Ian Mell, Global Green Infrastructure: Lessons for successful policy-making, investment and management (Routledge, 2016)

CHAPTER 2

The antecedents of green infrastructure

Olmsted, Howard and beyond

In 2006 Davies *et al.* (2006: 5) suggested that green infrastructure might be simply old wine in a new bottle. The suggestion that green infrastructure is nothing new has never really prompted much of a response from its advocates. They simply highlight that it re-interprets the most appropriate elements of different green space planning techniques, reframing them as the integrated approach known as *green infrastructure*. Green infrastructure is therefore not revolutionary and it has not developed out of the blue. What it is, though, is a more nuanced form of understanding between people, place and the environment, which helps its advocates to view development (and management) through a more holistic perspective (Benedict & McMahon, 2006). Duly, green infrastructure could be seen as a chameleon within planning, which enables its user to diversify its emphasis to suit the context of a specific development. Should this be considered a problem? At its very essence, planning – and within the context of green infrastructure, landscape planning – is a process of evolution, not stagnation (Isserman, 2014). Any debate of green infrastructure thus reflects, at least in part, the antecedents that have supported its development.

The following chapter draws on this rich history[1] to illustrate where a number of the key conceptual principles supporting green infrastructure have been adapted from. This covers green space planning discussions in the UK, North America and Europe, illustrating the complexity faced by the early green infrastructure researchers as they attempted to find a common lineage between diverse places, alternative approaches to delivery, historical antecedents and the fluency of planning policy-implementation systems around the world. Examples from the UK cities are discussed to show how our current reflections on society and place were developed (Cullingworth & Nadin, 2006; Town & Country Planning Association, 2012a), reviewing the value of garden cities and green belt designations and their influence on the spatial form of green infrastructure (Amati & Taylor, 2010; Thomas & Littlewood, 2010). From North America the work of Frederick Law Olmsted is presented, highlighting how the 'greenway' movement promoted landscape connectivity, increasing access and multi-functionality in cities (Ahern, 1995; Fábos, 2004). This chapter also briefly introduces how the reconstruction of some of Europe's cities have more recently utilised various aspects of what we now call 'green infrastructure' as a sign of public responsibility to promote livability and urban sustainability. All of which leads us to the present-day musings on the development of sustainable communities in the UK, USA and further afield in places like India, and the rise of green

urbanism as a form of environmental management (Beatley, 2000; Benton-Short & Short, 2007; Lehmann, 2011). These discussions are supported by a review of biodiversity planning, landscape ecology and ecosystem services approaches to environmental management that have been embedded into green infrastructure. This provides its advocates with a set of spatial principles to guide their understanding of green infrastructure and the delivery of multiple benefits across landscape boundaries (Hansen & Pauleit, 2014; Young, 2010). One further dimension that is integrated into these discussions is an understanding of water within green infrastructure thinking. The following discusses how water is explored in different green infrastructure arenas, highlighting its influence on landscape planning. This is of significant relevance in the USA, where water-centric investment in urban greening is the most frequently applied form of green infrastructure (Ahern, 2007; Hansen, 2013).

What each of these approaches brings to this book is an insight into how green space planning has changed over time. They also hint at the links between historic approaches to green space management and more recent practices, such as community forestry and green urbanism, in the shaping of green infrastructure (Mell, 2010). Just as landscape architects, like Olmsted, and philanthropists such as Howard endeavoured to rethink how we envision, develop and manage our cities, green infrastructure thinking has provided us with an ability to rethink our relationship and the value we find in landscapes (Davies, 2014; Herrington, 2009). Green infrastructure researchers have therefore mined planning history to highlight the positive aspects of these approaches, which have subsequently been engaged with by green infrastructure advocates. Such a process of evaluation that meets the needs of specific locations has thus provided green infrastructure planners with a versatility, as noted by Wright (2011) and Mell (2011a; 2013a), that can be considered as one of the most important aspects of its use. This chapter returns to this issue at regular junctures, assessing how various green space approaches have been reimagined as the basis for green infrastructure planning.

Each of the green infrastructure principles or antecedents presented in this chapter also highlights the complexity associated with developing landscapes. Due to the variability of understanding between academics, policy-makers and practitioners there has not been, to date, a unified consensus developed for how we should plan for landscape resources. We therefore need to debate green infrastructure as both a sum of its parts and as an inherently context-specific approach (Wright, 2011). As a consequence, the ambition discussed by Mell (2010) to create consensus for green infrastructure between disciplines and locations is often fraught with ambiguity and subtleties, which have proved difficult to mitigate. One example of this is shown in Table 2.1, where a range of constraints influencing green infrastructure planning in the UK and USA are highlighted (Mell, 2014). These suggest that although there is a level of consistency to green infrastructure discussions in different locations, there are nuanced understandings or applications of the concepts and principles in different locales. This also reflects the variation in project/delivery focus, support and outputs that green infrastructure has been imbued with in different contexts. Our understanding of these subtleties has changed as we become more aware of the influence that historical planning discussions have on current policy-practice discourse (McHarg, 1969; Selman, 2009). This is a recurring theme throughout as the

Table 2.1 Barriers

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Policy application
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Source: adapted from 2013; Mell, 2007, 20 Yorkshire Forest Partn UNEP-WCMC, 2011; H Landuse Consultants, *et al.*, 2007; Kambites Hellmund & Smith, 20

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Table 2.1 Barriers to green infrastructure development

Constraint	*Focus*	*UK*	*USA*
Funding	Financial	✓	✓
Policy formation	Political	✓	✓
Policy application	Political/financial		✓
Political support	Political/financial	✓	✓
Support of other sectors (i.e. transport, sanitation or housing)	Political/financial		✓
Delivery expertise/capacity	Financial/political	✓	
Capacity of resource base to accept/ support development	Environmental	✓	✓
Public responses to development	Political/financial	✓	✓

Source: adapted from Mell, 2014. Based on: Lennon, 2014a; Roe & Mell, 2013; Boyle *et al.*, 2013; Mell, 2007, 2009, 2011, 2013a; Lerner & Allen, 2012; Byrne, Lo & Jianjun 2015; South Yorkshire Forest Partnership & Sheffield City Council, 2012; Allen III, 2012; Siemens AG, 2011; UNEP-WCMC, 2011; Horwood, 2011; Wright, 2011; Beatley, 2000; 2009; Natural England and Landuse Consultants, 2009; Schilling & Logan, 2008; Tzoulas *et al.*, 2007; Ahern, 2007; Gill *et al.*, 2007; Kambites & Owen, 2006; Weber *et al.*, 2006; Benedict & McMahon, 2002; 2006; Hellmund & Smith, 2006; Little, 1990.

evidence of green infrastructure development is contextualised alongside planning praxis. The following sections trace the lineages of green infrastructure, providing a historical context to its development and use in landscape planning.

2.1 Parkways and greenways

One of the most instrumental approaches that shaped green infrastructure was the development of parkways and greenways. Greenways are linear features, predominately constructed of environmental features (e.g. trails) that originally aimed to facilitate movement from urban areas into the wider landscapes and countryside (Fábos, 2004). Developed first in the USA, they have subsequently been utilised around the world. The continued use of greenways as a cost-effective approach to landscape management reflects the growing calls for increased accessibility to nature by urban dwellers from the late 1800s onwards (Little, 1990). Greenways, therefore, keyed into a widening participation or interactivity with the landscape that was being requested as leisure time and access to transport made distance less onerous for urban populations. As a consequence, people were able to explore the countryside more easily, especially where accessible nature was located in close proximity to urban centres, required less of a pioneering spirit to visit and was facilitated by the implementation of organised trails (Little, 1990).

The development of these landscape features has been described as occurring in two eras: first, an era of expansion focusing on the development of boulevards and

parkways, which was followed by a second era that aimed to establish trail-oriented recreational greenways (Fábos, 2004). The current use of greenways extended these objectives to develop multi-functional networks promoting a range of recreational, economic and environmental benefits (Lindsey *et al.*, 2001). Potentially the most famous greenway development presented in the literature was constructed in Boston

Figure 2.1a Boston Common, Boston (USA).

Figure 2.1b Boston Back Bay Fens, Boston (USA).

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by Frederick Law Olmsted to aid the city's adaption to its specific New England climate. Boston's Emerald Necklace covers an area of over 1,100 acres (4.5 km²) and was designed, in part, to manage the ice/snow melt of the Charles River, which led to annual flooding (Benedict & McMahon, 2006). The success of this investment helped the city of Boston to limit some of the negative impacts of urbanisation through the development of a constructed wetland system. The investment also brought extensive socio-economic benefits to the city, with Boston Common acting as a hub for community activities, which is still the case today (Fábos, 2004).

Following the success of Boston's investment, a number of North American cities, including Indianapolis (Lindsey *et al.*, 2001), Toronto (Macdonald & Keil, 2012) and Montreal (Taylor *et al.*, 1995) all benefited from greenway-led regeneration. Moreover, in Vancouver the staging of the Expo '86 and the Winter Olympics in 2010 enabled the city to work with local communities to revitalise the inner harbour area, utilising linear parks and cycle/walking paths linking downtown with the wider metropolitan area (Fábos, 1995; Holden *et al.*, 2008). Each of these cities has, however, approached the development and management of greenways in different ways. This reflects the inherent variation visible in greenway design and, as Little (1990) proposed, they fall into five distinct categories of investment, namely: *Urban–riparian corridors*, *recreational greenways*, *ecological corridors*, *scenic and historic routes* and *comprehensive networks*, a number of which will be discussed in Chapter 4's discussion on Atlanta.

Each of these classifications can be identified in the literature as providing alternative outcomes for greenway planning (Hellmund & Smith, 2006). Therefore, although Little's prescriptive system offers an insight into how greenways were historically developed, we can assume that contemporary investments utilise more than one type. Moreover, in areas where greenways have a shorter history, this pattern becomes increasingly evident – for example in China (C. Xu *et al.*, 2011), the UK (Walmsley, 2006) and Europe (Beatley, 2012; Haaland & Gyllin, 2009), where researchers and planners discussed the variations they have experienced when working across disciplinary boundaries to achieve investment. It may be prudent to move beyond Little's classification and promote the use of a 'features-led' understanding of greenways, which may indicate a greater relevance to green infrastructure planning. Within the contemporary greenways literature the following principles have been used to extend Little's discussion, as well as those by Ahern (1995) and Jongman and Pungetti (2004): linear features that are spatially applied at different scales, which promote connectivity between people and place, and support a wide range of socio-economic and ecological benefits (Taylor *et al.*, 1995; Hellmund & Smith, 2006; Ryan *et al.*, 2006). Each has been used to promote a deeper understanding of greenways and identify the key elements, e.g. connectivity, that are integrated into green infrastructure planning.

2.2 Garden cities and sustainable communities

While greenways can be seen as a key precursor to green infrastructure planning in North America, they have been less significant in the UK. Alternatively, UK planners have drawn more frequently on the principles of the garden cities movement to

frame these debates. The relationship between garden cities and green infrastructure has been explored extensively by the Town & Country Planning Association (TCPA) (see Town & Country Planning Association, 2012a; 2012b). The principles proposed by Ebenezer Howard, the instigator of the garden cities movement, reflected the civic need to address a range of socio-economic and health and well-being issues in the late 1800s (Howard, 2009). He went further and advocated for the development of a large number of smaller and more compact cities close to large urban centres, which he called *garden cities*. Howard's development of the garden cities principles offered a 'peaceful path to social reform' (Fishman, 1982: 32) that attempted to place social equity at the centre of urban development. His 'three-magnets'[2] approach to integrating the civic duties of the town with the accessibility and amenity value of the county restructured the ways that urban areas could be built (Hall, 2002). The vision for Howard's garden cities therefore aimed to reinstall the critical link between health and well-being and human–environment interactivity (Howard, 2009).

Howard's vision echoed the design principles of Olmsted in Boston and New York, where Olmsted had wanted 'a ground to which people may easily go after their day's work is done' (Olmsted quoted in Hiss 1990: 44). Howard's three magnets presents a key indicator of how he envisaged linking people, place (socio-economic) and the landscape (environmental) in his vision. This highlights both the positive and negative attributes of urban and rural life, promoting a view that by integrating the urban and the rural simultaneously, the benefits would outweigh the problems of moving away from large urban centres (Howard, 2009). Howard thus aimed to incorporate the functional elements of urban and rural landscapes into his designs to achieve greater liveability and multi-functionality.

Unfortunately, only a small number of Garden Cities were realised, with Letchworth and Welwyn being the first developments which were specifically planned to integrate Howard's principles (Town & Country Planning Association, 2012a). Both cities were designed to strategically invest in accessible public space close to homes and centres of employment. This, as Howard observed, provided the physical/landscape framework of spaces that would, through proximity and accessibility, encourage people to spend more time in public green spaces. Howard's proposals also promoted a preventive approach to public health which addressed the need to provide a high-quality public realm alongside adequate housing provision to minimise the risk of spreading communicable disease (Hall, 2002; Howard, 2009).

Current development policies in the UK are now revisiting Howard's garden cities ideals.[3] Strong advocacy from the TCPA has informed government that the principles proposed by Howard (Fishman, 1982) are as relevant today as they were in 1898 (Town & Country Planning Association, 2012a). Evidence from the health literature, and in particular the research investigating obesogenic environments, reinforces these messages, highlighting that the form of the built environment directly influences the ways people interact with it (Booth *et al.*, 2005; Lake & Townshend, 2006). The provision of spaces that promote outdoor living, social interaction and an interest in the natural environment are becoming increasingly grounded and support positive interpretations of the relationship between green infrastructure and health (Town & Country Planning Association, 2012c).

While the debates supporting garden cities are ongoing in the UK, there has been a further, if limited, evolution of these ideas within the sustainable communities literature. Promoted extensively during the New Labour (1997–2010) administration in the UK, *sustainable communities* were proposed as a contemporary application of Howard's garden cities (Urban Task Force, 1999). Sustainable communities were proposed as a policy mechanism addressing a wide range of socio-economic and ecological problems in the UK's urban areas. Barton (2000) supported this assessment, noting that before development can be undertaken a review of communities' needs must be conducted to understand how best to sustain a community in the long term. Through a more directed engagement with communities, the Office of the Deputy Prime Minister (ODPM) proposed to improve social cohesion through the delivery of more appropriate forms of public investment (Office of the Deputy Prime Minister, 2003; 2002a). This included improving participation in development, the delivery of more efficient services and the promotion of a multi-functional urban landscape (Office of the Deputy Prime Minister, 2005a, 2005b). The role of green infrastructure in this process was to facilitate a more inviting and interactive landscape that people could use as quotidian space. The ODPM viewed the poor quality of the urban fabric of the UK as undermining the prospects for growth and thus worked to re-establish a sense of value and pride in these places (Raco, 2005). The outcomes of the programme, however, were relatively short-lived. With the election of the Conservative–Liberal Democrat Government in 2010, funding for the programme was cut. Moreover, although elements of the programme remain embedded within the National Planning Policy Framework (NPPF) (Department of Communities and Local Government, 2012), the breadth of the delivery objectives has been minimised.

2.3 Green belts

While current reflections on the delivery of sustainable communities may limit the inclusion of green infrastructure, there is a far more vocal discussion concerning green belts. As a mechanism to slow coalescence, they were first used in the UK after the Second World War to ensure that the expansion and redevelopment of London did not subsume the greater South-east of England (Hall & Tewdwr-Jones, 2010). At the centre of green belt discussions is a notion that they provide policy-makers with a simple and discreet form of environmental protection that provides spatial clarity to what can and cannot be developed (Rydin, 2003). Alongside the defence of London, a programme of green belt designations was created that provided further protection for a number of cities, including Oxford, Cambridge and Birmingham, as well as along the Liverpool–Manchester–Leeds corridor. These designations provided spatially significant reserves of greenfield and agricultural land from development to ensure that 'town' and 'county' remained distinguishable (Cullingworth & Nadin, 2006). In terms of green infrastructure planning, green belts, along with National Park designations in the UK, offer the most significant protection to landscape resources in the country. Green belts are, as a consequence, considered sacrosanct to many in the UK, promoting a policy framework that ensures that perceived environmental integrity of the countryside remains visible, but raises a number of dilemmas for green infrastructure planners.

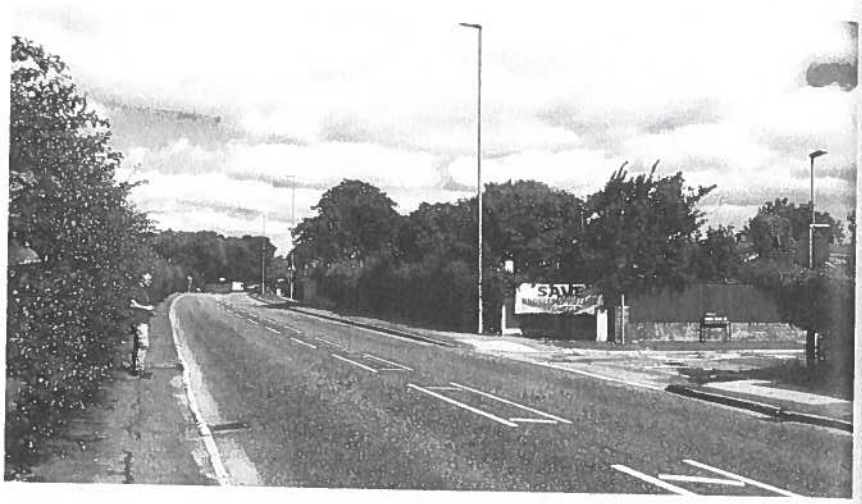

Figure 2.2 Green belt in Merseyside (UK).

First, they are landscape-scale resources which offer a contiguous form of green infrastructure around our major cities. Given the promotion of the Countryside In and Around Towns (CIAT) agenda by Countryside Agency and Groundwork (2005) in the early to mid 2000s, green belts were seen as an essential stepping-stone providing protection from development (Rydin, 2003). However, the location of these resources and their ecological and social value is contested (Gallent *et al.*, 2008). We therefore need to consider whether mono-functional green belt land is valuable. The arguments for and against green belts though are not this simple, yet the issue of spatial distribution and retention remain central to green belt discussions. A second issue relates to the rate of proposed housing development in the UK versus the availability of high-quality or locationally appropriate land, which is seen to be out of balance (Morrison, 2010).

There have been several calls (Cullingworth & Nadin, 2006; Gallent *et al.*, 2008; Gilg, 1996) to relax the green belt designations to free up land for housing. However, this can be considered as a very simplistic argument given that developers are selling the value of green infrastructure as a 'green and pleasant' living environment (Rydin, 2003). Furthermore, from a green infrastructure perspective there is an issue over the conversion of green spaces (including agricultural land) to housing, unless there is sufficient compensation or off-setting of the negative change in land use. Third, green belts have not always been managed effectively as multi-functional green infrastructure. As noted above, many fail to fully understand the lack of ecosystem or human value visible in these locations (Amati & Taylor, 2010). As a consequence, although environmental agencies including Natural England and the Wildlife Trust are attempting to improve the functionality of green belt areas, there is still an established level of opposition to such uses (see Natural England & Landuse Consultants, 2009).

Each of these issues raises doubts over whether green belts are an effective form of green infrastructure investment and management. Although they are similar conceptually (and in a sense spatially) to greenways, there is a greater scrutiny of the activities undertaken in green belts, potentially limiting their capacity to act as multi-functional resources. Therefore, although the spatial distribution of green belts in

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the UK provides a protected resource within the UK landscape (approximately 13 per cent of land cover), their functional value could be contested (Cullingworth & Nadin, 2006). However, despite the issues and ongoing discussions of the suitability of green belts, they are still in force in the UK and other locations. In Ahmedabad (India), the city's green belt was used to ensure that agricultural land is not converted to residential or industrial uses. This policy was rescinded in the most recent development plan as it had been suggested by the Ahmedabad Municipal Corporation (AMC) that its enforcement was unmanageable (Ahmedabad Urban Development Authority, 2013). More positively, the Canadian capital, Ottawa, has a long-established green belt around the city, while the Greater Toronto Area and Niagara Peninsula have placed an emphasis on managing the Golden Horseshoe green belt (Fitzsimons *et al.*, 2012; Taylor *et al.*, 1995). The European Union is also attempting to develop a pan-European network of linear green belts running north–south and east–west across its member states to ensure environmental resources are protected (European Commission, 2013; Terry *et al.*, 2006). One of the central issues to remember within this process is the notion that landscape-scale linear or circular green infrastructure resources should be designated and protected to maintain a significant proportion of the landscape from development (Benedict & McMahon, 2006; Davies *et al.*, 2006).

2.4 Community forestry in England

The foundations of greenways, garden cities and green belts are at the centre of how green infrastructure is developed spatially. Each of these approaches also supports a number of the key principles underpinning the development of landscape and urban greening, such as connectivity. They have, however, been applied in a number of different ways to meet localised needs. In the UK the main driver of this process has been the Community Forest Partnerships.

Green infrastructure in the UK was, and is, indebted to England's Community Forest Partnerships for their endeavours to develop the concept from the mid-2000s onwards (Mell, 2011b). From its initial conception, the Community Forest Partnerships have been the most actively engaged advocacy body working to establish green infrastructure. Their role was one of exploration and development. Working under contract to the Countryside Agency (now Natural England) and a number of local government bodies, they took the initial steps in identifying the main principles of green infrastructure. They produced evidence of how green infrastructure could act as a connective network of spaces promoting multi-functionality across urban and rural landscapes (see Davies *et al.*, 2006), and responded to the discussion of the CIAT (Countryside Agency & Groundwork, 2005) and the Accessible Natural Green Space Standards (ANGSt) agenda (Pauleit *et al.*, 2003). They also built on the work of English Nature and Natural England, reviewing how *proximity* and *accessibility* are essential elements of multi-functional green spaces (Mell, 2010; Schrijnen, 2000). One important facet of their role has been evidence gathering. From 2004 to 2010 the community forests worked with the Regional Development Agencies (RDAs) in England to provide a rationale for investment in green infrastructure through the Regional Spatial Strategy (RSS) process (Mell, 2011b; 2010). Following the change of government in the UK in 2010, the RSS framework (and their strategic policy

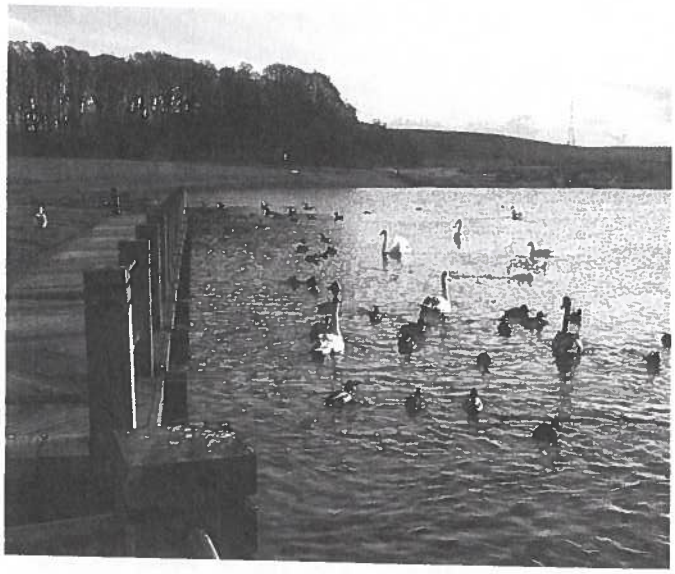

Figure 2.3 Herrington Country Park, Sunderland (UK).

objectives) was revoked, yet the community forests maintained their research/delivery functions to ensure that green infrastructure remained in the political spotlight.

The most successful partnership in this process has been the Mersey Forest, who have sustained their relationship with green infrastructure development throughout this period. While other forest partnerships (e.g. North-East Community Forest) have either ceased to trade or been forced to diversify, the Mersey Forest has remained a resolute force (Mell, 2011b; Mersey Forest, 2013a). Other partnerships, including the South Yorkshire Forest Partnership and the Red Rose Forest, have also been successful in promoting green infrastructure, although they could be considered to have been less successful in positioning themselves as key policy-practice delivery agents compared to the Mersey Forest. Both were involved with the Valuing Attractive Landscapes in the Urban Economy (VALUE) programme, which produced a set of proposals for the economic valuation of green infrastructure; work which has subsequently been promoted at a national and EU level (Mell *et al.*, 2013; South Yorkshire Forest Partnership & Sheffield City Council, 2012). Over the course of the last decade (2005–2015), England's community forests could be considered to have established themselves as the main agents supporting the conceptual development and delivery of green infrastructure in the UK.

2.5 Green urbanism and biophilia

As green infrastructure thinking has developed, its application has taken on the principles of a number of additional approaches to landscape planning. Jack Ahern of the University of Massachusetts (Amherst, USA) was one such innovator who engaged the principles of green urbanism with research on green infrastructure. He, and others such as Rob Ryan (also of the University of Massachusetts) and Maggie Roe (Newcastle University, UK), have therefore worked to extend the evolution of the concept into its current form.

Although green urbanism ideas have been predominately associated with the work of Beatley (2012, 2009, 2000) and Lehmann (2011), the principles they propose are also relevant to green infrastructure debates. Green urbanism promotes the notion that urban areas should attempt to moderate their behaviour to reduce the negative impacts on their ecological footprint, while acknowledging the interactivity of different human–environment activities within urban ecosystems. This view has been extended to support the notion that cities should be designed to function in ways analogous to nature; a view historically represented by McHarg (1969). These discussions go further by suggesting that the principles of green urbanism can be used to propose a more circular form of development that incorporate ecological networks and ecosystem services thinking as key elements of its symbiotic relationship between people and the landscape (Beatley, 2012; Mell, 2010). Finally, both Beatley and Lehmann stress the need to facilitate health lifestyles through accessible and multi-functional green infrastructure investment, which in turn helps create a better quality of life, place and environment. The main argument proposed within green urbanism is, therefore, one of circularity between people and place to ensure that an integrated and sustainable form of landscape planning is possible (Beatley, 2000).

Figure 2.4 Frederiksberg green space map, Copenhagen (Denmark).

The theory of biophilia extends the principles of green urbanism by placing a much greater emphasis on ecological perspectives of landscape planning. Building on the conceptual ideas of Wilson (1990), a biophilic analysis looks at how ecological resources can help create more liveable places. It also promotes the view that humans have an inherent or instinctive bond with the landscape, such as those proposed by Louv (2005), and places an emphasis on the maintenance of a continued relationship between them. This suggests that urban environments should be developed with a high proportion of green infrastructure to ensure that this association is maintained in perpetuity (Beatley, 2010).

2.6 Landscape ecology and ecosystem services

The spatial principles of green infrastructure have been shown to support the ideas of greenway planning, but they can also be seen in the central tenants of landscape ecology. Landscape ecology, as a discipline, proposes that environments are made up of connected, and in some cases fragmented, networks of ecological resources (Forman, 1995). It looks at how landscapes are shaped by the interaction of different ecological resources, and is explicitly a spatial process. Using the notion that landscapes are made up of a number of elements – *hubs*, *links* and *nodes* – landscape ecology proposes that environments which are multi-functional are able to utilise each to support ecological stability (Farina, 2006). In urban areas this can be achieved through the networking of habitats to allow the movement of biodiversity, as well as the flow of people (Breuste *et al.*, 2008; Jim & Chen, 2003). Landscape ecology

Figure 2.5 Wicken Fen National Nature Reserve, Cambridgeshire (UK).

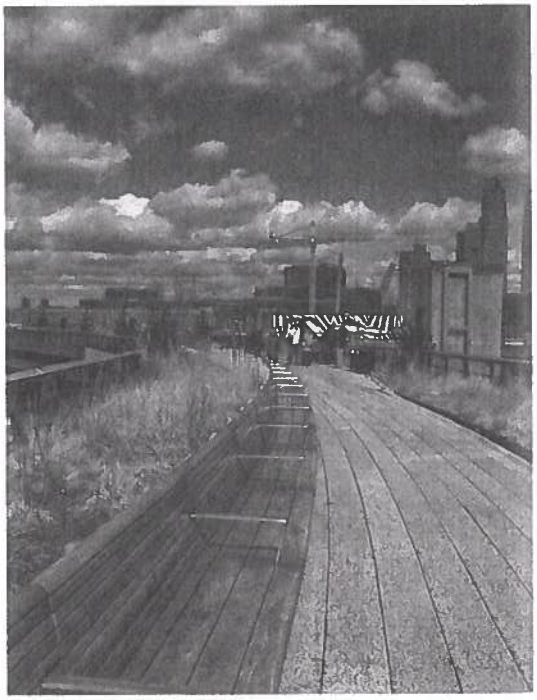

Figure 2.6 The High Line, New York (USA).

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thus provides the spatial framework for green infrastructure planning that enables its advocates to think strategically and across boundaries, to deliver effective green space management.

Developing these ideas has aided the growth of an ecosystem services approach to green infrastructure planning built upon the promotion of a strong ecological focus to frame investment opportunities. Based on the notion that landscape resources support four key functions – *supporting*, *provisioning*, *regulating* and *cultural* – ecosystem services have been proposed as offering a more rigorously scientific approach to understanding the interactivity of green infrastructure resources (Gill *et al.*, 2007; Tzoulas *et al.*, 2007). An ecosystem services approach to landscape planning, like landscape ecology, implies an inherent connectivity between resources, which are used to create equilibrium between use and management (Benedict & McMahon, 2006). Ecosystem services also provide scope to address the interactivity of environmental systems, an important aspect of green infrastructure thinking. By addressing how water, ecological and climatic systems interact, a discussion of ecosystem services can be used to address where dislocations in environmental networks are visible. It can, subsequently, offer solutions (using the services aspect of the concept) to propose alternative forms of management (James *et al.*, 2009; Young, 2010).

An ecosystem services approach to green infrastructure could also be described as offering a more prescriptive or mechanistic form of management (Hansen & Pauleit, 2014). Using the four *services* noted above, this approach looks at the synergies between resources to identify potential interactivities. To achieve this, ecosystem services advocates utilise complex evaluation techniques to understand the nuances of environmental relationships (Jongman & Pungetti, 2004). Therefore, while this approach offers a framework to assess the interactions of different environmental resources, it could be argued that it denies advocates the use of some of the more ephemeral or intangible actions of landscape resources (Andersson *et al.*, 2014). Although ecosystem services promote an understanding of cultural services, these appear to be the least well-formed. As a consequence, addressing green infrastructure issues from an ecosystem services perspective could be considered to be more closely aligned to environmental impact assessment or more traditional ecology practices to fully utilise the principles of green infrastructure (Mazza *et al.*, 2011). However, there is evidence that illustrates the value of establishing landscape classifications, as they provide a baseline for resource management (Mell, 2008). We could therefore suggest that rather than creating a separate line of academic argument for ecosystem services, they should be viewed as part of the toolkit of approaches that support green infrastructure. As a result, green infrastructure can incorporate the more culturally conscious debates of Lowenthal (1985), Tuan (1990) and Nassauer (1995) alongside the more formal ecological empiricism of Jongman and Pungetti (2004) and Farina (2006), as well as the evaluative approaches which underpin ecosystem services (Benedict & McMahon, 2006; Young, 2010).

2.7 Water-sensitive design and blue infrastructure management

For a number of years during the initial conceptualisation of green infrastructure, water was, at times, considered to be underrepresented (Benedict & McMahon, 2006). However, this did vary spatially, with some regions such as the USA heavily emphasising the role of water resource management in the discussions of green infrastructure (Ahern, 2007; Philadelphia Water Department, 2011). Our understanding of the role played by water in the presentation of green infrastructure could be considered to be less well established compared to discussions reflecting other terrestrial resources. Moreover, while the initial assessments of green infrastructure focused on identifying the functional value of different land use types and their potential functionality, water was often considered to be outside the remit of practitioners. Moreover, in some of the earliest summaries of green infrastructure (see Davies *et al.* 2006; Mell 2010) water is *reported* but not *debated* with the same significance as trees, grasses or biodiversity.

Consequently, the application of green infrastructure varied in how it approached the management of water resources. As a mechanism to raise the visibility of urban greening, water-centric discussions have potentially been the most successful advocacy approach used by its supporters (Mell, 2014). This has been particularly noticeable in the USA, where the engineered management of water is of national importance (Ahern, 2007; Benedict & McMahon, 2006). Practitioners in North America are simply the most vocal in their use of water-centric green infrastructure development when contrasted to their UK and European counterparts (New York City Environmental Protection, 2010; Philadelphia Water Department, 2011). One possible reason is the increased level of control the government and the Environmental Protection Agency (EPA) have on water management in the USA (Rouse & Bunster-Ossa, 2013). This allows these agencies (and their subsidiaries) to instigate and manage water-focused green infrastructure projects more directly

Figure 2.7
Water-sensitive green infrastructure design, Chicago (USA).

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Figure 2.8
Sabarmati waterfront re-development, Ahmedabad (India).

than those with predominately biodiversity or socio-economic benefits (Benedict & McMahon, 2006). Furthermore, the cost of supplying potable water (and maintaining supplies) is a key investment issue in the USA. The experiences of maintaining an adequate supply has led to major changes in the ways in which New York City and New York State approach the management of the Catskill watershed (Austin, 2014). Unfortunately, the economic influence of New York makes it a relatively delicate case in terms of balancing supply, demand and quality; other locations across continental North America (e.g. Phoenix or Portland, OR) are engaged with similar issues (Beatley, 2010).

Notwithstanding how the USA dominates the discussions of water-focused green infrastructure research, there has been a growing exploration of similar issues in Europe (Gill *et al.*, 2013; Hering *et al.*, 2010). Many cities in the former industrial heartland of central and northern Europe in the Netherlands, Belgium and Germany have been at the forefront of this, examining ways to re-establish value in polluted and derelict water bodies (Hellmund & Smith, 2006; Liebenath *et al.*, 2010). Furthermore, while some nations have attempted to address national- or international-scale green–blue infrastructure needs, especially those engaged with the European Union WFD (Forest Research, 2010), a greater number of city-scale investments are beginning to address water-based green infrastructure investment (Howes, 2008). Cities such as Malmö and Helsinki have been subject to water-based design problems, which have required a nuanced application of green infrastructure to meet both local and more strategic needs (Jaakkola, 2012; Lehmann, 2011). Each of these examples highlights an inherent variability in terms of addressing water-centric green infrastructure issues. Even though in some locations there is continuity in terms of the policy-delivery environment, e.g. through the EPA Memorandum

of Understanding (Environmental Protection Agency, 2014), there is still extensive variability in how water resources are conceptualised and managed. The diversity of investment does though provide practitioners with a toolbox of approaches to deal with the issues of water supply, quality and maintenance. If each of these variables can be integrated into a spatially appropriate management plan then the long-term sustainability of these resources can support more successful interventions in green infrastructure delivery (Rouse & Bunster-Ossa, 2013).

2.8 The development of green infrastructure policy and advocacy

While the academic literature has debated what green infrastructure is, how it should be used and what benefits it can deliver, it has fallen to practitioners to push these messages into practice. Throughout the advancements made in green infrastructure thinking, the role of advocates drawn from government, non-governmental organisations (NGOs), developers, community groups and the public have been critical (Lennon, 2014a; Wright, 2011). Although there may be a lack of consensus between how each group interacts with (a) each other and (b) green infrastructure, each of these stakeholder groups have helped to shape the policy and practice of green infrastructure investment (Mell, 2010). In terms of the most frequently discussed arenas of green infrastructure, the following snapshots from the UK and the USA illustrate the fluid nature of whom and how different agencies have been involved in the concept's development.

In the UK, green infrastructure advocacy was initially led by England's Community Forests Partnerships and the Countryside Agency. Although there were geographical differences in the extent to which green infrastructure was discussed (Mell, 2010), there was a visibly growing use of the term in policy (see Countryside Agency & Groundwork 2005), in scoping studies (Bedfordshire & Luton Green Infrastructure Consortium, 2007; Davies *et al.*, 2006) and in strategic guidance (Greater London Authority, 2012; Natural England & Landuse Consultants, 2009). Over time the influence of the Countryside Agency changed as they evolved into Natural England; in their current form Natural England are the UK government's lead agency supporting green infrastructure planning. Furthermore, in parallel with the changing structures and authority of Natural England, the Community Forest Partnerships solidified their role as the most prominent advocates for green infrastructure. In spite of the changing policy environment, they have remained central to the delivery of green spaces across a majority of northern England (Mell 2015a; 2016). However, due to changing funding structures it has not always been possible to ensure the longevity of all 12 partnerships, with the eight which remain having repositioned themselves to remain at the centre of green infrastructure planning (Mell, 2011b). More recently, a broader range of advocates has begun to engage more frequently with green infrastructure. In Forest Research (2010), the Town & Country Planning Association (2012a) and various local planning authorities (Cambridgeshire Horizons, 2011; Green Infrastructure North West, 2010; Mersey Forest, 2013a), green infrastructure has found a voice in policy-practice arenas helping it to evolve further.

The growth of green infrastructure planning was also associated with a specific policy arena in England throughout the 2000s. The process of plan-making in England prior to 2010[4] provided scope for regional advocates to work more directly with the production of RSSs, which set out the development goals of each of its regions (Thomas & Littlewood, 2010). The RSSs provided a platform for advocates to engage policy-makers in green infrastructure discussion with a view to embedding its principles into the RSSs. Green infrastructure in England was thus provided with a welcoming platform from which to report the benefits of the concept to a range of key policy-makers. However, post-2010 the UK government revoked RSSs, thus limiting the dialogue and reporting avenues between advocates and policy-making. Although the momentum witnessed in the RSS process was not lost, as advocates turned to sub-regional policy to promote its inclusion in policy (Mell 2010).

In parallel with the rise of green infrastructure in the UK, the Conservation Fund were leading its development conceptually, and in practice, in the USA. As discussed previously, the research of Benedict and McMahon (2006) was influential in shaping how the concept was, and is still viewed in the USA. Their work with the Conservation Fund across the USA, and in particular in Chesapeake Bay in Maryland (Weber & Wolf, 2000; Weber *et al.*, 2006) provided valuable insights into how it could be used to address natural resource management issues. The EPA has also held an important role in monitoring the development of green infrastructure through a series of memoranda aimed at providing delivery guidance for practitioners (Environmental Protection Agency, 2014). Following on from the Conservation Fund's and the EPA's promotion of green infrastructure, academics at the University of Massachusetts (Ahern, 2013; 2007; Ryan *et al.*, 2006) and the University of Washington (Wolf & Forest Resources, 2003) have continued to support its evolution with the University of Massachusetts organising the second and third editions of the Fábos Landscape & Greenways Planning Conference in Amherst (USA) and Budapest (Hungary), respectively, to disseminate the most contemporary research and practice on green infrastructure.

As the visibility of green infrastructure has increased, there has also been a corresponding development of city-scale strategies. Boston, New York and Philadelphia can be considered to have led this process, with the city government's signing into law legislation to protect, and in some cases enhance, the urban green space resource base (Fábos, 2004; New York City Environmental Protection, 2010; Philadelphia Water Department, 2011). As elsewhere, though, the uptake of these ideas has not been universal, with many cities failing to engage with green infrastructure as it is not seen as a planning priority (Benedict & McMahon, 2006).

The variability of advocate and stakeholder engagement seen in the UK and USA is also evident in Europe. Each member state of the European Union has taken a locally specific approach to developing green infrastructure, leading to varied discussions of whether they can be compared. In Belgium and Germany the regional development agencies (VLM – De Vlaamse Landmaatschappij in Belgium; VRS – Verband Region Stuttgart in Germany) have acted as key advocates developing green infrastructure policies (South Yorkshire Forest Partnership & Sheffield City Council, 2012), while in Paris the city government (Mairie de Paris) has recently offered the city's citizens an opportunity to allocate a proportion of €20 million for green infrastructure projects

(Willsher, 2014). City administrations and regional bodies in Europe thus appear to be replicating England's Community Forests, and the Conservation Fund in the USA, as leading the continued evolution of green infrastructure thinking (Beatley, 2000).[5]

The function of advocates is changing, however. As research begins to be reported from China and India, we are beginning to see the development of more practice/developer-led discussions of urban greening linked to economic development. The research of Jim and Chen (2006a, 2003) in China and Hong Kong has highlighted how financial valuations of green infrastructure are being undertaken to estimate the economic potential of green spaces to property developers. Furthermore, in New Delhi the city's administration have started to align effective environmental management with economic growth in the city's development master plan (Delhi Development Authority, 2007). In the Arabian Gulf the role of green space is one of aesthetic beautification, where green infrastructure is used by developers to sell homes and a lifestyle (Kenworthy, 2006). All of this highlights the growing variability within development debates asking whether investing in green infrastructure is economically viable. The evidence from China, Europe and the USA suggests that economic returns can outweigh the costs of investment, and that green infrastructure can be used to promote quality of place and liveability indicators (Siemens AG, 2011; South Yorkshire Forest Partnership & Sheffield City Council, 2012; Tyrväinen, 2001; Vandermeulen *et al.*, 2011).

2.9 Three eras of green infrastructure development: exploration, expansion and consolidation

As green infrastructure evolved as a concept from the late 1990s onwards, it is possible to identify a number of specific periods of its development. Pre-1999, apart from its use by the President's Council on Sustainable Development (1999), which addressed green space and landscape issues, the use of green infrastructure terminology was extremely varied. Although the classic texts of McHarg (1969) and Little (1990) proposed the concepts of landscape integration and connectivity, it has taken time to reframe these principles into the green infrastructure policy-practice we are now increasingly aware of. Therefore, despite the rise of the environmental movement in the USA from the 1960s onwards, which debated the need to think more holistically and sustainably about our environment (Pepper, 1996), these issues were not necessarily considered universally important in planning. The lack of a coherent narrative for green space planning has been a key aspect of developing the green infrastructure rhetoric we currently see. All of this helped the Conservation Fund in the USA and the Countryside Agency (Countryside Agency & Groundwork, 2005) in the UK to shape the initial conceptualisations of green infrastructure. The development of green infrastructure could therefore be considered as being placed into three distinct periods: *exploration*, *expansion* and *consolidation*.

2.9.1 Exploration (1995–2005)

The initial discussions of green infrastructure, the *exploration* phase, looked to establish what the concept was, which landscape elements should be considered as green

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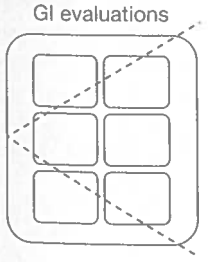

Stage 1 (1998–2005)

infrastructure and how it could be mapped using existing data sources (e.g. National Land Use Data – NLUD, in the UK). Green infrastructure debates at this time would now be considered limited; they also found it difficult to establish its value in policy discussions, which constrained the reporting of its benefits to policy-makers. Moving this process forward, the Conservation Fund was the first agency to extend the visibility of green infrastructure beyond a handful of practitioners. The research of Mark Benedict and Ed McMahon (2006, 2002) was pivotal, as they aligned green infrastructure planning with smart conservation at a number of scales in the USA. Most, if not all, subsequent research into green infrastructure takes its basic principles from their work. From this point onwards, research and practitioner reports started to use the term *green infrastructure* to frame conservation discussions at both a local and a strategic scale (McDonald *et al.*, 2005; Weber & Wolf, 2000). Over time an acceptance of green infrastructure terminology, and the ways in which it could be applied to landscape planning and conservation, have become increasingly visible (Benedict & McMahon, 2006).

The initial uptake of green infrastructure steadily engaged European academics and practitioners from the late 1990s onwards. Evidence of this process was reported by Sandström (2002), discussing the value of green infrastructure to Swedish planning debates, while Beatley (2000) debated comparable principles in his green urbanist assessment of Europe. In the UK, England's Community Forest Partnerships (2004) and the programmes of Countryside Agency & Groundwork (2005) helped to focus discussions on a number of key ideas: connectivity, multi-functionality, interrelated and supportive benefits and systems and a systematic (i.e. strategic) approach to landscape management in the mid-2000s. Each of these principles was used to shape how environmental NGOs (ENGOs) and local government approached the development, and in many cases redevelopment, of landscapes across the UK. They also laid the groundwork for further investigations into site-specific applications of

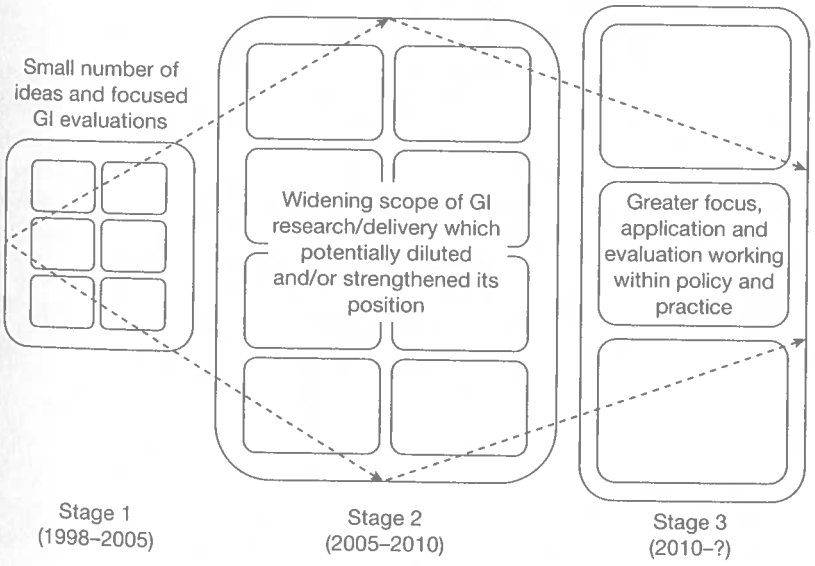

Figure 2.9 The three eras of green infrastructure development (scale, depth and focus).

green infrastructure, as well as the development of strategic policy based on the growing consensus of what it should deliver (Mell, 2010).

The initial exploration phase of green infrastructure enabled researchers to debate the ways in which it could be developed using alternative thematic interpretations. During this period researchers debated the value of green infrastructure to meet climate change, health and biodiversity/conservation, and other issues (see Gill *et al.* 2007; Mell 2007; Hostetler *et al.* 2011). Each subsequent discussion extended the initial conceptualisations of green infrastructure to illustrate how it could be used as an effective form of landscape and urban planning. Key references include Tzoulas *et al.*'s (2007) review of the proposed health benefits of green space, which helped to shape the way these issues are currently considered (Pretty *et al.*, 2007; Town & Country Planning Association, 2012c). Gill *et al.* (2007) and Goode (2006) gave assessments of how green infrastructure proposed methods of helping cities adapt to climate change. Weber and the Conservation Fund's work in Maryland was highly influential in promoting links between investment and the conservation of ecological networks, and has been used to frame some of the contemporary ecosystem services debates (Weber & Wolf, 2000; Weber, 2007; Weber *et al.*, 2006).

The work of each of these authors provided green infrastructure advocates with a number of avenues to explore, all of which are relevant in current policy discussions, as they promote a more detailed appreciation of socio-economic and ecological benefits, and make significant contributions to how we should manage the environment. Kambites and Owen (2006) extended a number of these arguments, looking at how green infrastructure could engage planning policy debates. They offered one of the first and, along with Lennon's (2014a, 2014b) recent discussions, potentially still most relevant assessments of the processes that green infrastructure needed to address if it was to become a grounded approach to planning. Subsequent research has shown that the proposals outlined by Kambites and Owen were used to shape green infrastructure thinking in the second stage: *expansion*.

2.9.2 Expansion (2005–2010)

The expansion phase reflected an increase in the number of academic, government and practitioners working with green infrastructure and the significant rise in discussions, policy guidance and research projects looking at the value of developing green infrastructure. In England this was strongly linked to the inclusion of the concept in the RSS process, where advocates used the growing body of research to relate the values of green infrastructure to regional government (Horwood, 2011; Thomas & Littlewood, 2010). The success of the RSS, though, was variable, with specific regions (the East of England, North-west and the North-east) being the most proactive advocates of investment in green space (Blackman & Thackray, 2007; North West Green Infrastructure Think Tank, 2006). Through the RSS, green infrastructure was inculcated within local government discussions because of the discursive depth and breadth of evidence presented by environmental and local government advocates.

A comparable process of praxis was also witnessed in the USA, where the continued influence of the Conservation Fund, and the release of Benedict and McMahon's seminal book (Benedict & McMahon, 2006), ensured the concept remained visible

in development debates. One of the key factors contributing to this process was the geographical scope of the Conservation Fund, which has regional chapters, to engage GI debates at a national, regional and sub-regional level. More recently, as an emphasis on stormwater and water catchment dynamic has been mainstreamed in green infrastructure debates, there has been an increasing engagement by the EPA with this process. They have supported its use through a series of prescribed Memoranda of Understanding (MoUs) explaining how it should be used to manage water resources (Dunn, 2010; Environmental Protection Agency, 2014). This reflected the historic engineered approach to investment in water management, but can also be presented more holistically by reflecting on how soft- or green-engineering can be used to promote more sustainable forms of investment (Ahern, 2007; Mell, 2013a).

The second period of GI development also saw a growing regional dialogue for the concept. The research and 'grey' literature[6] saw a broadening of how green infrastructure was planned through strategic documents, and where investments were taking place at a site, city and sub-regional scale (Mell, 2010). The number of strategies in the UK increased greatly during this period, with a similar process being witnessed across the USA, where major cities including New York, Chicago and Philadelphia started to explore the possibilities of green infrastructure as an effective approach to land management (Mell, 2014). Schilling and Logan (2008) explored this value of green infrastructure in the 'rust belt' of the USA, while Young (2010) and Dunn (2010) both addressed city-scale processes of interventions advocating for sub-regional investment. This period thus witnessed the beginnings of a more refined approach to green infrastructure that examined its value as a planning process using a set of nuanced thematic approaches. It differed from the initial stage, as the principles being used to guide GI were, by this stage, starting to show a level of consensus amongst advocates (Beer, 2010; Mell, 2010, 2008). This shift would be further exacerbated in the third phase: *consolidation*.

2.9.3 *Consolidation (2010 onwards)*

The current phase of green infrastructure research could be considered one of consolidation, as we now have a relatively grounded consensus discussing what green infrastructure is and how it should be developed (Mell, 2014, 2013a; Wright, 2011). This has been supported by the year-on-year growth of specific green infrastructure investment strategies, as well as an increasing awareness of its value to a number of thematic planning agendas (e.g. climate change). Therefore, while green infrastructure in the *expansion* period looked to assess how, where and why it was a relevant form of investment, the move towards *consolidation* developed a more detailed, grounded and robust evidence base to support development.

One factor influencing this process has been the growing realisation, especially at a global scale, of the economic, ecological and social value that green infrastructure can help deliver (Siemens AG, 2011). Beatley's (2009; 2000) research in Europe and Australasia showed this broadening trend, as did the consultation and adoption of green infrastructure strategies in the cities of New York (New York City Environmental Protection, 2010), Philadelphia (Philadelphia Water Department,

2011) and London (Greater London Authority, 2012). Further guidance has also been produced by Merk *et al.* (2012) and Siemens AG (2011) reflecting the opportunities for green infrastructure investment in Asia, examining the cost–benefit balance of greener and more sustainable cities. What each of these strategies and guidance documents illustrated was the ways green infrastructure is now seen as a nuanced approach to urban landscape management compared to other forms of development (Mell, 2014). Green infrastructure is thus being linked to greener, smarter and more efficient methods of urban development, which make connections between business, community and environmental needs (Austin, 2014; Hansen & Pauleit, 2014; Jones & Somper, 2014).

Furthermore, as guidance at a number of scales, i.e. city and national/international, has been developed to frame green infrastructure investment (European Commission, 2013), there has been a corresponding refinement of how specific thematic applications of the concept are utilised. Austin (2014) discussed this process by assessing the potential applications of biodiversity and ecosystems in North America and Sweden, while Rouse and Bunster-Ossa (2013) addressed the continuing reflection on grey vs. green water sensitive management in the USA. While both of these authors reflected more broadly on how green infrastructure could be implemented, such discussions have been supplemented by more detailed studies of how the concept can address financial concerns in North-west Europe (Mell *et al.*, 2013; Vandermeulen *et al.*, 2011; Wilker & Rusche, 2013), conservation and ecosystem services benefits in urban and suburban areas in the USA (Hostetler *et al.*, 2011; Young, 2010) and the need to develop an evidence base for politicians that emphasises the role of green infrastructure in addressing the adaptation of urban areas to climate change (Ahern, 2013; Carter & Fowler, 2008; Madureira *et al.*, 2011). The rise in research focusing on the economic evaluation of green infrastructure, the benefits of ecosystem services and its links to health have been three of the most significant areas of development during this period.

All of this suggests that the discussions of green infrastructure planning and its values are progressive as there has been a continuing engagement with it in urban and landscape planning. This also identifies an increasing refinement as practitioners become more adept at implementing its key principles. Throughout each of these three periods there has needed to be a consistent process of validation of, and a return to, a continuing referral to a number of established principles, each of which has been used to frame the development of green infrastructure around the world. Mell (2010) summarised this discussion, noting that: *multi-functionality*, *connectivity*, *accessibility* (and location/size of a resource), a *scaled* and *strategic approach* to investment, were all key aspects of an *integrated approach* to *strategic* and *local* green infrastructure policy-making. In subsequent research these principles have been utilised to shape how green infrastructure has been debated by planners, developers and practitioners. Therefore, although we have moved through three transitional periods, we can reflect on how each period has built on and refined a more subtle understanding of what green infrastructure is, and how it can be used.

One further aspect of green infrastructure thinking that remains crucial to our understanding of its value in landscape and urban planning is that regardless of what form of investment green infrastructure takes, we must consider it to be context

specific. The big questions of *who*, *what*, *where*, *when*, *why* and *how* may change; however, it remains important to reflect on the location and the socio-economic and political factors that influence development when discussing green infrastructure investments. Furthermore, although we can identify a consensus of which of its principles are considered to be accepted in each of the major green infrastructure planning arenas (see Mell 2014), there is still scope to highlight the differences between locations.

2.10 The geographical rise of green infrastructure thinking and planning

Throughout this chapter references have been made to green infrastructure development in the UK, Europe and the USA, with some of the additional discussions focusing on Asia and Australasia. Since the initial discussions of green infrastructure in the UK by Davies *et al.* (2006) and the Countryside Agency & Groundwork (2005), and by Benedict and McMahon (2006), Beatley (2000) and Sandström (2002) in the USA and Europe, engagement with the concept has increased. This reflects the geographical diversity of discussions, but also illustrates how the initial conceptualisations of green infrastructure are evolving geographically.

More recently this focus has shifted to include the growing discussion of green infrastructure in China, South-east Asia and, increasingly, India (Balooni *et al.*, 2011; Town and Country Planning Organisation & Government of India, Ministry of Urban Development, 2014). The rise of green infrastructure in these locations is illustrative of how a set of comparable principles to those used in the USA and Europe is becoming visible across Asia. Issues of urban expansion, population change and an overreliance on the environment are all influencing how governments and practitioners are engaging with green infrastructure. Most noticeably, green infrastructure has been linked to evaluations of real estate and landscape perceptions in China (Jim & Chen, 2006b; 2003; X. Xu *et al.*, 2011), while in South and South-east Asia (Balooni *et al.*, 2011; Mansor & Said, 2008; Sonak *et al.*, 2008) research has more directly addressed climate change. Moreover, research examining the value of green infrastructure in India and Pakistan discusses how the delivery of urban greening projects can address issues of social change, environmental capacity and balancing of socio-ecological needs with economic development (see Zérah 2007; Chaturvedi *et al.* 2013; Singh *et al.* 2010; Nagendra *et al.* 2012; Mell 2013b; Qureshi *et al.*, 2013; 2010).

An analysis of the research being reported in each of these geographical locations indicates that we are, potentially, seeing the beginnings of a truly global debate for green infrastructure. No longer is the concept confined geographically to Europe and North America, as it is showing that it can meet the development needs of a number of alternative locations. Mell (2014) reported that a meta-level consensus was visible in Europe and North America. He went on to note that despite the lag time for development, green infrastructure discussions in Asia and Australasia were starting to explore comparable issues to those seen in Europe. This suggests that green infrastructure has established itself as a planning approach that can address a wide range of development issues. It also highlights a need for a compendium

of research discussing green infrastructure development in a global context using examples from established and new development areas.

2.11 Summary

This chapter illustrated how a number of thematically, as well as spatially, different approaches to green space planning have been used to define the principles of green infrastructure. Each of the ideas presented in the discussions of greenways, garden cities and green urbanism highlighted how landscape planning is constantly evolving to ensure that economic, environmental and social needs are met. Table 2.2 outlines how this commentary manifests itself in green infrastructure planning in different locations. It also illustrates the complexity of trying to define consensus between green infrastructure advocates as to what, why and how it should be planned. The discussion presented in this chapter also reflects upon how temporal change, as well as spatial challenges in addressing expansion, occurs and continues to place additional, and in many cases excessive, stresses on environmental capacity. All of which have a noticeable impact on the form that green infrastructure takes, and how it is discussed in praxis.

Throughout, the chapter has reflected on a number of key principles which are now deemed to be established within green infrastructure thinking, namely: connectivity, linearity and networks, integrated approaches to landscape and socio-economic development, and the assumption that green infrastructure planning promotes an inherent multi-functionality in a given location. What the discussion of these principles suggested is that it is possible to redefine how we view our relationship with the landscape if we accept that human–environment interactions form a central tenant of their functionality. The value of such a reflection is to ensure that our understanding of the *hows* and *whys* of investment can be identified within the broader literature of green space and landscape planning.

Table 2.2 Focus of green infrastructure planning: 2005–2009

UK	*North America*	*Europe*
(1) Community forestry	(1) Climate change adaptation	(1) High-density urban development
(2) Sustainable urban design	(2) Micro-climate control in urban areas	(2) Mobility
(3) Urban renaissance	(3) Biodiversity conservation and assessments	(3) Climate change mitigation and adaption
(4) Sustainable communities	(4) Sustainable urban design	(4) Sustainable urban design
(5) Climate change adaptation	(5) Sustainable drainage systems	
(6) Healthy lifestyles and landscapes	(6) Smart growth	
(7) Biodiversity and conservation	(7) Water resource management	

Source: Mell, 2011b.

Notes

1 While the chapte it does acknowle onymous with th though, used ex stages.
2 The 'three-magn would utilise a tc
3 Although Howa predict the spee patterns, the pri viable (Cervero,
4 In 2010 a new in the UK. One planning, and w infrastructure de
5 The issue of whi development wil indicative of the locations.
6 The 'grey' literat by government the form of poli academic literatu

Notes

1 While the chapter does not reflect on green space management or practices in Asia, it does acknowledge that specific forms of urban green space development are synonymous with the Persian Gulf, India, China and Japan. These locations were not, though, used extensively to centre the debates of green infrastructure in its initial stages.

2 The 'three-magnets' are town, country, and town and country. Howard's garden cities would utilise a town and country approach to integrate nature into urban centres.

3 Although Howard's work has subsequently been critiqued as failing to adapt or predict the speed of changes in class structures, transport needs and employment patterns, the principle of developing connected urban green space networks is still viable (Cervero, 1995; Sarkissen, 1976).

4 In 2010 a new Conservative–Liberal Democrat coalition government was elected in the UK. One of their first acts of government was to revoke the regional tier of planning, and with it RSSs, which removed the most prominent platform for green infrastructure debates/development in England (European Commission, 2013).

5 The issue of which public or private bodies are currently leading green infrastructure development will be returned to in each of the case study chapters. This section is indicative of the variation in the administration of green infrastructure in different locations.

6 The 'grey' literature is considered as the practitioner and policy literature developed by government and advocacy organisations. This research is often presented in the form of policy and guidance documents and is less likely to appear within the academic literature.