Article

The Implementation of Green Infrastructure: Relating a General Concept to Context and Site

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Abstract: In the quest for more sustainable urban landscape development, the concept of 'green infrastructure' (GI) has become central in policy documents and as a multifunctional general planning tool. GI is not however a simple and unambiguous solution. While there in policy documents are claims for more and connected GI, actual urban development takes another direction. The densifying imperative is hard to combine with an increased and more connected GI. This paper argues for a critical and diversified approach to the concept of GI, to facilitate its implementation in urban planning and management. While GI most often is seen as a common asset and a public good, the actual land use negotiations and management responsibilities cannot be limited to a public service discourse, but should address more clearly a variety of actors. Linguistic as well as spatial definitions of the two relevant dichotomies of 'green-grey' and 'public-private' are crucial in GI location, design, construction and management, it is argued. Overarching representations of GI will be needed, but also – and linked to it – a spatial storm water plan and an overall plan for public space. The development over time will need an intersectorial implementation and management program. Thus some of the GI intentions may be implemented in planning processes, some through reorganisation and redesign of public space, and some by agreements with landowners.

Keywords: green infrastructure; sustainable urban development; urban planning; landscape representations

1. Introduction: Green Infrastructure—as entirety and as parts in a sectored society.

The discourse on green infrastructure (GI, here understood as particular constellations of space; linear and/or more centered; material and biological resources at a specific location) is multifaceted and sometimes ambiguous [1-10]. One underlying idea here is that within the discourse on sustainable urban development, this very multivalence of the concept of GI has prevented it from being realised and implemented to its full potential. The way public services are organized (still sectorial) is an obstacle, not only to cross-sectorial collaboration for sustainable urban development [11] but is also hindering complex, multiscale and multipurpose projects like GI development. Because of the need for multifarious data, analyses, knowledge and know-how, existing in a municipal organization as a whole, but sorted and divided in different departments, certain engagement is needed to collect all this input to a common whole. The inherent multifunctionality and attractiveness of the concept is not possible to implement by one professional sector alone, but requires access to knowledge not only about existing and planned urban structures (planning departments), but also about the physical and functional links between urban GI and the peri-urban

and rural landscape (environmental departments), as well as about the management and maintenance of public green space (park departments). Furthermore, the measures and means to actualize GI, are most often differently distributed between different kinds of landowners. The claim for both overarching and directed arguments, sets of data and synthesized knowledge, is not a paradox, but pointing at the need for both-and instead of either-or.

From the evolvement of GI benefits over time follows, that the concept is not only theoretically interdisciplinary, but also professionally cross-sectional, involving municipal administration and management, planning routines, political undertakings and citizens participation. Throughout Europe, neoliberalism has led to more complex (and complicated) management of public resources, and the authorities' power is being replaced by new power groupings, public-private management, business models, and innovative triple-helix projects. Theoretical as well as multifunctional aesthetically appealing models for GI remain highly valuable [1]. But when it comes to implementing them in real-life urban situations, methods are still insufficient to deal with complex site specifics. Even aiming for "a holistic understanding" [12] there are strong organisational structures, often locally specific [13] not supporting such changes in understanding GI. The joint quest for interdisciplinary research on many urban development issues [2,14-15] has not yet seemed far-reaching enough to support application of GI knowledge to physical, spatial structures in real urban settings. This involves linking of sectors and hierarchical layers, and the administrative and planning routines necessary to make use of available know-how. There are today experts with an interdisciplinary culture of knowledge; with understanding of e. g. scale-zooming and time-continuity [16]. But bringing more external expertise into planning is no guarantee that this knowledge culture will genuinely exert more influence on planning and development. Sectorial mindsets in the municipal and regional administrative apparatus cannot change overnight, or even in a decade [17].

In contrast to buildings or transport infrastructure, GI has a 'maturation period' that seems hard to acknowledge in, for example, urban planning routines, but may arise as a crucial factor in larger-scale implementation of green structure initiatives. While materialising GI (lay-out and planting) is a rapid process compared with buildings and transport infrastructure, fulfilling the aims of green structures takes longer (fig 1). GI will always by virtue of its nature as a structure composed of biological organisms, be more vulnerable than technical structures to modifications in the surroundings. This fact calls for more attention to be paid to management, organisation, maintenance, follow-up and evaluation of GI projects.

This article aspires to promote understanding of various issues involved in attempts to apply the notion of GI to urban development policies and planning strategies (also land use and management), as well as property development (including public and private resources) and scrutinize the implementation of GI as part of sustainable urban development. The strength and potential of the concept of GI may lie in its being more than the sum of its parts. To its living components and the constantly new threats facing them, is also attached an ever pending need for cooperation among different public administrative units and between public and private stakeholders in urban development. As such, the GI concept may actually be an important key to sustainable urban development in a wider sense as well.

Even if "nature" is a word most often connected to GI, it is necessary to reduce the associations to nature as implicit power, and not only realize, but also scrutinize; the specific materiality, its

properties, its growth potential as well as threats; the site and the actors on this site, as well as the different interests and plans affecting the site. In most cases, GI does not per se mean resilient ecosystems, but encompass biophysically (more or less) connected structures and the territory they cover, closely linked to the power and capacity to produce the structure and the responsibility for its sustaining; the policy and politics of the green and how it is represented and communicated. This reasoning implies that GI planning & design can only produce some of the preconditions for a GI (in terms of visions, policies, establishment of local standards and some control). The building, management and maintenance of GI, on a property basis, suggests long term programs and framework (as well as agreements between landowners), without which the expected functions and services will not appear. This is why these things every now and then should be discussed together, not only in sectors and disciplines. Roe & Mell [3] have paved the road for such a discussion, providing GI evaluation as a collaborative tool for reflection.

This article aspires to think in a long term, cross-sectorial way, by means of adding the dimensions of *land ownership* and *urban representations*, in order to identify knowledge gaps and over-bridging links, supposedly useful when realizing effective and functioning GI.

2. Materials and Methods: GI discourses, practices and cases

This is not a review article in an ordinary sense, since the purpose is not to define and delimit the research field of GI, but still it is a review, as it is the purpose to widen the discourse of GI, with support from various fields. Even if a lot of reasoning is based on literature within the discourse of GI, remaining inconsistencies in this field (such as not taking into consideration the limited effect of public policy on property management and development) are tentatively discussed, claiming a broader interdisciplinary foundation necessary, when looking into practical implementations. To this end this article is founded in urban planning theory as well as in the European sustainability discourses, as well as contacts and collaboration with professional practices, in research projects [8, 18-19] and collaborative case studies [20].

The operational hypothesis for this work has been that it is possible (and will be necessary) to merge knowledge from several research and professional fields to come further with how to provide green infrastructures in urban areas. By "several fields" is here certainly meant fields adjacent to each other, such as landscape architecture, urban planning and park management, but also more distant study areas, such as political science, semiotics and communication theory; i. e. this field is typically bridging "the two cultures" [21], although some very promising merging projects have been ongoing for some time [22]. The interdisciplinary quest is partly similar as the one ongoing within the field of health care [23-24], with some differences. While health care (although a meeting with different professionals and experts and a patient with aims and feelings) is a collaborative practice where the goal (eliminating or diminishing medical treatment) is relatively clear and agreed on, GI provision is not necessarily so. Therefore, if yet only briefly touched upon here, it is vital to include in the understanding of GI provision the conditions for both power play and negotiations, regarding land ownership, land use, management and responsibilities (figure 1).

3. Results: GI discourse needs to be diversified, to reach the actors of implementation and their collaboration.

3.1 Urban green and GI: from 'benefits of green space' to 'eosystem services'

Twenty years ago, in the mid-1990s, 'green structure' was a new topic for discussion. The 'urban green issue' had been simultaneously growing in many European countries in the 1980s and '90s, along with the prevalent mission to heed the significance of green areas, albeit with varying outcomes in different national contexts. 2000-2005 a COST Action, ('Green Structure and Urban Planning'; 50 scholars from 15 countries) met in workshops and seminars, and performed case studies, to investigate the preconditions, success factors and problems involved in green structure connected with urban planning [20]. This overlapped with and was followed by other similar European initiatives, enduring networks as well as conferences and workshops. These transdisciplinary activities complemented a growing research on urban green structures, often connected to departments of landscape planning [25-26], but more recently also in interdisciplinary settings, in a sustainability context [27].

Ian Mell, some years later, adopted a pan-European approach to develop the concept of GI and created a palette of conceptual gradients and terminology useful for deepening and broadening the understanding of the scholarly discourse [28]. While much of previous writings drew on case studies, Mell worked at a general level with a broad spatial and temporal scope. In investigating the concept, he made it more intelligible while also addressing the status of urban green within the stiffening competition for urban space, following the 'compact city' concept. GI has slowly shifted point of gravity from "a source providing benefits and recreation areas" to "an infrastructure for ecosystem services". This could (but does not have to) incline a shift from a spatial understanding of GI, to a technical/functional understanding of GI.

While Mell seems to follow the line of optimistic green structure researchers from three decades, Mick Lennon [29-30] scrutinises the evolving GI discourse from a more critical point of view. As he points out, the idea is hard to grasp and concretise in general terms, and thus not always successful in getting what it represents established as a concept with sufficient properties. On the contrary, in Lennon's examples, the concept of GI seems to represent a limited professional agenda or even serve as an attractive accessory to a political programme [29].

Lennon (in my interpretation) means that the concept of GI does not clearly represent anything but itself; it remains 'a representation of a representation of a representation' [31]. The concept refers to no specific 'reality', but is defined according to its status in certain discourses. From a communicative point of view this is certainly devastating, since a self-referring concept has no validity or recognition outside academic or professional discourses.

The problem is not the representational concept per se. (We often see, in e.g. the physics, that concepts are worked with and handled as realities, long before they are possible to detect as materialities.) In the case of GI, however, we are neither discussing microscopic or long-distance objects, nor expanding virtual realities, but are affecting human's everyday environment. Therefore, we have to take in consideration that much of the material, perceivable and ecologically effective properties of GI are just taken for granted and not mentioned.

Thus, GI as a concept is ambivalent and ambiguous. GI as everyday reality is not. It is what it is, in every single situation, not often working as an entirety, but as parts, connected to other kinds of structures. The conceptual ambivalence is displayed in both the change of name (from green

structure and green ways to green infrastructure, see table 1) and change in labelling the functions (from benefits of green to ecosystem services).

Even delimiting the concept to GI and ES (ecosystem services) conflicts remain between different kinds of goals and services [1]. These conflicts may seem incomprehensible at a general level but are evident in a situation of implementation. When such a situation arises, the implicit parameters of the situation also unfold and accordingly affect the nature and limits of the particular GI concerned, affording not only specific ecosystem services, but non-estimated side effects.

	"green structure"	"green infrastructure"	"greenways"
1990-1995	223	44	602
1995-2000	339	146	1350
2000-2005	697	797	2620
2005-2010	1300	4140	4480
2010-2014*	1400	**8210**	3930

Table 1. Hits on Google Scholar in 5-year-periods (noted 2014-09-30), for three concepts used to represent "green" parts of the urban landscape more or less in the same way. In Europe "green structure" seems to have been the more commonly used concept up until the millennium shift, while "green infrastructure" since then has increased much faster in frequency. "Greenways" is the most common word in the U.S.. It seems to be increasingly a subject for research (the last period is shorter), doubtfully affected by the European discourse. *(N.B. The figures should not be read as absolute. The interesting is the relational differences.)*

What happens depends on whether this takes place as part of a strategic planning dialogue, a political decision affecting property management or a development plan process, and what the context of GI and the various constraints on implementing it. Different choices will be made, resulting in GI and ecosystem services of various kinds:

> '*In the future, a combined GI and ES approach could be further developed into an innovative planning concept that captures the complexity and dynamic of social-ecological systems in urban areas and supports policy objectives such as sustainable development, environmental justice, social cohesion, or resilience.*' [1](p. 527)

Does it make any difference then, whether we call the effects of urban green and GI 'benefits' or 'ecosystem services'? If the label 'ecosystem services' leads to more concrete thinking when GI is implemented to provide certain services, this may be the case. However, this does not prevent deliberately vague use of either of these concepts in policy documents and political discussions. The clarity of a concept lies not in the word or label itself, but in whether there is an intention to make clear what the concept means, what effects it is planned to have, and by what means and through which stakeholders it is meant to be implemented and sustained. Kevin Thomas and Steve Littlewood compare and discuss the relatively new GI concept and the century-old 'green belt' idea [32] in relation to urban fringe property development and 'soft governance bodies':

> '*Green infrastructure policy, as a product largely of soft governance, provides a challenge to the hard government institutional setting of English planning, in particular to the established green-belt dominated discourse of the urban fringe.*' [32] (p.220)

Ahern [33] explains a similar take on the conflict between inert institutional routines and site specific constellations' judgments, in terms of resilience:

> '*When a major urban function or service is provided by a centralized entity or infrastructure, it is more vulnerable to failure. When the same function is provided by a distributed or decentralized system, it is more resilient to disturbance.*" [33] (p.342)

While GI implies an overall structure and a connective system, it becomes in fact an interface between holistic views like "the city" or "the urban landscape" on the one hand and site-specific ecologies on the other. In its full implementation, a GI would mean an entire system of connected spaces (within an urban area or a region), where each space is allowed to unfold and enrich its ES, according to long term management. Although this should be possible, this is not how we see ES implemented today, in comprehensive and development plans, and this is where we leave the realms of urban ecology and landscape architecture, and enter the field of land ownership and real estate development. It is not until we fully understand the significance of the actions connected to land ownership in the context of urban ecology that we can really test out how to implement far-reaching GI programs. Certainly, this has been possible on public land, e. g. municipally owned, but in a densifying trend, it is not likely that public space will be available for land use change to the same extent that it has been (and where most published examples of successful green structure implementations have been made).

3.2 Authorities' and stakeholders' capacities and responsibilities

The vast literature on GI (see table 1) largely focuses on its potential benefits for the urban environment. Through this we have access to both qualitative (what kind of benefits and how they are perceived) and quantitative (spatial and material measures) knowledge [1,3]. However, this essential knowledge does not suffice for direct implementation (which is also stressed by the authors), and must be supplemented with other kinds of knowledge: relational (how to understand GI in situ and in context) and communicative (how to express, combine and negotiate values as keys to well-functioning green infrastructure). Recently published articles stress the close relationship between GI and ecosystem services [34-35], but also make evident that 1) the ecosystem services resulting from GI are not necessarily identical with the potential benefits it brings, and 2) that applying knowledge of GI and ecosystem services often fails. This failure is due not to insufficient knowledge of how to achieve GI and the desired ecosystem services, but to systems and frameworks for planning and management of the urban landscape that are apparently incapable of taking into account these previously ignored qualities. When Patsy Healey describes the contemporary challenges for planning theory (36), she is pointing at "The Coevolution of Place Quality and Governance Capacity" as necessary to have in mind, not just in general, but from a site specific perspective:

> *'Both what are valued as 'good' place qualities and 'better' ways of doing governance work to promote their realization are rooted in specific histories and geographies.'*
>
> [36] (p. 4)

An apparent increase of "evidence based planning" [37] is not equivalent with planning systems having increased capacity to deal with new knowledge, but could instead be a sign of the increased need of branding choices and decisions [29]. This branding does not signify any change in planning practice. On the contrary, diminished resources for public services seems to restrain planning practice to implementation of regulations, with less (if any) application of evidence and less deliberation between the general and the specific [38].

To operationalise the site-specific and contextual conditions for implementation of a GI policy, GI as expressed in material, technical and functional terms must be supplemented by representational links to planning processes and routines. 'Ecosystem services', as a concept (for the effects or benefits of a green structure), is a step in this direction. This term makes it possible to label the specific services concerned and investigate the requirements, conditions and resources for implementing GI for these services.

Municipal strategic planning includes the responsibility to take into consideration all land throughout the municipal domain; in this respect, the local government authority overviews urban landscape change. This is not to say that the municipality has the power or jurisdiction to effect changes on all land. On the contrary, this power is distributed among the landowners, one of which is the municipality. Property patterns are specific to each city and municipality, and all landowners bear responsibility for their own property management. Overall, this responsibility for land management (including property development) covers the same area as municipal strategic planning, but is divided among a number of stakeholders or landowners.

In Figure 1 is identified two different ways in which the urban landscape in its entirety is handled, one superficial and one fragmented. As for actual property development (the task of changing the urban landscape), there is collaboration between the public and the private spheres. This results in a development plan followed by building projects. These projects may vary in size but, as a rule, only the specific building sites are concerned. Planning theorists have pejoratively termed this 'stamp planning', implying that the projects leave the context out of consideration and disregard both how the surroundings will influence the new project and what impact the project will have on its surroundings [39] All new infra structure must be rolled out in all these layers, to all potential stakeholders, for GI to be realised. This is particularly true given the high proportion of urban land with privately owned vegetation cover.

Every year, urbanized areas (with sealed soil, i.e. covered with impermeable surfaces like asphalt or concrete) in Europe are expanding even in cities with declining populations [40]. This is not an effect of 'planning', in the sense of responsible and deliberate implementation of development plans but, as the statistics show, of 'the tyranny of small decisions' [41] and the related 'tragedy of the
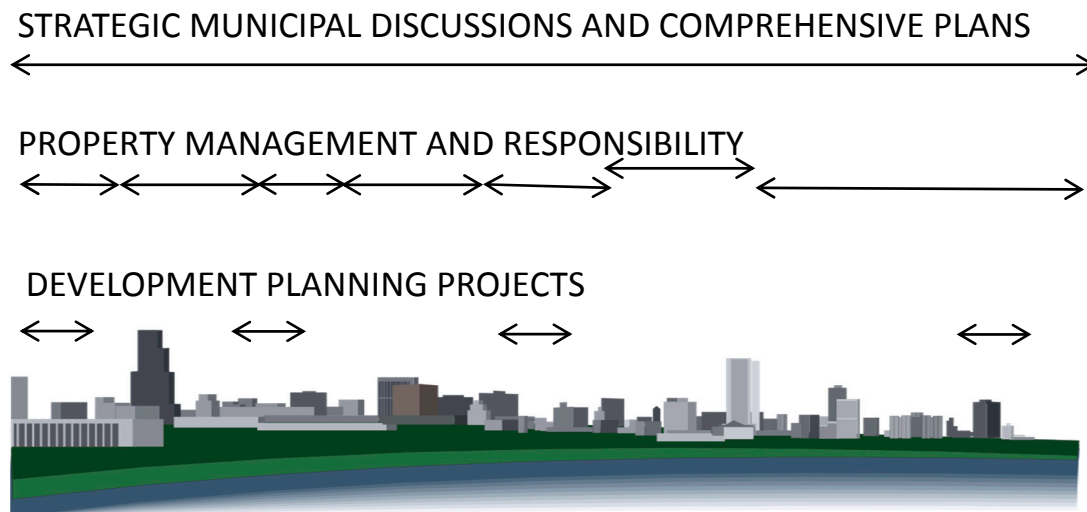
STRATEGIC MUNICIPAL DISCUSSIONS AND COMPREHENSIVE PLANS

PROPERTY MANAGEMENT AND RESPONSIBILITY

DEVELOPMENT PLANNING PROJECTS

Figure 1. There are different outreaches of responsibility for different actors in the urban landscape. Based on Swedish Plan and Building Act, comprehensive plans should encompass all land within the municipal borders, but they are not legally binding. Development plans are binding, but covers one or few building blocks at a time. After completed planning project, the property owner is responsible for the management of the site. Together, all property owners have the responsibility for the whole area within the municipality, but there is no forum for land management as a "whole".

commons' [42]. These small and individualized decisions are largely out of reach for today's planning activities designed to facilitate new urban development. If one homeowner chooses to pave over a garden, the rest of the city is unaffected. If hundreds of others follow suit, the whole city has a storm water problem [43-44].

Green structure issues at municipal level are largely handled by a 'green administration', such as the parks department [19]. At parks and planning departments, staff are careful to stay within the areas they control, i.e. usually municipal property, public space and space for transport infrastructure. If planners try to establish GI, it is likely that 1) only municipal land is considered, for formal reasons, and 2) the aspirations and ambitions connected with the concept will be opposed by various stakeholders in the urban landscape who are not even involved in the conversation. These issues concern private ownership of resources and cannot be resolved without this being taken into account.

3.3 Politicising the green

Distinguishing among different aims and values connected with biological growth, biodiversity, natural areas, well-managed gardens, parks and street trees, whether located in structured or haphazard ways, we must take into account both public and private green urban spaces. Accordingly, to politicise GI planning, one needs to understand the implications of ownership in terms of the functions and values of urban GI (seen as a common asset under public management). Here, 'politicise' means to fully understand a situation and its preconditions, and to initiate discussion of the 'why' and 'where' questions before 'technification', i. e. the 'what' and 'how' questions 'close the case' [45]. This contextualisation serves to problematize the concept of GI, in order to achieve a conscious implementation.

To date, discourses on urban greening, green structuring and green planning have largely relied on technical arguments, which have thus been used to 'close the case'. This often successful strategy for getting things done has the side-effect of covering problems associated with the prevailing combination of densification and greening, which undoubtedly diminishes the number of benefits achieved. To counteract this side-effect, one needs to step back to the 'why' questions about GI and politicise them, analyse the situation and prioritise accordingly, with more or less transparent motives.

Reverting to the distribution argument, the goal of GI for the whole city [46] is clearly compatible with the densification goal only if the green material (the individual plants of different species and various ecosystems) and green areas are not distributed uniformly throughout the city. Conditions vary and different districts do not require the same kinds of addition and alteration in relation to the whole. Obviously, then, in most European cities undergoing economic growth, green walls can be expanded in the city centre (with the highest property values) while the sports areas, copses for recreation and large residential outdoor spaces are kept on the outskirts. If the GI is intended to involve equal or perhaps even distribution of green benefits, what these ambitions mean in terms of spatial and economic values and resources must be sorted out. The most obvious argument becomes evident when distribution of land ownership and access to green areas are considered. Contextual preconditions for creating, changing or adding to the GI in public urban land are very different from those in private urban land.

The following diagram aims to sort out mixed-up or misunderstood concepts for parts of a GI, serving with different kinds of ES (Figure 2). It distinguishes between the public/private and the grey/green dimension, this being important for avoiding the false conceptualisation of private as grey and public as green. This is a common error to do since 'green' not only represents the greening function of chlorophyll, but is also contaminated with several cultural traditions and ideological tendencies in which 'green' could signal 'good', 'tolerant', 'allowed' or environmental. When policy documents mix private and public green areas (or rather, don't mention that the urban landscape is a patchwork quilt of pieces of land with different owners), a leap is made over the necessary negotiations which must preamble GI implementation for ecological and social services.
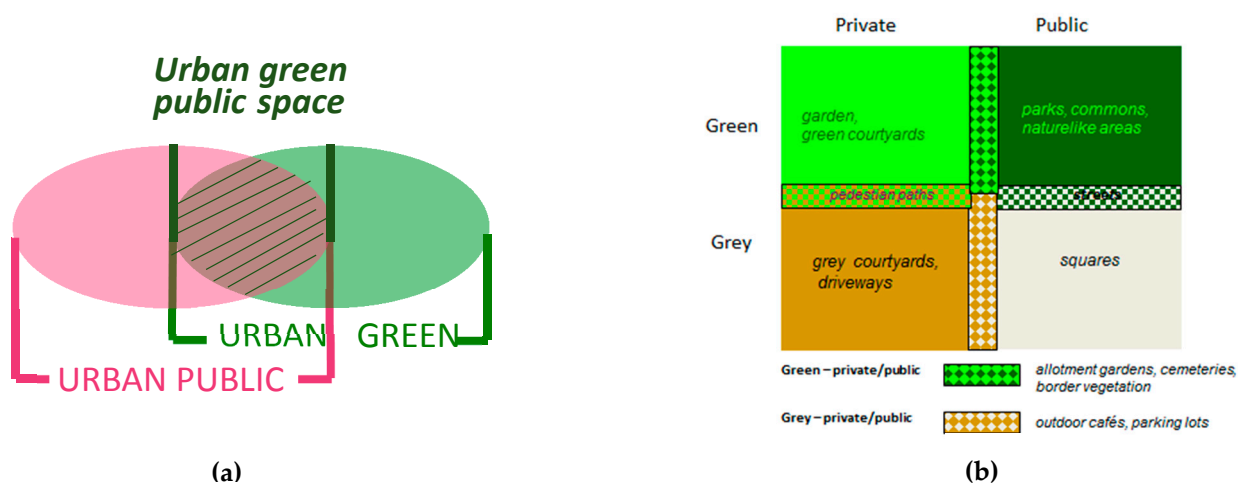

(a)   **(b)**

Figure 2. GI concerns both private and public areas. Urban public space is both green and non-green (**a**). Urban green public space is a fraction of both. By combining the private-public and the green-gray dimensions (**b**) a

typology appears which take into account spatial and material properties as well as the property of ownership. [18]

3.4. Representations of urban green and GI: an interface between general multi-functionality and site-specific conditions

There are numerous examples of confusion between 'urban public space' and 'urban greenery'. In green policy documents, 'green structure' is most often confined to public green space. Mapping of any European city will show, however, that this makes sense neither quantitatively nor qualitatively if we want congruence between the language and visual representations of the urban environment, on the one hand, and what we as urban citizens experience as such on the other. While most urban public space consists of roads and car parks, most urban greenery is (still) located in gardens and other private space. The existence of an important overlap does not logically allow these categories to be labelled as one. Especially concerning ecosystem services, it is crucial to understand urban space in terms not only of material, form and function, but also of who is responsible for managing and organising development in each area, including both day-to-day maintenance and long-term decisions and conditions (see Figure 1).

If we want to understand urban space in a full dynamic sense, in relation to specific situations, it is also essential for our representations of urban space — maps, plans and information — to be aligned with the purpose of meeting any conditions of relevance and concern. To date, urban maps and plans have not shown GI in a way that is useful in terms of maximising their potential benefits; instead, they display the difference between 'formal green structure' and 'actual green structure' [47]. Accordingly, conventional mapping of the urban landscape may be said to thwart any clarification of green structure concepts (Figure 3).

On the other hand, critically analysed, the same maps can also reveal some aspects taken for granted. One that is ubiquitous but neither acknowledged nor questioned in city maps is the private ownership of green resources. Blocks used for residential or business purposes are marked with the same colour, regardless of ownership and the amount of greenery. Instead, maps follow the labels used in planning processes for public green space. Thus, space under municipal management is painted green regardless of what kind of greenery it contains, while a residential block can be surrounded by extensive greenery without showing as green on a map. Arguably, this is insignificant now that we can use GPS and satellite pictures instead of maps for navigation. But the point is not how our surroundings are perceived from the ground, which is unaffected, but how the ground is perceived from maps, in professional planning work and regulated communication between planning authorities and citizens. Whatever advantages the current way of mapping cities may have, it is not conducive to GI innovation or implementation.

Figure 3. The standard way habit of representing "municipal green" with the green color, while privately owned land is represented with any color regardless of land use, confuses our conceptualization of the urban landscape. The quite considerable amount of private green space is therefore not counted as a common asset, which affects the work on ecosystem services.

To date, there have been no regulations on the design of private gardens for sustainable purposes or recommendations about the management and maintenance of private land for such purposes. In short, literature on GI and urban greening fails to discuss the implications of these structures that, in contrast to other urban structures, do not prevail in shape, materiality, functions or effects (and consequently do not result in the same perceptions and experiences over time), regardless of management.

Susanna Gill and others have convincingly shown the significance of private gardens in terms of urban water balance [43]. A considerable risk is posed by the trend of paving gardens with impermeable materials. Thus, private ownership and how its relationship with public needs is negotiated is of the utmost relevance in a discussion of green structure for urban water resilience.

The importance (and neglect) of institutional preconditions for linking theory and practice has been pointed out in case studies [3]. Roe and Mell have even described the situation as 'institutional schizophrenia' [3] (p. 650) and argued that, in the UK, there appears to be a mismatch between the policy aims and the potential for creating GI on the ground through collaborative stakeholder decision-making [3] (p. 669) They seem to be referring to a reality entirely opposed to what was claimed in the ESDP in 1999 as decisive for the future: horizontal as well as vertical cooperation [48] (p. 36).

4. Discussion

There is unequivocal evidence for multiple benefits from urban green [1-5]. These are thought to include increased biodiversity, a better capacity for storm water management, a reduced urban heat island effect, healthier air conditions (less dust, more humidity), a more salubrious living environment and improved characteristics of public meeting places.

There is also, however, a persisting gap between the benefits of a generalised 'urban green' and the expectations of effects when implementing GI in a specific context. The effects cannot materialise regardless of 1) the nature of conditions before the GI project; 2) how well the project is adapted to the local context and site-specific factors; and 3) long-term visions, maintenance requirements and adaptation potential. Another question that is commonly omitted is whether the new structure will fulfil its function immediately or whether the anticipated result is attainable only when there is a certain volume of biomass or foliage, or degree of biodiversity, has been achieved.

The contribution this article aims at adding to the necessary critical thinking around how GI can be implemented, within site specific circumstances, to accomplish generally approved multiple functions and ES. As well as specific professional jargons has been developed, separating planners, landscape architects, engineers and park managers from each other, we need to create new common, intersectional jargon, about how to achieve urban fabrics with enough green quantities and qualities for the potential benefits, as part of the design of developments, but also as part of planning and design of a social infra structure and as part of an infra structure for ES. This will not always coincide with a program easily agreed on. Plants will certainly in many cases add to the value of buildings, whereas a public park in the vicinity will not necessarily do so. GI could be developed as means to create a purposive composition of buildings, transport infra structure and green infra structure, but it is as much in the way this process is governed as in the potential of GI, if it will end up as a realization of the potential.

The arguments put forward are directed at the fulfilment of the potential of GI and could be understood as suggestions for continued research in three directions, in line with the figures. While the first (figure 1) touches upon the issues of management (and illustrates the problem of "the tyranny of small steps") in a planning context, the second (figure 2a and b) concerns the difficulty to separate the two dichotomies "green-gray" and "public-private". The third, (figure 3) pictures the problem with representation of the dichotomies in figure 2. While the city map is clear about the borders of ownership, it does not show what is green or gray. The satellite picture, on the other hand, is clear on the green-gray distinction (on a canopy level), but does not show the functional and ownership borders visible from the ground. A conscious planning, design and management of GI, needs to take off from an awareness of the situation, its conditions, constraints and potential, visually represented in a comprehensible way. This is not least important in collaborative GI projects with different kinds of stakeholders, with both public and private interests, possibly also with ambitions to involve citizens without ownership.

I do not claim that the aspect of linking among functions, resources and stakeholders is new discovery. It is not, but since much of the everyday environment is taken for granted there is more relevant knowledge to be found. The potentially optimal GI is built, not only from knowledge and assets brought to a site or structure, but also from what is already there.

Thus, the ownership aspect is crucial in linking general structural functions, site-specific constraints and options with the stakeholders' capacity, capability and responsibility. If we leave the scientific and technical domain and enter the everyday world of habitation, property speculation and extreme social complexity, general principles never suffice, but must be adjusted and elaborated on in specific situations. In increasingly complex settings, not least regarding urban development, theorists may have a new role: keeping track of progress in processes formerly seen as sectorial interests, one undoubtedly being GI.

While many ideas that impel action concerning urban green space derive from the public domain, responsibility for launching initiatives and taking action for change lies mainly with landowners, most often private, and frequently numerous and both economically and politically diverse. Whether an area is 'green' at a certain time is therefore never the sole criterion for the space having certain functions, providing certain benefits and being part of a particular infrastructure. The very potency of change is inseparable from it.

Figure 2 gives some examples of what may be inserted into a general diagram to measure space in a specific urban area. To understand and elaborate on the dimensions (by, for example, asking what would actually happen if green space increased in relation to grey), one would need to combine the diagram with a GIS and tables of categorised data on the areas measured. So far, to my knowledge, this has not been done. It may therefore be stated that, despite all the promotion of green space in urban areas and the existing consensus on the blessings of creating it, we have not yet

attained any certainty on the overall outcomes of these projects, considered as GI, This means that we are not just lacking sufficient examples of GI effects on the urban fabric as an entirety, but also ways of estimating possible side effects.

5. Conclusions

The upshot of this discussion is not merely a critique of the present state of planning practice concerning GI and a minor contribution to bridging the gap between theory and practice. It also contributes to a new angle: one that questions long-established private property rights in an increasingly densified urban situation. What is questioned is not the right to have private property, but the right to manage urban land without taking public good into consideration. This may appear to be a minor difference compared with the current situation. Most planning and building laws, already impose restrictions on urban development; limiting land use, building height etc. Another round of these regulations, in terms of (even clearer) arguments for GI, may reveal further options. But restrictions per se will not be enough to create green structures that function as intended and provide the benefits wanted. More significant will be the new visual representations of GI, not as separate systems in a built-up urban environment, but as integral parts of the urban landscape, understood and managed as such, in collaborative, intersectorial, participatory networks that are yet to be created.

As Figure 3 shows (see also [47]) new visual representations of GI, as part of the urban landscape are needed in order to support understanding of the potentials and obstacles in GI provision and implementation. This is needed for more detailed, quantitative relational knowledge on how to weave GI into the urban fabric. This is also needed for urban planning and management purposes, in order to provide the best foundation for public and private initiatives and negotiations.

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