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THE CASE FOR MAINSTREAMING NATURE-BASED SOLUTIONS INTO INTEGRATED CATCHMENT MANAGEMENT IN IRELAND

Marcus J. Collier and Mary Bourke

ABSTRACT

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The intensification of European policies, agreements and regulations for climate action, water resources, energy, agriculture and forestry, and biodiversity is pressurising governments to adopt a wider portfolio of actionable solutions that are more financially and socially sustainable as well as scalable. Traditional engineering solutions, such as grey infrastructure, are the standard approach to the management of waterways, particularly when it comes to water purification and flood prevention or abatement. However, grey infrastructure depreciates over time, necessitating costly and technology dependant interventions on a continual basis. Green infrastructure, on the other hand, often appreciates over time and can provide multiple co-benefits in the longer term; this is the nature-based solution approach. This paper outlines the potential of nature-based solutions and integrated catchment management. It describes how current integrated catchment policy and programmes would benefit from this new approach and posits that nature-based solutions are a complimentary technology that would have multiple co-benefits in the Irish landscape.

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INTRODUCTION

Many planners and policymakers are increasingly drawing from an ecosystem approach to establish multifunctional green infrastructure for mitigating the negative and socially undesirable impacts of climate change, and this often is focussed in urban settings (e.g. Derkzen *et al.* 2017; Gill *et al.* 2007; Shih 2016; Sussams *et al.* 2015; Zolch *et al.* 2016). Green infrastructure has been identified as a key engineering as well as societal solution with respect to riparian areas and flood alleviation (Alves *et al.* 2019; EEA 2017; Li *et al.* 2020; Raška *et al.* 2019; Zellner *et al.* 2016). Many definitions and conceptualisations of green infrastructure exist, but the most useful in the context of this paper is a 'strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings.' (EU 2013, p. 8). This infers that green infrastructure has a high potential for implementing many sustainable land-use policies through the scaling out of 'nature-based solutions'. These solutions, which are inspired by nature and natural processes, are designed to complement engineered/technical solutions to mitigate disaster risk and the effects of climate-related flooding whilst augmenting social and cultural values (EEA 2015, 2017). 'Nature-based solutions' is

a new term in the lexicon of planners, managers and policymakers, the definition of which is still contested (Eggermont *et al.* 2015; Faivre *et al.* 2017; Frantzeskaki *et al.* 2019). Bridgewater (2018), for example, contends that 'nature' is largely an undefined entity in the nature-based solution concept while Frantzeskaki *et al.* (2019) argue that it ought to be integrated with other solutions such as technology-based or culture-based solutions, although currently there are few working examples of this.

In the Irish planning and management policy, 'nature-based solutions' is as yet an unfamiliar term, although some local authorities are beginning to explore the implications of the idea (e.g. DCC 2019; SDCC 2018). However, much of the nature-based solution debate is concerned with the greening of cities (Connop *et al.* 2016) as is evidenced by the plethora of nature-based solution EC Horizon 2020 projects that are in progress at this time. The projects are producing a variety of outputs such as technical guidelines for designers and managers (e.g. Eisenberg and Polcher 2019) or compendia of nature-based solution examples for planners and city-makers (such as UNEP 2019). European rural funding for enhanced biodiversity is being deployed in EIP and LIFE projects (e.g. the Bride project and Duhal-low LIFE project). These place the stakeholders and communities in leadership positions to effect grass-roots change and work closely with all participants

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to develop solutions. However, the purpose of this paper is to examine the impediments to popular acceptance of the nature-based solution approach outside cities, especially on a topic where Ireland is perceived to have a high climate risk: flooding.

NATURE-BASED SOLUTIONS

Nature-based solutions are: ‘actions which are inspired by, supported by or copied from nature’ which result in ‘multiple co-benefits for health, the economy, society and the environment, and thus they can represent more efficient and cost-effective solutions than more traditional approaches’ (EC 2015). Eggermont *et al.* (2015) has proposed three types of nature-based solutions:

- Type 1: those that follow the IUCN approach and see them as mechanisms for managing and restoring protected ecosystems;
- Type 2: those that fit the broad theme of the agri-environment for augmenting the sustainability and multifunctionality of managed landscapes;
- Type 3: those that follow the EC definition and seek to (re)create ecosystems in heavily impacted areas, such as cities.

A unified and agreed upon definition still eludes practitioners and researchers, but it is clear that a nature-based solution is not merely green infrastructure or the result of valuing newly recognised ecosystem services. Ideally, a nature-based solution is specifically designed, or preferably co-designed, to address multiple, interconnected problems (ecological, environmental, social, etc.), in a manner that has multiple co-benefits (also ecological, environmental and social, etc.). Thus, it follows that the solution in question ought to be competitive with non-nature-based, or technology-based, solutions that are developed to address the same problem.

Examples of nature-based solution implementation in Ireland are few, and as such Irish policymakers could greatly benefit from the compilation of a compendium of nature-based solutions, especially with respect to their efficacy in addressing, for example, the Sustainable Development Goals (SDGs). However, some nature-based solutions do exist and mainly relate to urban water management (for examples of some Irish nature-based approaches, see LGMA Research 2020). A noteworthy example can be seen in the recent extension of the LUAS tram system in Dublin, which saw the adoption of a nature-based approach by embedding street trees in extensive pits to mitigate the effect of storm-water along the line, a successful nature-based solution strategy that is being adopted in other city schemes such as the Liberties Greening Strategy (DCC 2015). While there are few physical examples, there are even less where the effectiveness or impact

of the nature-based solution has been measured over a longer term. In other cities, such as London, a nature-based solution approach has been adopted over a longer timeframe, and a strong evidence base has been built on the co-benefits of such an approach (Connop *et al.* 2016).

In the riparian zone, nature-based solutions have the potential for flood relief, building flood resilience, mitigating point source or diffuse pollution to the environment, intercepting silt and/or acid runoff from forestry and peatland management activities, and so on (Hartmann *et al.* 2019; Liquete *et al.* 2016). The idea is not necessarily new; nature-based solutions that have been in operation in the landscape for some time include those in place for the management and control of nutrient runoff, such as the use of

- vegetated buffer zones in riparian areas for point-source and diffuse nutrient runoff (especially N and P) in agri-environmental contexts (Aguir Jr *et al.* 2015; Hille *et al.* 2018; Janssen *et al.* 2018; Stutter *et al.* 2019; Vought *et al.* 1995),
- constructed wetlands for sewage and runoff management (Mitsch 1992; Shutes 2001),
- catch crops to reduce nutrient leaching (Constantin *et al.* 2010),
- broadleaved woodlands to buffer the effects of episodic acid runoff in conifer afforested areas and acid-sensitive zones (Collier and Farrell 2007; Ryan *et al.* 2012),
- *Salix* spp. (and other biomass plantations) to treat excess nutrient (Bialowiec *et al.* 2012) and sewage (Börjesson and Berndes 2006), as wind-breaks (Foerid *et al.* 2002), for phytoremediation (e.g. Xue *et al.* 2015), water purification (Perttu and Kowalik, 1997), and so on.

However, in these examples the ‘nature’ that is being utilised may not necessarily be biodiverse nature, as the species selected to achieve maximum efficacy and impact may not be, for example, indigenous or diverse. So, while this might qualify to be termed as nature-based solutions there is little regard for the social, ecological, economic and behavioural co-benefits that the current nature-based solution framework entails.

DISCUSSION

Although nature-based solutions have only recently entered the purview of mainstream policymakers, there is now a compelling business case (EIB 2018), an emerging health and well-being cases (Han and Hyun 2018; van den Bosch and Ode Sang 2017a, b; Vujcic *et al.* 2017) and a strong biodiversity case (Nash *et al.* 2019; Seddon *et al.* 2019; The Nature Conservancy 2018) for incorporating nature-based solutions into planning and design of urban and

rural landscapes. When it comes to river catchment restoration and management one may assume that a nature-based solution approach would result in multiple benefits over a longer term. However, those responsible for river catchment management in Ireland may feel that they are applying nature-based solutions in practice. In this context, three approaches to river catchment management can be identified. These approaches, whilst seeming to be nature-based in principal, are not necessarily in alignment with the nature-based solution ideals in practice.

The first approach best describes the principal management practice in Ireland and which falls under the legal jurisdiction of the Office of Public Works (OPW) (Gutman 2019). In river catchment management, the OPW carries out drainage maintenance and manage larger infrastructural flood relief schemes (OPW 2019), especially dredging in order to permit faster flow. Their approach to riparian management can be described as ‘hard’ engineering solutions, such as mechanised channel clearance and construction of defensive embankments along rivers (Brew and Gilligan 2019). There is an ambition to integrate what is perceived as essential works with ‘nature’, and these guidelines provide management prescriptions for specific protected species. However, the OPW is confined in its actions by the immediate political and societal demand for protection of property. Such management also needs to be aligned with the legal requirements of, for example, the Water Framework Directive (WFD), the Habitats Directive and the Birds Directive (EEC 1979, 1991, 1992).

For flood risk management, the OPW prepares flood plans as a central part of the government policy on flood risk management. This is intended to meet Ireland’s obligations under the 2007 EU ‘Floods’ Directive (FD). To this end there has been a recent change in OPW’s direction. First, it is committed to work with the Environment Protection Agency, local authorities and other agencies during the project-level assessments of physical works and more broadly at a catchment-level to identify any natural water retention measures (NWRM) that can have benefits for the WFD, flood risk management and biodiversity objectives. Second, it has identified that local level of activity may provide a suitable point of coordination for local flood risk management activities such as flood protection works being implemented under the Minor Works Scheme or the promotion of natural water retention measures. Third, it has mandated that consideration be given to ensure that the planned works provide benefits with regards to other objectives in the delivery of the EIP (e.g., water quality, biodiversity) where reasonably possible and viable these may include the use of NWRM, removing barriers to fish migration

or the creation of habitat features. Although at present, there is no transparent mechanism for ensuring the delivery of the ‘alternatives’ to harder engineering approaches or indeed the definition of ‘viable’ in the context of flood risk. Finally, the OPW has set up a Natural Water Retention Measures Working Group to advise the WFD National Technical Implementation Group (NTIG) on proposals for including NWRM as part of a broader suite of mitigation measures that could contribute to the achievement of environmental objectives set out in the second RBMP. While this is positive, there is no doubt that we await the implementation of many aspirations. This, in combination with a general lack of awareness of the potential of nature-based solutions, can make decision-making, in the absence of a nature-based solution decision support framework in Ireland, difficult and may result in the imposition of grey infrastructure into the riparian zone to the medium-term detriment of ecological processes. Thus, while the nature-based solution approach may be ideal, in practice it is necessary to draw on existing, validated engineering standards and in many cases this results in blunt, hard engineered solutions.

The second approach is the desire for taking a ‘soft’ engineering solution approach. This is also in the purvey of the OPW (2019), but considering their legal imperative it is often the case that ecological engineering companies and contractors, often independent of the OPW, are in a better position to work to a more local context. Resulting actions are variable, but generally—and comparison with the deepening of riverbeds through dredging and other hard processes—this second approach works to stabilise revetments and banks along rivers and streams using a combination of hard (e.g. gabions) and soft (e.g. *Salix* spp. establishment) solutions. Thus, this approach seeks to draw from some nature-based principals in order to restore riverbanks (e.g. Barker 1995), though there can be less concentration on a diversity of species in preference for species that will do a good engineering job. In the initial phase of this approach there can be a considerable amount of stream adjustment and mechanical manipulation, as with the hard engineering approach of the OPW, but in the concluding part of the process, when ecological interventions are being put in place, the morphology of the riparian zone appears to be more ‘natural’. This process may appear to follow a nature-based solution framework, but where both approaches fall short is in the derivation of multiple social and economic co-benefits, one of the central aspirations of the nature-based solution approach. One of the main barriers to adopting such an approach is whether nature-based solutions can ‘compete’ effectively with non-nature-based solutions. This barrier derives from equating effective riparian restoration to a reduction in downstream flooding

(i.e. protection of property), rather than a more holistic assessment on whether the resulting riparian system is self-regulating, requires no further engineered interventions and yields increases in ecosystem service values over a longer timeframe. This is an area that has not yet been quantified, and the above-mentioned Horizon 2020 projects are seeking to establish this case.

A third approach addresses longer term riparian management and ecosystem service values from a grounded angle and relies at its core on a collaborative, community driven and generally more inclusive consultation process. This approach is typified by a complex co-creation process with local communities and a supporting fund (such as the Community Water Development Fund through the Local Authority Waters Programme (DoHPLG 2018) <http://watersandcommunities.ie/>). While mostly focussing on education and empowerment, this approach also supports local wetland research and ecological restoration beyond the catchment. It is targeted at a longer-term cost-effective paradigm because it is coupled with education and awareness programmes and habitat creation, so it appears to embrace a nature-based solution framework. However, where this third approach is not wholly a nature-based solution approach is in the monitoring and evaluation of a wide range of indicators of efficacy. Such indicators include water quality enhancement, climate resilience, increasing biodiversity, participatory governance, community health and well-being, social cohesion and innovation. While the Horizon 2020 projects mentioned earlier—and the current focus within the European Green Deal—all seek to develop monitoring and evaluation indicators, there is no mechanism in Ireland for the measurement of the co-benefits of nature-based solutions (either in river catchment management or in other areas). This is therefore a principal barrier to mainstreaming nature-based solutions in Ireland, though one that could be rectified with little additional cost.

That said, the component parts do exist. The nature-based solution approach to river catchment management seeks to combine the efficacy and immediacy of the first two engineered approaches with the collaborative and co-created approach of the third. What remains is for this to be embedded with a comprehensive effectiveness monitoring and programme that quantifies the multiple co-benefits of river catchment management, in scale and over time (Addy *et al.* 2016) as the absence of evidence of the efficacy of nature-based solutions for flood mitigation remains a significant obstacle (e.g. Daddon *et al.* 2017). Thus, it is simultaneously aimed at targeted, local-scale interventions of nature-based solutions that combine cumulatively for catchment scale effectiveness. This nature-based approach has not yet become established in the Irish context

(and is still emerging on a global context) though there is strong case for it (Addy *et al.* 2016). This approach has the aspiration of implementing a 'multifunctional form of green infrastructure that can play an important role in catchment-scale flood risk management' (Collentine and Futter 2018, p. 76). There are some local-scale interventions in existence in Ireland, such as blocking drains to rewet degraded peatlands (Farrell and Doyle 2000; 2003; Renou-Wilson *et al.* 2018). Of import is the rise of the River Trusts in Ireland. Although it varies across the country, their mandate ranges for community-level education about riverbank erosion controls to catchment-scale plans for nature-based solutions to flooding hazards (e.g. Bourke *et al.* 2020). In other jurisdictions, local scale interventions such as species rewilding (e.g. the (re)introduction of the beaver) have shown excellent promise in flood management on a catchment scale (Law *et al.* 2017), and while such interventions can engender political and social concern, they offer a tantalising insight into the co-benefits of nature-based solutions for both addressing climate-related issues and biodiversity restoration. It is perhaps an opportunity to establish whether local-scale interventions may be cost-effective as well as socially desirable, something that would assist in addressing the SDGs.

Already mentioned as a barrier is the lack of knowledge by stakeholders. Other jurisdictions have undertaken assessments of barriers in landowners' perceptions (Holstead *et al.* 2017; Waylen *et al.* 2018). A similar assessment in the Irish context is required as the limited data available (Buckley *et al.* 2016; Buckley *et al.* 2012; Clarke *et al.* 2016) suggest that the socio-economic aspect may be a significant barrier to implementation.

CONCLUSIONS

The approaches discussed here appreciate the role that 'nature' can play in the management and control of flooding, though each conceptualises the values of nature differently. The 'hard' engineering approach can regard nature as peripheral to the more urgent societal expectation of alleviating flooding. The 'soft' engineering approach views nature as supplemental element of the overall solution and as such the species selected are those who have the best short-term impact (such as fast-growing *Salix* spp.) over a longer-term biodiversity focus. In both of these approaches nature may be viewed as peripheral. The alternative approach views nature as having multiple benefits (co-benefits) and these values include educational, research and awareness values, but is very localised. All three approaches can be classed as nature-based in some degree of intensity, though the nature in question is not necessarily

indigenous. In all approaches, wider societal, cultural and health co-benefits are usually not accounted for, indicators of effectiveness are limited in scope, and monitoring is at best *ad hoc*. The nature-based solution approach sees these as integral to the process from the outset.

It is clear that Ireland must make diverse, systemic changes in order to mitigate flooding episodes and that there is a compelling case for using a nature-based solution approach to both tackle immediate concerns but also to build longer term resilience and biodiversity into management practices. It is also clear that more effort needs to be made to improve knowledge, experience and capacity in adapting existing catchment management policies, regulations and activities to embed nature-based solutions for climate adaptation. Thus, there needs to be better coordination on flood management planning, especially in the longer term and with co-benefits at the forefront of planning.

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