

AESOP Conference 2014

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*Planning for Resilience to Multiple Stressors –
operationalising the theory of social-ecological resilience through green infrastructure planning*

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Abstract

Stresses present in different forms and call for subtly different responses. Conventional modes of planning seek to render such stressors manageable by administering them discretely. This has generally resulted in a segregated approach to spatial planning wherein functional delineations have become institutionally 'sedimented' within planning authorities (flood risk management, open space demand, biodiversity protection etc). This 'silo mentality' foregrounds efficiency at the expense of flexibility and restricts the scope for interdisciplinary collaboration. Consequently, it impedes a holistic social-ecological perspective on resilience by limiting adaptive potential. This paper aims to explore innovative ways in which planning practice can facilitate greater social-ecological resilience when planning in stressful places. With this in mind, the paper poses four interrelated questions: (1) What does social-ecological resilience mean? (2) Why plan for social-ecological resilience? (3) What does planning for social-ecological resilience entail? (4) What does planning for social-ecological resilience look like in practice? The paper responds to these questions through an analysis of how an Irish local authority has sought to overcome the limitations of traditional planning approaches by innovatively employing the 'green infrastructure' (GI) concept in developing policy and design ideas for the urban periphery of Dublin City. Drawing on documentary and interview material, the paper appraises the transformative potential of the GI planning approach by investigating its capacity to facilitate horizontal integration between different planning authority departments, deliver connected multifunctional spaces and cater for ecological conservation while concurrently facilitating sensitive urban development.

Keywords: social-ecological resilience, green infrastructure, planning

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1 Introduction

Debates on the direction of planning policy are sites where concepts emerge, are considered and given representation. Attention to such debates thereby offers insight into why and how theoretical perspectives influence or fail to affect the way planning issues are identified, conceived and addressed (Rydin, 2007; Tewdwr-Jones, 2012). One long standing debate in planning theory and practice has been a struggle to resolve the tensions between economic growth and environmental protection (Owens and Cowell, 2011; Baker and Eckerberg, 2008; Torgerson and Paehlke, 2005). Whilst Anglophone systems have always acknowledged care for the environment, meanings, representations and status of environmental issues as compared to development priorities have fluctuated over time (Davoudi et al., 1996). Within this context, the much documented ‘spatial turn’ in planning debates in the 1990s/2000s witnessed planning systems shifting beyond narrow land-use concerns to embrace a role of spatial coordination, characterised by flexible policy approaches and multi-scalar interventions. While ‘sustainable development’ became commonly cited as the ultimate goal within such spatial strategies (Briassoulis, 1999), much literature charted the primacy given to the competitiveness agenda (particularly at the city-region scale) – see for example, Counsell and Haughton (2003). In this context, environmental assets were perceived as ‘development assets’, performing a key role in place identity and packaged as quality of life capital (Owens and Cowell, 2011). Discourses surrounding sustainable urban environments were dominated by narrow debates surrounding compact urban forms, viewed as delivering both central city urban renewal and addressing the emerging climate change agenda through reducing the spatial separation of daily activities and therefore mitigating greenhouse gas emissions through reduced car dependency.

Although sustainable development provided a flexible discourse for formulating spatial strategies, the growing concern with stressors such as climate change has provided an important emerging context for spatial planning. These concerns have been heightened by the emergence of late modernity’s reflections on the contribution of planning practices to environmental destruction. This has generated broad anxiety regarding the capacity of planning to adequately redress the problems posed by the multiple, complex and entangled issues that characterise nature-society relationships (Davoudi, 2012a; Coffey and Marston, 2013; Krueger and Gibbs, 2007). The emergence of ‘social-ecological systems’ thinking represents a recent turn in efforts to acknowledge this complexity and reorient thinking towards a more holistic perspective on the fundamental entwining of social and natural environments (Davoudi et al., 2012; Walker et al., 2006; Folke et al., 2003; Folke et al., 2010). Planning theorists have seen promise in this perspective and therefore focused much attention on locating ways to enhance the ‘resilience’ of such systems to a variety of environmental, political and institutional stressors (Wilkinson, 2012b; Evans, 2011). This has entailed a flurry of thinking on how the goals and objectives of planning can be adjusted to better account for social-ecological systems and how the resilience of such systems can be advanced (Scott, 2013; Davoudi et al., 2012; Cumming, 2011). Nevertheless, there remains a paucity of examples to illustrate what planning for social-ecological resilience might look like in practice and what forms of planning activity are required for its realisation (Wagenaar and Wilkinson, 2013).

Thus, this paper seeks to address this knowledge gap by exploring innovative ways in which planning practice can facilitate greater social-ecological resilience when planning in stressful places. The paper poses four interrelated questions: (1) What does social-ecological resilience mean? (2) Why plan for social-ecological resilience? (3) What does planning for social-ecological resilience entail? (4) What does planning for social-ecological resilience look like in practice? As such, this paper contributes to debates on substantive issues in planning theory and practice concerning how planning activity should be conducted in a more self-reflective, responsive and holistic manner (Forester, 2013; Rydin, 2007).

In seeking to answer these questions, the paper presents an analysis of how an Irish local authority has sought to overcome the limitations of traditional planning approaches by innovatively employing the 'green infrastructure' (GI) concept in developing policy and design ideas for the urban periphery of Dublin City. This concept emphasises the co-production of social-ecological assets between nature and society. It encourages the functional and spatial integration of green and blue spaces to deliver ecologically sensitive and socially beneficial environments that are more responsive to stressors. The paper examines documentary and interview material in appraising the transformative potential of the GI planning approach by investigating its capacity to facilitate horizontal integration between different planning authority departments, deliver connected multifunctional spaces and cater for ecological conservation while concurrently facilitating sensitive urban development.

The remainder of the paper is structured in four sections. The first of these outlines the concept of social-ecological resilience. The following section describes how this theoretical perspective can be given practice form via the GI planning concept. The subsequent section then employs a brief case study to illustrate what the GI concept may look like when applied in planning practice. The conclusion considers the potential of GI to help re-reframe planning towards a more holistic social-ecological systems perspective that focuses on enhancing resilience by addressing the complexities of spatial planning for human-environment relations.

2 Social-Ecological Systems and Resilience

Social-ecological resilience is an amalgamation of two related concepts that together propose a holistic perspective on human-nature relations and how to manage change. To fully comprehend the concept's relevance to planning, it is therefore necessary to examine the origin of its composite elements and how these have been assembled. Accordingly, this section examines both 'social-ecological systems' and 'resilience' thinking. How these concepts have informed the idea of social-ecological resilience is subsequently explained.

2.1 *Social-Ecological Systems*

Humanity is most often conceived as acting upon ecological systems rather than constituting an element of such systems (Goudie, 2009; Coates, 1998). Through this lens, management of ecological systems is seen to entail governance of a world external to, but influencing the wellbeing of society. However, since the early 1970s, there has emerged a growing awareness that human and ecological influence are profoundly interconnected and therefore inseparable (Folke, 2006). Now a perspective frequently evident across a range of disciplines, this view contends that many of the problems in natural resource management stem from a failure to acknowledge these inextricable connections (Folke et al., 2010). Thus, envisaging a world comprised of complex and inter-linked 'social-ecological systems' is thought to better reflect human-environment relations. In this sense, humanity is conceived as a constituent in a system with compound interdependent feedback loops that determine the system's overall dynamics. Accordingly, the concept emphasises humans 'as' and 'in' nature rather than separate to and above nature (Glaser et al., 2012). Such social-ecological systems are understood to operate at multiple interrelated spatial and temporal scales. Each system is considered a semi-autonomous structure nested within a hierarchy of systems. Hence, each system comprises a subsystem of another system in the hierarchy, and in turn, contains a number of subsystems within itself (Gunderson and Holling, 2001). The interactions across these system scales are thought fundamental in shaping the dynamics at any particular focal scale (Teigão dos Santos and Partidário, 2011). From this perspective for example, a neighbourhood, municipal park, city, river catchment and state may all represent interrelated subsystem levels in a broader social-ecological system. In recent years, research concerning social-ecological systems has increasingly been associated with the concept of 'resilience'. Thus, appreciating how planning theory and practice seeks to employ this view of

human-environment interactions necessitates attention to debates on the meaning and potential applications of ‘resilience’ thinking.

2.2 Resilience

Resilience is essentially a heuristic for thinking about change management. Fundamental to the concept is an assumption of non-linear dynamics in complex, nested and interrelated hierarchical systems (Eraydin and Taşan-Kok, 2012; Folke, 2006). The term emerged in the context of systems ecology where it was used to describe the ability of ecosystems ‘to absorb changes of state variables, driving variables, and parameters, and still persist’ (Holling, 1973, p.17). Subsequent to its initial use, the expression has been employed across a range of disciplines from psychology (Norris et al., 2008) and regional economic development (Pendall et al., 2010; Dawley et al., 2010), to national security (Lentzos and Rose, 2009) and urban planning (Evans, 2011; Wilkinson, 2012b). However, it is its use within the ambit of social-ecological systems planning and management that primarily concerns this paper. Many of those employing the term seek to use it to help shift planning towards a more adaptable activity that is responsive to disturbance. In such instances, use of the concept in planning is assigned a normative content. In particular, those employing the term envisage that management for greater resilience opens up desirable pathways for development in a world where the future is difficult to predict (Plieninger and Bieling, 2012; Barr and Devine-Wright, 2012).

Much contemporary debate concerning the use of resilience in planning centres on the distinction between ‘equilibrium’ and ‘evolutionary’ interpretations of the concept (Scott, 2013). The former understanding has its roots in disaster management and concerns a ‘survival discourse’ that focuses upon the ability of a system to ‘bounce back’ towards ‘business as usual’ following a catastrophe (Shaw and Maythorne, 2013). However, this perspective has received criticism concerning the appropriateness of seeking system persistence rather than adaptation when a crisis emerges (Davidson, 2010). For example, Porter and Davoudi (2012) question the desirability of seeking a return to the residential market conditions that preceded the 2008 global financial crisis, as to do so would be to normalise a dysfunctional system that precipitated fiscal calamity.

In contrast to equilibrium based approaches, ‘evolutionary resilience rejects the notion of single-state equilibrium or a ‘return to normal’, instead highlighting ongoing evolutionary change processes and emphasising adaptive behaviour’ (Scott, 2013, p.600). This interpretation focuses on resilience as enabling transformation of social-ecological dynamics such that disturbance supplies the stimulus for re-invention and thereby ensures strength through continuing reflection and adaptability (Erixon et al., 2013). Hence, an evolutionary interpretation of resilience entails a more radical and optimistic perspective that embraces the opportunity to ‘bounce forward’ (Shaw and Maythorne, 2013). It seeks to supplant a desire for stability with the acceptance of inevitable change such that it inverts conventional modes of thought by ‘assuming change and explaining stability, instead of assuming stability and explaining change’ (Folke et al, 2003, p.352).

However, the concept of resilience is not without its detractors, with recent years witnessing an increase in critical attention to use of the term (Welsh, 2013; Porter and Davoudi, 2012; Brand and Jax, 2007). Much of this concern relates to how the concept is ‘abstract and malleable enough to encompass the worlds of high finance, defence and urban infrastructure within a single analytic’ such that it ‘is fast becoming a pervasive idiom of global governance’ (Walker and Cooper, 2011, p.144). Here, resilience thinking is conceived as ‘a power-laden framework’ (Cote and Nightingale, 2012, p.484) that serves to ‘reinforce and extend existing trends in urban and regional development policy towards increased responsiveness to market conditions, strategic management and the harnessing of endogenous regional assets’ (MacKinnon and Derickson, 2013, p.260). In this sense, resilience thinking is suspiciously viewed as neoliberal rhetoric that buttresses established discourses of

entrepreneurialism and competition (Pendall et al., 2010; Christopherson et al., 2010). Others relate it to a broader form of language which obstructs 'rational societal negotiations that acknowledge the political dimensions of global ecology' (Hornborg, 2009, p.256).

Nevertheless, the concept of resilience seems itself to be resilient to much of this criticism, with its deployment mounting in planning theory, if not yet in practice (Davoudi, 2012b). Here, thinking in terms of resilience is thought to encourage flexible responses to the constraints of land use planning (Erixon et al., 2013; Ahern, 2013), adaptability to broader environmental and economic disturbance (Pike et al., 2010; Haider et al., 2012; Fünfgeld and McEvoy, 2012), and a capacity for positive institutional evolution (Shaw, 2012; Scott, 2013; Teigão dos Santos and Partidário, 2011). It is from such perspectives that the concept is seen to help inform human-nature interactions, most prominently through theorising about social-ecological resilience.

2.3 Social-Ecological Resilience

Social-ecological resilience is a framing device that merges the concepts of 'social-ecological systems' with 'evolutionary resilience' to inform planning for human-nature relationships in changing contexts. In essence, it seeks to provide a means for considering 'how to innovate and transform into new more desirable configurations' (Folke, 2006, p.260). Social-ecological resilience thus amalgamates a descriptive viewpoint with an analytic perspective and normative position. Accordingly, those advocating this approach see it as both a scientific discipline and a governance discourse (Wilkinson, 2012a). Thinking on social-ecological resilience may thus be seen as displacing discourses of 'sustainable development'. Although Scott (2013, p.601) notes how many authors conceive it 'as a means to further elaborate (rather than replace) sustainable development', there is a fundamental difference between traditional approaches to sustainable development and the more dynamic focus of social-ecological resilience. This centres on divergent perspectives regarding the process of transition towards a more sustainable future. Enhancing the resilience of social-ecological systems involves a holistic approach to embracing change that emphasises ongoing adaptation (Walker and Salt, 2006). It promotes continuous experimentation (Evans, 2011) and accommodates the trial of novel ideas (Ahern, 2011). In contrast, conventional approaches to sustainable development focus on locating an optimal development path and then pursuing such a course until a state of sustainability is achieved (Blewitt, 2008). Consequently, thinking in terms of social-ecological resilience presents a more dynamic perspective of sustainability that reconfigures the basic principles guiding thought and action. Hence, social-ecological resilience challenges planning theory and practice by seeking to radically re-frame traditional perspectives on how the world is constituted and the appropriate modes for operating within it.

In particular, planning is seen to have a crucial role to play in terms of reducing vulnerability and transforming the footprint of the places where people live and work so that they can cope with and recover more quickly from extreme disturbances of environmental stressors such as flooding or heat (O'Neill and Scott, 2011). Addressing such challenges requires a sea-change in planning processes and practices to fully integrate the social and ecological dimension alongside traditional planning concerns. It is in this context that the 'green infrastructure' (GI) approach has emerged as a planning discourse and set of planning practices. Consequently, GI may be viewed as a way to give practice-based form to abstract theoretical concepts concerning social-ecological resilience.

3 Green Infrastructure

The GI approach moves beyond traditional site-based approaches of 'protect and preserve' towards a more holistic ecosystems approach, which includes not only protection but also enhancing, restoring, creating and designing new ecological networks characterised by multifunctionality and connectivity.

While the origin of the GI planning concept remains debatable (Allen, 2012; Rouse and Bunster-Ossa, 2013; Roe and Mell, 2013; Pankhurst, 2012), and there are a variety of interpretations as to what it entails (Ellis, 2012; Cameron et al., 2012; EC, 2012), virtually all understandings resonate with the frequently referenced definition advanced by Benedict and McMahon (2006, p.1) as: ‘an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions...and provides a wide array of benefits for people and wildlife’. As a descriptive statement, this definition provides a useful focus upon which numerous social-ecological planning issues can converge. However, understanding how this can be translated into resilience enhancing practice involves teasing apart the core principles of the GI planning approach. These are thus identified and discussed below.

Firstly, to the fore among green infrastructure principles is the requirement to respect the context in which GI planning operates and to which a GI plan addresses (TCPA and WT, 2012; William, 2012). Here, GI planning is seen to entail ‘a design vision that translates [a] planning strategy into physical reality while heeding the ecological and cultural characteristics of a particular locale – whether a region or an individual building’ (Rouse and Bunster-Ossa, 2013, p.5). To advance such context sensitivity, a GI planning approach stresses the principle of interdisciplinarity and collaboration (Barnhill and Smardon, 2012; Davies et al., 2006; SG, 2012; Mayer et al., 2012). Such a *collaborative approach* applies to the conception, design, implementation and maintenance phases of a GI planning initiative. Moreover, promoters of the GI approach stress the need for collaboration to extend beyond the walls of expert institutions to involve non-specialist citizens whose ‘subjective human needs, preferences, and perceptions are often decisive’ in the formulation and implementation of successful GI initiatives (Erickson, 2006, p.280).

Secondly, advocates of a GI approach contend that planning for the protection and enhancement of valuable ecological assets and functions should precede the allocation of lands for development (TCPA and WT, 2012; LI, 2013). Such assets are the abiotic and biotic attributes that underlie the provision of functions valuable to society. For example, a naturally occurring floodplain would amount to such an asset should it function in aiding flood water attenuation, facilitating the slow release of such flood water and thereby prevent the inundation of residential properties. Furthermore, such a floodplain may serve as a valuable ecological asset through providing wintering grounds for wildfowl, while concurrently serving recreational and educational purposes during the summer months. In emphasising the merit of protecting GI assets and functions prior to other forms of development activity, GI is thereby regarded as *fundamental infrastructure* (Roe and Mell, 2013, p.653) necessary for the delivery of a better environment for human and non-humans alike (Grant, 2012).

Thirdly, GI approaches emphasise *connectivity* as central to promoting a holistic perspective on social-ecological systems. Indeed, a review of GI practice in the UK lead Kambites and Owen (2006, p.490) to conclude that connectivity is ‘a pervasive and desirable characteristic of both green infrastructure itself and the process of green infrastructure planning’. A GI planning approach seeks to integrate the spatial concept of ecological networks originating in landscape ecology (Forman and Godron, 1986) with the greenways concept stemming from a more anthropocentric spatial planning tradition (Hellmund and Smith, 2006). An ecological network is ‘a framework of ecological components, e.g. core areas, corridors and buffer zones, which provides the physical conditions necessary for ecosystems and species populations to survive in a human-dominated landscape’ (Jongman and Pungetti, 2004, p.3). Greenways differ from ecological networks in their greater focus on human recreational access and mobility, as well as in their more linear format (Gobster and Westphal, 2004). Ahern (1995, p.134) defines greenways as ‘networks of land containing linear elements that are

planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic, or other purposes compatible with the concept of sustainable land use.’

The fourth core principle of the GI planning approach is *multifunctionality*. It is this focus on seeking to enhance the resilience of social-ecological systems that Benedict and McMahon identify as differentiating GI planning ‘from conventional approaches to land conservation and natural resources protection because it looks at conservation in concert with land development and man-made infrastructure planning’ (2006, p.2). Accordingly, those studying GI see multifunctionality as ‘an integration and interaction between functions’ (Roe and Mell, 2013, p.655). In this sense, GI gives practice form to theorising on how planning may enhance social-ecological resilience by orientating spatial planning towards a focus on improving positive synergies between abiotic, biotic and social systems. We take this argument forward by illustrating in the following section how a GI planning approach facilitates the practice application of thinking on social-ecological resilience. Specifically, we employ a brief case study example of innovative GI planning activities in the northern periphery of Dublin City, Ireland. In doing so, we seek to demonstrate how the core principles of GI planning can be translated into practice and thereby enhance social-ecological resilience.

4 Planning for Social-Ecological Resilience

4.1 Context

Between 1995 and 2008 the Republic of Ireland experienced considerable economic, demographic and urban growth. During this period, land use governance struggled to negotiate the complex planning and environmental policy issues associated with unprecedented pressures for urban and infrastructural development (Davies, 2008). While growth rates significantly reduced post-2008, policy issues associated with over a decade of intense development demands remain (Kitchin et al., 2012). Keeping pace with such growth, and subsequently addressing its consequences, have preoccupied planning policy activity in Ireland for almost two decades. It is against this backdrop that new policy solutions have been sought to remedy multiple complex and pressing land use governance issues. To the fore of such endeavours has been the emergence of the green infrastructure (GI) planning concept. The emergence of this concept has been most pronounced in the planning activities of local authorities (Lennon, 2014). At a local authority level in Ireland, ‘The development plan has always been and continues to be the basic policy document of the planning authority in which the planning objectives for the area are set out’ (Grist, 2004, p.228). Such development plans comprise a written document and associated maps. In addition to the production of their development plan, local authorities may produce local area plans to offer more detailed direction on the development of specific geographic areas or theme related issues.

Fingal County Council (FCC) has been proactive in using its county development plan and local area plans to promote a GI planning approach. FCC is located in North County Dublin. The area administered by FCC encompasses a transition of land uses from the urban-suburban continuum extending from Dublin City to a rural coastal and agricultural landscape containing numerous European nature conservation sites designated under the provisions of the EU Habitats and Birds Directives. FCC advances a GI planning approach in an effort to reduce tensions between growth management and environmental protection. This entails a holistic perspective on planning that seeks to augment the potential for social-ecological synergies that furnish quality of life enhancements while concurrently advancing ecological conservation. This innovative approach also seeks to facilitate adaptation to both predictable change and unforeseen events. Thus, the GI approach advanced by FCC seeks to promote an ‘evolutionary’ perspective on planning for the resilience of social-ecological systems. Realising resilience in this context is organised around the core principles of GI planning outlined above, namely; a collaborative approach, viewing ecological assets as

fundamental infrastructure, promoting connectivity, and advancing a multifunctional perspective on land use planning. How each of these core principles have been applied in practice is discussed below.

4.2 Collaborative Approach

FCC is a comparatively new organisation having been established in 1994 when three new local authoritiesⁱ were created following the dissolution of Dublin County Council (Oireachtas, 1993). Officersⁱⁱ within the council suggest that this relative youth engenders perceptions of innovative possibilities wherein roles have not yet become ‘sedimented’ (Peters, 2005; Scott, 2008). Reinforcing this identity as a dynamic local authority, FCC has undertaken a self-initiated reorganisation of its disciplinary divisions. This reorganisation was instigated with the intent of facilitating greater collaboration between the array of council professions deemed pertinent to land use planning activities. In essence therefore, it was initiated to redress the ‘silo mentality’ in traditional planning activities ‘whereby different departments of a local authority work separately from each other – and occasionally in conflict with each other’ (Kambites and Owen, p.490). A central element of this administrative reorganisation was the merging of several previously discrete departments into a newly created ‘Planning and Strategic Infrastructure’ division. This new division includes strategic planners, drainage engineers, traffic planners, parks professionals, the biodiversity officer and the heritage officer. These professions had formerly been distributed in different departments, such as the ‘planning department’ or the ‘drainage department’. This root and branch administrative reorganisation facilitated communication and collaboration by professionals who previously had little contact beyond formal cross-departmental channels. Positive working relationships soon emerged and synergies developed as ill-formed presumptions and mutual suspicions dissipated and cooperative planning efforts evolved. As noted by one interviewee,

I think ‘Planning and Strategic Infrastructure’ makes sense. Because in the past like we would have had the Planning Department planning for things, and other Departments then delivering major infrastructure, but now you have kind of those things being thought about in a more integrated way...So the reorganisation helps I suppose in terms of making it more possible for people to come together, to talk together. So we’re not as silo’ed as we were...And now I think there is much more realisation that the silos are less fixed, and so people are much more willing to talk horizontally across the organisation. (Interviewee A8)

Thus, the administrative reorganisation of FCC has advanced the potential of the local authority to plan ‘in a more integrated way’ by facilitating collaborative effort by a spectrum of professionals drawn from an array of theoretical backgrounds, practices and opinions (Benedict and McMahon, 2006, p.40). Such increased ‘horizontal’ communication and working arrangements has helped promote more comprehensive and efficient responses to a multitude of complex stressors by enabling concerted action in achieving seemingly disparate goals such as flood control and habitat conservation (Novotny et al., 2010; EC, 2012; FCC, 2011). GI has facilitated this by presenting a ‘centring concept’ that various professions can ‘buy into’ (Interviewee A8) in forging interdisciplinary collaborative working arrangements. Hence, advancing the GI approach has enabled ‘a co-ordinated approach from a multi-disciplinary, cross-organisational, cross-boundary team of partners’ (TCPA, 2012, p.10) that enhances the potential of the local authority to plan for social-ecological resilience.

4.3 GI as Fundamental Infrastructure

The Fingal County Development Plan 2011-2017 (FCC, 2010) stresses the fundamental importance of a social-ecological systems perspective. Specifically, the insertion of a GI chapter prior and adjacent to

the subsequent conventional 'Physical Infrastructure' chapter signals an interpretation of GI as a strategically important concept binding together the various economic, physical, environmental and social objectives of the plan. In this way, GI is advanced as a framework for coordinating the policy issues identified and discussed in the ensuing sections of the plan, for example, biodiversity, landscape and public open space provision. This view of the GI approach as a providing a planning framework for a more holistic form of social-ecological thinking is illustrated by the opening comments of the development plan's GI chapter which states,

Green infrastructure provides space for nature (or biodiversity) and the natural systems which regulate temperature, reduce storm flows, provide us with clean water and air, and a multitude of other benefits...The emergence of green infrastructure planning is a response to the growing recognition of the many benefits which green space provides to society and of the need to plan for its protection, provision and management in tandem with plans for growth and development. (FCC, 2010, p.91)

Furthermore, the development plan stipulates that local area plans produced subsequent to its adoption will be required to promote this planning approach to ensure the 'protection, management, enhancement and provision of green infrastructure which is fully integrated with new development' (FCC, 2010, p.96). In this sense, GI planning is seen to 'provide a framework for future growth while also ensuring that significant natural resources will be preserved for future generations' (Benedict and McMahon, 2006, p.41).

4.4 Connectivity

Prior to the advocacy of a GI planning approach, FCC had advanced habitat connectivity via ecological networks (FCC, 2005). Such networks render otherwise fragmented ecosystems biologically coherent by facilitating species movement and genetic exchange (Opdam et al., 2006). Therefore, the essence of ecological networks is 'biopermeability and environmental continuity' (Pungetti and Romano, 2004, p.110). Although promoting spatial and scalar integration, these networks focus primarily on 'ecological' connectivity. Consequently, this wholly ecological focus failed to fully reflect the socio-cultural dynamics intrinsic to social-ecological systems thinking. However, following greater acquaintance with GI theory and the consequent advocacy of a holistic approach to planning, FCC has sought to advance a more functionally integrated network of key sites that meet several socio-cultural objectives while concurrently maintaining ecosystems integrity. As noted by one interviewee when reflecting the GI planning approach,

It's [GI] basically trying to link up your key ecological features which are amenity features, your water features and the likes of that...

...most of the important major conservation in the county is within this network so if you're going to do any development near it, whether it's amenity or whether it is roads or water or housing, these are the key features that need to be protected and it's more to see how can we work with you to incorporate that. If you build a housing estate and the river runs through that, how can we design the flood plain at the river in such a way that it will actually suit everybody. So it is still an amenity space, but wildlife can live there too...it's trying to combine those different things. (Interviewee A2)

In this sense, by advocating a GI approach to planning, FCC has sought to promote spatial connectivity along the form presented by ecological networks so as to assist biodiversity conservation while concurrently seeking to broaden the function of the network to facilitate anthropocentric utility

(Pankhurst, 2012). This GI network is given graphic representation in a series of planning maps accompanying the County Development Plan that identify key sites of conservation and amenity value linked via a series of multipurpose corridors. A key aspect of planning this GI network has been the use of spatial data analysis in identifying opportunities for enhanced connectivity. As specified in the County Development Plan,

In practical terms, green infrastructure planning means the development of map-based strategies. These strategies map existing green infrastructure resources, assess future needs and indicate where management measures are needed and where new green infrastructure is to be provided in the future. Strategies are evidence-based and generally use Geographic Information Systems (GIS) to collate, map and analyse information. This map-based approach...allows a focus on maximising benefits in the creation of a connected and multi-functional green infrastructure network. (FCC, 2010, p.92)

In this way, FCC employs spatial data analysis to formulate multifunctional map based strategies to improve connectivity. In keeping with the core principle that GI should be conceived as ‘fundamental infrastructure’, the GI networks devised in this way are used to structure spatial planning activity. Informing such strategies is ‘robust scientific knowledge gained from a number of fields including landscape ecology, land use planning theory and practice, and landscape psychology’ (Roe and Mell, 2013, p.653). Using such evidence, efforts are made to produce comprehensive maps of GI assets from which to formulate site-specific initiatives that consolidate the broader GI network. However, Kambites and Owen (2006, p.488) advise that if such cartographic exercises are ‘not set within an effective planning process, the mapping of green infrastructure, albeit a vital component of the process, remains little more than a technical exercise’. Accordingly, mapping GI assets is a means to an end rather than an end in itself. In this sense, maps form tools which aid rather than replace critical engagement with a GI planning approach. Engaging with this approach ultimately requires promoting synergistic social-ecological integration by focusing on how the multifunctional potential of GI networks can be sensitively realised.

4.5 Multifunctionality

FCC foregrounds multifunctional GI planning as crucial to advancing a more holistic social-ecological approach to planning. The prominence given this multifunctional perspective is illustrated by the central ‘aim’ of the council’s GI approach outlined in the development plan:

Create an integrated and coherent green infrastructure for the County which will protect and enhance biodiversity, provide for accessible parks and open space, maintain and enhance landscape character including historic landscape character, protect and enhance architectural and archaeological heritage and provide for sustainable water management by requiring the retention of substantial networks of green space in urban, urban fringe and adjacent countryside areas to serve the needs of communities now and in the future including the need to adapt to climate change. (FCC, 2010, p.89)

Hence, in its focus on connectivity and multifunctionality, the GI approach advocated by FCC reverses traditional planning practices wherein attention is directed at the provision of single functions (e.g. conservation, recreation) in specific locations with little interest shown to spatial and institutional integration. The next section briefly illustrates how this social-ecological perspective in planning policy has been carried forward into more detailed design guidance in an effort to maximise resilience

to a multiplicity of interacting stressors. This illustration is furnished by way of an examination of two local area plans produced within the GI policy framework set by the FCC County Development.

4.6 Stapolin-Baldoye & Portmarnock South Local Area Plans

These two pioneering local area plans (LAPs) were adopted by Fingal City Council in May and July 2013 respectively (FCC, 2013a) (FCC, 2013b). The LAP lands are contiguously located and interrelated (see Figure 1). Both plans employ a GI approach to holistically frame and integrate policy initiatives concerning landscape, biodiversity, sustainable urban drainage, archaeology and built heritage, as well as open space and recreation. The GI approach is central to this.



Figure 1
Stapolin-Baldoye & Portmarnock South LAP lands

4.6.1 Collaborative Approach

In reflecting on the production of these plans, those involved in overseeing policy formulation stress the role of the GI concept in focusing a diversity of practice backgrounds on potential synergies. In this way GI helped stimulate collaborative engagement between professionals, and between the council and other agencies. As noted one planner involved in the plan production process,

Whether that is with your other Departments, or whether it was the other Agencies, it's all about collaboration. (Interviewee A4)

This collaborative approach is reflected in the way the plans seek a multifunctional perspective on spatial planning (see below), wherein each parcel of land is seen to offer the potential to serve a combination of functions, such as biodiversity conservation and flood risk management or recreation and drainage (see Figure 2). Moreover, a collaborative approach to plan formulation extended beyond FCC as the council sought synergies with contiguous lands in the Congriffin-Belmayne LAP produced under the auspices of the adjacent Dublin City Council (see Figure 1). Consequently, FCC and DCC entered into a series of meetings with each other and local communities in seeking to advance seamless physical connections between the LAP lands. This was a lengthy learning process which council staff believe greatly enhanced a holistic perspective on social-ecological integration between the LAP lands and the broader urban periphery. It also helped foster new and positive working relationships between staff in the different councils, thereby aiding future collaborative efforts (Interviewee A8).

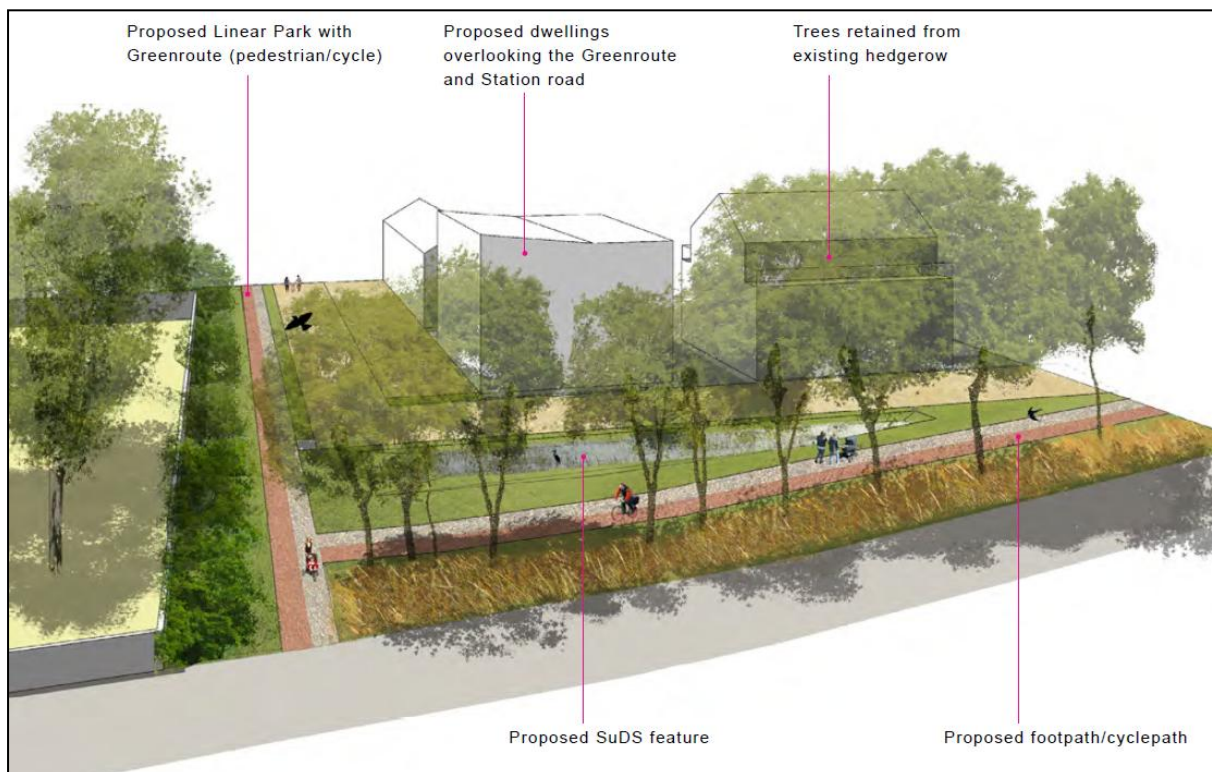


Figure 2
Enhancing Social-Ecological Resilience via a Collaborative Approach to Land Use Integration

4.6.2 GI as Fundamental Infrastructure

In formulating these plans, FCC viewed ecological assets as fundamental to enhancing the social-ecological resilience of the plan areas. As noted by one of the planners involved in formulating the plans,

We started with drainage and SuDS and our hedgerows and the features which we felt were important to keep. And we tried to suggest a layout, not a detailed layout, but basically the way the site could be broken up, based on that. So, in that sense, GI was massive to those because it created the layout and the design principles for the development. (Interviewee A1)

Here, this planner conveys a process of ‘sieve mapping’ wherein the features of a site considered essential to conservation and/or development objectives are first identified, assessed and graphically illustrated. In noting the importance of SUDS and hedgerows, GI assets are identified as fundamental infrastructure in the analysis of the site. The functions these assets perform in facilitating drainage management and ecological connectivity thereby shaped the plan’s policy provisions by informing the production of guidance on the location, quantum and design of other land uses (see Figure 3).

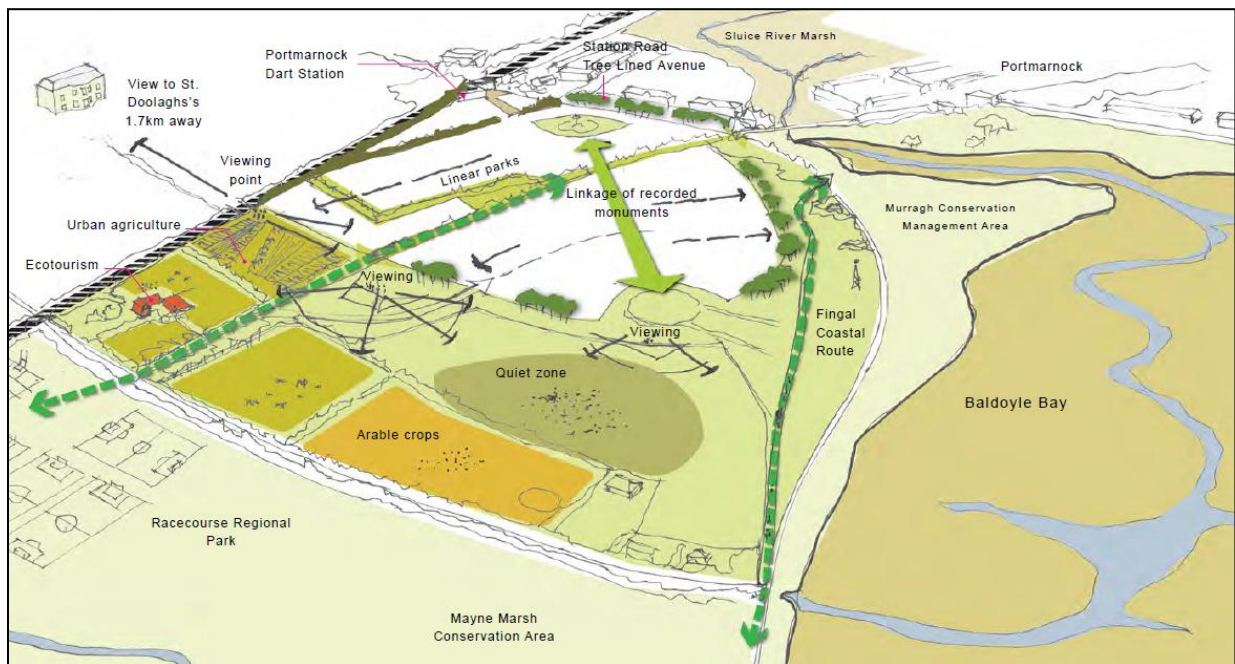


Figure 3

Drainage and Ecological Concerns Informed Land Use in the Portmarnock South LAP

4.6.3 Connectivity

A desire to promote connectivity both within the plan lands and with contiguous land uses is given prominence in the plans (see Figure 1). This is reflected in the ‘Overarching Green Infrastructure Strategy’ for the Baldoyle-Stapolin Local Area Plan which states,

This LAP seeks to create a green infrastructure network of high quality amenity and other green spaces that permeate through the plan lands while

incorporating and protecting the natural heritage and biodiversity value of the lands. (FCC, 2013a, p.18)

Illustrated in this strategic objective is a desire to integrate both the biological focus of ecological networks with the social concerns of greenways to deliver multifunctional connectivity.

4.6.4 Multifunctionality

Through a detailed and iterative environmental assessment process, both local areas plans negotiate the development constraints posed by various conservation designations (SPA, SAC, Shellfish Waters) in a manner that sensitively accommodates a range of stressors generated by urban expansion. In reflecting on this, the same planner recalled that,

We were acutely aware of the sensitivities of the site, we were acutely aware that we were about to put in potentially large populations...and there was the migratory [birds], the geese in particular and various other birds. There was also some, particularly in the Portmarnock site, some really good hedgerows. There was an open ditch...And we always felt that we had to put in some active space...so we needed to see how we could deal with that. (Interviewee A1)

In responding to the local environmental conditions and potential stresses posed by urban expansion, the LAPs seek to promote social-ecological resilience through integrating all new residential areas with parkland, sustainable urban drainage schemes, non-motorised transport routes and spaces for ‘urban farming’ that are specifically designed to assist community development (see Figure 4).

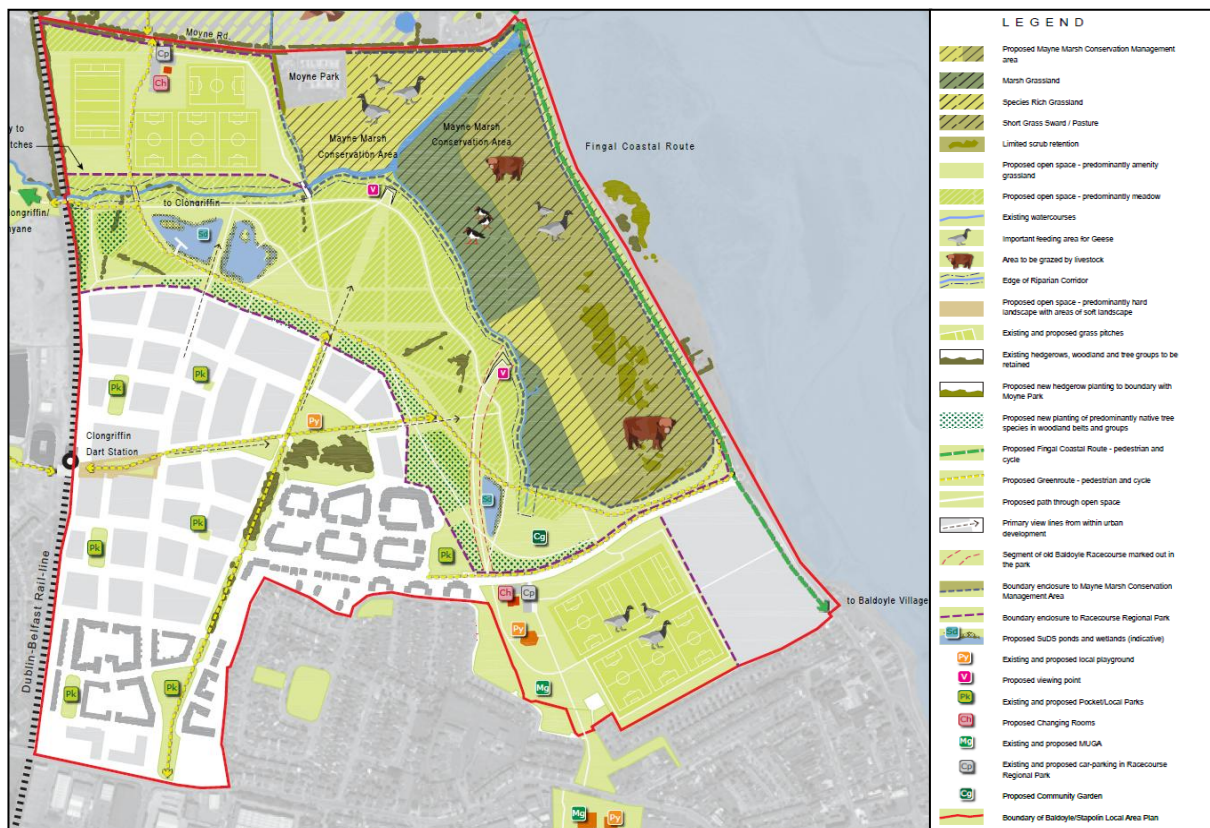


Figure 4
Integration & Multifunctionality in the Stapolin-Baldoyle LAP

A key feature of these plans is thus how they work synergistically in facilitating high quality urban extensions to the Baldoye and Portmarnock urban areas while concurrently protecting the ecological integrity of contiguous EU designated sites. In comparison with conventionally produced LAPs in Ireland, these plans are atypically detailed in the provision of design guidance. It was felt that this was necessary to ensure the proper implementation of the relatively novel GI concept being advocated (Interviewee A6). Consequently, the plans detail mowing regimes, direction on how SuDS should be incorporated into the design of the public realm, and guidance on public lighting so as not cause undue interference to nocturnal animals.

5 Conclusion

This brief review of FCC's efforts to advance a GI planning illustrates how this approach may be seen to give form to social-ecological thinking in planning practice through furnishing an 'organizational strategy that provides a framework for planning conservation and development' (Benedict and McMahon, 2006, p.15). However, such a GI approach moves planning beyond a simple recalibration of contemporary modes of thinking and doing. Rather, it involves a 'transformation' in the ways spatial planning systems are structured and how practitioners conceive the world in which they act in and upon. To embrace these challenges we argue for a deepening of social-ecological systems thinking in spatial planning theory and practice. This involves a re-scoping of spatial planning practice to place ecology and environmental concern as central to planning practice. Such a turn also necessitates devising more effective procedures to ensure more ecologically sound outcomes in the planning process, which may require an institutional culture change and an expanding of core competencies of professional planners. In this regard, GI as fundamental 'infrastructure' has the potential to provide a powerful metaphor for new experimental approaches for promoting social-ecological resilience thinking in planning. Put differently, it offers the possibility to place 'green' infrastructure in a similar position to traditional 'grey' infrastructure in terms of requiring investment and provides a positive, proactive narrative rather than traditional 'preserve and protect' conservation approaches.

With a focus on improving the multifunctional potential of connected local and landscape scale environmental assets, such a GI approach supplies 'the "umbrella" for disciplines to unite' (Wright, 2011, p.1011) and consequently promotes 'increased dialogue between planners, developers, and policy-makers' (Mell, 2010, p.241). In accord with the holism of social-ecological thinking, a GI approach focuses on positive synergies. It facilitates working on numerous schemes at various scales that reinforce each other's spatial and functional attributes in a variety of ways. Establishing a GI framework for connecting these initiatives provides the means through which such endeavours generate long term positive synergies that are mutually beneficial to both society and the environment. In doing so, it is contended that the GI approach offers an effective means to operationalise the social-ecological thinking in spatial planning in a flexible manner that promotes adaptive response to predicted and unforeseen stressors, thereby facilitating social-ecological resilience.

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ⁱⁱ Interviewees A2 and A8