Green Infrastructure:
Defining the conceptual space

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What is green infrastructure?

- does *green* mean green in the sense of green *'vegetation'* – trees, leaves, forests?

or

- does *green* mean green in the sense of *'environmentally friendly'* i.e. opposite to traditional (grey) infrastructure?

green infrastructure

- does *green infrastructure* mean green open spaces and corridors ?
- does *green infrastructure* mean specific **urban** design interventions for climate amelioration and amenity (e.g. urban trees, green roofs and walls) ?

- what about the blue part of these spaces (i.e. blue-green corridors)?
- What about **landscape** structures promoting infiltration, recharge and flood attenuation?
- What about **urban** design interventions that are more blue (e.g. rainwater harvesting?)

What is green infrastructure?

- *'Green infrastructure* as a term relates to the connective matrices of ***greenspaces*** that can be found in and around urban and urban-fringe landscapes' **(MeII 2008)**

- '*Green Infrastructure*: the physical environment within and between cities, towns and villages. The network of open spaces, waterways, gardens, woodlands, green corridors, street trees and open countryside that brings many social, economic and environmental benefits to local people and communities' **(TEP 2005)**

What is green infrastructure?

- 'Two main definitions of green infrastructure are used ; some refer to trees in urban areas as GI because of the "green benefits" they provide, while others use GI to refer to engineered structures (such as water treatment facilities or a green roof) that are designed as environmentally friendly' **(Beauchamp & Adamowski 2013)**

- Green infrastructure is 'an adaptable term used to describe an array of products, technologies and practices that use natural systems – or engineered systems that mimic natural processes – to enhance overall environmental quality and provide utility services' **(US EPA 2013)**

- 'Green infrastructure is a network of multifunctional green space, both new and existing, both rural and urban, which supports the natural and ecological processes and is integral to the health and quality of life of sustainable communities' **(DCLG 2010)**

What is green infrastructure?

'Green infrastructure has been described as…

- a physical thing to be delivered **(Sandstrom 2002, Environment Agency 2005)**
- a model for sustainable development **(TEP 2005)**
- an approach to working **(Kambites & Owen 2006)**
- a planning and design concept **(Ahern 2007)**
- environmental assets and functions on the ground: natural areas, conservation lands, working farms, ranches and forests, and wilderness **(Benedict & McMahon 2002)**

- **Practitioners do not know whether green infrastructure is a philosophy or a tree, when in effect it could be both of these things'** **(Wright 2011)**

- **Planners have argued that it could be a '*corruptible concept*'** **(Wright 2011)**

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Towards a comprehensive green infrastructure typology: a systematic review of approaches, methods and typologies

Carlos Bartesaghi Koc[1] · Paul Osmond[1] · Alan Peters[2]

- ‘There is no consensus on a comprehensive classification for green infrastructure’
- ‘This is a consequence of the diversity of disciplines, application contexts, methods, terminologies, purposes and valuation criteria’
- Reviewed 85 studies from 15 countries
- Results show the relevant literature (i) lacks a common terminology and (ii) that a universal typology is impractical
- Concluded that GI could be organized into 4 main categories

Tree canopy (TC)	Green open spaces (GOS)	Green roofs (GR)	Vertical greenery systems (VGS)
Green canopy	Green belts	Eco-roofs	Bio-walls
Green streets	Green corridors	Green rooftops	Green façades
Green alleys	Green covers	Living roofs	Green walls
[Street] Trees	Greenspaces	Rooftop gardens	Living walls
Shrubs, shrubbery	Greenways		Vertical landscaping
Tree cover	[Vegetated] Ground covers		Vertical vegetation
Urban forestry	Ground surfaces		
Urban tree canopy	Land covers		
Woodland	[Public] [Urban] open spaces		
[Forest]land	Urban land		
	[Urban] vegetation structures		
	Vegetative covers		

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- Although not exclusively urban, does seem to emphasize urban green infrastructure
- Does not appear to include 'blue corridor' elements
- Does not include SUDS and water-oriented urban green infrastructure (e.g. bioswales, infiltration gardens)

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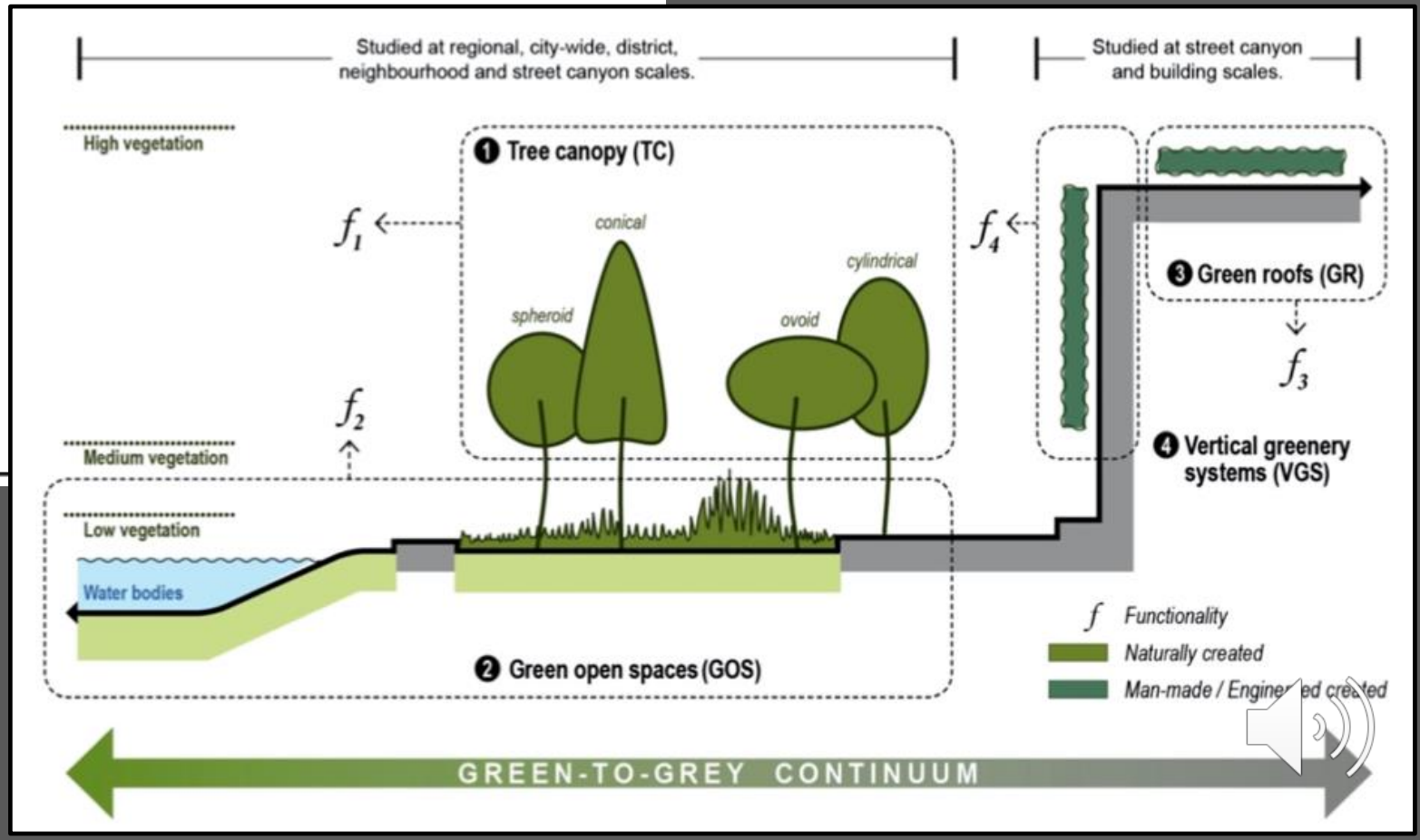
- But what about integrated blue green systems?



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Towards a comprehensive green infrastructure typology: a systematic review of approaches, methods and typologies

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So what about the blue?

- 'As a generic concept, GI also includes water' **(Beauchamp & Adamowski 2013)**
- The importance of water in green infrastructure thinking had led some to suggest that a potential subcategory of blue-green or turquoise infrastructure should be considered **(Ahern 2007)**
- In France in 2010 the term '*tram vert et bleu*' (green infrastructure and blue) was introduced as an extension of the concept of *trame écologique* which had been developing 1990-2000 **(Beauchamp & Adamowski 2013)**
- Referring to 2005-2010, **Mell (2017)** notes, 'As an emphasis on stormwater and catchment dynamics has been mainstreamed within North American GI debates, we have witnessed increasing engagement by the EPA. They have supported GI through a series of memoranda outlining how GI should be used to manage water resources'
- Ideas of 'green-blue veining' also gained traction in Europe, particularly in The Netherlands **(Ghofrani *et al.* 2017)**

2013

Green infrastructure is

"a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates greenspaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, green infrastructure is present in rural and urban settings"

(European Commission 2013)

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A Comprehensive Review of Blue-Green Infrastructure Concepts

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Abstract. Climate change is expected to result in more intense and longer-lasting droughts and increase in the frequency and intensity of heavy rainfall events. The combination of drought followed by intense rainfall increases the risk of severe flooding, with impacts on a range of natural and anthropogenic systems, including infrastructure (road washouts, damage to houses) and impacts on agriculture (soil erosion and loss of crops and livestock). Blue-Green Infrastructure (BGI) is an interconnected network of natural and designed landscape components, including water bodies and green and open spaces, which provide multiple functions such as: (i) water storage for irrigation and industry use, (ii) flood control, (iii) wetland areas for wildlife habitat or water purification, and many others. This paper provides a review of information on the impact of BGI on environments, particularly on water resources and vegetation. Efforts have been made to review the BGI development situation in different countries. Based on the research reviewed, the authors suggest the following as priorities for future research into the environmental impacts of BGI: determining the feasibility of BGI and determining the impacts of applying the BGI for major regions where there have been considerable nature-based recreation and tourism resources.

Keywords. *climate change, extreme events, sustainability, resilience, Blue-Green Infrastructure*

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POSITION

FUNCTION

SCALE

Table 1

Classification of BGI components based on their contribution to flooding mitigation and their position (Cruijsen, 2015)

	Surface	Sub-surface	Aboveground
Infiltration retention	parks and forests, permeable pavement, storm water flow-through planters, storm water trees, bio retention garden, bio retention swales, regional agriculture	subsurface storage with retention capacity	green facades, green roofs, trees
Storage retention	regional wetland, retention storage basins, seasonal storage and rainwater harvesting		rainwater tanks
Detention	surface detention ponds, water square	subsurface storage tanks	blue roofs

- **Regional or urban** (agriculture, parks, protected areas, public spaces, wetlands, retention and detention ponds)
- **Block** *(collections of private or public segments)* (planters, permeable pavement, water squares, subsurface storage)
- **Private** (blue and green roofs, private gardens, rainwater containers)

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Essays and Perspectives

Ecosystems as infrastructure

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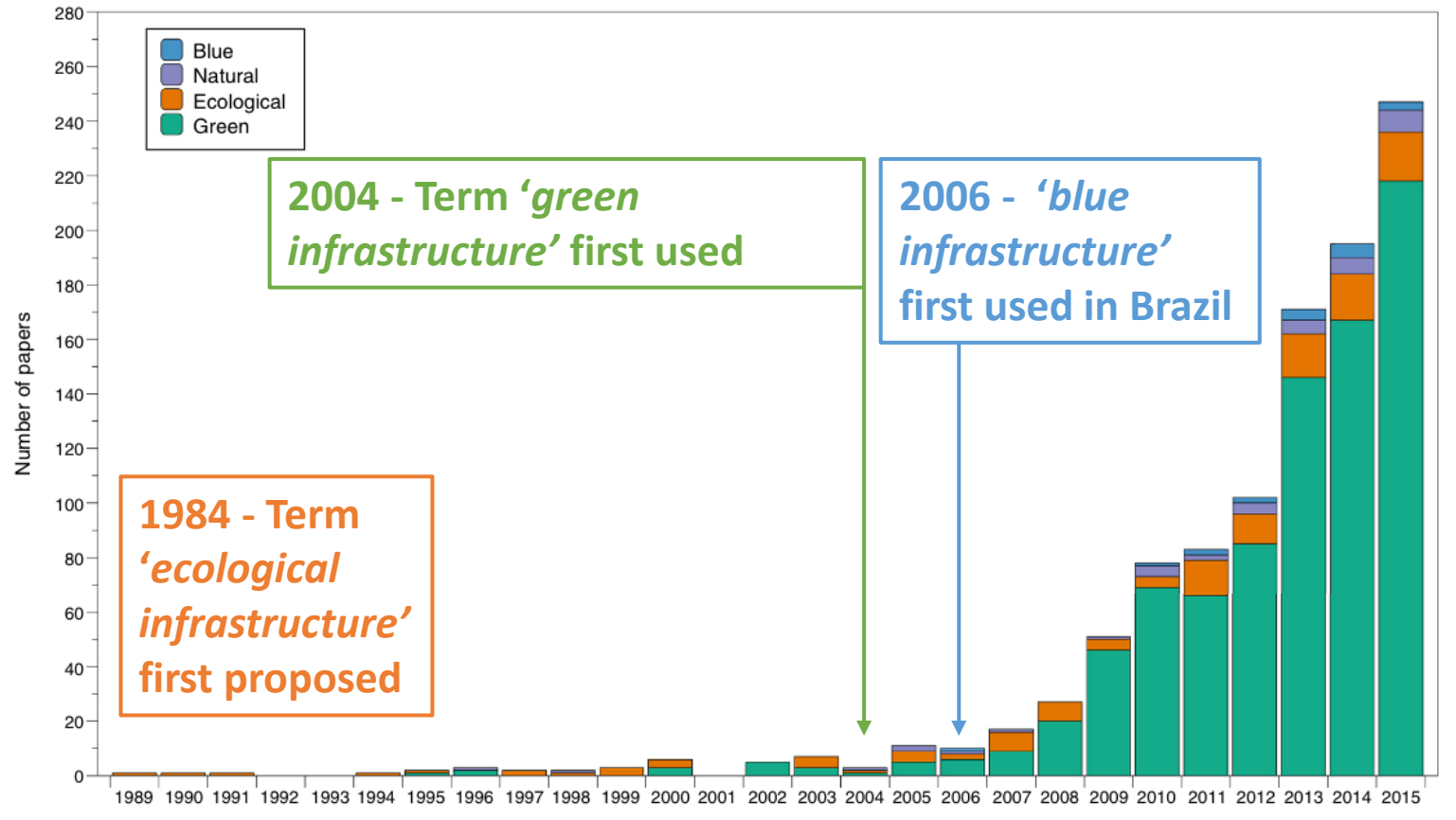
ABSTRACT

Infrastructure is usually defined as all elements of interrelated systems that provide goods and services essential to enabling, sustaining or enhancing societal living conditions. Although traditionally, infrastructure included only all human-made assets, since the 1980s, both scientists and conservationists have suggested that ecosystems should be also considered as a type of infrastructure. Here we review the evolution of the concepts of 'ecological', 'green', 'natural' and 'blue' infrastructures and evaluate how these concepts have been used in the scientific literature. We found that although the term 'ecological infrastructure' was the most used until 2004, 'green infrastructure' became the dominant one after then. All terms have been applied mostly to urban settings, terrestrial ecosystems and emphasised supporting and regulating ecosystem services, with a strong emphasis on the mediation of water flows in urban centres and the maintenance of species lifecycles, habitat and gene pool protection. We suggest that green infrastructure should be the term adopted to facilitate communication between scientists, conservationists and decision-makers. We also suggest a general concept for green infrastructure aligned with the major global conventions alongside a set of design principles.

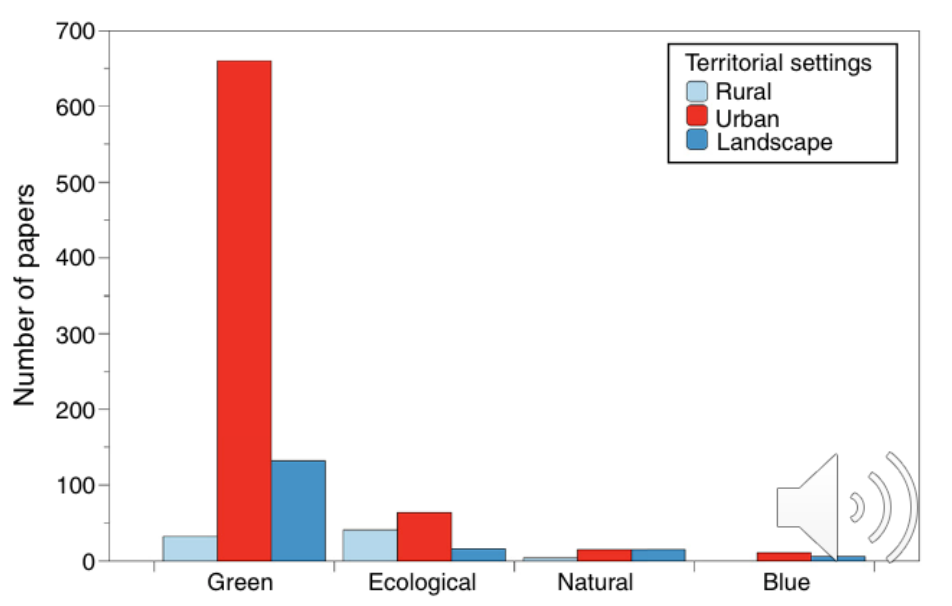
These authors conclude:

- ‘Although the concept of ecosystems as infrastructure is well justified (Frischmann 2012), there is no consensus on how to name and define this type of infrastructure.
- Over the last few decades, scientists and conservationists have combined the words “ecological”, “natural”, “green” and “blue” with the word “infrastructure” to describe the idea
- Although the proliferation of different names and concepts to refer to the same idea is expected when the idea comes from people working under different academic traditions, dealing with different contexts and seeking different goals, it can also lead to misunderstandings and the fragmentation of the issue
- What fragmentation does not, in turn, is help with mainstreaming the idea into a policy agenda’

- 1989 to 2015 – (*Web of Knowledge* and *Scopus*)
- 852 papers referencing green infrastructure
- 122 papers referencing ecological infrastructure
- 18 instances of blue infrastructure
- In 2015, 83.3% of papers used the term green infrastructure



- Authors endorse the use of '*green infrastructure*' because of its common use and it has been adopted in policy in the US and Europe
- Authors endorse the use of the EU definition but suggest it needs to be reframed to include biodiversity conservation, mitigation of greenhouse gasses and adaptation to climate change as its major objectives



Green infrastructure is

"a strategically **planned** network of natural and semi-natural areas with other environmental features **designed** and **managed** to deliver a wide range of **ecosystem services**. It incorporates **greenspaces** (or **blue** if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, green infrastructure is present in **rural** and **urban** settings"

(European Commission 2013)

PLUS:
biodiversity conservation, mitigation of greenhouse gasses and adaptation to climate change as major objectives

If we accept this as a working definition, what tools do we need?

Available [here]

Thanks for listening!

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