Levels to Address Human-Nature Relations in Cities Through Geo-data Processing Strategies: A Mini-Review

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Abstract: This mini-review examines the use of GIS analyses in studies that explore human-nature relations in urban contexts. Publications were retrieved using the same search terms in Google Scholar and Web of Science, sorted by relevance, and the resulting first 30 publications from each database were considered for this review. For the purpose of this mini-review, a typology was developed to characterize publications according to level of approach, human-nature interaction, scientific purpose of quantification and level of GIS technique. Our results indicate that there are very few urban human-nature publications that use GIS techniques (n=7). The resulting seven publications were grouped whether they used GIS for mapping, spatial analyses to produce explanatory variables, or in combination with participatory techniques. Our results indicate that geo-data is currently underused in studies examining urban human-nature relations.

Keywords: Human-nature relationship, urban nature, urban green infrastructure, geo-data processing, GIS

1 Introduction

Urban environments are complex, especially compared to their non-urban counterparts considering both environmental interactions and human-nature relation. This becomes even more apparent when general ecosystem complexity is related to the density of interaction per unit of area in cities. In addition, it cannot be neglected that the third dimension of space plays a crucial role in many urban environmental assessments. Hence, both three-dimensionality and relational density makes it much more difficult to handle geo-data, or develop and implement descriptive, explorative and analytical methods and techniques that make use of geo-data.

Parallelly, urban environments, as considered in human-nature interaction, are a complex issue. Here, urban green infrastructure consisting predominantly of managed and maintained vegetation structures, like those in gardens and parks, meet a high demand for ecosystem services. Through the human lens, natural elements in cities are often perceived in combination, sometimes in contrast with built-up structures.

For a scientific GIS-related approximation of human-nature relations, the questions arise: Is it possible that geo-data processing helps to solve specific problems in a research approach that brings people and urban nature together? Or is this impossible due to the complexity of urban geo-data? Are there fundamental features in scientific approaches on human-nature relations that do not allow quantification by geo-data?

Especially in cities, diverse backgrounds of both people and nature (e. g., FISCHER et al. 2018, STRAKA et al. 2016) drive human-nature relations. On the one hand, depending on an individual's personal development, people perceive, value and interact with nature in different

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ways (BOTZAT et al. 2016). On the other hand, nature is driven by human action, thus mirroring how people interact with natural elements in cities (VIERIKKO et al. 2020). For example, perceptions of urban greenery may be affected by cultural background, including beliefs and traditions (HOYLE et al. 2019) or where people grew up or live (BASHAN et al. 2021). Also, the values that people assign to urban green can, for example, be influenced by differences in rural or urban upbringing, educational background, and the surrounding environmental greenness of a person's residence (EGERER et al. 2019). Yet, many studies that work at the human-nature interface predominately consider data derived exclusively from questionnaires or observations only. The potential of relating such assessments with geo-spatial data could particularly improve insights into how people's perceptions, values and attitudes are associated with the environment in which they live from a neutral perspective.

In our paper, we therefore provide a short literature review on how in current state of the art GIS modelling approaches are used to examine urban human-nature relations. As a background for our mini-review, we classify publications according to their use of GIS-techniques, epistemological considerations and following categories of human-nature relations in an urban environment.

We hypothesize that there are few studies, which employ sophisticated GIS analyses to consider human-nature relations in urban environments. Through this short review, we intend to clarify the current state-of-the-art of such studies for the urban context. In addition, we want to draw a perspective for future research. A better understanding in how we could combine approaches and methods at the intersection of human-nature relations *and* geo-data can broaden our urban ecological understanding, and improve urban planning approaches.

2 Three Backgrounds for a Typology

2.1 Human-nature Relations under Concern

Human-nature relations can be considered from an individual or structural approach. A structural approach is applied if societal, geo-spatial or physical structures are considered, whereas at the individual level the focus is on the biophysical and psychological establishment of interactions. Ecosystem services or land-use related analyses give examples for structural approaches, as well as studies on regional cultural practices.

On an individual level, there is growing interest in the background and effects of human-nature connectedness (HNC) (e. g., PARKER & SIMPSON 2020, KLANIECKI 2018, SEYMOUR 2016). This approach has its roots in evolutionary biology, evolutionary psychology, social economics and environmentalism as substantiated by according to Hancock in 1985 (PARKER & SIMPSON 2020), and emphasizes that the "human-nature relationship goes beyond the extent to which an individual believes or feels they are part of nature" (SEYMOUR 2016, 4). Also, the Biophyllic Cities approach (e. g., ZARI 2019) has its background in HNC-considerations. In parallel, how people connect and relate to nature is increasingly considered via standardized approaches such as the nature-relatedness scale (see NISBET et al. 2008, NISBET & ZELLENSKI 2013) and recommended for urban ecological studies (STRAKA et al. 2021). Cross-disciplinary methods and insights like these that relate, for example, to environmental psychology, are increasingly used in the urban ecological context, thereby providing the sphere of ecology and the urban environment with methods and tools from social science (BOTZAT et al. 2016).

In our review we rely on combined approaches of the natural and the social sciences, including those from environmental psychology, and a more analytical systems approach. With these approaches, we consider three aspects that can describe human-nature relations: (1) Following the basic concept of ecology, human beings perceive the biophysical environment by visual, olfactory and auditory sensors (Fig. 1, left side, "Stimulus"). (2) Cognition, emotive and somatic impact (Fig. 1, middle, "State") and (3) Environmental behaviour and action (Fig. 1, right side, "Response")

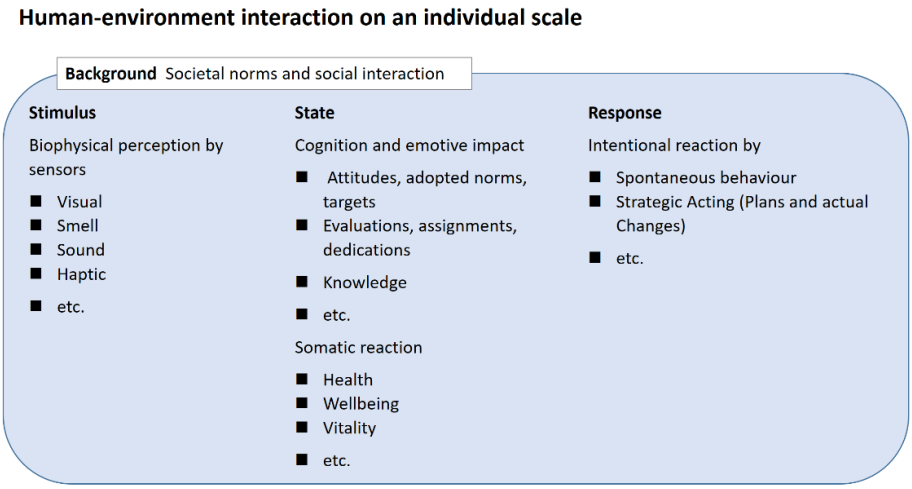

Fig. 1: Human-Environment relations from a comprehensive perspective (SCHWARZ-V.RAUMER, unpublished lecture notes)

2.2 Purposes of Quantification

In many fields of research, and well within geo-data processing, quantification is a process of model building, i. e. the transfer of a complex issue into an abstract model world that is easier to manage cognitively. Quantification of information supports the three basic stages of scientific work: description/empirics – explanation/theory – prognosis/simulation (Fig. 2). In the narrower sense, quantification involves collecting measured values to form central parameters (variables) in order to obtain basic information on the status and, for example, the potential change of the measured object. For this purpose, usually a metric is introduced that uses real numbers, and through which objects and states can be compared. When we transfer this general procedure to how we quantify and interpret an object, e. g. an urban landscape, we may also neglect information during data collection and processing – information that is outside of the general scope of our study field. WEISS (2006, 19; translated) fears that "if we quantify the landscape, it will melt away like sand between our fingers". This suggests that the unquantifiable quality of the landscape as an environment is what makes a "landscape" in the first place, and that quantification does not provide adequate access to landscape quality – understood as quality of experience. Here, the questions arise: which landscape views and metrics represent helpful tools and which properties of the "landscape" can be quantified? It is not a matter of listing properties within an inventory, but of grasping landscapes as a whole.

Quantification constitutes a broad field in science, which is illustrated in Fig. 2. At a descriptive level, quantification approaches used in exploration, e. g., in big data sets, provide insights to help answer the question "What is?". This can lead to a hypothesis, which is operationalized by a data-driven quantification concept that allows for verification. If the findings can be trusted, "What if?" can be explored as a subsequent question by the application and transfer of the gained knowledge to other places and future times.

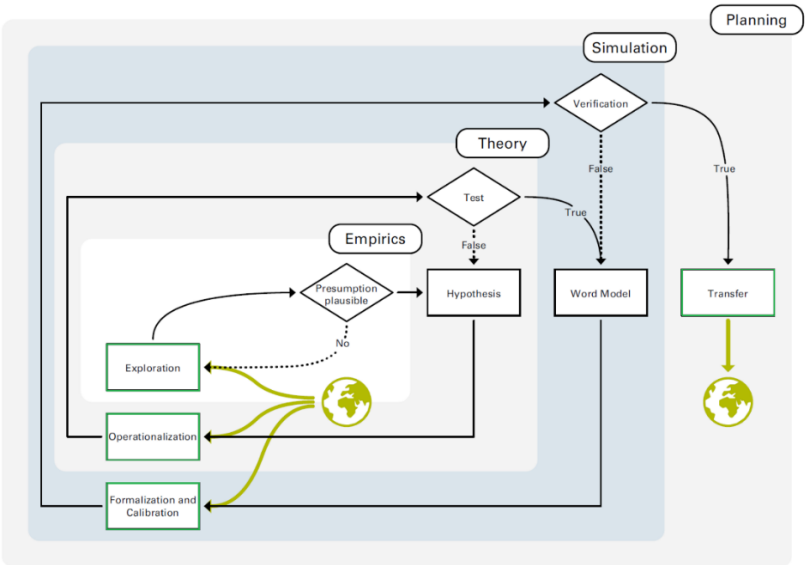

Fig. 2: System of obtaining scientific knowledge through quantification. Green boxes indicate levels and steps in quantification (SCHWARZ-V.RAUMER, unpublished lecture notes)

According to the level of quantification, a research study can be (1) explorative, (2) explanatory or (3) projective. GIS supports all three levels of quantification: Through mapping and applying geo-processing tools, hypothesis formulation can be supported. Through spatial analyses, it is possible to generate data for statistical analyses and with complex modelling, spatial extrapolation or dynamic simulation is possible.

2.3 Levels of GIS-technique used

Many classifications of GIS-techniques are available, sorting tools or addressing fields of application (e. g. as a classic citation: MAGUIRE et al. 1993). Here we use a classification according to the three identified levels of complexity:

(1) Mapping (for visualisation, orientation, inventorying, etc.),
(2) Using standard geo-processing tools (to balance distance, neighbourhood and spatial incidence, to derive new variables or metrics, for combining and summarizing purposes, for inter- and extrapolation, etc.), and
(3) Using scripts and codes or coupling additional software to apply general algorithmic procedures (for modelling, simulation, etc.).

3 Review Method

For the mini-review, we established a review list that consisted of information on each included study as depicted in table 1 and table 2. The studies included in the review list were derived from an article search in two commonly used databases for general literature research of scientific documents.

The search strategy was divided in two steps. In step one a search was first conducted in Google-Scholar (GooS) followed by Web of Science (WoS), using the same key words as search terms (i. e. 'human-nature,' 'urban' and 'GIS') and the same inclusion/exclusion criteria according to the established review list.

For the purpose of this mini-review, we chose to analyse the 30 most relevant results from each search engine, as this should provide a solid overview on the amount, context and approaches of the field.

We then went through all listed publications and rejected individual publications primarily for the following reasons:

- Being "just" reflective: the keywords appear in the publication, but there was no original research regarding the topic of interest in the publication. E. g., for the field of planning and design, KULLMANN (2018) writes about cultural history and changes of paradigms.
- Human-nature relationship or urban environment or GIS not addressed or interlinkage is missing: this occurs if our key words appear in the article, but they are not substantially considered or linked (e. g., Buijs et al. 2018).

In a second step, we classified the results based on the typology described above and according to the following dimensions and assignments:

- **Level of the approach:** *Structural* or *Individual*
- **Human-nature interaction:** *Stimulus* or *State* or *Response*
- **Scientific purpose of quantification:** *Exploring* or *Explaining* or *Projecting*
- **Level of GIS technique:** *Simple* or *Medium* or *Complex*

In addition to the assignment to the different categories within the four typologies, the role of GIS in each study is shortly described in our mini-review list.

4 Result

The GooS search yielded approximately 12,000 results. Sorted by relevance, the first 30 were published between 1999 and 2022. Only three of these publications (10%) met the nexus of our search; the other 27 (90%) publications were rejected for at least one reason (see table 1). The three publications accepted for our mini-review from this step are: GHERMANDI et al. (2022), WANG et al. (2019) and IVES et al. (2017a).

Using just the search term 'human-nature', the WoS search yielded 9,546 publications. Refinement using the additional search term "urban" reduced the result to 411, and further refinement using the term "GIS" resulted in 14 publications. Two of these publications, WANG et al. (2019) and IVES et al. (2017a), coincided with the GooS search result. Eight (57%)

publications did not meet acceptance requirements, according to at least one of the reasons listed in table 1. Thus, from this step four additional publications were identified, yielding a total of seven publications that met our criteria. Table 2 summarizes the complete search results and provides the assigned type within each category (i. e. level of approach, human-nature interaction, scientific purpose of quantification, level of GIS technique) for each included publication. For example, for the category 'level of approach' a publication can have the type 'structural' or 'individual.'

Table 1: Reasons for rejection of publications in the search result (GooS = Google Scholar, WoS = Web of Science)

	GooS	WoS
Publication is "just" reflective	11	1
Complete article unavailable	4	
Human-nature relationship not addressed	3	2
Urban environment not addressed	5	3
GIS not addressed	6	1
Interlinkage not subject of analysis per se (pedagogical purpose)	1	
Book citation leads to inclusion in the research result, but no contribution in this collective volume is appropriate	1	
The inclusion in the research result is not explicable		1

5 Discussion

Why don't we have more? To conclude with a list of only 7 publications is surprising when we consider the obviously "burning" problem of improving urban environments, both as livable environments per se, but also in regard to pressing global issues like climate change adaption. In addition, we can perceive that spatial analysis, location-based data availability and the ease of use of IT facilities is still developing, but is an emerging and promising topic. Likewise, the availability of relevant and complete data accessible to urban ecologists and urban planners might differ in geographical regions.

Table 2: Publications as result of the search and assigned to the typology

Category	Level of the approach		Human-nature interaction			Scientific purpose of Quantification			Level of GIS technique			Role of GIS
Type	Structural	Individual	Stimulus[1]	State[2]	Response[3]	Exploring	Explaining	Projecting	Simple	Medium	Complex	
Ghermandi et al. 2022		X		X		X			X			Location of geo-taged Photos
Ives et al. 2017a		X	X	X		X	X			X		PGIS survey Providing regressors
Ives et al. 2017b		X	X	X		X	X			X		PGIS survey Providing regressors
Rupprecht et al. 2015		X		X	X	X			X			Mapping study sites
Tammi et al.2017	X			X		X			X			Mapping ES valuation
Wang et al. 2019		X	X				X					PGIS survey Spatially processed regressors
Zwierchowska and Lupa 2021		X		X	X		X			X		Spatially processed regressors

[1]Perception/Incorporation [2]Attitude/Value/knowledge/physical state [3]Behaviour/activity

Our search was a quite simple search. Thus, there may be additional relevant publications that could have been included by using similar search terms and synonyms. The search terms were selected with the intention to reveal the human-nature nexus that was explicitly aimed to address. If we had used synonyms for the search term 'human-nature,' we may have found additional studies that were similar to TAMMI et al. (2017) that examines Ecosystem Service valuation, but that didn't specifically address the human-nature nexus as we intended it for this mini-review. The other two terms, "urban" and "GIS", can hardly be substitued, as they are keywords that very broadly address the target field of publications and should therefore inevitably occur. Additionally, the aim of this study was to look beyond basic landscape-level metrics like NDVI or tree canopy cover that are derived from remote sensing methods and may be used within GIS analyses. Thus, our findings indicate that there is a lack of research,which uses sophisticated GIS analyses to consider human-nature relations in urban environments.

This lack of research may stem from a variety reasons. The first is that social science and geo-spatial techniques work on different scientific grounds. There is a tradition in social science not to rely only on quantitative methods. Empirical social research, which is mainly based on applied descriptive and inference statistics, conceptualises social aspects in a very limited approach compared to the libraries filled by "qualitative" approaches relying on arguments and not on figures. An individual is a universe for a social scientist but may appear

only as an attribute coordinate for a GIS-Expert. But again, for the individual in which social science observes or interviews a respondent an urban green area may be just "a park", but for the GIS-related science a complex urban landscape with different environmental attributes.

The second reason is that the urban fabric is not easily converted to a series of overlaid GIS-layers. Here, pattern-dependent *processes* are necessary for an appropriate representation of the real world (e. g. transportation, urban growth, flows in energy or provision networks). Additionally, building information, 3D representation, as well as information on network structures like moving people, cars, substances and energies, are necessary but difficult to handle in a data model from a technical point of view.

Finally, we again must address the notes from the introduction on the complexity of the human-nature relations in urban environment per se, caused primarily by three-dimensionality and relational density.

What do we have? We can summarize table 2 by three different types of studies:

1) GIS is used for *mapping* study areas, locations of data collection or both. For example, RUPPRECHT et al. (2015) conducted a houshold survey on informal green space (IGS) in Brisbane, Australia and marked on a map the location of sample plots. GHERMANDI et al. (2022) mapped locations of data collection by indicating the number of retrieved geotagged photographs within regions in City of Haifa, Israel. TAMMI et al. (2017) provide an Ecosystem Service (ES) valuation map and represent the only publication, which considered a structural level by mapping ES values for the region of Tampere, Finland, including services in the inner and outer urban core. These three examples are shown in Figure 3.

2) *Spatial* analyses resulting from GIS can be used to create *explanatory variables* in explanatory models for human perception, valuation, attitude, behaviour, use or activity. For example, ZWIERCHOWSKA & LUPA (2021) first show the location of pre-schools in Poznan, Poland and the proportion of green infrastructure within a 300m-Radius of these schools. Then they combine the accessibility of greenspace to the answers of an online survey about the "frequency and the duration of outdoor activities" and on "pre-school managers' awareness of the importance of contact with nature for children's development".

3) *Participatory* techniques use *GIS* to reveal human perception, valuation, attitude, behaviour, use or activity. WANG et al. (2019), IVES et al. (2017a) and IVES et al. (2017b) go beyond using geo-processing to generate data on potentially independent variables in an analysis. They use participatory elements in capturing information on greenspaces in the city. All three studies ask respondents in a survey to mark greenspaces and other places of interest. Answers were related to distance analyses and lead to a "spatial representation of complex human-nature relationships" (IVES et al. 2017a).

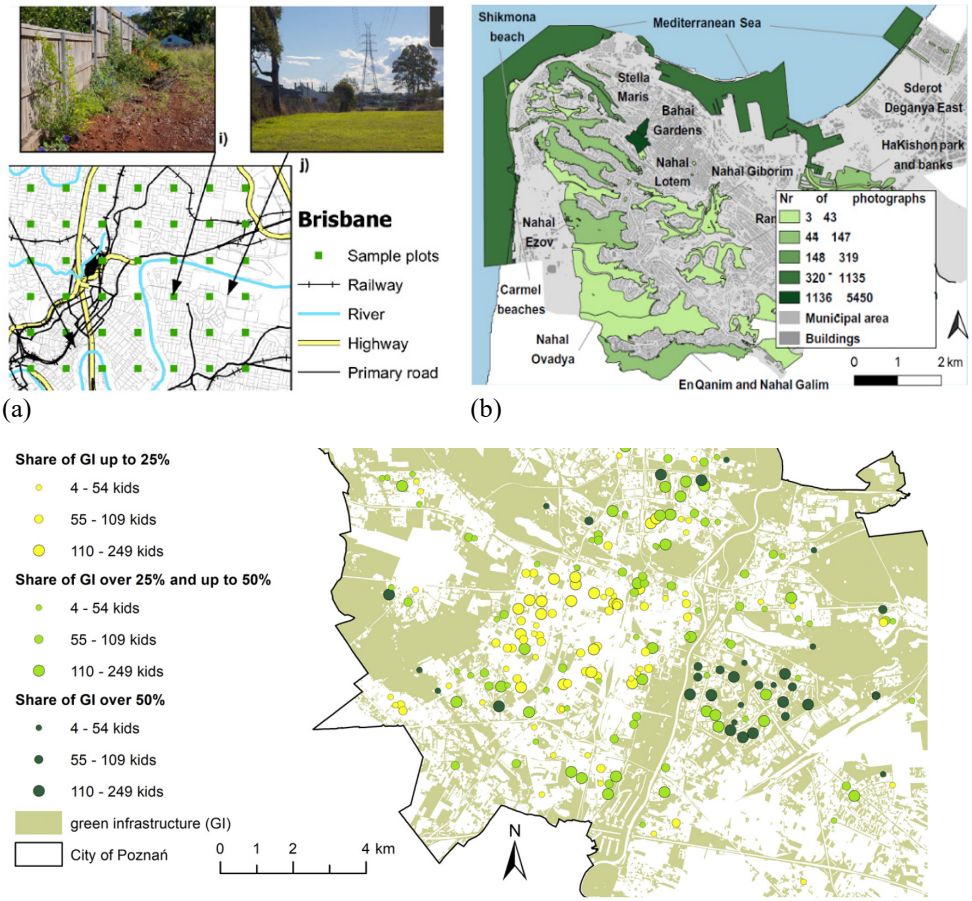

Fig. 3: Maps showing locations of data collection: (a) from RUPPRECHT et al. (2015), (b) from GHERMANDI et al. (2022), (c) from ZWIERCHOWSKA & LUPA (2021)

What could and should we have? The easiest approach to determine how geo-data processing can help foster urban human-nature studies is to generate more geo-data or to more intensively use relevant, pre-existing geo-data. Two signals suggest that an increasing availability of data is imminent. First, increasing awareness of the importance of urban vegetation, will lead to increased efforts to capture vegetation structures at a broader extent, for example by using remote sensing techniques. Secondly, Building Information Modeling (BIM) boosters the digitalisation of urban assets (as a background read AGARWAL et al. 2016), yet still largely outside of the context of urban greenery. As BIM extends to the improvement of the digitalization of urban greeney, more relevant geo-data will become available.

While increasing the amount of relevant geo-data available will help encourage the development of urban human-nature studies, the quantity of data is not the primary issue, but rather the quality. It is evident from many studies that the quality of urban vegetation, and therefore the qualities of the vegetation itself, are essensial for a good human-nature relationship.

Because of this, it is crucial to obtain more detailed spatial information about the characteristics of urban vegetation such as age, composition, diversity and further dynamic characteristics. Higher quality geo-data that includes these aspects will allow for the development of more robust studies at the human-nature nexus.

Most spatial analyses, which employ GIS-derived explanatory variables, consider distance-related aspects. Accessibility is one such aspect that is frequently cited in human-nature relations and is considered in many studies. However, accessibility is often included in a very simplified manner to avoid complicated spatial analyses. Using circular neigbourhoods or euclidean distance is a very weak substitute for actual access distance. Employing more advanced spatial tools would increase complexity but allow for more complete and accurate analyses. Additionally, when quantifiying access, not only distance should be considered, but also the mode of transportation. Mode of transportation (e. g. by bike, foot, public transportation, car, etc.) will affect the travelled route, and the experience thereof, and therefore must be included when relating accessibility with human behaviour or attitudes towards urban nature.

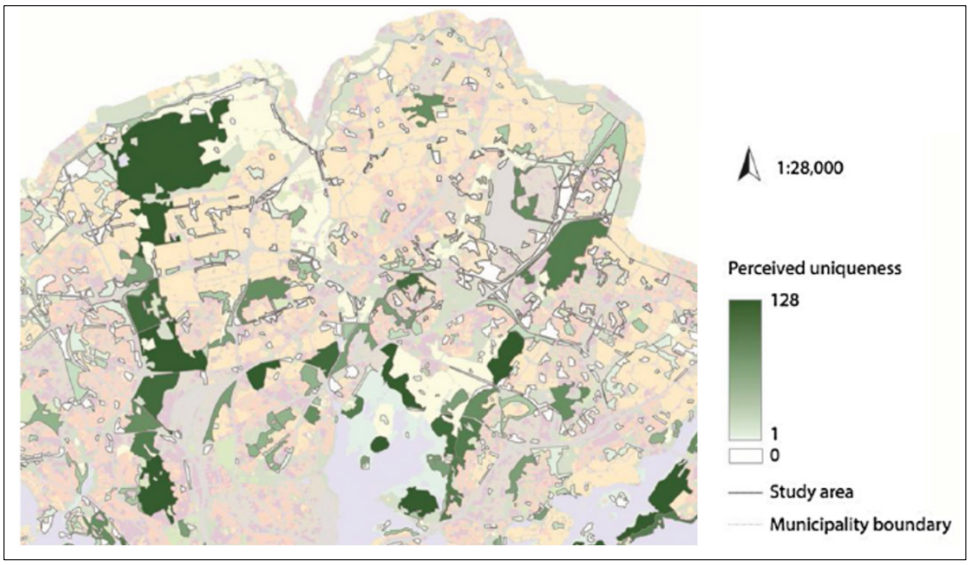

Fig. 4: Representation of perceived uniqueness of urban forests in Helsinki/Finnland from WANG et al. (2019), modified by authors

Finally, and perhaps most importantly, many further geoprocessing methods and GIS-analyses could, and should, be considered in urban human-nature studies. These include but are not limited to: the visibility of urban nature (including from a person's place of residence), basic neighborhood characteristics (e. g. noise, green infrastructue, vegetation on private and public property), and the quality of routes between a person's workplace or other basic urban locations and their residence.

6 Conclusion

This mini-review was a first step to explore how, and to what extent, GIS methods are used in studies that examine urban human-nature relations. Initial results indicate that there are few studies that utilize geo-data processing in their examination of human-nature relationships in urban contexts. It is important and purposeful to conduct a more thourough sampling of the literature and continue analyzing additional publications using the assignment of types and levels employed in this mini-review. Although currently underused, geo-data can play a critical role in studying urban human-nature relations as methodologies develop that merge approaches in social science and urban ecology using geo-spatial techniques.

References

AGARWAL, R., CHANDRASEKARAN, S. & SRIDHAR, M. (2016), Imagining construction's digital future. McKinsey Productivity Sciences Center, Singapore. https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future (March 22, 2022).

BASHAN, D., COLLÉONY, A. & SHWARTZ, A. (2021), Urban versus rural? The effects of residential status on species identification skills and connection to nature. People and Nature, 3 (2), 347-358.

BOTZAT, A., FISCHER, L. K. & KOWARIK, I. (2016), Unexploited opportunities in understanding liveable and biodiverse cities. A review on urban biodiversity perception and valuation. Global Environmental Change, 39, 220-233.

BUIJS, A., FISCHER, A. & MUHAR, A. (2018), From urban gardening to planetary stewardship: human–nature relationships and their implications for environmental management. Journal of Environmental Planning and Management, 61 (5-6), 747-755. https://doi.org/10.1080/09640568.2018.1429255.

EGERER, M., C. ORDÓÑEZ, B. B. LIN & D. KENDAL (2019), Multicultural gardeners and park users benefit from and attach diverse values to urban nature spaces. Urban Forestry & Urban Greening, 46, 126445.

FISCHER, L. K., HONOLD, J., CVEJIĆ, R., DELSHAMMAR, T., HILBERT, S., LAFORTEZZA, R., NASTRAN, M., NIELSEN, A. B., PINTAR, M., VAN DER JAGT, A. P. N. & KOWARIK, I. (2018), Beyond green: Broad support for biodiversity in multicultural European cities. Global Environmental Change, 49, 35-45.

GHERMANDI, A., DEPIETRI, Y. & SINCLAIR, M. (2022), In the AI of the beholder: A comparative analysis of computer vision-assisted characterizations of human-nature interactions in urban green spaces, Landscape and Urban Planning, 217. https://doi.org/10.1016/j.landurbplan.2021.104261.

HOYLE, H., JORGENSEN, A. & HITCHMOUGH, J. D. (2019), What determines how we see nature? Perceptions of naturalness in designed urban green spaces. People & Nature, 1 (2), 167-180. https://doi.org/10.1002/pan3.19.

IVES, C. D., OKE, C., HEHIR, A., GORDON, A., WANG, Y. & BEKESSY S. A. (2017a), Capturing residents' values for urban green space: Mapping, analysis and guidance for practice. Landscape and Urban Planning, 161, 32-43.

IVES, C. D, GORDON, A., OKE, C., RAYMOND C. M., HEHIR, A. & BEKESSY, S. A. (2017b),

Spatial scale influences how people value and perceive green open space. Journal of Environmental Planning and Management. doi:10.1080/09640568.2017.1388219.

KLANIECKI, K., LEVENTON, J. & ABSON, D. J. (2018), Human–nature connectedness as a 'treatment'for pro-environmental behavior: making the case for spatial considerations. Sustainability Science, 13 (5), 1375-1388. https://doi.org/10.1007/s11625-018-0578-x.

KULLMANN, K. (2018), Design with (human) nature: recovering the creative instrumentality of social data in urban design. Journal of Urban Design, 24 (2), 1-19. doi: 10.1080/13574809.2018.1433530.

MAGUIRE, D. J., GOODCHILD, M. F. & RHIND D. W. (1993), Geographical information systems: principles and applications, Vol. 1/2. Longman, London.

NISBET, E. K., ZELENSKI, J. M. & MURPHY, S.A. (2009), The Nature Relatedness Scale: Linking Individuals' Connection With Nature to Environmental Concern and Behavior. Environment and Behavior, 41 (5), 715-740. doi:10.1177/0013916508318748.

NISBET, E. & ZELENSKI, J. (2013), The NR-6: a new brief measure of nature relatedness. Frontiers in Psychology, 4. doi: 10.3389/fpsyg.2013.00813.

PARKER, J. & SIMPSON, G. D. (2020), A theoretical framework for bolstering human-nature connections and urban resilience via green infrastructure. Land, 9 (8), 252.

RUPPRECHT, C. D. D., BYRNE J. A., UEDA, H. & LO, A.Y (2015), 'It's real, not fake like a park': Residents' perception and use of informal urban green-space in Brisbane, Australia and Sapporo, Japan, Landscape and Urban Planning, 14, 205-218. https://doi.org/10.1016/j.landurbplan.2015.07.003.

SEYMOUR, V. (2016), The human-nature relationship and its impact on health: A critical review. Frontiers in public health, 4, 260. https://doi.org/10.3389/fpubh.2016.00260.

STRAKA, T. M., KENDAL, D. & VAN DER REE, R. (2016), When Ecological Information Meets High Wildlife Value Orientations: Influencing Preferences of Nearby Residents for Urban Wetlands. Human Dimensions of Wildlife, 21 (6), 538-554.

STRAKA, T. M., COLEMAN, J., MACDONALD, E. A. & KINGSTON, T. (2021), Human dimensions of bat conservation–10 recommendations to improve and diversify studies of human-bat interactions. Biological Conservation, 262, 109304.

TAMMI, I., MUSTAJÄRVI, K. & RASINMÄKI, J. (2017), Integrating spatial valuation of ecosystem services into regional planning and development. Ecosystem Services, 26, Part B, 329-344. https://doi.org/10.1016/j.ecoser.2016.11.008.

VIERIKKO, K., GONÇALVES, P., HAASE, D., ELANDS, B., IOJA, C., JAATSI, M., PIENINIEMI, M., LINDGREN, J., GRILO, F., SANTOS-REIS, M., NIEMELÄ, J. & YLI-PELKONEN, V. (2020), Biocultural diversity (BCD) in European cities – Interactions between motivations, experiences and environment in public parks. Urban Forestry & Urban Greening, 48, 126501.

WANG, Y., KOTZE, D. J., VIERIKKO, K., NIEMELÄ, J. (2019), What makes urban greenspace unique – relationships between citizens' perceptions on unique urban nature, biodiversity and environmental factors, Urban Forestry and amp; Urban Greening (1-9). https://doi.org/10.1016/j.ufug.2019.04.005.

WEISS, H. (2006), Was heisst Qualität der Landschaft? Gedanken über Wahrnehmung, Nichtwahrnehmung und die objektive Subjektivität des Landschaftsbegriffs. Landschaftsqualitäten: Festschrift für Prof. Dr. Klaus C. Ewald anlässlich seiner Emeritierung, 15-22.

ZARI, M. P. (2019), Understanding and designing nature experiences in cities: a framework for biophilic urbanism, Cities & Health. doi:10.1080/23748834.2019.1695511.

ZWIERZCHOWSKA, I. & LUPA, P. (2021), Providing contact with nature for young generation – A case study of preschools in the City of Poznań, Poland. Urban Forestry & Urban Greening, 65, 667, https://doi.org/10.1016/j.ufug.2021.127346.