions, with a focus on surface permeability. *Int. J. Disaster Risk Reduct.* 76, 102990 <https://doi.org/10.1016/j.ijdrr.2022.102990>.
- Young, R.F., 2011. Planting the Living City: Best Practices in Planning Green Infrastructure—Results From Major U.S. Cities. *J. Am. Plan. Assoc.* 77, 368–381. <https://doi.org/10.1080/01944363.2011.616996>.
- Young, R.F., McPherson, E.G., 2013. Governing metropolitan green infrastructure in the United States. *Landscape Urban Plan.* 109, 67–75. <https://doi.org/10.1016/j.landurbplan.2012.09.004>.
- Zaleska-Jonsson, A., Wilkinson, S.J., Wahlund, R., 2020. Willingness to Pay for Green Infrastructure in Residential Development—A Consumer Perspective. *Atmosphere* 11, 152. <https://doi.org/10.3390/atmos11020152>.
- Zardo, L., Geneletti, D., Pérez-Soba, M., Van Eupen, M., 2017. Estimating the cooling capacity of green infrastructures to support urban planning. *Ecosystem Serv.* 26, 225–235. <https://doi.org/10.1016/j.ecoser.2017.06.016>.
- Zhang, D., Wang, W., Zheng, H., Ren, Z., Zhai, C., Tang, Z., Shen, G., He, X., 2017. Effects of urbanization intensity on forest structural-taxonomic attributes, landscape patterns and their associations in Changchun, Northeast China: Implications for urban green infrastructure planning. *Ecol. Indic.* 80, 286–296. <https://doi.org/10.1016/j.ecolind.2017.05.042>.
- Zhang, F., Chung, C.K.L., Yin, Z., 2020. Green infrastructure for China's new urbanisation: A case study of greenway development in Maanshan. *Urban Stud.* 57, 508–524. <https://doi.org/10.1177/0042098018822965>.
- Zhang, S., Muñoz Ramírez, F., 2019. Assessing and mapping ecosystem services to support urban green infrastructure: The case of Barcelona, Spain. *Cities* 92, 59–70. <https://doi.org/10.1016/j.cities.2019.03.016>.
- Zhang, X., Ni, Z., Wang, Y., Chen, S., Xia, B., 2020. Public perception and preferences of small urban green infrastructures: A case study in Guangzhou, China. *Urban For. Urban Green.* 53, 126700 <https://doi.org/10.1016/j.ufug.2020.126700>.
- Zhang, Z., Meerow, S., Newell, J.P., Lindquist, M., 2019. Enhancing landscape connectivity through multifunctional green infrastructure corridor modeling and design. *Urban For. Urban Green.* 38, 305–317. <https://doi.org/10.1016/j.ufug.2018.10.014>.
- Zhang, Z., Zhang, G., Su, B., 2022. The spatial impacts of air pollution and socio-economic status on public health: Empirical evidence from China. *Socio-Econ. Plan. Sci.* 83, 101167 <https://doi.org/10.1016/j.seps.2021.101167>.
- Zidar, K., Belliveau-Nance, M., Cucchi, A., Denk, D., Kricun, A., O'Rourke, S., Rahman, S., Rangarajan, S., Rothstein, E., Shih, J., Montalto, F., 2017. A Framework for Multifunctional Green Infrastructure Investment in Camden, NJ. *UP* 2, 56–73. <https://doi.org/10.17645/up.v2i3.1038>.
- Zölch, T., Maderspacher, J., Wamsler, C., Pauleit, S., 2016. Using green infrastructure for urban climate-proofing: An evaluation of heat mitigation measures at the micro-scale. *Urban For. Urban Green.* 20, 305–316. <https://doi.org/10.1016/j.ufug.2016.09.011>.
- Zölch, T., Rahman, M.A., Pfeleiderer, E., Wagner, G., Pauleit, S., 2019. Designing public squares with green infrastructure to optimize human thermal comfort. *Build. Environ.* 149, 640–654. <https://doi.org/10.1016/j.buildenv.2018.12.051>.
- Zulian, G., Ronchi, S., La Notte, A., Vallecillo, S., Maes, J., 2021. Adopting a cross-scale approach for the deployment of a green infrastructure. *OE* 6, e65578. <https://doi.org/10.3897/oneeco.6.e65578>.