Expanding the horizons of integrated flood risk management: A critical analysis from an Irish Perspective.

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Abstract

Millions of people around the world are exposed to some degree of flood hazard, with the level and magnitude of exposure increasing with climate change. Arising from the scale of recent flood experiences across Europe, the European Union adopted the Floods Directive in 2007 to bring about greater assessment and management of flood risk across the EU. In addition to introducing a timescale for member states to prepare flood risk management plans, this directive encapsulates the paradigm shift that involves a more holistic approach to flood management by requiring consideration of both structural and non-structural measures. This paper explores the evolution of flood management in Ireland, the intellectual gaps remaining to fully achieve an integrated flood risk management system, and tentative suggestions about a way forward.

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1.0 Introduction

Over recent decades the profile of extreme flood events has been increasing, with imagery of large numbers of people and property - whether in cities, in towns, or in rural areas - suffering the impact of flooding, being increasingly witnessed. In the period between 1998 and 2004 there were 100 major floods experienced across Europe, including on the Danube and Elbe rivers, variously resulting in 700 fatalities, insured financial losses of €25billion, and displacing over half a million people (SEC 2006a). More recently about €12billion in damages was experienced in 2013 alone across just nine central and eastern European states (Jongman et al. 2014). Rising public concern about flooding is grounded in these experiences, but also added to by the strong scientific consensus that climate change will exacerbate these types of events in the future (IPCC 2013). Indeed, there is evidence emerging that the frequency and intensity of flood events are already being influenced by climate change (Pall et al. 2011; Min et al. 2011).

The traditional management response to flooding has been to construct various types of (defensive) infrastructure to reduce the likelihood of flooding. However, there is a longstanding change in the manner in which the management of flood hazards and disasters are approached with UNDRO reasoning in 1991 that a paradigm of protection was no longer appropriate, and that a more holistic perspective was required; moreover, a paradigm shift from one focused upon protection to one of risk management is more appropriate (Schinze 2006). Here, where risk can be considered to be a combination of likelihood and consequences (Johnson and Priest 2008), risk-based decision-making, involves adopting a 'whole systems' approach to consider all potential interventions that may alter flood risk (Sayers et al. 2002). Given the adoption of this new approach, there is now widespread acceptance that risk cannot be managed through structural solutions alone (White 2008; Lennon et al. 2014) with incorporation of non-structural measures now central to achieving flood resilience (Wolsink 2010; Werritty 2006). Additionally, the application of a risk-based approach allows combinations of structural and non-structural measures to be assessed and compared so investment can be prioritised to achieve the largest reduction in flood risk overall (Sayers et al. 2002).

Within the context of this paradigm shift, the development of integrated risk management plans with a spatial dimension (Hartmann and Spit, 2015) represents an emerging research agenda within flood management and related urban planning literatures. The overall aim of this paper is to explore some of the complexities of its application, and with reference to an Irish case, consider whether integrated flood risk management can further its ambitions. The paper proceeds with an outline of Europe's policy response to flooding, before the Irish experience is detailed. Building on emergent research areas, a gap the practical implementation of integrated flood risk management is discussed, before the potential for greater collaborative opportunities is discussed.

2.0 The Floods Directive

Notwithstanding the various flood experiences across European states, including transboundary and pan-European scale events, by the mid-2000s there was no explicit flood policy co-ordination at a European level. Even with the adoption of the Water Framework Directive (WFD) by the European Union in 2000 (see Howe and White 2002), consideration of current or future flood risk was not one of the main objectives of the WFD, rather its primary focus is on the achievement of good quality for all water bodies. Nevertheless, such pan-European flooding episodes, and also rising levels of vulnerability (e.g. numbers of people exposed and assets located in floodprone areas), provided motivation to the European Commission to identify that 'concerted action at Community level would bring considerable added value and improve the overall level of flood protection' (EC 2006; para 120). The political outcome of this proposal emerged as the EU Floods Directive with its primary objective being the establishment of flood-risk management plans at the river-basin scale, although

being applicable to all sources of flooding[1]. However, rather than contemplating the prospect that policymakers preparing such flood risk management plans might be predisposed to prioritising structural measures, the Directive enshrines the emergent paradigm shift and requires a holistic approach that integrates combinations of 'hard' and 'soft' (non-structural) measures to deliver, *inter alia*, prevention, protection, preparedness, emergency response, and recovery.

More specifically, each member state is required to implement the Floods Directive in a three-stage process over a specified timescale (see table 1). However, the manner in which member states implement and achieves the objectives of the Directive is, in many respects, left to each member state to determine. The requirements of the Directive include:

Firstly, undertaking a preliminary flood risk assessment, using historic data and predictive analysis, to identify areas of significant risk; and the potential adverse consequences of future floods.

Secondly, for areas at significant risk, flood hazard and flood risk maps must be produced. These maps must consider extreme, medium probability, and high probability event scenarios, with hazard maps portraying the flood extent, water depth and water velocity, and risk maps portraying the potential adverse consequences i.e. people at risk, economic activity and the environmental damage potential.

Finally, flood risk management plans (FRMPs) must be drawn up for these flood scenario zones. These plans must take into account assessed flood extent, flow paths, and flood storage potential, impacts on natural habitats, and the potential for their restoration, the role of land use practices, option of controlled flooding of certain areas during flood events, and role of water-dependent infrastructures. Furthermore, these plans are required to consider the characteristics of each river basin and specifically address measures to: prevent flood damage by avoiding development on floodplains or adapting development to flood risks (i.e. prevention); reduce likelihood of flooding such as floodplain restoration (i.e. protection); undertake awareness raising and communicate roles and responsibilities in an emergency (preparedness); and also consider the integration of flood forecasts and early warning systems (SEC 2006b; CEC 2007). As part of the plan development process there must be participation of the public, and also consideration of relevant costs and benefits, with the plan ultimately setting out a prioritised set of measures to achieve the objectives of flood risk management.

Table 1. Timetable for Floods Directive Implementation

Nov. 2007	Directive enters force
Nov. 2009	Transposition into provisions of national laws
Nov. 2010	Administrative arrangements to be in place
Dec. 2011	Preliminary flood risk assessment
Dec. 2012	Public participation process initiated
Dec 2013	Flood hazard and flood risk maps
Dec. 2015	Flood risk management plans

Source: CEC (2007)

3.0 Implementing the Floods Directive: The Case of Ireland

Ireland is currently progressing the development of its respective FRMPs relating to seven river basins districts; and this includes three international (transboundary) river basin districts. However

[1] The Directive refers to river floods, flash floods, urban floods and floods from the sea in coastal areas

prior to discussing the Directives implementation, it is necessary to understand the evolution of flood management in Ireland.

3.1 Evolution of flood management in Ireland

Whilst the majority of present day motivations concerning costly and impactful flooding in Ireland are urban-related, the origins of flood management initiatives in Ireland had different purposes. Since at least the mid-19th century, various pieces of drainage legislation[2] were introduced to provide for drainage of land to facilitate its improvement for agriculture and also to provide local employment on programmes of public works (Lohan 1994). As a result several hundred minor improvement schemes (Drainage Districts) were carried out during the 19th century on localised areas of river catchments, with legislation updated periodically.

However, following the report of the Brown Commission (1938-40), the first substantive flood-related act[3] of the modern Irish state was enacted in 1945. This provided for Arterial Drainage Schemes to be carried out across total river catchments - differing from the earlier district-based schemes - and thereafter maintained by the Commissioners of Public Works. Consequently a programme of arterial drainage works was initiated, being primarily concerned with the protection of agricultural land. As a result, by 2002, forty arterial drainage schemes benefiting 650,000 acres of hitherto poorly-drained lands had been carried out under the 1945 Act and maintained by the Commissioners for Public Works, with consequential benefits for some urban communities falling within the river basin areas (Goodbody, 2008).

Reforms to European agricultural policy reduced pressure to further extend access to, and improve the productivity of, agricultural lands. Flood-related concerns became increasingly focused on urban floodprone areas owing to a series of urban flood events in the 1980s and 1990s, and combined with Ireland's increasing levels of urbanisation, this led to calls for a shift in policy emphasis to deal with serious urban and localised flooding problems. Legislation introduced in 1995[4] shifted emphasis from such river-basin wide drainage schemes to the protection of urban areas from flooding. Under these flood relief schemes, prioritisation was given to urban floodprone areas where both the density of flood-affected properties, and the potential damage avoided are greatest.

In parallel, existing planning and development legislation[5], which up to then placed emphasis on drainage (i.e. regulating and controlling the provision of, *inter alia,* sewers and drains), was updated in 2000. This new legislation[6] was the first time that Irish planning law gave the planning system explicit powers to provide for restricting or controlling *new* development in areas at risk of flooding.

Nevertheless, a series of extreme flood events in Ireland in the early 2000s (e.g. River Slaney 2000, East Coast tidal flooding 2002, Tolka River flooding 2002), combined with a series of extreme flood events across UK (in 1998 and 2000) and in Central Europe (2002) prompted a further comprehensive policy review. Similar to the policy models endorsed in the UK (*Making Space for Water*) and Netherlands (*Room for the River*), the main finding of the Flood Policy Review Group was that *"the focus in dealing with floods should be on management of the risk and living with floods rather than on defensive action against the hazard,"* (OPW, 2004: 84). The review group endorsed a return to river-basin area analysis, rather than flood analysis being limited to urban areas, with

[2] Drainage and Navigation (Ireland) Acts 1842-1857; Drainage and Improvement of Lands (Ireland) Acts 1863-1892.
[3] Arterial Drainage Act 1945
[4] Arterial Drainage Amendment Act 1995
[5] Local Government (Planning and Development) Act 1963
[6] Planning and Development Act 2000

greater co-ordination of development, management and conservation actions within river basin management plans. The review highlighted the need for such river basin management plans to take a risk-based approach and also the need for both structural and non-structural measures. However, it maintained that the avoidance of flooding should remain urban-focused and that schemes should be proactively prioritised rather than being initiated in response to flood events. Finally, it put emphasis on people taking their own precautions, and identified the necessity to provide information and flood warning systems to facilitate greater preparedness and emergency response.

There are two other important national policy documents that are now incorporated into contemporary Irish flood management. National planning guidelines, *The Planning System and Flood Risk Management*, were adopted in 2009 and planning legislation was updated in 2010[7] to strengthen the application of the guidelines. These guidelines provide for: the avoidance of development in areas at most risk of flooding; adoption of a sequential locational approach when assessing the suitability of locations for new development; and compliance with the Flood Risk Management FRMPs produced by the CFRAM programme. The other document is the emergency planning framework, which outlines the approach for local authorities and relevant emergency responders to take when managing, coordinating or responding to a flood event. Moreover this framework, subject to periodic review[8] and update, forms the basis of modern emergency planning for local, regional and/or national emergency situations.

3.2 Progressing Implementation of the Floods Directive

The transposition of the Flood Directive into Irish law[9] specified the Office of Public Works (OPW) as the competent authority for flood risk management in Ireland, both as the main source of policy co-ordination and also as the operator of flood defences. In order to implement the Floods Directive, the OPW initiated a Catchment Flood Risk Assessment and Management (CFRAM) programme in 2011, and the plans that emerge will respond both to the changes envisaged in the Irish flood policy review (see OPW 2004) and also the requirements of the Directive. In line with the Directive, the CFRAM Programme comprises of the three-stage process and explicitly incorporates three main consultative elements. In summary, each CFRAM study provide for number of key stages (see OPW 2015), including:

- Data Collection & Surveying
- Flood Risk Review
- Hydrology Analysis
- Detailed Hydraulic Modelling
- Flooding Mapping
- Development of Flood Risk Management options
- Strategic Environmental Assessment & Appropriate Assessment
- Flood Risk Management Plan

To date, the OPW has identified 300 areas of significant flood risk throughout Ireland and is in the final stages of statutory consultation on published flood hazard and risk maps for these areas. The CFRAM programme has also published high level measures for each CFRAM plan, and with Strategic Environmental Assessment also being scoped to further inform each Flood Risk Management Plan.

[7] Planning and Development (Amendment) Act 2010
[8] see JCEHLG (2010) and DoECLG (2010)
[9] S.I. No. 122 of 2010 (European Communities Assessment and Management of Flood Risk Regulations 2010)

3.2.1 *Lee CFRAM Study*

Preceding the rollout of the national CFRAM programme, a pilot phase was undertaken. The most high profile was the Lee CFRAM Study, covering the Lee river catchment and incorporating the city of Cork, the second city of Ireland. Its stated objectives were to:

- assess flood risk, through the identification of flood hazard areas and the associated impacts of flooding;
- identify viable structural and non-structural measures for managing the flood risks for localised high-risk areas and within the catchment; and
- prepare a strategic Flood Risk Management Plan (FRMP) and associated Strategic Environmental Assessment (SEA) that sets out the measures and policies that should be pursued by the Local Authorities and the OPW to achieve the most cost-effective and sustainable management of flood risk within the Lee catchment" (OPW et al. 2014:viii).

Where flood risks were found to be significant, the Lee FRMP has identified a range of potential flood risk management options to manage these risks, including structural options (e.g. flood walls and embankments) and non-structural options (e.g. flood forecasting and development control). Costs and benefits of each measure were also assessed with, for example, the key structural measure for Cork city centre i.e. permanent flood walls (10.5km) and/or embankments (1.9km) to manage both tidal and fluvial risk that affects 2143 buildings (located within the combined flood extent of the estimated 0.5% AEP tidal and 1% AEP fluvial flood event), and having an estimated cost of €144million and with a resultant benefit cost ratio of 1.2. The plan also provides that such works will be progressed on a 'no regrets' basis meaning that adaptability to future flood risk is to be provided through, for example, adequacy of foundation design enabling incremental increase in defence height.

A key non-structural measure cited is the planning and development control measures that were agreed with the Lee CFRAM study for the South Docks area (see Cork City Council 2008). This specific area of the city is planned for major redevelopment, although its ground levels are generally below high tide and vulnerable to flooding. Acknowledging the residual risk of the perimeter protection being breached or overtopped, the plan for this area refers to:

- Raising of internal ground levels;
- Provision of perimeter protection;
- Setting a minimum floor level;
- Provision of flood resilient/resistant building design;
- Restrictions on sensitive development;
- Development of an Emergency Response Plan (with early warning system).

As mentioned already, the key non-structural measures are supported by planning guidelines, and also a major emergency framework. Moreover, all the FRMP measures put forward are underpinned by extensive field-based surveying, data collection and analysis, hydrological modelling, socio-economic analysis, and analysis of costs and benefits (damage avoided). Conceptually, the approach being applied to the South Docks area, being transformed through redevelopment over time so as to reduce the current level of flood risk and accommodate 'safe' development in the future, has parallels with elements of an evolutionary approach to resilience thinking. However, the failure to fully incorporate the socio-ecological components in flood risk management systems (see Cornell and Jackson 2013), i.e. account for human-environment behavioural interactions, in this area (South Docks) and across the Lee FRMP more generally is an important omission. This omission will not be unique to the Lee FRMP nor will it be confined to Irish FRMPs, but rather is more likely to be an

exemplar of standard practice. If the hazard and receiving environment are extensively modelled and analysed, the question arises as to whether people's behaviour and how that behaviour is influenced by the built environment is as important a factor that may influence risk, and worthy of more attention?

4.0 Theoretical considerations for flood risk management

Before proceeding to further consider the question outlined above, it is useful firstly to think about the different conceptualisation of flood risk management - what it aspires to achieve; and how different concepts have contributed differentially towards the conceptualisation of flood management and urban water management over recent years. Such theoretical contributions have emerged from systems theory, resilience theory, urban design, and risk management.

A system may be described as a complex of interacting components in combination, with the relationships between them enabling the identification of a single entity or process (Laszlo and Krippner 1998). Systems theory builds on such an understanding of a system, and, by limiting reductionism to 'reduction to dynamics' as opposed to classical science's 'reduction to components', it provides a holistic framework for analysis of complex issues across nature and society (Laszlo and Krippner 1998). De Bruijn (2004) and Mens et al. (2011) argue that the application of a systems approach can help flood management achieve its goals as the dynamics of the river and its interactions with people and the environment can be better understood. The systems concept systems is widely applied in ecology since Tansley first proposed the concept of the ecosystem (Tansley, 1935), with a characteristic feature of such ecosystems being that they recover from disturbances and the principal characteristics of the system are restored; this characteristic being referred to as resilience (Holling 1973).

This original ecological concept, resilience, is now also widely applied to include the social dimension (Scott 2013), with Adgar (2000, 2003, 2006) advancing social-ecological resilience within the context of climate change. This has been developed further to recognise both institutional and social/individual abilities (Gonzalex-Riancho et al. 2015). However, debate about the application of the concept beyond ecology has tended to focus on the distinction between 'equilibrium' and 'evolutionary' interpretations of resilience (Scott 2013; Davoudi 2012) with the former focussing on the ability of a 'system' to 'bounce back' (Shaw and Maythorne, 2013), whereas the latter emphasises an ongoing evolutionary change process (Scott, 2013). In the context of evolutionary change, resilience is seen as enabling transformation so that disturbance is seen to provide opportunities for re-invention (Lennon et al. 2014), perhaps embracing the opportunity to 'bounce forward' (Shaw and Maythorne, 2013). There has been a lack of critical attention paid to 'resilience' in terms of the types of possibility that it presents to urban flood risk management (Park 2013; Lennon et al. 2014). Park (2013) argues that the application of resilience thinking cannot be reduced to examining the component parts of flood systems but rather is an outcome of an ongoing evaluative and adaptive process that recognises incompleteness of knowledge. The *Foresight Future Flooding* report similarly promotes a system-based perspective (Penning-Rowsell et al. 2013), contending that no single response provides an effective solution to the expected increase in future flood risk, and that a portfolios of flood response measures is required to achieve a more resilient future, with the appropriate balance dependent on future conditions (Evans et al. 2004).

Such a portfolio of measures incorporates a role for planning and urban design, with the accommodation of water through water-sensitive urban design (Rodriguez et al. 2014) and a sense of 'living with flood risk' (Scott 2013) now having an established agenda with such places now being realised on the ground (e.g. HafenCity, Hamburg). Whilst such an approach, that is, providing lower-risk [safe] water-sensitive developments, perhaps through redevelopment opportunities, can take

advantage of various sustainability attributes of urban living (access to public transport, greater education opportunity, variety of services etc.), the extent to which such developments that are located in the managed floodplain is safe development, or rather a 'safe development paradox' is remarked upon by Stevens et al. (2010). However, such an approach can still deliver a net reduction in overall flood risk whereby the product of flood likelihood and potential consequences are lessened through transformative redevelopment.

5.0 Flood risk management systems: further analysis

Returning to the series of questions postulated at the end of *section 3.2.1*, this author argues that a system-based approach to flood risk management requires the impact of all interventions to be assessed upon the system as a whole – the impact of changes on flowpaths, the impact on the built environment, the impact on people and in particular the likely interactions that will emerge, and whether these interactions will lessen or strengthen preferred preparedness behaviours. Furthermore, failing to understand the range of peoples' perceptions of risk, their perceptions of the environment and how that shapes their behaviour may undermine some of a flood risk management systems capabilities to fully deliver an integrated approach to flood risk management.

As a result of urbanisation there seems to be increasing levels of disconnectedness with nature (Restall and Conrad 2015), and this can insulate people from environmental stimuli (Stilgoe 2001). Extending this argument, investment in structural solutions that are intended to reduce risks to known hazards can have perverse outcomes that end up, paradoxically, increasing vulnerabilities by providing a false sense of security (Park 2013). If defences are overwhelmed or suffer failure the likely catastrophic consequences may be exacerbated by a decline in cognition of environmental cues with such sources 'hidden' behind defences or buried in underground culverts. It has been shown in numerous studies that proximity to a hazard influences can risk perception (Zhang et al. 2010), however as Pagneux et al. (2011) showed, about 30 percent of residents living in a floodzone did not perceive themselves to be at flood risk owing to misperception. This can have implications for the implementation of emergency plans or enforcement of evacuation orders whereby a portion of people do not consider themselves to be at risk. Similarly a failure to consider environmental perceptions may inhibit the correct selection or design of preferred evacuation routes (see Vilar et al 2013), failing to achieve necessary integration between emergency planning requirements with land use planning (Saunders et al. 2007).

6.0 So what can be done?

Many scholars are increasingly calling for a more collaborative approach to the design and implementation of flood risk management plans (Challies et al. 2015). Such an approach, bringing together divergent stakeholders could help people to:

- unpick the various perspective that inform how stakeholders interpret risk, often varying between lay people and experts (Aven 2012; Siegrist and Gutscher 2006), by going beyond technocratic knowledge production towards a 'co-productive' collaborative model (Cornell and Jackson 2013)
- get a greater understanding about the real proximity of climate change, the scale of the challenge, and what a vision of climate change might look like under various scenarios (Lieske 2012);
- get a greater understanding of what the present range of intangible possibilities are like in order to comprehend what is feasible in terms of urban transformation, and what a 'resilient' landscape would comprise (see White 2006),
- move towards an agreed vision about its achievement (O'Neill 2013)

There is an emerging body of scholarly knowledge available for practitioners to gain an understanding of the influence of the built environment on people's perception of risk (O'Neill et al. 2015; Curtis et al. 2014), and also people's perception of the environment and how that influences behaviour (e.g. Khan 2012). Gaining some insight into these factors might help stakeholders come forward with innovations and new approaches to improve connectedness of people with nature, whilst simultaneously improving flood risk management.

7.0 Conclusions and a way forward?

As pointed out by Cornell and Jackson (2013), to conceptualise risk as a product of whole-system relations requires an understanding the interactions between people and the environment as well as an understanding about the nature of the hazard. To achieve this requires further inter-disciplinary collaboration between a wide diversity of stakeholders, researchers and practitioners. Whilst not putting forward a body of primary evidence to support this paper's contentions, it is intended to stimulate debate and new research priorities, rather than form an agenda for immediate implementation in practice. Further debates can only be fuelled by further research as well as considerable stakeholder interaction and collaborative governance initiatives.

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