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Enabling Relationships with Nature in Cities

Johan Colding [1,2,*], Matteo Giusti [1], Andreas Haga [1], Marita Wallhagen [1] and Stephan Barthel [1,3]

1 Department of Building Engineering, Energy Systems and Sustainability Science, University of Gävle, Kungsbäcksvägen 47, 80176 Gävle, Sweden; Matteo.Giusti@hig.se (M.G.); Andreas.Haga@hig.se (A.H.); Marita.Wallhagen@hig.se (M.W.); Stephan.Barthel@hig.se (S.B.)

2 The Beijer Institute of Ecological Economics, Royal Swedish Academy of Sciences, P.O. Box 50005, SE-104 05 Stockholm, Sweden

3 Stockholm Resilience Centre, Stockholm University, Kräftriket 2B, SE-106 91 Stockholm, Sweden

* Correspondence: Johanc@beijer.kva.se or Johan.Colding@hig.se

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Abstract: Limited exposure to direct nature experiences is a worrying sign of urbanization, particularly for children. Experiencing nature during childhood shapes aspects of a personal relationship with nature, crucial for sustainable decision-making processes in adulthood. Scholars often stress the need to 'reconnect' urban dwellers with nature; however, few elaborate on how this can be achieved. Here, we argue that nature reconnection requires urban ecosystems, with a capacity to enable environmental learning in the cognitive, affective and psychomotor domains, i.e., learning that occurs in the head, heart and hands of individuals. Drawing on environmental psychology, urban ecology, institutional analysis and urban planning, we present a theoretical framework for Human–Nature Connection (HNC), discuss the importance of nurturing HNC for children, elaborate on the role of property-rights and the importance of creating collective action arenas in cities for the promotion of urban resilience building. As values and environmental preconceptions underly environmental behavior, there are limits to achieving HNC in cities, as presumptive sentiments toward nature not always are positive. We end by discussing the role of new digital technologies in relation to HNC, and conclude by summarizing the major points brought forward herein, offering policy recommendations for HNC as a resilience strategy that can be adopted in cities throughout the world.

Keywords: Human–Nature Connection; cognitive; affective and psychomotor environmental learning; resilience building; sense of place; immersive technologies; property rights; urban green commons

1. Introduction

As urbanization endures on a global scale, policy makers, planners and urban designers need to think about how to improve the sustainability of cities to a much greater extent. Local conditions, cultural contexts, socio-economic history, institutional path dependency, etc., determine what potential solutions can be achieved in order to build more ecologically compatible cities. In this overview paper, we present lessons learned about the Human–Nature Connection (HNC). In addition to presenting an overview and theorizing around HNC, we discuss how collective action arenas in cities can enable a relationship with urban nature with a potential to promote urban resilience building. Resilience building in relation to the natural environment has emerged as a lens of analysis that serves a platform for interdisciplinary dialogue and collaboration and is about "cultivating the capacity to sustain development in the face of expected and surprising change and diverse pathways of development and potential thresholds between them" [1].

The global COVID-19 pandemic all too clearly demonstrates how vulnerable our societies are to various types of disturbance and stresses, which often appear as true wicked problems and surprises.

Wicked problems are largely unsolvable in the sense that solutions to one aspect of the problem discloses or generate other, even more complex problems, which demand further solutions [2]. When disturbances hit us, whether pandemic, climate-related or socio-economic, they remind us that we need to think considerably more on how to nurture resilience, or a 'buffering capacity', to deal with unknown and known disruptions in constructive ways [3,4]. For one thing, city governance needs to create increased preparedness to deal with shocks on the global food system, climate-change effects and socio-economic disruptions that potentially can affect quality of life in cities [5,6].

The preservation of ecosystems is of critical importance in urban resilience building, since their services are critical to psychological, physical and spiritual human wellbeing [7,8], and also provide adaptation to extreme weather events [9]. Current urbanization pressures, however, result far too often in the loss of ecosystems, with adverse effects on biodiversity [10], which, in turn, can reduce opportunity for urban residents to interact with and experience natural environments. Current urbanization pressures have globally led to a general decline in urban dwellers' everyday interaction with nature [11], stressing the need to connect, or 'reconnect', urban dwellers with nature [12,13]. For one thing, it will be extremely difficult to gain public support for taking action against climate change without environmentally concerned citizens of all ages [14]. Emblematic to this point is Pyle's famous quote: "What is the extinction of a condor to a child that has never seen a wren?" [15] (p. 147).

Paper Outline and Aims

Deliberately shifting societal values to promote sustainable futures is a well-debated strategy in nature conservation [16–18]. One conclusion is evident from these academic exchanges, namely that the transformative potential of deliberate interventions in how humans relate to nature is a crux of future sustainable societies. However, vast gaps of knowledge impede the development of interventions to ameliorate such relationships. We assume herein that strengthening HNC among urban populations is pivotal for both urban resilience and for urban sustainability, as green infrastructures may promote general urban resilience building, related to a vast array of external disturbances [19,20], and also specifically related to enabling resilient levels of human wellbeing inside cities [8,21,22]. Further, we assume that HNC enhances people's willingness to protect and manage urban green infrastructures of importance for urban resilience. HNC is argued to promote general pro-environmental behaviors and, hence, play part in sustainability transformations [23,24]. We acknowledge, however, the complexity involved in such assumptions, as the knowledge-action gap, value-action gap and the attitude-action gap are still unresolved issues in psychology and in the humanities [2,25].

Framed by resilience theory, environmental psychology and learning theory, we here make the argument that policies concerning urban ecosystems to a greater extent need to enable activities that nurture environmental learning in the cognitive, affective and psychomotor domains, i.e., learning that occurs in the head, heart and hands of individuals. The resilience approach to sustainability is less about controlling, and more about creating conditions of opportunity for navigating transformations toward sustainability [1], where continuous learning is an important feature of 'the navigation process' [26].

Colding and Barthel [27] (p. 162) have earlier elaborated on an approach they coined cognitive resilience building, denoting "the mental processes of human perception, memory and reasoning that people acquire from interacting frequently with local ecosystems, shaping peoples' experiences, world views, and values towards local ecosystems and ultimately towards the biosphere". They wanted to emphasize that resilience building is not only an external endeavor (e.g., building resilience in ecosystems or social systems), but also an exercise for transforming human behavior in the way people think, feel and relate to nature.

In this paper, we go beyond merely the cognitive dimensions of peoples' relation to nature, by stressing that HNC-building fundamentally entails a person's affective and psychomotor modes of interacting with nature. Contextual, experiential and psychological dimensions of HNC identified in the existing literature [28] and practitioners knowledge [24] have all been found, in an empirical study, to be crucial to shaping one's desire to protect nature. Additionally, Sipos, et al. [29] argue that

engaging with Bloom's influential three domains of learning (i.e., cognitive, affective and psychomotor learning) may enable transformative experiences and learning in society. Mezirow [30] argues that their integration may ultimately lead to perspective transformation: the process of questioning and adjusting one's world-view in light of newfound knowledge, "and/or transformation of the behavioral domain: the interaction of cognitive, affective and psychomotor learning that shapes the way one behaves" [31] (p. 23).

Our prime motive behind this paper is that regular interactions between people and nature follow the current trend of persistent decline of nature in cities [11]. This phenomenon has been called the 'extinction of experience' of nature, and is recognized as having detrimental effects on nature conservation worldwide [11,32,33].

With a focus on enabling a relationship with nature for urban dwellers, and drawing on environmental psychology, urban ecology, institutional analysis and urban planning, this paper is organized as follows: we begin by presenting a theoretical background of the Human–Nature Connection (HNC), followed by a discussion about the importance of nurturing human–nature relationships for children. We proceed by elaborating at more depth on what role property rights play for HNC, as well as discussing the importance of creating collective action arenas in cities, with an ability to promote psychomotor environmental learning. This is followed by an elaboration on the role of values and environmental preconceptions play for HNC. In this era of increased digitalization and the notion of smart cities, we also address what role new digital technologies can play in creating linkages to urban nature. We conclude by summarizing the major points brought forward herein, offering some policy recommendations concerning the kind of HNC among urban populations, which are vital for resilient processes towards urban sustainability.

2. Theoretical Background

2.1. Human–Nature Relationships and Human–Nature Connection

Some scholars in academia have recently remarked that cultural human–nature relationships in Western societies are both a root cause of current unsustainable patterns of development, and the crux to embarking towards a more sustainable society [34–37]. Simultaneously, the same remarks have been made in popular writing [13]. The ways societies perceive, value and interact with non-human life forms and natural resources have to transform radically in order to support sustainable lifestyles. In other words, achieving sustainable human societies require a "mind shift at the scale of a 'Copernican revolution' [...] to put our minds in harmony with the earth system we depend on" [38]. Despite various normative goals, for instance, supporting biodiversity conservation [32], promoting pro-environmental behaviors [39,40] or enabling sustainable development [12], research in a variety of different disciplines aims to promote such a mind shift. However, research that actively promotes the transformation towards more symbiotic relationships with nature is still at its infancy [28,41]. This is because of a variety of factors. First, because human–nature apparent dichotomy is entrenched in Western civilization [42] and academic culture [16,17]. Second, because there is no philosophical agreement of whether nature has an intrinsic, extrinsic or relational value for humankind [43,44]. Third, because these different disciplines rely on different ontological grounds and the integration of their results is very limited [28]. However, in the broadest sense human–nature relationships can be conceived in similar fashion to human–human relationships [23,45,46]. Some psychometric methods to analyze the psychological inclusion of nature in a human 'self' are indeed a direct modification of those used to measure empathy among people [45,47]. In line with the existing literature [23,24,28,48], human–nature relationships are considered sustainable in this paper when they enable, promote, or assist lifestyles that progressively lower the negative impact on the biosphere. This is what we consider here to be the Human–Nature Connection (HNC). In its very definition [24], HNC describes a relationship with nature that encompasses many attributes already identified elsewhere in the academic literature. For example, the ability to be comfortable and curious about nature [49], the capacity to experiences

awe and wonder [50], ecological literacy [51] and a connection with natural landscapes [52]. These attributes are aggregated in three distinguished and consecutive abilities: the ability to be *in* nature, *with* nature and *for* nature [24].

2.2. Questioning Disembodied Views of Nature

Raymond et al. [48] argue that the current ecosystem services framework promotes a non-cultural and decontextualized understanding of the benefits provided by ecosystems. Such conceptualization of ecosystem services is grounded in a disembodied view of nature "which views the mind as independent of the body, culture and the environment" [48] (p. 2). That means that the value provided by an ecosystem (e.g., ecosystem services) is conceived to be implicit in the ecosystem itself. In the context of environmental management, this anthropocentric view of nature promotes its commodification [53], and further separates humans from nature in the everyday culture. In contrast, an embodied ecosystem approach [48] means that the value provided by an ecosystem is an emergent property of a set of human–nature relationships. These are relationships that exist in individuals within a local socio-environmental system, which, in turn, is embedded in a larger culture. Under this relational approach, the value provided by the ecosystem is defined as "systems of meaningful relationships between mind, body, culture, and environment" [23]. In a systematic and multidisciplinary literature review, Ives et al. [28] noted that the literature on sense of place, on psychological drivers of pro-environmental behaviors and on direct nature experiences can all contribute to the identification of sustainable patterns of human development. However, their integration is limited and problematic, because the concept of nature is often used departing from a disembodied approach. When experiential, psychological and contextual dimensions are analyzed together, studies show that attachment to certain kinds of dense urban environments can have a detrimental effect on people's desire to act pro-environmentally [23]. Ultimately, an embodied approach aims to analyze mind, body, culture and environment as one system, in search of HNCs that drive sustainable development trajectories.

3. Children's Habitats and Human–Nature Relationships

Deep seated HNC emerge during childhood [54,55], and seem to remain rather stable in adulthood [56]. Arguably, the main promoters of HNC are authentic nature experiences during childhood [57–60]. However, most children now live in highly urbanized landscapes, with little access to natural areas [61]. Soga et al. [62] highlight examples where children in Japan spend much less time in nature environments than only ten years ago, and that 12% of English children have not visited a green-space environment in a whole year. In the UK, 8- to 13-year-old children spend 16 min a day in natural locations, and, among 14- and 15-years old, this decreases to 10 min [63]. At the same time, children in the USA spend 7 1⁄2 h a day in front of a screen [64]. Coincidently, children know Pokémon better than animals [65]; prioritize the protection of animals seen on the Internet, rather than local animals [66]; and can distinguish several hundreds of corporate logos, but identify only a few local plant or animal species [67].

Limited exposure to direct nature experiences in childhood is worrying, because experiencing nature during childhood shapes certain aspects of a personal relationship with nature that are crucial for sustainable decision-making processes in adulthood [55,68,69]. Mitigating against growing phobias and disaffection of nature shaping the everyday habitat by promoting sustainable relationships with nature is crucial [23,70,71]. Biophilic design [72] and the analysis of nature-connecting habitats [23,24,71] have this goal. Everyday exposure to natural environments is shown to be formative for children's HNC from as young as five years old [71]. Unfortunately, children's association with the dense and lively urban environments demotivates children to protect nature [23]

Developing nature-reconnecting habitats for children is a spatial design intervention for enabling stronger HNC, including a stronger sense of place among children [24,73,74]. Sense of place could be relevant for both the cognitive and affective environmental learning domains of HNC [75,76]. Studies show that active green-area management promotes sense of place [77–79], and that such a HNC can give

rise to a feeling of moral responsibility and behavior towards the environment [71,80,81]. A number of researchers have also shown how HNC relates to more traditional value-based or cognitive hierarchy models of environmentally significant behavior [81,82], while the value–action gap is not yet a resolved issue in sustainability science [40,60,83].

4. Property-Rights, and Human–Nature Relationships

In a study of the nature routines of preschool children in Stockholm, Sweden, it was found that preschools closer to nature had children who were more empathetic and concerned for non-human life forms, and were more cognitively aware of human–nature interdependences [71]. While the spatial distribution of natural areas is an important factor for enabling HNC, property rights is an equally important aspect to consider. Institutional scholars have long recognized the role of property rights in linking people to nature [84] and in shaping incentives behind human exchange, whether political, social or economic. However, the dynamics of property rights regimes and their bundles of rights have largely been ignored in urban sustainability studies [27,85]. However, the decentralization of management rights from local governments to local-level organizations and groups, such as neighborhood groups, local communities, NGOs and similar, is increasing in many parts of the world, as it holds implications for the eradication of ecological illiteracy [86].

While urban design determines proximity (both metric and cognitive distance) to urban nature, property rights arrangements affect HNC by regulating omission to or entry to nature in cities. This is often determined by whether land (and water) is owned and controlled by the government, or in private or collective ownership. In addition, a bundle of rights and responsibilities regulate entrance rights to land, the right to withdraw resources from land, the right to manage resources, and the right to exclude non-owners from enjoying the benefits that land provides, as well as the right to alienate (e.g., sell) or lease out land (Table 1).

Table 1. The bundles of property rights are held by individuals with different positions, and are frequently held in the cumulative manner of the table, encompassing rights of access (i.e., "the right to enter a defined physical area and enjoy nonsubtractive benefits"); withdrawal ("the right to obtain the resource units or "products" of a resource"); management ("the right to regulate internal use patterns and transform the resource by making improvements"); exclusion ("the right to determine who will have an access right, and how that right may be transferred"); and alienation ("the right to sell or lease either or both of the above collective-choice rights") [87].

	Authorized Entrant	Authorized User	Claimant	Proprietor	Owner
Access	x	x	x	x	x
Withdrawal		x	x	x	x
Management			x	x	x
Exclusion				x	x
Alienation					x

Source: Modified and adapted from Schlager and Ostrom [88].

It is worth emphasizing that few property rights regimes in cities enable a larger set of urban residents to actively manage land in cities. As Table 2 indicates, many natural and semi-natural habitats, such as public parks, street alleys, bioswales, pocket parks, etc., only offer access rights to land, but do not offer management rights to ordinary residents, but rather to public and private land care takers and park administrators. In situations where land is held in private regimes only the owner (and his or her associates) enjoys management rights to land. In contrast, common property-rights regimes allow for a considerably larger set of the urban populace to manage land in cities, especially lands managed as urban green commons (UGCs) that represent urban ecosystems of diverse ownership that depend on collective organization and management [27].

Table 2. Bundle of rights to nature from a citizen-perspective in relation to different landforms. In residential gardens only the owner can conduct gardening. In street tree alleys and parks, people normally only have access rights. Allotments and PAC-gardens increase the opportunity for urban residents to have management and access rights to urban ecosystems relative. (x) = partial rights. Modified and adapted from Colding et al. [27].

	Residential Garden	Tree Alleys	Parks	Allotments	PAC-Gardens
Access	x	x	x	x	x
Withdrawal	x			x	x
Management	x			x	x
Exclusion	x			x	(x)
Alienation	x				
Governance type	Private	Public	Public	Common	Common

4.1. Psychomotor Environmental Learning in Cities

It has for long been proposed that healthy urban environments should provide the opportunity for and encourage stewardship of natural resources through the opportunity to recycle, reduce, and reuse [89]. As pointed out earlier, such stewardship needs also involve children. However, the same way as property-rights regimes in large have been ignored in urban environmental policy building, environmental learning that involves land stewardship of a greater set of urban residents has also been neglected. Ecological stewardship of different kinds involves psychomotor learning, which comprises learning by doing and through practice [90], ranging from tacit and unconscious learning to explicit and codified learning [91]. Hence, much psychomotor learning is never articulated, it is simply what we do, or "what changes our ability to engage in practice, the understanding of why we engage in it, and the resources we have at our disposal to do so" [92] (p. 97).

The enhancement of resilience building at a more transformational scale in society requires the existence of ecosystems that also provide opportunities for humans to physically engage with nature, (Figure 1) i.e., through manual or physical skills coordinated by the arms, hands, fingers, and feet, without verbal processes. Planners and urban designers need to pay increased attention to such land-management systems. Ecologists have for long referred to psychomotor learning in cruder terminology as 'ecosystem management' or 'ecosystem stewardship' [93].

Figure 1. Illustration of how urban environments could promote cognitively-affectively-psychomotorically engaged children, elucidating the therapeutic effect of symbiotic relationships with nature.

Sustainable agriculture education [31] and gardening [29,94] comprise psychomotor learning and involve, but is not limited to, the formation and retention of memories and skills in the motor cortices [95]. Barthel et al. [96] provide several examples of ecosystem management practices in Stockholm that comprise psychomotor learning, referring to these practices as 'social-ecological memory', involving practical skills for gardening and wildlife support, e.g., creating habitat support for the diversity and abundance of wild bees and other pollinators, as well as habitats for the support of insectivorous birds. Similarly, Giusti [23] provides evidence of ecological and social benefits that occur when children lead a project of nature conservation.

4.2. Collective Action Arenas and Psychomotor Environmental Learning

Planners and urban designers need to foster arenas in cities that promote collective action and where urban residents can interact with nature more fundamentally with their heads, hands and heart. Collective action refers to action taken together by a group of people whose goal is to achieve a common objective. At the operational level this can, for example, be achieved by designing collective-choice property rights that include management, exclusion and alienation of natural resources [87]. Extensive fieldwork has established that individuals in many parts of the world voluntarily organize themselves so as to gain the benefits of creating and enforcing rules for managing and protecting natural resources [97]. Creating collective action for resilience building is especially important in cities to counteract ecological illiteracy. An interesting type of collective action arenas that promote HNC in cities is "urban green commons" (UGCs), representing land forms managed as common property and where control and management rights to land are held by an identifiable community, or group of users, that may craft their own institutions (i.e., rules) for managing the resources [27]. UGCs can be viewed as the urban analogues to the local commons that can be found in rural settings and in traditional societies, where common-property systems are plentiful [98–100]. In contrast to stewards of rural commons, people managing resources in urban green commons do not depend on these for their daily livelihood, but partake in UGCs for a number of reasons, such as having an interest to learn about gardening, having contact with nature, to socialize and for keeping up intra-cultural identities [101–103].

An individual that becomes member in an urban common holds rights as a proprietor (Table 1). The same individual, however, only has the rights of an authorized entrant when accessing a public green space such as a park; hence, an individual is not allowed to pick flowers in most public parks (withdrawal right) or cultivate vegetables and flowers (management right). That urban commons grant people the right to manage land and cultivate food in cities, stimulate psychomotor learning skills, which in turn can improve ecological literacy [104–106].

One example of UGCs is public-access community gardens (PAC-gardens) that represent urban gardening projects located on public land in the city of Berlin (Figure 2). These gardens grant management rights to parts or whole parklands that are collectively managed by stewardship groups. In a study by Bendt et al. [86], it was found that PAC-gardens promote four broader learning streams, including: (1) learning about gardening and local ecological conditions; (2) learning about self-organization and social integration; (3) learning about the politics of urban space; and (4) learning about social entrepreneurship.

Since partaking in PAC-gardening, most respondents stated that they had learned about micro-ecological conditions, e.g., soil quality, shade patterns, heat levels in different parts of the garden, local wind patterns and had also become more aware of climate change and displayed an increased concern for environmental issues [86]. Hence, PAC-gardening instills participants with new, or reinforced, awareness of ecological issues and processes, operating at greater scales than the gardens themselves [86]. Barthel et al. [96] provide examples of psychomotor learning skills in relation to allotment holders in Stockholm. As allotment gardening involves inter-relational processes between people, as well as between people and other organisms, individual trial-and-error practices generate experiences in individuals and modify ecological practices, which may or may not be transmitted to others via mimicking or oral means [96]. For example, gardeners learn to monitor how plants and

animals in allotments respond to management inputs. Out of the 362 surveyed allotment gardeners, 27% stated that they enhanced habitats for small birds, and 45% said that they enhanced habitats to support bumblebees that are critical to maintain for pollination. There also exist strong social norms in allotment gardens to exclude the use of pesticides and synthetic manure. The gardeners also hold norms to grow certain vegetables, fruits, berries and traditional flowers. These norms are enforced by way of social pressure.

Figure 2. Prinzessinnengärten, a public-access community (PAC)-garden and an urban common at Moritzplatz in Berlin Kreuzberg. Local residents and people from all over Berlin get a chance to dig into the soil, work with their hands and, together with others, cultivate vegetables and take care of and manage green space. To gather around an activity like urban gardening, city inhabitants become active stewards of the green environment, and can make a difference in facing the real challenges that humans face today with climate change and the loss of biological diversity and ecosystem services. Photo: Seven Frames Film Production.

While there might be hybrid forms of UGCs that draw on private forms of roof gardening or utility garden allotments, an often-time neglected aspect of green roofs that commonly replace natural areas on the ground, is that they only are accessible to a limited set of urban residents [107]. PAC-gardens, in contrast, are open to anyone living in the city, although membership may be a way to regulate congestion [27].

5. Identity-Environment Fit and Environmental Preconditions

Previous studies on how HNC is strengthened in societies have not paid enough attention to individuals' preconception of nature (or worldview), such as their previous values and environmental concerns. Preconceptions could, of course, be of many kinds, such as positive, indifferent and negative. Recent studies in psychology indicate that preconceptions, in many cases, determine behavioral choices in relation to the environment. For example, in a study by Sörqvist et al. [108], it was found that environmental concerns determined the self-reported sensory experiences of products. Experiments showed that such preconceptions shaped people's perception, performance and sensations, such as tasting, comfortability, proofreading and even the color vision of participants [109,110], establishing that such effects of environmental labelling of products was greater for people that scored high in environmental concern, compared to people that scored low in environmental concern.

Values and environmental concern are also relevant for how people form expectations about future events like, future experiences, decisions and behavior, and that the relationship between environmental concern and values play part in such psychological dynamics [82,111].

Not surprisingly, environmental concerns and values also shape how we experience the features of the natural environment. An experiment showed that participants who were told they were listening to industrial sounds reported lower restoration than participants who were told they were listening to sounds with nature characteristics, even if, in reality, all participants listened the same sound [112]. Schultz and Zelezny [113] showed that people with self-transcendence values tend to care more for environmental issues over economic growth, and were more engaged in pro-environmental behaviors, and individuals that valued self-enhancing life goals had a more egoistic concern for environmental issues.

Halpenny and Caissie [114] showed that people's concern and empathy for wildlife and natural environments under danger of being transformed appear to be in line with the same value orientation as described above. Schultz [115] found that concern for environmental problems was fundamentally linked to the degree to which people view themselves as part of the natural environment.

Along with the reasoning above, a study by Rossi et al. [116] found that values are important mediators for people's perception and experience of natural settings, and that this, together with worldviews and ethics, influences people's ability to strengthen HCN. This holds important ramifications for urban planning. In some sense, cities represent a refuge for people having adverse views of nature. For example, many dwellers in urban areas display a fear of nature, due to cultural reasons [117]. Lush green area habitats may be frightening for people for safety reasons; hence, designs of semi-natural environments in cities often need to account for safety through technical measures, e.g., width of sidewalks, presence and brightness of street lights, etc. [118].

6. New Digital Technologies and Human–Nature Relationships

Ever since Roger Ulrich published his classic study showing that patients with windows against greenery recovered faster, felt better and used less painkillers than patients with a view of a settlement [119], there has been interest in exploring the role of different technologies in providing nature experiences, albeit as a surrogate of nature contact. Nature photography and videos, art and recorded sounds are examples of indirect nature contact that have been shown to be health-promoting [120,121]. Even though digital technologies may reduce the actual time spent in outdoor natural environments, digital technology, such as the use of immersive technologies like virtual reality, mixed reality and augmented reality, may have positive environmental impacts. Augmented reality is a technology that uses virtual reality to add virtual objects to real environments in real-time, using technological devices for the overlapping of images [122]. Studies show that it can be used to make public space, e.g., parks and open space natural habitats, more attractive to different age groups [123]. Pokémon Go, for example, brought people outdoor to places they might otherwise not have visited [124] and can improve players' sense of place and connection to places.

Augmented reality is increasingly used in planning processes, as it is gaining momentum as a tool for visualizing urban design choices, and for promoting stakeholder participation [125]. For example, immersive technologies can be used by allowing users to experience what a neighborhood may look or feel like by superimposing designs over a two-dimensional plane [126]. Augmented reality applications can also be used for monitoring and visualizing ecosystem services, such as displaying urban tree cover, and also add augmented information on site about planted vegetation, and how the different varieties of plants should be managed (Figure 3). Used in this way, this technology might have the potential to promote affective relationships to nature, although this requires further study.

Immersive technologies are also used as a pedagogical tool to spread environmental knowledge. However, to what extent these technologies promote HNC represents a hitherto unexplored research frontier. Hypothetically, they have the potential to make people more environmentally concerned, for example, by taking action against climate change [127]. While augmented reality may promote cognitive and affective environmental learning [128], most still only deal with the augmentation of vision. While technologies for the augmentation of other senses are under development, such as balance, touch, acceleration, temperature, and sound, we are probably quite far away from developing

tools with the ability to promote psychomotor environmental learning that enables development of deeper layers of HNC.

Figure 3. The higher the biological values are, the more complex a green area can be to understand and manage in a correct way. In the EU project *Augmented Urbans—Visionary, Participatory Planning and Integrated Management for Resilient Cities* researchers are investigating if the use of AR technologies can help shaping more resilient cities with increased stakeholder participation. In one of the local action projects in the city of Gävle, Sweden, the University of Gävle, in collaboration with the municipality owned housing company Gavlegårdarna, is developing and testing AR tools for giving tenants and managers of outdoor environments site-specific GIS positioned up-to-date information in their phone when they carry out garden work. Such a tool could make it easier to design and plant greenery with high biodiversity.

While urban simulation games such as SimCity can help students gain intellectual access to complex ecological systems, there are also significant limitations, e.g., the tools do not represent actual cases, lack connection to real places and provide simplistic experiences and understandings of HNC. Hence, it is important to link real and virtual elements in augmented reality in environmental education [129,130]. A pivotal issue is also to consider how to counteract the increasing amount of screen time that children face nowadays [13].

7. Concluding Remarks

As pointed out in the introduction, how humans relate to nature in cities is an issue of immense importance for urban resilience and for sustainability transformations. Folke [1] argues that the resilience approach concerns encouraging transformative environmental learning at small scales, and initiatives to emerge and spread across levels and scales. Deep leverage points for sustainability transformations involve broad-based socio-cultural processes of self-concept change and social norm formation [41], where learning towards stronger HNC in cities plays an important part [23,60,71].

At present, new digital technologies are integrated into the operation of city functions, as in the form of smart cities [131,132]. The applicability of immersive technology, like augmented reality, will inevitably increase quite drastically in the near future, together with artificial intelligence. To what extent they will contribute to HNC, however, is an open question. As pondered upon herein, augmented reality can promote outdoor activities and the use of urban space. However, enhancing HNC does not only require a mind shift in people's way of thinking, but also a change of heart, and also needs to preferably involve active engagement and authentic relations [133,134].

Hence, people's affective and psychomotor domains should not be left out when devising opportunities for HNC in cities. Additionally, HNC-learning cannot solely be achieved through the creation of more spatially accessible natural environments in cities, but needs to be circumscribed by property rights that allow institutional accessibility for people to physically engage with natural environments. It has been argued that people acquire positive attitudes toward an attitudinal object because of what they do behaviorally, as opposed to the opposite assumption that people behave in certain ways because they like it [101,135]. There are also limits to achieving HNC in cities, as presumptive sentiments toward nature not always are positive.

We conclude by stating that policies aiming to achieve stronger HNC in cities—instead of trying to change people's values through information campaigns—should create spatial and institutional accessibility to HNC building activities. To enhance sustainability transformations through fostering HNC, the city and its culture must allow people's 'nature-care-taking behaviors' to develop over time. However, the privatization of public space is a global phenomenon [136] and when public green space is lost, the spread of 'environmental generational amnesia' likely follows [58], which diminishes chances for HNC in cities. Thus, and as another policy advice, planners and policy makers need more meticulously address the fact that urban residents increasingly lose access and use rights to land and resources in cities [137]. Instead of privatizing public land, policy makers need to a greater extent consider spatially accessible urban green commons as solutions to fiscal shortcuts, at least as interim solutions. In this way, local governments can promote resilient processes towards sustainability in cities through HNC by still owning land, but transfer proprietor rights to local civic groups, social networks and NGOs.

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