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Legal Aspects of Flood Management

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11. Legal Aspects of Flood Management

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Abstract

Flood management demands an institutionally and sectorally integrated response that can work effectively across multiple scales over time. This is an immensely challenging problem for legal frameworks that will only get more difficult as global change continues and flood risk increases. Implementation capacity and the effectiveness of legal frameworks varies tremendously across jurisdictions, but experience suggest progress is being made. The chapter concludes that there are two integrating tracks being followed with respect to flood management: disaster risk management, and consolidation with water resources management. More effective consolidation of these, along with advances in human rights approaches will be beneficial.

Introduction

The purpose of this chapter is to examine some of the ways in which law is relevant to flood management, and to set out a number of the most recent key developments in the ways that national governments have attempted to manage floods.

The law relating to floods cuts across many different areas: disaster management and emergency response; tort; civil defence; water; urban planning; coastal zone management; and land use, to name just a few. There has historically been an assumption among some that the study of the legal or governance aspects of flood management should be seen as a ”soft” approach to flood management, compared with the ”hard” infrastructural focus favoured by engineers, but this is rather more binary than the reality. In fact, as will be seen below, law is as directly relevant to ”soft” approaches such as natural flood management as it is to “hard” solutions such as infrastructure development, the latter requiring authorisations provided under legislation for example, and neglecting the legal aspects of the “hard” solutions may in fact be a contributory *cause* of flooding rather than helping prevent it.

Much of the legislation expressly dedicated to flood management is concerned with the allocation of responsibilities across institutions, delimiting institutional functions and financial issues, and clarifying questions of liability. It is also greatly concerned with the definition of triggers that necessitate particular responses, obligations and rights. Historically, the prevailing view of those promulgating flood legislation was that flooding was always bad, insofar as it could damage property and cause loss of life. Flood regulation is generally regarded as an ecosystem service (see for example Haines-Young and Potschin, 2010), and therefore a benefit for humanity. In fact, the impacts of flooding are both negative and positive: flooding may be necessary for providing nutrient-rich sediment needed for agriculture (Egyptian flood irrigation techniques outlasted ditch-based irrigation practiced by other ancient societies because of sediment provision and the avoidance of salinization) and can be a critical factor in the recharging of aquifers. Floods also provide ecological triggers for some migratory fish and have important ecosystem rejuvenation characteristics (APFM, 2013). Legal frameworks must allow, facilitate and accommodate these positive elements while minimising the impacts of the more negative aspects.

Although floods take place across multiple scales, this chapter will focus on legal frameworks that apply at the national level and below, but other than with respect to the European Union, will not address the issues that arise in the context of international water and transboundary floods (see instead Rieu-Clarke, 2008).

The ways in which the various facets of law interact with flooding changes over time, and may be disaggregated in many different ways. For simplicity, this chapter will adopt a structure based on hazard, risk and vulnerability as this corresponds best with much of the scientific analysis that has been done on floods, and this provides a useful framework in which to examine the law. The following analysis does not pretend to be exhaustive, but seeks to highlight some of the key elements of each, and those areas where legal aspects may be of most note for the future.

Hazard

There are a number of different types of flooding, each with unique combinations of causal elements. Although there is no universally accepted typology of floods, Barredo (2007) suggests that floods are generally grouped into three categories: river floods, flash floods and storm surge, to which can be added the further groupings of groundwater floods (Younger, 2007, 180-181), ice-jam floods, dam and levee failure floods, debris, landslide and mudflow floods. A further distinction can be drawn between extensive long lasting floods and those that are local and sudden. Combined events are also possible: for example, flash floods causing river floods downstream (Barredo, 2007) and in Bangladesh, saltwater flooding incidents occur largely as a result of cyclone activity, but the fact that annual river flooding can inundate up to 60% of the whole country (Salehin *et al*, 2007) makes flooding there highly complex. Floods may therefore take a multitude of forms, and this creates pressure on legal frameworks to respond appropriately.

Defining floods is difficult (Jones, 1997) partly because scientific understanding of floods sees increased flows as simply part of a hydrological continuum. From a societal perspective, a flood is defined by its impact on property or human life, and from the standpoint of the law, a flood is only a flood if it has triggered a legal response by an affected party. Howarth's distinction between 'natural inundation' and 'flood' is instructive (Howarth, 2002). Early flood legislation tended to avoid defining them – for example, there is no definition in the 1928 in the USA (United States Congress., 1928) or in the Flood Prevention (Scotland) Act of 1961. This is no longer the case, with primary legislation now incorporating definitions that differ across jurisdictions. It may be that this has been driven, at least in part, by the growing demand for insurance: the National Flood Insurance Program in the USA contains a definition that is drawn directly from the insurance context, being the:

> "*general and temporary condition where two or more acres of normally dry land or two or more properties are inundated by water or mudflow*" (see NFIP website at www.floodsmart.gov).

In the European Union, art.2 of the Floods Directive defines floods thus:

> *the temporary covering by water of land not normally covered by water. This shall include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and may exclude floods from sewerage systems (*European Parliament and Council, 2007)

The mapping of flood hazard is essential for the understanding of which areas are prone to flooding, and under what circumstances. The Floods Directive requires that Member States prepare Flood Hazard Maps based principally on river basin districts or relevant coastal areas, identifying those areas where flooding is most likely. Areas where the likely return period of flooding is more than or equal to one hundred years are deemed medium risk in the directive's categorisation (European Parliament and Council, 2007, art.6). Hazard maps must not only include scenarios for flooding caused by precipitation events, but should also take account of sudden events such as the failure of flood defences (as happened in New Orleans under the influence of Hurricane Katrina) and of dams, glacial lakes and storage facilities. Maintenance of dykes and dams (Vorogushyn et al, 2010) may fall below optimal levels in many countries, and problems with reporting and monitoring levels may undermine what appear to be strong legal measures. Dams and storage reservoirs are important elements of a flood management strategy (see Tarlock, 2012 for the US example), but the consequences of their breach or overtopping must be incorporated in hazard maps. In mountainous regions such as the Himalayas, understanding the extent of the hazard posed by glacial lake outburst floods (GLOFs) is also critical, but these phenomena unfortunately coincide strongly with relatively weak state capacity to produce hazard maps and make them publicly available. Iceland is the exception to this in terms of both its capacity to deal with such floods and their relative frequency, with hazard mapping of its equivalent of GLOFs, jökulhlaups, a priority. Interpretation of flood hazard maps connects directly with the legal and planning contexts, because progressively more restrictive limitations on land use can be applicable as event frequency and magnitude increase (and vice versa), and this can be linked directly to e.g. colour-coded hazard probability zones on the map, with colour codes based on the expected return period of a particular magnitude.

The question of data availability will be addressed below, but requiring inundation maps for dam failure should be mandatory for both private and public operators (for an example of how this can work in practice, see Victoria State Government, 2013). Hazard maps do not commonly include inundation areas in the event of dam failure, but this is because such events are viewed as too rare. Emergency plans will normally be required at the EIA stage for dam construction, indicating planning and implementation procedures, in the event of a breach, monitoring processes, and the potential area of inundation clearly set out (see for example Mouvet *et al,* 2001). This may limit the proportion of the public who have access to such information, but ordinarily emergency planning procedures implemented by the dam's operators should include appropriate coordination and information availability for those living in the inundation area. There may be more general concerns with making this sort of information more widely available, for example, specifically those linked to the potential for informing terrorism.

The duration, velocity, extent and depth of flood events can be influenced by a number of anthropogenic factors. These include land use within the flood zone, such as urbanisation that reduces infiltration capacity, and upstream of the flood zone, including for example de- and af-forestation, soil compaction and agricultural intensification (Forbes *et al* 2015; Wheater and Evans, 2009). Flood plain zoning is intended in part to limit construction in flood zones, as this will affect the extent of flooding and drainage capacity. Interference with drainage channels will also have an effect on the speed with which flood waters are able to disperse – that this remains problematic is highlighted by the fact that much of the case law on flooding in the UK at least has concerned culverts (Howarth, 2002). Waterlogging can be a significant problem with respect to dykes and polders, where drainage channels may be inadequate or their maintenance may be neglected. Flood events take place but water is unable to drain properly (Kobayashi and Porter, 2012; Nicholls *et al*, 2016), and this can be especially problematic when saltwater inundation has taken place, as is the case in Bangladesh, for instance (Nicholls *et al*, 2016), with longer term impacts being exacerbated by the extended harm to poldered agricultural land and freshwater supplies

While flood hazard may be affected by direct anthropogenic activities, the indirect influence of humanity is also manifested through climate change. Flood risk is increasing in some areas, due to the effects of climate change on e.g. sea level rise, and on weather patterns that are resulting in more intense rainstorms and more intense storms (see for example IPCC 2014, at 8). The IPCC 5th Assessment Report identifies a number of approaches that might be used for managing individual risks of climate change, and although it does not mention the quality of legal, institutional and policy frameworks explicitly, it is clear that these are fundamental for the achievement of the approaches listed (e.g. early warning systems, hazard mapping etc. – IPCC 2014, 15). This is all especially true with respect to deltaic areas that are vulnerable not only to sea level rise, but also to natural subsidence and to the influence of upstream uses and impoundments of rivers that affect sediment supply, erosion patterns and sediment trapping. Recent research has also indicated that the effects of socio-economic developments may be proportionately much greater than those resulting from climate change itself (Winsemius *et al*, 2016), and although the study is limited to river flooding alone, this gives impetus to the idea that governments potentially have a great deal of scope to alleviate the consequences of future flooding through the choice of appropriate adaptation responses and policy direction.

The expected increase in the number of intense storms and precipitation events in certain parts of the world highlights the difficulty in quantifying the hazard from flash floods. These are the result of intense rainfall over a small area over a short period of time (less than 6 hours according to the US Geological Survey) – (Barredo 2007, at 131). They are normally more common in hilly and mountainous areas, but flat land can be vulnerable too, if the conditions are right. Spain has been particularly badly affected in Europe since 1950 (Barredo, 141). Flash floods are of interest mainly because of their disproportionate representation in flood casualty figures: Barredo's study of European flood events between 1950 and 2005 indicates that 40% of the casualties of flooding have been as a result of flash floods (Barredo 2007; and Marchi *et al*, 2010), and the Asian Development Bank indicates that the figure is higher in China, with 70% of the casualties of flooding coming from flash floods (Kobayashi and Porter, 2012, 6). The difficulty in forecasting flash floods, and the urgency with which this capacity is needed, is underlined by the extensive research that has been funded to that end (see for example Quevauviller, 2011).

Problematic modelling is not limited to flash flooding. The extent to which conventional water storage dams are incorporated into flood hazard mapping has been addressed above. Dams may however be designed for a number of purposes (one of which is of course flood amelioration) and recent events have drawn attention to dams that are designed to store mining waste, so-called tailings dams. The most notorious incidents in recent memory occurred at Mount Polly in Canada and Baia Mare in Hungary, with the latest in November 2015 with the Mariana tailings dam failing in Brazil. Although it is unclear at this stage why it happened and what the long term consequences might be, the village of Bento Rodrigues was overwhelmed by the flood released after the Fundão dam ruptured killing at least nineteen people (Kiernan, 2016). Prosecutors are now seeking damages to cover the costs of remediation, but with media sources suggesting that enforcement and lax monitoring contributed to the collapse, a quick solution seems unlikely.

The problems associated with tailings dams have been understood for many years (see for example ICOLD, 2001), but efforts to improve emergency management and early warning procedures have not stemmed the increasing number of dam collapses. The World Information Service on Energy maintains a non-exhaustive list of tailings dams collapses, and their impacts, as far back as 1960 (at http://www.wise-uranium.org/mdaf.html. See also Kossoff *et al*, 2014), cataloguing around 100 incidents, not all which entailed flooding *per se*, but all involving inundation of some sort. Tailings dams are particularly problematic with respect to flooding for a number of reasons: modelling the impact of their failure is difficult, partly because the nature of the debris held behind the dams makes the direct comparison with conventional dams inappropriate. A reliable methodology is required in order to inform understanding of the potential impact of such a failure (Rico *et al* 2007). Tailings dams vary enormously - e.g. in terms of height, design, material, storage volume, and the nature of the material stored behind them – and their scale increases with the life of the mine they serve. Making predictions about the nature of the impact of a failure in terms of the area affected is therefore difficult, but what is known is that they are more likely to fail than conventional water dams because of their characteristics (including the use of local materials for fill, for example, and a lack of clear regulations as to the design of tailings dams) (Rico *et al* 2008). Application of the rarity standard used for conventional dams is therefore neither practical nor realistic.

Aside from these issues and the potential for the long-term damage to the environment caused by the toxicity of tailings, the interface with flood management more generally may be uncertain at best. In re-examining the two definitions of 'flood' given above, it will be noted that the EU limits its regulation to situations where there is inundation by water only: it does not include mudflow as the USA does. The impact of development restrictions is clearly highly relevant here, but not all jurisdictions have the capacity to enforce limitations on land use. Even in richer countries that nominally seek to restrict land use on areas prone to flooding, economic and political considerations can easily over-ride flood hazard mitigation priorities. The opposite is true in poorer countries, where the poor will develop and live on land that is potentially most vulnerable to flood hazard, land slips and mudslides. This will be discussed further below, with respect to vulnerability.

With respect to coastal flooding, the Dutch response to centuries of flooding, and more especially the catastrophic flood of 1953, was the construction of Delta Works that protect inland areas from coastal inundation. With natural subsidence and an increase in the population and level of economic activity in the area prone to flooding, the risk of flooding has gone up substantially since the 1953 flood. The approach now in the Netherlands is to protect against floods through the annually-revised Delta Programme (mandated under the Delta Act on Flood Risk Management and the Freshwater Supply (States General of the Netherlands, 2011)) and to flood proof urban development (Van Alphen 2015). Similar approaches are also now at various stages of development and planning in both Vietnam and Bangladesh, though their efficacy has not yet been tested in these different contexts. More broadly, the need for levees and floodwalls to be kept properly maintained has been strongly underlined by the Hurricane Katrina experience in New Orleans, with robust monitoring regimes needed to ensure that the state of maintenance is understood. See for example Verchick (2015) on the uncertain condition of storm surge levees in the United States. In many countries, floodplains are the most fertile land, and therefore most suited for agricultural cultivation. Efforts to restrict construction in these areas are therefore likely to fail – Assam in India is a case in point – and the impact of flooding correspondingly inflated.

Risk

While flooding is a hazard, flood *risk* can be defined as a combination of the severity of a particular event with the probability of its occurrence, as mediated by the social vulnerability of the human system affected (Brooks, 2003). Art.2 of the Floods Directive uses a slightly different interpretation, with less overt focus on the vulnerability of the affected population:

> *combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event*.

The basic assumption underpinning many of these analyses is that flood risk is a function of the severity of a particular event and the chances of it actually happening, combined with a quantification of its impact on the human and physical systems affected. This latter element must necessarily include an understanding of what the UNISDR calls the "characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effect of a hazard" (quoted in Smith, 2013, 53): vulnerability.

Leaving aside the question of vulnerability to the following section, the impacts of flood include direct losses such as immediate economic losses, loss of life, and treatment costs. Indirect losses might also include a measure of economic and social disruption, and potentially also premature death and longer term health problems (Smith, 2013, 25). Direct impacts can also include the mortality rate that follows flood events due to the resulting spread of disease (Smith, 2013). This latter effect can be in some cases be more significant than the immediate results of a flood: in the case of the Banqiao dam collapse in China when 175,000 people died following what has been described as a 1 in 2,000 year event, the flood itself caused only one sixth of the death toll, with the vast majority dying as a result of famine and disease afterwards (Fish, 2013). Floods can potentially cause an increase in transmission of water borne disease (e.g. diarrhoeal disease, leptospirosis), vector-borne disease (e.g. malaria), among others (WHO, 2006). Establishing appropriately robust legal frameworks is a major problem as they need to be capable of mitigating impacts from floods, minimising the vulnerability of affected populations and putting in place emergency response frameworks that have the momentum to provide support for disease control and medical relief for some time following the event itself.

Between 2000 and 2015, the total damage from floods globally was just under US$430 billion, giving an annual average of around $27bn (Guha-Sapir *et al*, 2016). Hallegatte *et al* (2013) suggest that this could rise to $63bn per year by 2050. During the same period, almost 90,000 people lost their lives as a result of flood events (Guha-Sapir *et al*, 2016). The fact that urban development is a significant element in this rise, and this is being exacerbated by the general global trend towards urbanisation. 66% of the world's population is projected to live in urban areas by 2050 (compared with 54% in 2014 (UN DESA PD, 2014)). In addition, most major urban centres lie on, or in close proximity to, bodies of water (Jha *et al*, 2011). This will have a significant impact on flood risk as the potential impact of flood events will be massively increased.

Reducing the impacts of flooding may be done a number of different ways. The first is through the development of infrastructure designed to contain flood flows and storm surges. This has been fundamental to the US approach, securing protection through the use of levees, and allowing construction on protected floodplains (Tarlock, 2012). Engineered solutions have also been key elements of flood management strategies historically in Japan (Takahashi, 2011), China (Kobayashi and Porter, 2012) and the Netherlands (to name a few only).

Flood protection measures will not prevent damage in all eventualities, however, as there will always be events that exceed infrastructural capacity. The costs involved in constructing and maintaining this infrastructure will continue to increase as urbanisation progresses and sea levels continue to rise (see e.g. Jonkman *et al*, (2013) specifically on coastal flood infrastructure and sea level rise). Such infrastructure may also have significant impacts on local ecosystems (Nicholls *et al*, 2016). Furthermore, there are fundamental problems with the idea of 'protecting' an area through the use of levees, as the risk to 'protected' areas is actually magnified because more people build on it, and when levees break (as they do), the impact is much larger (Tarlock, 2012). Progressive urban development over time may affect run-off patterns and undermine the effectiveness of water control infrastructure (Takahashi, 2011). The realisation that engineered solutions can never provide unlimited levels of protection has led to greater focus on other approaches, and a reassessment of the need to contextualise flood management within water resources management on a basin scale more broadly. The Chinese response to disastrous floods in 1998, in its '32 word' policy, was to directly acknowledge the role of land use management in exacerbating the impact of floods, and consequently focused heavily on afforestation and natural flood retention areas (Kobayashi and Porter, 2012).

One of the alternative management tools that has been receiving much greater attention is natural flood management. This focuses on slowing, or storing flood waters using natural features rather than 'hard' infrastructural interventions. It seeks to balance natural capacity with existing land uses such that rather than replacing floodworks, it enhances these existing defences and management in a cost-effective way – there is no binary choice between hard and 'soft' protection / prevention methods. It also allows provision of some degree of flood protection in areas where risk may be low or where there is frequent small scale flooding (Forbes *et al* (2015)). In Scotland, new legislation has mandated the use of natural flood management in implementing the Floods Directive (Flood Risk Management (Scotland) Act 2009 s.20 (Scottish Parliament, 2009)).

In order to put the natural flood management systems in place, arrangements may need to be agreed with landowners that effectively limit the uses to which their land may be put. This may involve afforestation to slow run-off, or simply ensuring that land is left unused and undeveloped so that flood waters can accumulate there. Ideally (to avoid problems associated with repeated negotiations), these land use restrictions must remain in force for successive owners although the duration of the applicable restriction may be dependent on the relevant land use tenure (Law Commission 2014, at 83). Conservation easements (also described as covenants or burdens depending on jurisdiction) restrict the use to which private landowners can put their own land (or parcels thereof), in order to protect the interests of neighbouring land owners, or more broadly, the public interest – see e.g. Reid (2013). In return for financial compensation payments, land owners have been encouraged to modify the use of their land so that it is managed in a way that mitigates flood risk, or to agree to allow particular areas of land to be subject to flooding (see, e.g. Law Commission, 2014). It may be that public interest considerations might justify repeated temporary flooding of particular parcels of land, but this will be jurisdiction-specific, and can be messy (see Tarlock, 2012 for the US situation on takings).

The question of impact was historically addressed with respect to damage to property and loss of life, but as noted above, this has been adapted over time to incorporate the environment itself. In the EU, the Floods Directive is tied directly to water resource management and its associated legislation, the 2000 Water Framework Directive (WFD) (European Parliament and Council, 2000). The latter is primarily concerned with water quality, conjunctive management at basin level of ground and surface waters, and the achievement of environmental objectives. Echoing the Disaster risk management framework that will be examined further below, the Floods Directive emphasises in its preamble that flood risk management plans should focus on prevention, protection and preparedness. Art.7(2) requires member states to prepare flood risk management plans at the WFD-linked river basin district level in the first instance. Like the WFD and its demand that environmental objectives are met, flood risk management objectives should be established that address "*the reduction of potential adverse consequences of flooding for human health, the environment, cultural heritage and economic activity, and, if considered appropriate, on non- structural initiatives and/or on the reduction of the likelihood of flooding*". When this was transposed in Scotland, a duty was imposed on Ministers to, among other things, "promote sustainable flood management" (Water Environment and Water Services (Scotland) Act, 2003, s.2(4)(b)(i) (Scottish Parliament, 2003)). Interpretation of the term "sustainable flood management" was elaborated by technical groups (the National Technical Advisory Group, and latterly the Flood Issues Advisory Committee), and this focused primarily on enhancing resilience through four inter-connected elements: awareness; avoidance; alleviation; and assistance (see Spray et al, 2009).

The difficulties inherent in flood plain zoning have been alluded to above. Ensuring that the building of new properties within floodplains is restricted can have clear beneficial impacts on flood risk. The impacts of flooding may change over time, and this is driven in part by physical and climatic factors, such as changes in precipitation patterns or the geomorphology of a particular water source. Risk may be transferred across areas prone to flooding as a result of new construction and this may not only exacerbate the risk to properties already suffering from flooding, but also create risk for properties hitherto unaffected by flooding. As a consequence, curtailing building in flood risk areas is a popular approach, although the rigorousness with which it is applied may be affected by other drivers, such as the need to construct strategic infrastructure. Political drivers such as population pressures, urbanisation and the attractiveness of floodplain land are also important, and these may over-ride efforts to minimise floodplain construction: the Financial Times estimated at the end of 2015 that 7% of new houses were being built annually on floodplains, in defiance of the

Environment Agency (Allen and Bounds, 2015; see also Harvey, 2016), which does not have a veto. The fact that risk changes over time highlights the need to regularly review and potentially revise flood risk management plans.

Vulnerability

As with 'hazard' and 'risk' above, there is no single accepted definition of 'vulnerability' when it comes to flooding. It is a key element of risk (Kobayashi and Porter, 2012), but analysis of vulnerability can be made temporally, taking account of the period before, during and after a flood event (Balica et al, 2012), with the latter referring specifically to resilience (see also Smith, 2013). In the analysis of Balica et al (2013), resilience is a mitigating element in the overall calculation of vulnerability, offsetting the problems caused by the hazard itself and a community's susceptibility to it. Legal frameworks are widely accepted as being influential with respect to vulnerability (Handmer and Monson, 2004).

The vulnerability of those living in areas that are liable to flooding varies dramatically, but the poor are often disproportionately affected. This is evident in Bangladesh (Nicholls *et al*, 2016) and in the consequences of Hurricane Katrina on the poorest areas of New Orleans (Gabe *et al*, 2005). A comprehensive examination of the role of law in each of the many elements of vulnerability cannot be undertaken here, but a few key aspects can be addressed, especially with respect to susceptibility of human populations and their resilience post-flood.

The first relates to the availability of information. In situations where people have the luxury of choosing where they construct their homes and locate their businesses based on factors beyond immediate necessity, the availability of accurate flood hazard maps will have a major influence on their choice. In richer countries, this is facilitated through dynamic online hazard maps, like those mandated under the Flood Directive – examples can be found at http://map.sepa.org.uk/floodmap/map.htm for Scotland, http://www.risicokaart.nl/en/ for the Netherlands, and in the non-EU context, http://dnrm-floodcheck.esriaustraliaonline.com.au/floodcheck/ shows hazard maps for Queensland in Australia. These are the same maps that are used by lending institutions and planning authorities, and may be used to limit financing for construction or property purchase, or to prohibit construction altogether. Developments in early warning systems also serve to minimise harm to human health, with mobile communications technology in both rich and relatively poor countries potentially using text messaging services to raise alarms.

Over the past fifteen years or so, a more institutionalised and holistic approach to reducing vulnerability has been taking root, with the advance of disaster risk management frameworks, where flooding is incorporated into broader legislation that deals with disaster management for all types of event (whether earthquake, tsunami, flood or in some cases, civil emergency situations). There was a flurry of disaster management legislation around the turn of the 21st century, driven in part by the Hyogo Framework for Action of 2005 (United Nations, 2005) and its successor, the Sendai Framework (United Nations, 2015).

These include: South Africa in 2002; Queensland (2003); Bangladesh, India and Sri Lanka in 2005; Canada in 2007; Pakistan and the Philippines in 2010. These are all fundamentally based on a number of key principles:

- prevention,
- mitigation,
- preparedness,
- response and
- rehabilitation / recovery.

The approach recognises that complex vertical and horizontal integration across scales and sectors, and across time, is required if the impacts of flood events are to be minimised, and that "a continuous and integrated multi-sectoral multi-disciplinary process of planning and implementation of measures" is needed (Disaster Management Act, 2002, South Africa, s.1 (Parliament of South Africa, 2002)).

From the perspective of 'response', there is normally a hierarchy of institutional responses based on the scale of the event, so that local institutions, which are normally at the implementation end of the flood management process, are not swamped by events that overwhelm their capacity. It is effectively the direct application of the principle of dynamic subsidiarity, decision making at the lowest appropriate level in the circumstances: if circumstances do change, institutional responses will upscale with the event.

The language used in the Floods Directive does not tally directly with the terminology used above. The directive focuses primarily on reducing the impact of floods on the environment and on society, but the measures to be incorporated into the flood risk management plans do not expressly concentrate on the susceptibility or resilience of communities. That does not mean, however, that Member States will not adopt measures that reduce susceptibility or increase resilience – the Scottish transposition referred to above highlights the perceived need to frame flood risk management measures within resilience (Spray *et al*, (2009)).

These two approaches – incorporating flood risk management within water resources management; and addressing flood risk management in a broader disaster risk management framework – are not mutually exclusive, but evidence does not suggest that efforts in the Disaster Risk Management (DRM) context are necessarily being coordinated in line with the needs of water resources management at the basin level. Of the countries noted above that have disaster risk management legislation, South Africa might be considered one of those most likely to have connected the two, but in reality this has not been the case (Humby, 2012).

One other method of reducing the impact of floods on society that is increasingly being examined is the provision of insurance, whether by private or public institutions. Traditionally, insurance has been used most extensively in wealthier countries, but the industry is expanding from what is admittedly a very low base in developing nations – for example, recent floods in Kashmir created losses of almost $16 billion, but insured losses were only around $236 million (Parvaiz, 2015). Initiatives that introduce elements of flood insurance in very poor countries are being piloted currently (for example by Oxfam) in line with cultural norms and affordability concerns.

Policy decisions must be taken by national governments regarding the apportionment of the costs of insuring against risk of flooding. Should individual homeowners shoulder the burden alone, or should this risk be subsidised in some way? In the UK, the FloodRe scheme (under the Flood Reinsurance (Scheme Funding and Administration) Regulations 2015), which came into force in April 2016, effectively facilitates affordability for those who would otherwise pay very high premiums, by spreading the cost of insurance across all householders. A levy is taken from all household insurance, which is then consolidated to create a separate resource pool. Insurers that become involved in the scheme will then provide flood insurance as normal under the bundled property insurance process, but the flood risk element would be passed on to a specialist flood reinsurer, FloodRe, which would then cover flood losses from the pool created by the general levy. This would keep flood insurance affordable for those most at risk, through a cross-subsidy from all property owners. The UK is one of the few countries to include flood insurance as an integral part of buildings insurance. Such 'bundled' approaches are comparatively unusual (Lamond and Penning-Rowsell, 2014). The National Flood Insurance Program in the USA has been fraught with problems for many years, but the cumulative effects of a general lack of interest or incentive for property owners to insure, for developers to avoid risky development, and for banks to enforce mandatory insurance requirements seems to have pushed the program over point of no return, and it awaits a final reckoning by government (Tarlock, 2012).

There are other specifically legal aspects of vulnerability and resilience, although these are not often incorporated in their analysis. The first relates to questions of liability generally for damage caused by flooding, and the question of how feasible it may be to hold public authorities and private institutions or individuals accountable for failures in fulfilling their obligations. These are directly relevant to questions of resilience because the burdens of flooding cannot be appropriately distributed unless they are spread equitably. While there has been case law at the extreme end of credibility (causation in the claim that flash floods in Rapid City were the result of cloud seeding using table salt was sadly never tested, but legal action was dismissed – see Dennis, 2010), Takahashi (2011) describes a spate of actions taken by property owners against river managers in the 1970s for negligent water resource management. Most notoriously, the federal Flood Control Act of 1928 expressly relieves the United States government of any liability for damage or harm caused by flooding. Thus while the US Corp of Engineers was judged to be grossly incompetent following levee breaches resulting from Hurricane Katrina, they could not be found to be financially liable (Nossiter, 2008).

The second legal aspect relates to the increasing importance of human rights legislation with respect to seeking redress for the damage caused by flooding. In

Marcic v. Thames Water (2003) 37 EHRR 28, for reasons unrelated to human rights, the appellant did not ultimately succeed in their case against Thames Water for frequent flooding caused by the latter's sewerage system. The House of Lords did however agree that there had been a breach of Art.8 of the European Convention on Human Rights on the "*right to respect for private and family life, his home and correspondence*", and Art.1 of the First Protocol on the peaceful enjoyment of possessions.

In a 2012 case in the European Court of Human Rights, Mrs. Kolyadenko and five others succeeded in their claim against the Russian Federation, following the release of water from the Pionerskoye dam in response to unusually heavy rainfall in Vladivostok in 2001 (*Kolyadenko and others v. Russia* 17423/05, [2012] ECHR 338). The claimants' properties were flooded as a consequence of the poor maintenance of the channel that was supposed to act as a conduit for flood waters. Claims were made under a number of headings, but for the purposes of this analysis, those made under Art.2 (right to life), Art.8 and Art.1 of the First Protocol are the most relevant. These claims largely succeeded, with a causal relationship being drawn between the neglect of the channel and the flooding. Arguments from the Russian government that the flooding was simply the result of a natural event for which they could not be blamed were rejected by the court. The question of liability for what can be perceived as a natural event is one that has underpinned much of the case law on flooding.

In South Africa, human rights have been connected directly to the question of response, with the Constitutional Court stating that democratically elected governments are obliged to provide relief to the victims of disasters (*Minister of Public Works & Ors v Kyalami Ridge Environmental Association & Anor* [2001] ICHRL 33 (29 May 2001)).

Conclusions

The overwhelming conclusion that can be taken from an analysis of flood management globally is that the days of reliance on infrastructural solutions alone are over. Global efforts to reduce the terrible effects of flooding clearly indicate that flood protection can never be absolute, but that effective planning, risk management, emergency response and rehabilitation can mitigate the impacts.

Flood management demands an institutionally and sectorally integrated response that can work effectively across multiple scales over time. This is an immensely challenging problem that will only get more difficult as global change continues and flood risk increases. Implementation capacity varies tremendously across jurisdictions, and the effectiveness of legal frameworks to accommodate changing circumstances and the multitude of factors that need to be considered, is always going to be variable.

There appear to be two tracks being followed with respect to trying to integrate some of these considerations with flood management: the disaster risk management approach, and the consolidation of flood risk management with water resources management. These are both welcome, and it is especially gratifying to see that with respect to the former especially, it does seem possible to implement in poorer countries. The experience of Bangladesh in its disaster risk management policy, strategy and standing orders, demonstrates that the level of integration required can be achieved in ways that have seen the impacts on human lives of flooding reduced drastically over the past ten years or more. This has not been true with respect to water resources management more generally, and it does not yet appear that what might be called the DRM and WRM approaches are being coordinated sufficiently, even though they are mutually complementary. A further delineation can be seen between the impacts of floods on humans directly (in terms of loss of life and of property) and the environmental impacts. These appear consolidated in the Floods Directive, but it may be that definitions of flooding need to be expanded in some cases to ensure that the full consequences of inundation from sources other than water are managed appropriately. With tailings dams collapsing so frequently, robust approaches are needed to ensure the hazards they create for the environment and for communities are considered fully.

Recent experience of the use of human rights legislation suggests this might be a promising route for those seeking redress for harm caused by flooding. These cases suggest that the use of human rights legislation may become more important in the future. It is easy to conceive of cases brought by those adversely affected by flooding in instances where there has been for example inappropriate urban development, poor implementation of flood zoning or illegal deforestation.

Despite the magnitude of problems associated with flooding, it is clear that the need for integrated and holistic responses is being taken on board progressively by national governments. This gives hope that in the longer term legal frameworks that affect and are affected by flood events will improve in effectiveness and reduce flood impacts on the environment and society.

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