Urban Transformations

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Planning cities with nature for sustainability transformations — a systematic review

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Abstract

The future coexistence of human and nonhuman nature on an urban planet is at risk. A crucial lever is the transformation of human-nature relationships in and through cities. Urban planning as a sustainability intervention has the potential to reconnect cities with nature. To shed light on transformative potentials of urban planning in the context of human-nature connections, we conducted a systematic literature review. We analysed 71 empirical studies from Europe published between 2016 and 2022. We characterised the research using qualitative analysis, and applied the leverage point perspective as the main focus to identify blind spots and future research needs. Our review reveals a highly interdisciplinary field with research focus on transformation *through* planning, while issues of transformation *in* planning tend to receive less attention. Furthermore, the studies rather deal with shallow leverage points for sustainability transformations both in terms of system levels and human-nature connections. In order to unlock the potential of urban planning, future research should pay more attention to the inner dimensions of planning and human-nature connections in cities. Furthermore, research should be more concerned with the visionary modes of urban planning, e.g. by discussing what is (not) desirable in the future.

Highlights

- The review links urban planning with the leverage points perspective and human-nature connections as important levers for sustainability transformations.
- Deep leverage points are less frequently addressed than shallow leverage points.
- Inner dimensions of human-nature connections are less frequently approached than outer dimensions.

Policy and practice recommendations

- The consideration of human-nature relationships in and through cities is key to sustainability transformations.
- To foster urban sustainability transformations, more attention should be paid to visionary modes of urban planning by considering the goals, visions and underlying individual or shared beliefs and values of the planning actors.

- To strengthen urban sustainability transformations, urban planning should be studied more strongly from a transdisciplinary perspective that integrates non-scientific and especially societal actors into the research process.

Introduction

The global social-ecological crises are increasingly exceeding critical thresholds thereby threatening the future coexistence of human and nonhuman nature (Rockström et al. 2023). One of the main causes of these crises is urbanisation, the extent and acceleration of which is also steadily increasing (Elmqvist et al. 2021). Given that we live on a primarily urban planet, cities will determine the viability and success of a quest for global sustainability (Elmqvist et al. 2018). One can assume that sustainability has to become urban, paradoxically considering cities both as a nexus of social-ecological crises and as a prerequisite for their solution (Brenner & Schmid 2015). At least since the United Nations Conference on Housing and Sustainable Urban Development (Habitat III), cities have been seen as drivers of sustainable development, and urban sustainability has become a high priority in policy debates and agendas worldwide. On questions of urban transformations towards sustainability, a field of research is developing in which different systemic research perspectives interact in an interdisciplinary context (Wolfram et al. 2016). While research on transformation issues has been ongoing for some time, the number of articles that address urban transformation with the normative goal of sustainability has been increasing (Koch et al. 2018). Linked to this is the claim that deep or radical systemic change is required for cities to become sustainable (McPhearson et al. 2021). This gives rise to questions concerning *what* should transform in cities and *how* (Hölscher & Frantzeskaki 2021; Torrens et al. 2021).

Regarding the question *what* to transform, a key shift is the transformation of human-nature relationships in and through cities (Colding et al. 2020). For example, the lack of physical interaction between human and nonhuman nature in cities (Soga & Gaston 2016) or the spatially decoupled resource consumption through cities (Seto et al. 2012) are discussed as drivers of human-nature alienation. Therefore, reconnecting with nature may act as a deep leverage point for sustainability transformations (Artmann 2023; Ives et al. 2018; Riechers et al. 2021a, b, c). The leverage points perspective is a systems theory proposed by Meadows (1999) and elaborated for sustainability science by Abson et al. (2017). The authors summarise four main system levels that represent a hierarchy of leverage points to change the overall system. It is assumed that interventions have different transformative power depending on which of these system levels they are aimed at: Interventions at the parameter and feedback level are comparatively easy to implement but pursue little transformative power. In contrast, interventions at the level of design and intent are thought to have deep leverage, but are difficult to achieve. For example, the paradigms of a system are difficult to change despite their profound transformative power (Davelaar 2021). This could include, for example, the necessary shift from a utilitarian and anthropocentric account of human-nature relationships to qualities of care and reciprocity (Muradian & Gómez-Baggethun 2021), addressing social norms and deeply held personal and shared values and beliefs that structure behaviour and practices (Abson et al. 2017; Ives et al. 2018).

On the question of *how* sustainability transformations can be approached, urban planning can play an important role as it addresses the physical, social, economic and environmental development of metropolitan regions, cities and neighbourhoods (European Conference of Ministers Responsible for Regional Planning 2007). In fact, there is an increasing call for spatial planning to recognise and take a proactive role in promoting sustainable transformations (Albrechts 2013; Hansen et al. 2022; Hofmeister et al. 2021). In this context, urban planning acts in a future-oriented and normative way and intervenes consciously and purposefully in urban development, e.g. through plans, programmes and measures (Bush & Doyon 2019). Since planning activities aim to actively influence the development of existing urban systems, we consider urban planning itself as a potential sustainability intervention. Crucial to the way in which planning exploits this potential seems to be the way in which planning perceives its role and fills it with life, i.e. what planners consider meaningful and appropriate in their historical, spatial, or political context. It can be stated that in local urban planning, different historically evolved rationalities on the role of planning overlap, meaning how urban planning is understood and approached (Wolfram 2018). However, these evolving rationalities (such as rationalism, incrementalism, participation, or collaboration) place different emphases on how planning can influence the urban system, including how change can be organised (authoritative and solution-oriented vs representative and democratically legitimated) or what purpose these changes serve (optimising the status quo vs. radical change). Based on this, two different modes of planning can be distinguished (ibid.): In the regulatory mode, influenced by its roots in rationalism and incrementalism, planning seeks to bring about urban change through, among other things, optimising the status quo and a short- and medium-term solution orientation. On the other hand, visionary planning, which is informed by other rationalities such as cooperative and strategic planning, is oriented towards long-term goals and tries to base its activities on different values, knowledge and practices (ibid.). Therefore, we assume that these different modes have an impact on the potential of urban planning as a sustainability intervention. However, further research is needed on how these different transformative potentials of urban planning have been addressed by research so far.

To provide an integrative perspective on how urban planning can foster sustainability transformations, the leverage points perspective offers a theoretical framework that bridges causal and teleological explanations for system change (Abson et al. 2017; Meadows 1999). The causal explanation is based on the assumption that transformations result from interactions between system elements. In this context, interventions are expected to act as rather shallow levers for overarching system changes. In contrast, the teleological explanation assumes that it is primarily human intentions that influence the course of a system: In this context, interventions represent deep levers for system change (Fischer & Riechers 2019). Based on these explanations, we argue that urban planning in the regulatory mode tends to act on causal relationships, for example, optimising the status quo such as in the context of urban green infrastructure (e.g. Gavrilidis et al. 2019). Research addressing this mode is therefore more concerned with shallow leverage points (that are easy to change but have less transformative potential). In contrast, urban planning in the visionary mode tends to take a teleological approach, for example, questioning underlying normative orientations,

for example, the implementation of degrowth into planning policies (e.g. Ruiz-Alejos & Prats 2022). Research that focuses on this mode of planning tends to address deep leverage points (that are difficult to change but have great transformative potential). However, we hypothesize that planning research has so far failed to address areas of deep leverage points for sustainability transformations, as noted for example by Angheloiu and Tennant (2020) for urban sustainability interventions. In line with Riechers et al. (2021a, b, c), we argue that the ways in which human-nature connections are addressed by urban planning have not yet been adequately explored in the face of severe social-ecological crises.

To investigate this assumption, we conducted a systematic literature review on the role of urban planning in the context of sustainability transformations and human-nature connections. We are aware of the challenge of conducting a review in a highly interdisciplinary context. Since the role of planning can be considered from many different research perspectives, a variety of topics, methods, fields of action and actor constellations in different spatial and cultural contexts can be expected. To address this challenge, we used a qualitative method of analysis to cope with the complexity of research on the role of urban planning (see Sect. "Data analysis"). However, it is this inter- and multidisciplinary perspective on urban planning that can provide an integrative overview of leverage points for sustainability transformations that are already being researched or have received too little attention so far. Recent systematic literature reviews with a leverage point perspective have looked at coastal and marine pollution (Riechers et al. 2021a, b, c), energy and food systems (Dorninger et al. 2020; Zimmermann et al. 2023), and urban interventions (Angheloiu & Tennant 2020). However, to the best of our knowledge it still lacks a systematic review of the role of urban planning as an enabler of change in general, and in particular with a focus on human-nature connections as an important lever for sustainability transformations (Ives et al. 2018; Riechers et al. 2021a, b, c). While urban planning may be an important collective actor when it comes to rethinking the relationship between people and nature in cities (Pineda-Pinto et al. 2022), current research on human-nature connections focuses on the individual level, examining, for example, how connectedness with urban nature relate to pro-environmental behaviour (Whitburn et al. 2019) or how individual perceptions of ecosystem services can be used to improve the design of urban green spaces (Buchel & Frantzeskaki 2015). This research often neglects the collective level (e.g., groups of people or organisations) (Ives et al. 2017), although the reflection of human-nature connections in collective decision-making processes appears to be significant in explaining sustainability outcomes (Muhar et al. 2018).

In the face of these challenges and research gaps, we explore the role of urban planning in reconnecting cities with nature for sustainability transformations, addressing three research objectives:

1. Providing an overview on how the role of urban planning is studied in the context of sustainability transformations and human-nature connections,
2. Exploring which understandings of transformation become visible and which leverage points are taken into account, and
3. Identifying how nature and human-nature connections are addressed.

Considering the major benefits of systematic literature reviews (Gough et al. 2017), our review organises and synthesises the respective state of the art that is highly relevant for urban sustainability transformations and identifies blind spots for future research needs in the context of our research objectives. Thereby, the paper ties in with the discussion of sustainability transformation *through* planning (e.g. Albert et al. 2021; Bush 2020) while also making references to the discussion of transformation *in* planning (e.g. Albrechts et al. 2020; Othengrafen & Levin-Keitel 2019), that is, how planning itself needs to change in light of future challenges.

Method

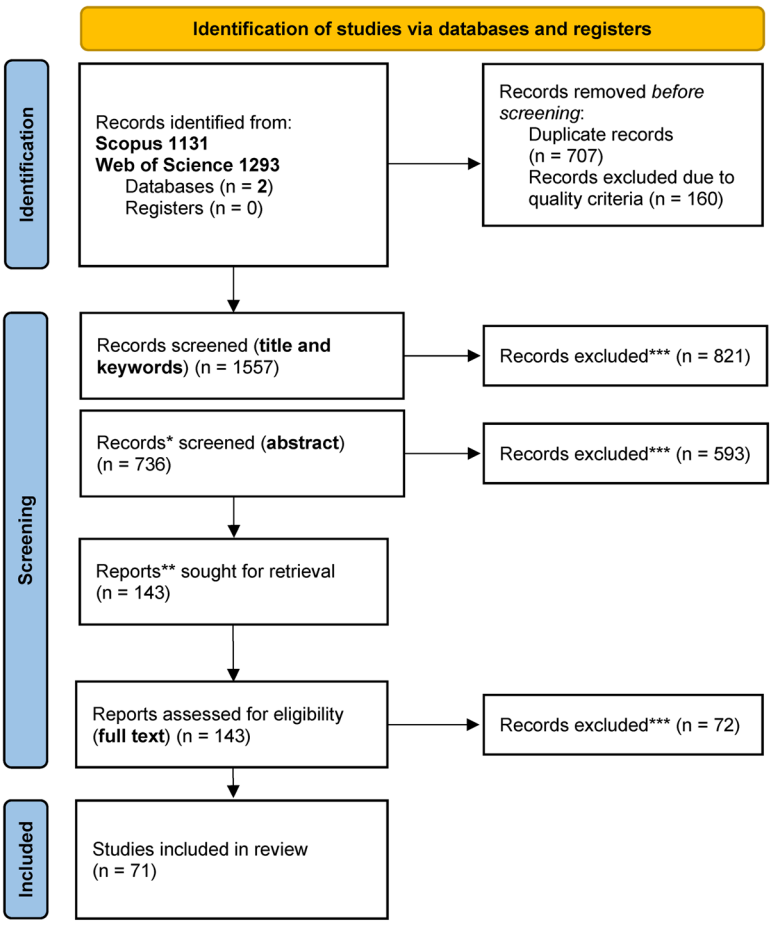
Data collection

In order to understand how research is addressing the role of planning in reconnecting cities with nature for sustainability transformations, we conducted a systematic literature review following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement (Page et al. 2021). For each step, we published the bibliographic data and the screening decisions as a dataset (https://doi.org/10.5281/zenodo.8359407). We developed a search string that encompasses different levels of coding to find studies which relate to the five key aspects of the topic, namely cities, planning, sustainability, transformation and nature. These five coding levels were separated with the Boolean operator OR (see Table 1).

We applied the search string on two scientific databases (Scopus, Web of Science) in May 2022, subject to their individual search requirements. We considered publications from 2016 to 2022 in the English language whose database entries were exhaustive and contained these terms either in the title, abstract or keywords. We chose 2016 as a starting point because it was the year of the UN-Habitat III conference which elevated the role of cities in sustainability to a global stage (Bai et al. 2016). In addition, the search was limited to articles, reviews and editorials in peer-reviewed journals, excluding books and grey literature to focus on high-quality research. After

Table 1 Coding levels, search terms and inclusion criteria for the systematic literature review

Coding Levels	**(1) Cities** **(2) Sustainability** **(3) Urban Planning** **(4) Transformation** **(5) Nature**
Search Terms	(1) city, urban, municipalit*, town (2) sustainab*, (3) planning, (4) transformat*, transit* (5) natur*, biodiversity, ecosystem, landscape, environment*, green infrastructure, blue infrastructure
Inclusion Criteria	Type: Peer-reviewed original empirical articles Language: English Publication: 2016–2022 Geography: Europe Content: Is the spatial context of cities addressed? Is planning addressed as a field of action? Is any kind of nature addressed?



* Records: The title or abstract (or both) of a report indexed in a database or website (Page et al. 2021).
** Reports: A document (paper or electronic) supplying information about a particular study (Page et al. 2021).
*** The decisions made on the basis of the exclusion criteria can be found in the corresponding data publication (Harms et al. 2023).

Fig. 1 PRISMA 2020 flow diagram for systematic reviews (Page et al. 2021)

duplicates were removed, we conducted the screening in three consecutive steps with two reviewers on the identified 1557 articles. Because database searches capture many studies that use the same terms but do not have the same focus, we systematically applied exclusion criteria when screening (Gough et al. 2017). Thus, articles not dealing with either sustainability or the spatial context of cities were excluded. In addition, articles without reference to the role of planning or any kind of nature were excluded (see Table 1). In case of uncertainty, the decision was in favour of inclusion. In the case of exclusion, a double check by both reviewers was carried out. Before screening the full texts, we decided to limit the scope to empirical studies in countries of the European Union (including UK) to provide a sample based on comparable legal frameworks and planning cultures. All reasons for exclusion during screening were documented in a spreadsheet database. Finally, 143 articles were sought for retrieval and assessed for eligibility, resulting in 71 articles selected for further analysis (see Fig. 1).

Data analysis

We analysed the data with a qualitative coding scheme, employing MAXQDA for data processing. In a dataset, the description of all variables, their meaning and reference points in the literature is published (https://doi.org/10.5281/zenodo.8359407). The coding scheme was tested and refined on 15 randomly selected papers prior to applying it to the entire sample. Consistency in the use of the coding frame was increased by cross-checking the test coding of the two reviewers. However, there is a methodological limitation here, as coding behaviour changes over time both between and within individuals, and reliability is strongly dependent on the subjective assessments of the reviewers involved (Belur et al. 2021).

Coding scheme

The overall coding scheme reflects the three research objectives and comprises four categories with a total of 18 variables. The response options were derived both inductively and deductively from the literature (see Table 2).

To address the first research objective, we developed the variables in the first and second category that identify the research approaches and methods involved and the views on the role of urban planning in different urban governance and policy systems.

The second research objective is mapped in the third category and comprises the ways in which the studies relate to the topic of transformation. In doing so, we put an analytical focus on the leverage points perspective to deductively capture the system levels addressed. Based on Abson et al. (2017), we differentiated between four system levels: parameter, feedback, design and intent. Here, the parameter and feedback level refer to mechanistic elements and characteristics of the system as well as interactions between them, the design level to the social structures and institutions, and the intent level to the emergent direction in which a system is heading (ibid.). In our analysis, we coded the parameter level if the creation or modification of blue-green infrastructure was addressed, for example. The feedback level was assigned to studies that dealt for instance with the management of resources or the connectivity of green spaces. We allocated the design level, for example, when the studies dealt with questions of policy integration or participation. Finally, the intent level was coded when, for example, planning goals or paradigms were addressed.

The third research objective is addressed by the fourth category and detects the ways in which nature and human-nature connections are considered. For the latter, we applied the typology provided by Ives et al. (2018), which differentiates between material, experiential, cognitive, emotional and philosophical human-nature connections.

Table 2 Qualitative coding scheme with 18 variables grouped into four categories

Category 1 Research Perspectives	Category 2 Urban Planning	Category 3 Transformation	Category 4 Nature
1. Case geography 2. Spatial scale 3. Disciplinary Approach 4. Case type 5. Data type 6. Data collection 7. Principal topic	8. Level of planning 9. Action field 10. Governance 11. Planning dimensions 12. Planning practice 13. Planning actors	14. Usage 15. Scientific Standpoint 16. System level	17. Type of Nature 18. Human-Nature Connections
Research Objective 1		**Research Objective 2**	**Research Objective 3**

With this typology we deductively mapped the extent to which outer and inner dimensions of human-nature connectedness are considered. Regarding the outer dimensions of human-nature connectedness, we recorded the use of resources as material human-nature connections and the direct interaction with natural environments as experiential connections. Concerning the inner human-nature connectedness, we categorised environmental knowledge or awareness and attitudes or values towards nature as cognitive connections, feelings of attachment to or empathy towards nature as emotional connections and worldviews about the relationship with nature as philosophical connections.

Different types of variables

We employed the different types of variables from Table 2 when collecting the data, including categorical variables with nominal scaling, categorical variables with ordinal scaling and one binary variable. One part of the variables is exhaustive and mutually exclusive, e.g. only one principal topic can be addressed. Other variables allow multiple answers, e.g. the content and process of planning can be examined in the same study. The allocation of these differences to the respective variables is given in the corresponding data publication (https://doi.org/10.5281/zenodo.8359407).

Subsequently, a quantitative analysis of the responses was carried out. For this purpose, the relative share of the answer categories in the total sample was recorded in order to be able to evaluate the relevance of the respective answer categories. The evaluation differed slightly depending on the variable type. For nominal and binary variables, we calculated the percentage of each response category out of the total number of codes assigned. For ordinal variables, we calculated two different percentages: The first number indicates the proportion of papers that deal with the topic in a marginal way, i.e. the topic is mentioned but not considered in depth (code 1), and the second number shows the proportion of papers that focus on the topic, i.e. the topic is studied in depth (code 2).

Finally, a Sankey diagram was created to illustrate selected connections between important variables to summarise our findings.

Results

In this section we present the findings structured in the order of the four categories of the qualitative coding scheme to inform the research objectives. The following applies to all sections, and if a percentage is given in brackets, it refers to the share of the total sample for the respective categorical variable. If two percentages are given, it refers to ordinal variables, with the first value representing code 1 and the second value representing code 2 (see Sect. "Data analysis").

Research perspectives

The results of the first category on research perspectives are summarised in Fig. 3 and are explained in detail for each variable below. It can be noted that most studies are conducted in Sweden (18%), followed by Italy (14%), Spain (9%), Portugal, Germany, United Kingdom (each 7%), Netherlands, Poland and Romania (all 6%) (see Fig. 2). Spatially, the case studies focus on different scales ranging from site level (15%), neighbourhood (12%), district (15%), city (31%), region (20%) up to the national level (7%). With regard

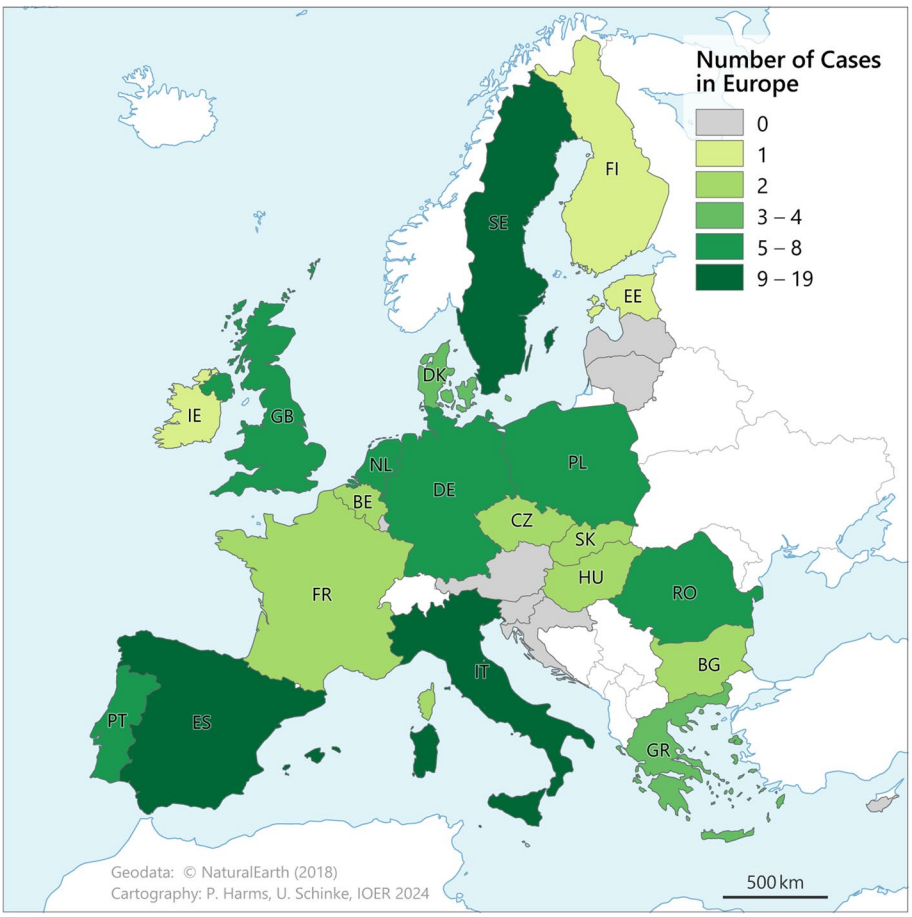


Fig. 2 Geographical distribution of empirical case studies under review

to the disciplinary approaches, it can be noted that the majority pursue interdisciplinary research approaches (82%), one fifth pursue transdisciplinary approaches (18%). Studies that only integrate data, techniques, or concepts of a single discipline are not represented in our sample, demonstrating the interdisciplinary focus of our review (see Sect. 1). Two-thirds of the case studies are single case studies and one-third is multiple case studies. The majority of the studies use qualitative data (47%) (e.g. document analysis and interviews), followed by studies that employ mixed data types 35% and the minority that focus exclusively on quantitative data (18%) (e.g. geographical and statistical data) (see Fig. 3, Sect. "Urban planning"). When clustering the responses to the principal topic variable, we identified five overarching themes which overlap and are not absolutely clear-cut, but nevertheless provide an overview of the integrative research field. Most studies deal with a spatial perspective. These studies are aggregated as landscape and urban management (35%), and address, for instance, strategic spatial planning or spatial metrics and indicators as support for decision making. Studies grouped as nature-based solutions (25%) include approaches that stress the benefits of nature for cities and include studies on ecosystem services, blue-green infrastructure and ecosystem-based adaptation. Studies on land cover and land use change (20%), frequently articulate a historical perspective, and discuss spatial trends (e.g. urbanisation) in landscapes or other

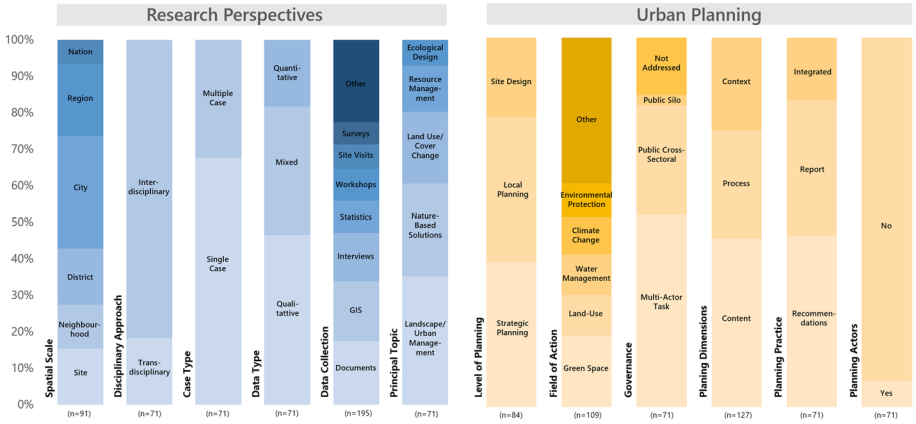


Fig. 3 (own graphic): Percentage of responses to variables in category 1 (research perspectives, see Sect. 3.1) and category 2 (urban planning, see Sect. "Urban planning")

spatial units (e.g. land use classes). Studies on resource management (13%) are mainly represented by socio-technical perspectives and focus on the role of actors in the transition of technical subsystems (e.g. water management). Ecological design studies (7%) mostly take a formative perspective by creating architectural designs or guidelines for urban areas (e.g. biophilic design) (see Fig. 3).

Urban planning

In order to understand the studies' perspectives on the role of urban planning in depth, we examined how planning is framed by research and which aspects are empirically investigated. The results are summarised in Fig. 3.

In terms of planning level, i.e. the levels at which planning processes and tools can influence the decision-making context, we analysed whether the studies cover issues of strategic planning, local planning or on-site planning (Cortinovis et al. 2021). Strategic planning includes studies that investigate comprehensive urban development strategies (39%). Local planning addresses the allocation of different land uses and functions in the city by planning (39%), while on-site planning focuses on detailed planning at the site level (22%). With regard to the action fields of urban planning, most studies deal with green space planning (19%), followed by land use planning (11%), urban water management (11%), climate change adaptation and mitigation (10%) and environmental protection (9%). The as *Other* (40%), grouped fields of action are diverse and encompass transport planning, food planning, regional planning or landscape management, each individually representing 5% or less of the total amount. Concerning applied governance perspectives, most studies investigate urban planning as a multi-actor task involving governmental and non-governmental actors within the wider context of urban governance (52%). Also significant is the perspective of planning as a cross-sectoral public task involving governmental actors from different departments (e.g., environment, housing, health) (30%), whereas narrow perspectives on planning as a public task with actors from one single department are hardly represented (3%) (see Fig. 3).

According to Wiechmann (2008), planning can be examined from three closely interwoven but delimitable planning dimensions encompassing what to plan (content), how

to plan (process) and why to plan (context). Almost half of the studies (46%) deal with the content dimension of planning, i.e. addressing what issues and problems are raised, and how they can be perceived or influenced. The study of planning processes, i.e. raising questions about procedures, instruments and actors involved are less represented (29%). Similarly, the dimension of the planning context, i.e. targeting relevant societal challenges and the governance, structures, organisations and legitimations of planning, is less prominent (25%). In addition, we can show that the studies commonly make recommendations for planning practice that may or may not involve a direct examination of real-world planning activities in advance. Therefore, we traced differences in the manner in which the studies relate to and interact with planning practice. Interestingly, the majority of the studies formulate recommendations for planning without examining planning itself (46%). In the remaining studies, planning is empirically investigated either from an external perspective (37%) or from an integrated perspective (17%). In the former, the researchers report on the planning process; in the latter, the researchers themselves are part of the planning process and thus their studies take on an integrated perspective of planning practice. In each of the two latter categories, a particular aspect of planning is examined in detail, e.g. the organisation, laws, instruments or the role of planning actors in terms of power or collaboration. However, the planning actors and their personal views on the issues discussed are rarely addressed. The personal view represents a person's subjective belief, value or worldview. It includes both individual and shared understandings and assumptions about the world that influence the perception, interpretation and construction of reality (O'Brien 2018). Although these aspects address deep leverage points for sustainability transformations (see also Sect. "Transformation"), only five studies (7%) deal with personal views, such as emotions, place attachment or responsibility (see Fig. 3).

Transformation

To shed more light on the topic of transformation, we examined how the studies relate to the topic in general and how different leverage points were tackled within the research. The results are summarised in Fig. 4. The way the studies relate to the topic of transformation differs fundamentally. A majority of the studies deal with transformation in an empirical way (64%), while the other papers only use the term to contextualise the study (36%). The studies that empirically address transformation take either a descriptive (39%) (e.g. analysis of spatial transformations) or a normative standpoint (61%) (e.g. fostering sustainability transformations) (see Fig. 4, Sect. "Nature").

In analysing the system levels, we distinguished between shallow and deep leverage points for sustainability transformations. We examined whether these are merely discussed as a side issue in the paper (represented by the first percentage) or whether they are a fundamental focus in the study (represented by the second percentage) (see Sect. "Data analysis"). If we look at the share of both together, it is shown that most studies address the shallow leverage points of parameters (30%, 28%) and feedbacks (23%, 39%) (see Fig. 4). In terms of parameters, the studies shed light on individual elements of the urban system, such as the creation, modification or protection of blue-green infrastructure or seek to inform decision-making (e.g. by calculating the number and distribution of green spaces or analysing the territorial drivers of land use). System feedbacks

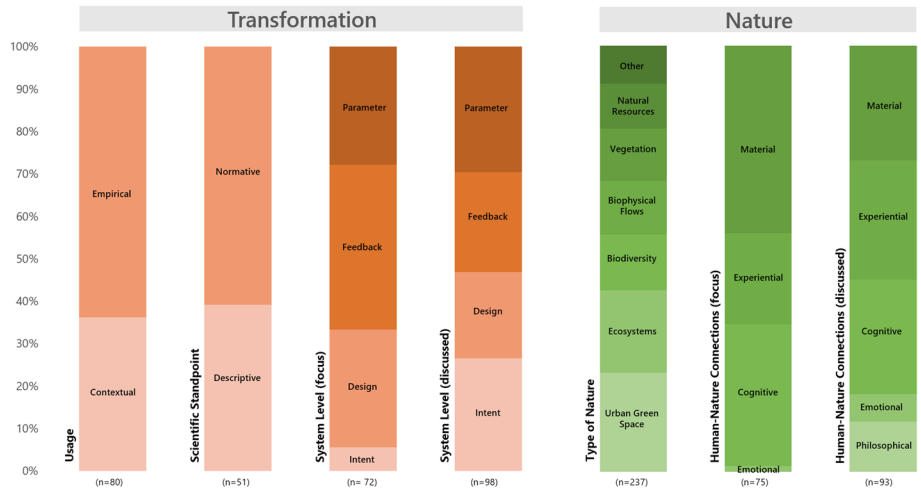


Fig. 4 (own graphic): Percentage of responses to variables in category 3 (transformation, see Sect. "Transformation") and 4 (nature, see Sect. "Nature")

are addressed by examining the interaction between planning and other components of the urban system (e.g. green space accessibility, water management or nature-based solutions for climate adaptation). Regarding the deep leverage points, the design of planning is regularly addressed (20%, 28%), while the intent of urban planning plays only a minor role, in particular when this leverage point is not only touched upon but in the research focus (27%, 5%) (see Fig. 4). When it comes to the system design, research is concerned with the question of how planning is or should be organised. The studies deal with topics such as actor collaboration, knowledge sharing, governance structures, policy integration, or issues such as responsibilities, trust and work culture. The system intent is addressed, for example, by thematising planning goals (e.g. densification or greening), by developing visions and narratives, or by discussing planning paradigms, i.e. the normative orientation of planning, e.g. (de)growth.

Nature

In this category we explored how nature and human-nature connections are thematised in the studies. The results are summarised in Fig. 4. The first step was to determine which types of nature are referred to thematically in the studies. The results show that they mostly focus on urban green spaces, such as parks or gardens (23%), followed by ecosystems such as rivers or forests (19%), biodiversity, and biophysical flows such as rainwater (both 13%), vegetation in general without spatial localisation (12%), and natural resources such as wood or food (11%) (see Fig. 4).

In terms of human-nature connections, we have distinguished between outer and inner dimensions, i.e. physical connections and psychological connections (see Sect. "Data analysis"). Most studies focus on the outer dimensions in terms of material (27%, 44%) and experiential (28%, 21%) connections (see Fig. 4). The material connections are addressed through resource and land use, e.g. wood as a building material or urban agriculture. Resource and nature conservation activities or the creation of new green spaces are also addressed, as well as the opposite trends, such as the destruction

of nature and land consumption, for example, through densification strategies. The experiential human-nature connections are mainly addressed through accessibility to green spaces, recreational activities such as walks and the improvement of climate comfort through water and greenery. Among the inner dimensions, cognitive connections are most often addressed (27%, 33%). In contrast, emotional (6%, 1%) and philosophical (12%, 0%) connections are rarely discussed (see Fig. 4). The cognitive connections are evident in topics such as knowledge about environmental management and ecological conditions, awareness and education, as well as raising the issue of various values of nature (e.g. monetary values or social-cultural values such as landscape values). The few emotional connections relate to various forms of engagement with sense of place and place attachment by both residents and planners. The philosophical connections are addressed, for example, through the awareness and care of the local natural-cultural heritage or the relationship of people to landscapes and the responsibilities that arise from this, such as stewardship.

Connections between variables

To gain further insights into our research objectives, we have created a Sankey diagram. The Sankey diagram links four response categories of the coding scheme, highlighting connections between important variables, thus illustrating the substantive and conceptual strands and relationships in the studies reviewed. The planning content is frequently considered in all thematic clusters, especially in studies on land cover and land use change, ecological design and nature-based solutions. Studies on resource management and nature-based solutions are also often concerned with planning processes, whereas studies on landscape and urban management are more concerned with the planning context (see Fig. 5). Looking at the relationship between these thematic clusters and system levels addressed, we found that the land cover and land use change studies primarily address the parameter level. The studies on ecological design also take this level into account, but partly also focus on the feedback and design level. The discussion of the feedback level dominates in the clusters on landscape and urban management and on nature-based solutions. The studies on nature-based solutions also deal with the design level, which is likewise strongly illuminated by studies on resource management. The intent level is scarcely in focus, with the

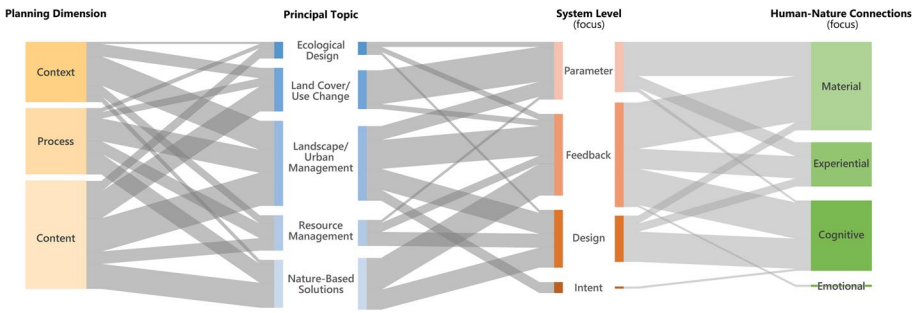


Fig. 5 (own graphic): Sankey diagram showing connections between the variables planning dimension, principal topic, system level (focus) and human-nature connections (focus). Due to different numbers of overlaps between the variables, there is an imbalance between the variables in the inflows and outflows. The choice of colours is intended to support the visualisation

exception of four papers in the landscape and urban management cluster (see Fig. 5). Lastly, we highlight the link between the system levels and the types of human-nature connections. It appears that the studies focusing on parameters primarily look at the material dimension of human-nature connections. The papers focusing on the feedback level have a broader understanding of human-nature connections and emphasise material, experiential as well as cognitive connections. Studies focusing on the design level primarily address the cognitive dimension of human-nature connections. It is particularly striking that there is just one paper in the sample that focuses on both system intent and one of the five dimensions of human-nature connections (see Fig. 5).

Summary

The sample analysed is diverse in terms of the spatial and thematic references of the research perspectives. The research is mostly interdisciplinary, with qualitative methods being used most frequently. Research on urban planning often considers multi-actor processes and looks at diverse fields of action. Most studies deal with the planning content, i.e. the question of what to plan. In addition, the studies often formulate recommendations for planning, although they do not report directly on the planning process and are not involved in the planning itself.

With regard to transformation, there is a slight majority of studies that examine the topic empirically and take a normative standpoint by referring to transformations towards sustainability. In the sample analysed, the majority of research addresses shallow leverage points. When it comes to deep leverage points, it is primarily the design level that is addressed, although the intent level is at least discussed as a side aspect in several studies. The reference to nature is made in many ways. For instance, studies often refer to green spaces or specific ecosystems in the city. The study of human-nature connections often refers to the outer dimensions, such as material or experiential connections. When looking at the inner dimensions, research on cognitive connections to nature dominates.

When analysing the links between variables, it became apparent that the thematic focus of the studies (principal topic) is often linked to both a specific perspective on the planning itself (planning dimension) and on the leverage points (system level). In addition, when shallow leverage points are the focus of the studies, material or experimental connections are often investigated. In contrast, research on cognitive connections is related to both deep and shallow leverage points.

Discussion

Our review is based on the understanding of urban planning as a potential sustainability intervention and the assumption that planning research has so far failed to address the areas with deep leverage for sustainability transformation. To explore this in depth, we therefore discuss the identified research perspectives on urban planning (research objective 1), as well as the leverage points (research objective 2) and human-nature connections (research objective 3) addressed by the research.

Research perspectives

Inter- but not transdisciplinary

Our results show highly interdisciplinary research perspectives on the role of urban planning as a sustainability intervention. In fact, in the face of complex sustainability problems, this can be seen as a strength, as greater interdisciplinary integration of knowledge and policies across different planning sectors is urgently needed (Hansen et al. 2022; Næss 2023). Through its focus on knowledge integration, interdisciplinary research seems likely to provide insights into overcoming silo thinking in planning practice. This is also reflected in the reviewed studies, as they highlight policy silos as a challenge (e.g. Suleiman 2021). However, our findings also show that transdisciplinary research approaches are not widespread, despite their importance in fostering urban sustainability transformation (Wolfram & Frantzeskaki 2016). In contrast, our results reveal that researchers tend to make recommendations without interacting with planning practitioners. Future research should therefore study urban planning from a transdisciplinary perspective such as by conducting urban experiments or living labs (Ehnert 2023; Rizzo et al. 2021). Promising areas of focus for such collaborative approaches include nature-based solutions (Wickenberg 2024) or planning for biodiversity in the city (Parris et al. 2018).

Diverse perspectives on planning

Furthermore, we observe that the studies often do not define in detail what is meant by (urban) planning, or in the words of Healey (2023), that the term planning is challenging as a "vague signifier". Because of this definitional vagueness, we looked broadly and systematically at the studies to show what is being researched. Our findings reveal multi-layered and broad research perspectives, for example, on the level of decision-making and action fields (see Sect. "Urban planning"). Furthermore, we note that despite their thematic breadth, the five identified thematic fields deal mostly with the content of urban planning rather than the process or context dimension (see Fig. 5). Thus, the studies often examine what planning does (e.g. how urban structures or processes are optimised through planning interventions), showing a strong focus of research on transformation *through* planning. Since planning processes and the planning context are less strongly addressed, questions of transformation *in* planning tend to receive less attention. In terms of changing planning processes, the studies on nature-based solutions and resource management provide valuable clues on actor collaboration (e.g. Dunn et al. 2017) and co-production (e.g. Wihlborg et al. 2019). The planning context is mostly examined in landscape and urban management studies, e.g. when discussing alternatives to growth ideology (e.g. Ruiz-Alejos & Prats 2022), examining social norms or ethics in planning (e.g. Hagbert et al. 2020).

Lack of planners´ views

In addition, our findings highlight a research gap regarding the personal views of planning actors. This is in line with a lack of attention to the influence of professional and working environments on personal views, demonstrated, for example, through climate governance (Wamsler et al. 2021) or landscape management (Muhar & Böck 2018). This gap could be explained by the fact that the inner life often escapes explicit analysis in

more traditional research approaches and instruments, either because of a lack of methodology or because the research does not consider the individual as an agent of change (Horcea-Milcu 2022; Ives et al. 2020). Furthermore, it seems challenging to explore subjective views in sustainability related research, as there is often a lack of clarity about which specific aspects of people's inner world are relevant and the epistemological and methodological foundations for researching inner worlds are not yet well established (Frank et al. 2024). However, research indicates that the understanding of the professional role and the underlying values of planners are important to understand transformative planning practices (Othengrafen & Levin-Keitel 2019). Since planners make decisions based on their values and interests, they can be seen as moral actors (Pineda Pinto 2020). This ethical perspective on the personal views of planners brings into focus questions regarding inner transformation as a prerequisite for outer change into focus (Ives et al. 2020; Wamsler et al. 2021). It also ties in with the research gap of how planners can establish themselves as agents of change (Hansen et al. 2022). The few studies in our review that address personal views examine planners' environmental values (Gustafsson et al. 2019), the influence of assumptions and emotions (e.g. Johannessen & Mostert 2020), and personal responsibility and commitment (e.g. Suleiman 2021). Further research could deepen these perspectives on the inner dimensions of planning, i.e. values, assumptions, attitudes and emotions of planners, in order to address deep leverage points in the context of human-nature connections. Such research can address, for example, how urban planners can establish human-nature partnerships that incorporate aspects of ecological justice while assigning nonhuman nature agency and legal personhood (Artmann 2023).

Transformation

Our findings indicate that transformation is already widely taken up as an empirical research topic, even if the normative goal of sustainability is not always addressed (see Sect. "Transformation"). However, we did not investigate which understanding of sustainability is applied in each case. Nevertheless, any kind of normativity seems to be a key contribution to the debates on sustainability transformation *through* and *in* planning.

Tendency towards shallow leverage points

To shed further light on the relation between urban planning and sustainability transformation, we applied the leverage point's perspective. Our analysis shows that there is a tendency in the studies to address shallow leverage points (parameter and feedback level). This result is in line with our assumptions and with the results of other reviews that have applied the perspective on, for example, food and energy systems (Dorninger et al. 2020). In our case, we can show that the result is related to the parallel focus of the studies on planning content (see Sect. 4.1). For example, the focus on planning content is especially evident in land use and land cover change studies which, at the same time, place strong emphasis on the parameter level. The same applies to studies on nature-based solutions and landscape and urban management which, at the same time, focus on the feedback level (see Fig. 5). Thus, we assume that these content-oriented studies are primarily concerned with causal relationships in urban systems (e.g. by increasing the share of green spaces or improving the management of rainwater) on which urban

planning interventions (could) have an impact. Furthermore, it seems likely to us that the tendency of research to focus on shallow leverage points and causal relationships goes hand in hand with more empirical research into planning that takes incremental and reactive approaches. However, rather incremental and reactive planning approaches, that seek to improve the status quo in a piecemeal and results-oriented manner, prevent a transformative understanding of planning in favour of short-term solutions (Malekpour et al. 2020; Rizzo et al. 2021). We recognise that planning interventions on shallow leverage points are important and can lead to positive outcomes. However, they are unlikely to lead to fundamental change towards sustainability (Abson et al. 2017).

Necessity of dealing with deep leverage points

In order to strengthen transformative-oriented planning, there is need for future research to engage more intensively with deep leverage points, i.e. the design and intent of planning. The design level points to the structures, institutions and organisation of planning and is linked to the question of how these can change in order to strengthen urban sustainability. Our review shows that research is already addressing the design level working on topics such as knowledge integration, collaboration and co-design (e.g. Albrechts et al. 2020). Research is also discussing methods of policy coordination and integration (e.g. Dorst et al. 2022), as well as improving the involvement, participation and empowerment of different stakeholder groups (e.g. Wamsler 2017). However, future research is still needed to explore, in more depth, transformative strategies to overcome structural barriers against urban sustainability in planning (Næss 2023). The system level of intent, i.e. the orientations of planning, which are expressed in the form of goals, visions and underlying individual or shared beliefs, norms, values, worldviews, are dealt with the least in the studies examined. This is in line with the opinion of Abson et al. (2017) that this system level represents a deep leverage point but is difficult to change, and is therefore rarely addressed in the scientific and practical discussion of sustainability. The underestimated importance, thus far, of inner dimensions is increasingly recognised in academia (Ives et al. 2020; Wamsler et al. 2021). Thus, the current external orientation of research should be complemented by an internal focus. In order to unlock the full potential of urban planning as a sustainability intervention, more attention should be paid to the inner dimensions.

Transformative potential of planning intent

Hence, we take a closer look at the studies that already engage with the intent level. First, some of the studies deal with social norms, environmental awareness, beliefs and values, and capacities such as reflexivity in planning (e.g. Wamsler et al. 2020). Secondly, another group within the studies deals with guiding principles, visions and goals, i.e. what is (not) desirable in the future, e.g. conflicts between green and grey solutions or (de)growth (e.g. Xue 2018). Exploring these conflicting goals, guiding principles and notions of justice seems essential for change *through* and *in* planning. In particular, the negotiation of conflicts relating to the inner dimensions of sustainability is necessary, as it entails the underlying values and worldviews. Moreover, it is about both the role of the individual in the collective and navigation of a multiplicity of values in order to enable socially robust change towards sustainability (Ives

et al. 2020). Thirdly, the remaining portion of the studies discuss methods to create a shared intention, e.g. visions and narratives (e.g. Erixon Aalto et al. 2018). In this context, arts-based methods offer planning research a rich set of techniques to capture and analyse data that are often not considered in more traditional forms of research. Therefore, the role of art-based methods could be strengthened here, for example by integrating artistic means to include more diverse forms of expression (Carpenter & Horvath 2022), or by co-creatively developing cultural narratives with planning practice (Grenni et al. 2020).

Nature

Our analysis of the role of urban planning in the context of human-nature connections shows references to multiple types of nature. These are mainly established in the form of functional planning and design. The main issues are the creation, protection and adaptation of green spaces, the improvement of water governance in close connection with blue-green infrastructure and nature-based solutions, food issues raised by agricultural land use and urban gardening, and the identification and enhancement of biodiversity.

Tendency towards outer human-nature connections

We distinguished the five types of human-nature connections using Ives et al. (2018). They discuss a close link between their framework and the leverage points perspective and suggest that inner connections (philosophical, emotional, cognitive) are deep leverage points for sustainability transformations. They also suggest that these inner dimensions have been underestimated by sustainability research thus far. Our results support this claim, since the majority of the studies address outer dimensions of human-nature connections (see Fig. 4). From the leverage points perspective, this bias highlights a research gap in addressing inner human-nature connections as deep leverage points for sustainability transformations. With regard to urban planning, Woiwode (2016) notes that the material, physical and technological levels of problem-solving often dominate and issues such as interiority, the inner being and consciousness are marginalised. For researchers in general, it can be challenging to investigate the psychological, cultural and spiritual connections between humans and nature because discrete thoughts are difficult to measure, problems of articulation arise and the willingness to share inner connections to nature with researchers may (not) be present (Gould & Schultz 2021). Nevertheless, there are studies that are already strengthening the inner connections of city dwellers with nature. For example, one study examined what people appreciate in urban nature among individuals and discussed this approach as a planning intervention to promote mental health among the participants (McEwan et al. 2020). However, studies on outer connections also make valuable contributions to sustainability transformations, as changes are also needed in the material and experiential dimensions (e.g. increasing the proportion of green spaces or the interaction with nature). This is particularly promising, when sensory, meaningful and emotional activities with nature are promoted (e.g. through gardening), that have the potential to change personal values and worldviews in the long term (Artmann et al. 2021).

Cognitive focus on inner human-nature connections

Regarding inner human-nature connections, our results show that the cognitive connections strongly dominate. For instance, the studies explore specific knowledge about the management of nature-based solutions or climate adaptation (e.g. Schubert et al. 2018), and provide knowledge through indicators of ecosystem services (e.g. Haase & Wolff, 2022). In the studies analysed, values are another important branch of cognitive connections, addressing the aesthetic value of nature (e.g. Suleiman et al. 2020) and general cultural values such as landscape values (e.g. Hersperger et al. 2020). Although a debate has emerged in recent years in the context of the IPBES valuation framework (Díaz et al. 2015) about a shift from utilitarian to values of care and an extension of the community of justice to nonhuman beings (Jax et al. 2018; Muradian & Gómez-Baggethun 2021), the planning studies examined do not make direct reference to this literature. However, they discuss issues of care and the associated sense of responsibility of citizens vis-à-vis urban green spaces and landscapes in the context of participatory processes (e.g. Pietta & Tononi 2021). In addition, some studies consider the cultural identity of landscapes (e.g. Albrechts et al. 2020) and territories (de las Rivas Sanz & Fernández-Maroto, 2019) or treat urban green as places of social cohesion (e.g. Frantzeskaki 2019).

Although scholars note that urban planning theory has evolved from a primarily anthropocentric view of nature to a more holistic social-ecological understanding (Duvall et al. 2018), other researchers suggest that widespread basic assumptions about technological control and the availability of natural processes still frequently lead to a deeply utilitarian valuation of nonhuman nature in decision-making (Muhar & Böck 2018; Muradian & Gómez-Baggethun 2021). In this respect, it is remarkable that only one study concentrates on the intent level of planning. In this study, it is shown that a professional identity, i.e. shared professional values and principles (intent level) linked to planners' personal commitment to environmental protection (cognitive connection), can promote sustainability practices in planning (Murtagh et al. 2019).

Transformative potential of emotions and ethics

In the overall view of addressing human-nature connections as levers for sustainability transformations, we find that the studies rarely address the emotional and philosophical connections (see Fig. 4). However, these hidden inner dimensions of urban life are closely related to the physical material effects that become visible in the form of design and infrastructures (Woiwode 2016). Cultural ecosystem services are a widely used concept for researching the non-material dimensions of the human-nature relationship. These are also explicitly addressed in the analysed studies (e.g. Schubert et al. 2018). However, it is a very broad categorisation that encompasses a wide range of ecosystem services, including among others: recreation, cognitive development, social relations and aesthetic values. In our analysis, we have assigned these aspects to different types of human-nature connections in order to examine the inner non-material dimensions of human-nature connections in more detail. We recorded recreational activities as experiential connections, aesthetic values as cognitive connections, as well as sense of place and place attachment as emotional connections. The latter two are closely related, with sense of place describing more generally how people perceive and experience a place, and place attachment describing more specifically the emotional bond between people

and place. Nonetheless, we have interpreted both as evidence of engagement with emotional connections (e.g. Usher et al. 2021). Beyond our analysed sample, to strengthen emotional connections, it is proposed to improve planners' compassion towards animals, plants or landscapes (Lyles et al. 2018). Art-based methods are also important here, for example to uncover and evoke feelings (Muhr 2020) or to enable multispecies placemaking (Sachs Olsen 2022). Also in terms of the deepest leverage points, the philosophical connections, i.e. worldviews about the relationship with nature, there are few exceptions that deal with related topics like awareness and responsibilities towards the environment (Wamsler et al. 2020); citizens' reconnection with a river (Vall-Casas et al. 2019); co-evolutionary approaches enhancing the ethics of responsibility/ stewardship (Sanna et al. 2020); socio-natural relations embodied in agricultural land use (Melo 2020); awareness and care of local natural-cultural heritage (Albrechts et al. 2020). However, research on the deep leverage points of human-nature connections are poorly featured in our review, so that it seems promising for future studies to take this aspect more into account. A promising field of research that addresses a broader conceptualization of human-nature relations, including the inner dimensions seems to be landscape management and planning (Flint et al. 2013). We largely excluded these studies in our review because they do not focus on cities. However, the transfer of insights from this field to the urban planning context seems promising, e.g. regarding visioning in the context of human-nature connections (van Rooij et al. 2021).

Study limitations

Our systematic literature research provides a comprehensive overview about current research dealing with transformative potentials of urban planning in the context of human-nature connections. However, our study has its limitations, both in terms of methodology and content-related questions. Methodologically, we designed the coding levels to identify relevant studies at the intersection of urban planning, sustainability transformation and human-nature connections. Therefore, we did not directly address the inner dimensions of sustainability by using keywords such as mindsets, values or spirituality. Future reviews related to urban planning could take a closer look here and focus on the emerging field of research on inner transformations (Ives et al. 2023; Wamsler et al. 2021).

Furthermore, our review was limited by excluding meta-studies and conceptual papers, grey literature and sources not published in English. By doing so, we may have missed sources published by non-governmental organisations reflecting, for example, the importance of wilderness in cities (Deutsche Umwelthilfe 2014). Content-wise, we only included studies conducted in urban areas in the European Union (including UK) in order to keep the amount of data manageable. This is a source of bias in our results, as there are large cultural differences in how cities and regions are planned around the world and how human-nature connections are understood and lived; factors emphasised in discourses on the geography of sustainability transitions, taking into account formative place-specific factors (Köhler et al. 2019). Future research could benefit from including studies from a wider range of geographical regions. In particular, comparative analysis with planning studies in the Global South is highly relevant. These studies might criticise Western anthropocentric destructions of nature and focus more closely on

philosophical human-nature connections reflecting the role of spirituality, Indigenous values and non-anthropocentric worldviews fostering sustainability transformations (Reeves & Peters 2021; Woiwode 2012). Striking examples of a different understanding of the relationship between humans and nature can be found in countries such as New Zealand, India, Bolivia or Ecuador, where the personhood for nature has been enshrined in the respective constitution (Corrigan & Oksanen 2021; Reeves & Peters 2021).

Conclusions

Urban planning can play an important role as a sustainability intervention to foster human-nature connections in cities and beyond. To understand this potential in more detail, we identified empirical studies in countries of the European Union (including UK) and analysed them by applying the leverage point perspective as a main focus of analysis. In order to highlight strengths and weaknesses as well as focal points and blank spots in a strongly interdisciplinary field of research, we firstly provided an overview of the research perspectives on the role of urban planning. Secondly, we explored the perspectives on transformation and the leverage points addressed, and thirdly, we revealed the perspectives on nature and the human-nature connections discussed.

With regard to the first research objective, we found that empirical research already focuses on sustainability transformation *through* planning. In contrast, research on transformation *in* planning is comparatively rare. In terms of the second objective, it became apparent that the studies rather address shallow leverage points for sustainability transformation in urban planning. In relation to human-nature connections, our findings show that deep leverage points, in this case the inner dimensions (i.e. emotional and philosophical human-nature connections), have also been scarcely addressed thus far. Based on these research gaps, we propose two promising directions for future research. First, the external orientation of research should be complemented by a stronger consideration of the inner dimensions of planning and especially the inner human-nature connections in cities. In doing so, the subjective views of the planning actors under the specific conditions of their working environment should be examined more closely. Second, future research should pay more attention to the visionary modes of urban planning by considering the intent level, i.e. goals, visions and the underlying individual or shared beliefs, norms, values and worldviews. This can be done, for example, by addressing what is (not) desirable in the future or by exploring methods to create a common intention. From our point of view, the integration of these research perspectives opens up added value to rethink the way transformation-oriented planning relates to human-nature connections in cities and beyond, while paving the way for future empirical studies based on this integrative approach.

Abbreviations

Habitat III	United Nations Conference on Housing and Sustainable Urban Development
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses

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